Luminant

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

January 28, 2022

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: Vermilion Power Plant North Ash Pond/Old East Ash Pond; IEPA ID # W1838000002-01, 03

Dear Mr. LeCrone:

In accordance with 35 I.A.C. § 845.200, Dynegy Midwest Generation, LLC (DMG) is submitting a construction permit application for the Vermilion Power Plant North Ash Pond/Old East Ash Pond (IEPA ID # W1838000002-01, 03). One hardcopy is provided with this submittal.

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

Sincerely,

Cynthia E. Vodopivec

Cynthia Vodopivec
SVP-Environmental Health and Safety

Enclosures

Form CCR 1

Illinois Environmental Protection Agency

CCR Surface Impoundment Permit Application

Form CCR 1 – General Provisions

Bureau of Water ID Number:
W1838000002

CCR Permit Number:
Initial Permit

Facility Name:
Vermilion 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		
	Vermilion Power Plant		
1.2	Illinois EPA CCR Permit Number (if applicable)		
	Initial Permit		
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 10188 East 2150 North Road		
	County name Vermilion	County code (if known)	
	City or town Oakwood	State IL	Zip Code 61858
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) Phil Morris	Title Senior Director - Environmental	Phone Number 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 Collinsville	State IL	Zip Code 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.

W1838000002-01 (see Attachment A)	☑	Attached written description
W1838000002-03 (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	**Date Signed**
Cynthia E. Vodopivec	1/27/2022

Form CCR 2CA

Illinois Environmental Protection Agency

CCR Surface Impoundment Permit Application

Form CCR 2CA – Corrective Action Construction

Bureau of Water ID Number:
W1838000002

CCR Permit Number:
Initial Permit

Facility Name:
Vermilion 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.	North Ash and Old East Ash Pond
1.2	Identification number of the CCR surface impoundment (if one has been assigned by the Agency).	W1838000002-01, W1838000002-03
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 B.
1.5	How long has the CCR surface impoundment been in operation?	See Attachment B.
1.6	List the types of CCR that have been placed in the CCR surface impoundment.	See Attachment B.
1.7	List the name of the watershed within which the CCR surface impoundment is located.	See Attachment B.

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 B.	
	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 C.

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 Section 2.2 of the construction permit application.	
	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.	
		0 GPD	0 dTn
	2.5	Estimate length of time the CCR surface impoundment will receive CCR and non-CCR waste streams.	
		NA	
	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).

Form 2CC	Illinois Environmental Protection Agency CCR Surface Impoundment Permit Application Form CCR 2CC – Closure Construction

Bureau of Water ID Number: W1838000002 **CCR Permit Number:** Initial Permit **Facility Name:** Vermilion Power Plant	For IEPA Use Only

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

Design and Construction Plans (Construction History)

1.1	CCR surface impoundment name.
	North Ash and Old East Ash Pond
1.2	Identification number of the CCR surface impoundment (if one has been assigned by the Agency).
	W1838000002-01, W1838000002-03
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 B.
1.5	How long has the CCR surface impoundment been in operation?
	See Attachment B.
1.6	List the types of CCR that have been placed in the CCR surface impoundment.
	See Attachment B.

Design and Construction Plans (Continued)			
	1.7	List the name of the watershed within which the CCR surface impoundment is located.	
		See Attachment B.	
	1.8	What is the size in acres of the watershed within which the CCR surface impoundment is located?	
		See Attachment B.	
	1.9	Check the corresponding boxes to indicate that you have attached the following:	
		☑	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, range, 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 surface impoundment.
		☑	A statement of the approximate dates of construction of each successive stage of construction of the CCR surface impoundment.
		☑	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.
	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 C.			
	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 Section 2.2 of the construction permit application.			
	2.4	The rate at which CCR and non-CCR waste streams currently enter the CCR impoundment in gallons per day and dry tons.			
		0	GPD	0	dTn
	2.5	Estimate length of time the CCR surface impoundment will receive CCR and non-CCR waste streams.			
		NA			
	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.

Attachments (Continued)		☑	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.
		☑	A list of interested persons in attendance who would like to be added to the Agency's listserv for the facility.
		☑	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: CLOSURE (35 Ill. Adm. Code 845.220(d))

Closure	6.1	What is the closure prioritization category under 35 Ill. Adm. Code 845.700(g), if applicable?	
		Category 4	
	6.2	Indicate that you have attached the following by checking the corresponding boxes:	
		☑	The final closure plan, as specified in 35 Ill. Adm. Code 845.720(b), which includes the closure alternatives analysis required by 35 Ill. Adm. Code 845.710.
		☑	Proposed schedule to complete closure.
		☐	Post-closure care plan as specified in 35 Ill. Adm. Code 845.780(d).

SECTION 7: GROUNDWATER MODELING (35 Ill. Adm. Code 845.220(d)(3))

Groundwater	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 closure 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 model.

Prepared for

Dynegy Midwest Generation
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

CONSTRUCTION PERMIT APPLICATION

VERMILION POWER PLANT
OLD EAST ASH POND AREA
NORTH ASH POND AREA
OAKWOOD, ILLINOIS

Prepared by

Geosyntec consultants

engineers | scientists | innovators

134 N. Lasalle Street, Suite 300
Chicago, Illinois 60602

Project Number CHE8404B

January 2022

Geosyntec consultants

TABLE OF CONTENTS

1. Introduction 1
   - 1.1. Facility Information 1
   - 1.2. Legal Description 2
   - 1.3. Previous Assessments 2

2. Construction Permit 4
   - 2.1. History of Construction 4
   - 2.2. Narrative Description of Facility 4
   - 2.3. Site Maps 5
   - 2.4. Narrative Description of Proposed Construction 6
   - 2.5. Plans and Specifications 8
   - 2.6. Groundwater Monitoring Program 8
   - 2.7. Certification 10
   - 2.8. Corrective Action Construction 11
     - 2.8.1 Corrective Action Summary 11
     - 2.8.2. Interim Measures 12
   - 2.9. Closure Construction 13
   - 2.10. Training Program 14

Geosyntec consultants

TABLE OF CONTENTS

ATTACHMENTS

Attachment A	Legal Description (845.210)
Attachment B	History of Construction (845.220)
Attachment C	Chemical Constituents – CCR (845.230)
Attachment D	On-Site Transportation Plan (845.220)
Attachment D-1	*Surrounding Area Transportation Plan*
Attachment D-2	*Plant Transportation Plan*
Attachment D-3	*Regional Transportation Plan*
Attachment E	Site Location Maps (845.220)
Attachment E-1	*Topographic Vicinity Map*
Attachment E-2	*Floodplain Hazard Map*
Attachment F	Site Plan Maps (845.220)
Attachment G	Plans and Specifications (845.220)
Attachment H	Hydrogeologic Site Characterization (845.620)
Attachment I	Groundwater Monitoring Plan (845.630-650) *Design and Construction Plans of a Groundwater Monitoring System* *Groundwater Sampling and Analysis Program*
Attachment J	Public Notification and Meeting Certification (845.240)
Attachment K	Groundwater Modeling Results (845.220)
Attachment L	Groundwater Collection Trench Design Drawings
Attachment M	Closure Prioritization Category Letter (845.700)
Attachment N	Final Closure Plan and Closure Schedule (845.720) *Closure Alternatives Analysis (CAA) and Corrective Measures Assessment (CMA)/Corrective Action Alternatives Analysis (CAAA) (845.710)*
Attachment O	Monitoring Natural Attenuation (MNA) Evaluation
Attachment P	Corrective Action Plan (CAP) (845.670) *Monitored Natural Attenuation Evaluation – Long-Term Monitoring and Contingency Plan*
Attachment Q	New Onsite Landfill Feasibility Assessment
Attachment R	415 Illinois Compiled Statutes (ILCS) 5/22.59(b)(4) Certification Statement

1. INTRODUCTION

Dynegy Midwest Generation, LLC (Dynegy) is the owner of the inactive coal-fired Vermilion Power Plant (Plant), also referred to as Vermilion Power Station, located approximately 13 miles Northwest of Danville, Illinois. According to the Illinois Environmental Protection Agency (IEPA), this power plant has three surface impoundments: North Ash Pond Area (NAP), Old East Ash Pond Area (OEAP), and New East Ash Pond (NEAP). The IEPA assigned identification numbers assigned to these impoundments are: W1838000002-01 for the NAP; W1838000002-03 for the OEAP; and W1838000002-04 for the NEAP. There are no National Inventory of Dams (NID) numbers assigned for the NAP or OEAP by the Illinois Department of Natural Resources (IDNR). The NID number for the NEAP is IL50291.

This construction permit application was developed in accordance with 35 Ill. Admin. Code 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845).

This construction permit application is for the Old East Ash Pond Area and North Ash Pond Area. They are being closed together and the construction permit application is combined as one closure area.

1.1. Facility Information

Section 845.210(b)(1): *All permit applications must contain the name, address, email address and telephone number of the operator, or duly authorized agent, and the property owner to whom all inquiries and correspondence must be addressed.*

Facility:	Old East Ash Pond Area (OEAP) North Ash Pond Area (NAP) Vermilion Power Plant 10188 East 2150 North Road Oakwood, IL 61858
Owner/Operator:	Dynegy Midwest Generation, LLC 1500 Eastport Plaza Drive Collinsville, IL 62234 Phil Morris, Sr. Director Corporate Environmental 618-606-7788 phil.morris@vistracorp.com

1.2. Legal Description

<u>Section 845.210(c):</u> *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.*

Legal description of the facility is provided in **Attachment A**.

1.3. Previous Assessments

<u>Section 845.210(d):</u> *Previous Assessments, Investigations, Plans, and Programs*

Because the Vermilion Power Plant was not operating as of October 19, 2015 the surface impoundment was not regulated by 40 C.F.R. Part 257 and therefore no previous assessments, investigation plans or programs were previously completed.

<u>Section 845.210(d)(1):</u> *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.*

No previous hydrogeologic site investigation or characterization, groundwater monitoring well or system, or groundwater monitoring plan have been completed with a seal from an Illinois Licensed Professional Geologist or Licensed Professional Engineer. However, field investigations have been completed that will be utilized in the following sections of this report.

<u>Section 845.210(d)(2):</u> *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) provided that the previously completed assessments meet the applicable requirements of those Sections.*

No previous assessments are available.

<u>Section 845.210(d)(3):</u> *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 previous assessments are available.

<u>Section 845.210(d)(4):</u> *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.*

No post-closure care plan was previously approved by the IEPA.

2. CONSTRUCTION PERMIT

2.1. History of Construction

<u>Section 845.220(a)(1):</u> Design and Construction Plans (Construction History)

The History of Construction for the Vermilion Power Plant as required by Section 845.220(a)(1) is provided in **Attachment B**.

2.2. Narrative Description of Facility

<u>Section 845.220(a)(2):</u> 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.

<u>Section 845.220(a)(2)(A):</u> 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 OEAP and NAP and analysis of the chemical constituents found within the CCR is provided in **Attachment C**.

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

Closure by removal at the facility will include removing approximately 992,000 cubic yards of coal ash from the OEAP, as well as 1,171,000 cubic yards of coal ash from the NAP.

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

The OEAP and NAP did not have CCR placed after October 19, 2015 and are therefore defined as inactive CCR surface impoundments per the CCR Rule Section 845.120 Definitions. There are no waste streams currently entering the OEAP and NAP as they are both inactive CCR surface impoundments at an inactive facility.

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

There are no waste streams currently entering the OEAP and NAP as they are both inactive CCR surface impoundments at an inactive facility.

<u>Section 845.220(a)(2)(E):</u> *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.*

The NAP and OEAP are inactive surface impoundments with no active on-site transportation for CCR materials. An On-Site Transportation Plan was developed as required by Section 845.220(a)(2)(E) and is provided in **Attachment D** that includes all on-site access roads and the surrounding roadways. The transportation plan figures consist of three figures with various scales for the site and surrounding areas. **Attachment D-1** includes the site with a minimum 5,000 feet radius around the site. **Attachment D-2** includes a zoomed site plan. **Attachment D-3** includes a larger area with all main service corridors, transportation routes, and access roads to the facility.

2.3. Site Maps

<u>Section 845.220(a)(3):</u> *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].*

The Site Location Maps showing the information required in Section 845.220(a)(3) is provided in **Attachment E**. **Attachment E-1** consists of the most recent USGS topographic map (2013) which illustrates the facility, facility boundary, and the property at least 1,000 meters beyond the facility boundary. The limits of the 100-year floodplain, surface waters, and prevailing wind direction are shown in **Attachment E-2**. Areas identified as Nature Preserves, Historic, Archaeological and/or Critical Habitat Sites are illustrated in the Hydrogeologic Site Characterization Report (Appendix A of **Attachment H**).

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 Maps showing the information required of Section 845.220(a)(4) are included in the following:

- All existing CCR surface impoundment locations is included in the proposed closure drawings included in **Attachment G,** drawing **G-110**.

- The proposed CCR landfill is included in the New Onsite Landfill Feasibility Assessment included in **Attachment Q**.

- The above ground boundaries of the facility and all CCR surface impoundments are included in the closure drawings included in **Attachment G,** drawings **G-120, G-130,** and **G-140.**

- The below ground boundaries of the facility and all CCR surface impoundments are included in the closure drawings included in **Attachment G,** drawings **C-200, C-210, C-220, C-330, C-340,** and **C-350**.

- All existing groundwater monitoring wells are included in **Attachment F**. No groundwater monitoring wells are proposed at this time.

- All main service corridors, transportation routes, and access roads to the facility are included in **Attachment D-3**.

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 final closure for the OEAP and NAP inactive CCR surface impoundments is closure by removal. The NAP and OEAP will be closed as one concurrent, continuous, or semi-continuous operation (removal action).

The OEAP contains a cover of vegetated fill consisting of lean clay, silty clay, and silty sand with varying amounts of sand and gravel. The NAP is not covered. The OEAP cover soil will be excavated and stockpiled onsite for future use as backfill following the removal of CCR materials from the impoundments.

The NAP contains water in its northern sections; it has exposed coal ash above the impounded water level and coal ash below the impounded water. The OEAP does not contain water. Water from the CCR Impoundments is required to be removed and the CCR dewatered in accordance with the Illinois Attorney General (IAG) Interim Order (Order) entered June 30, 2021.

The closure plan will require physical alterations to the surface impoundments, including removal of waters from the surface impoundments. The closure construction activities include removal of open water from the ponds, referred to as "unwatering" and also includes partial removal of pore water contained in ash-filled portions of the surface impoundments, referred to as "dewatering".

Discharge of unwaters would occur from removal of the free surface water in the NAP. These waters generally result from storm water precipitation. There is no ponded water in the OEAP area as it is filled and graded to drain surface water. Channels will be cut into the ponded ash in the NAP. These channels will facilitate the passive drainage of the majority of the unwaters and some smaller amounts of the dewaters to a collection point and then pumped and discharged to the Secondary Pond and then to the River through the NPDES outfall (003). Discharge of dewaters would occur from removal of the water from pore spaces in deposited ash in the surface impoundments. After the free surface unwaters (i.e., storm water) are removed from the surface impoundments and to facilitate more active drainage of the dewaters, additional channels will be excavated into the valley areas of the proposed earthen cover geometry. Deeper sumps may be installed along selected areas of the channels. The dewaters will be drained to a collection point and then pumped and discharged to the Secondary Pond and then to the River through the NPDES outfall (003).

The existing coal ash will be consolidated and removed from the NAP and OEAP. All areas affected by releases of CCR from the CCR surface impoundment will be decontaminated in accordance with 845.740(a). Moisture conditioning may be required prior to hauling of CCR materials. This shall be completed by working and drying the CCR materials to meet placement and hauling requirements. Groundwater monitoring will be performed in accordance with Section 845.740(b).

The visible CCR will be removed, as well as any pipes and discharge structures within the surface impoundment. Visual observations will be conducted to verify CCR excavations are completed to the native foundation soils or embankment slopes. The coal ash will be hauled to a landfill that meets State requirements of IAC Part 811 and will also be compliant with 40 CFR 257 for CCR landfills; this landfill is proposed to be onsite.

The eastern berms that do not contain coal ash will be excavated/breached at select locations to allow for drainage of stormwater flow. This material will be used as low permeability soil or general fill. The area will be graded and/or backfilled and vegetated with wet to mesic plants appropriate to final hydrology following excavation of the coal ash from the NAP and OEAP. The backfill will be designed to manage non-contact stormwater.

All structures and conveyances used to manage CCR will be decontaminated or removed and sent to a licensed landfill.

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.

The closure design plans are included in **Attachment G** in accordance with Section 845.220(a)(6). The design plans are consistent with the narrative description provided in Section 845.220(A)(5). The design plans include stripping of cover where applicable, the removal of CCR waste, and grading to manage stormwater flow. Further description of the closure construction is provided in Sections 2.4 and 2.9.

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:

The Groundwater Monitoring Program details are described in the following sections.

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

Hydrogeologic site investigations for OEAP and NAP are provided in **Attachment H**.

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 for a groundwater monitoring system as required by Section 845.630 are provided in **Attachment I**.

<u>*Section 845.220(a)(7)(C):*</u> *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 Section 845.640 and 845.650 is provided in **Attachment I**.

2.7. Certification

<u>Section 845.220(a)(8):</u> The signature and seal of a qualified professional engineer.

CCR Unit: Dynegy Midwest Generation, LLC; Vermilion Power Plant, Old East Ash Pond Area and North Ash Pond Area

I, John Seymour, 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.

John Seymour
Printed Name

John Seymour 1/25/2022
Signature Date

062.040562 Illinois 30 November 2023
Registration Number State Expiration Date

JOHN P. SEYMOUR
062-040562
LICENSED
PROFESSIONAL
ENGINEER
STATE OF ILLINOIS

Affix Seal

<u>Section 845.220(a)(9):</u> 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.

Certification that the public notification and public meetings have been completed as required by Section 845.240 is provided in **Attachment J**.

2.8. Corrective Action Construction

2.8.1 Corrective Action Summary

Potential groundwater impacts have been identified and installation and operation of a groundwater monitoring network under a groundwater monitoring plan are being implemented as described in this Construction Permit Application. A Closure Alternatives Assessment (CAA) has been completed for the OEAP, NAP, and NEAP. Corrective action is required for OEAP and NAP but is not required for the NEAP. A combined Closure Alternatives Assessment (CAA) and Corrective Measures Assessment (CMA)/Corrective Action Alternatives Assessment (CAAA) has been prepared for all three impoundments. This combined CAA and CMA/CAAA is provided in **Attachment P**.

A Monitored Natural Attenuation (MNA) evaluation and corresponding report was completed to provide input to the CMA/CAAA and is provided in **Attachment O**.

<u>Section 845.220(c):</u> 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:

The Corrective Action Construction details are described in the following sections.

<u>Section 845.220(c)(1):</u> Corrective action plan (see Section 845.670);

The Corrective Action Plan (CAP) as required by Section 845.670 is provided in **Attachment P**.

<u>Section 845.220(c)(2):</u> 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 results for the Corrective Action Construction as required by Section 845.220(c)(2) is provided in **Attachment K.**

<u>*Section 845.220(c)(3):*</u> *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);*

Any necessary licenses and software needed to review and access both the models and data contained within the models will be provided by a file share application prior to February 1, 2022.

<u>*Section 845.220(c)(4):*</u> *Corrective action groundwater monitoring program, including identification of revisions to the groundwater monitoring system for corrective action; and*

A corrective action groundwater monitoring program is described in the Monitored Natural Attenuation Evaluation – Long-Term Monitoring and Contingency Plan provided in **Attachment P**.

2.8.2. Interim Measures

<u>*Section 845.220(c)(5):*</u> *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).*

The following are Interim Measures that are planned to be implemented:

1. Groundwater Collection Trench

   The Groundwater Collection Trench is required by the Illinois Attorney General (IAG) Agreed Interim Order entered on April 30, 2021 (Order). Under the Order, an Interim Corrective Measures Plan (ICMP) was submitted on August 16, 2021. The ICMP provided a Scope of Work for the Groundwater Collection Trench. The Scope of Work included a discussion of:

   - Phase 1 – Pre-permitting Phase
   - Phase 2 – Permit Application Phase
   - Phase 3 – Design Phase
   - Phase 4 – Construction Phase including a schedule

The ICMP is included by reference. The Scope of Work in the ICMP has been expanded to include design drawings, presented in **Attachment L**.

2. Unwatering and Dewatering

Unwatering and dewatering is required by the Order. The ICMP provides a Scope of Work to unwater (remove surface water) and dewatering (removal of pore water in the coal ash). The ICMP and Scope of Work are included by reference. The Final Scope of Work will be included in construction bid documents.

2.9. Closure Construction

Section 845.220(d): Closure Construction. In addition to the requirements in subsection (a), all construction permit applications for closure of the CCR surface impoundment under Subpart G must contain the following information and documents:

The Closure Construction details are described in the following sections.

Section 845.220(d)(1): Closure prioritization category, if applicable (see Section 845.700(g));

A CCR Surface Impoundment Category Designation and Justification letter was submitted to IEPA on May 19, 2021. The OEAP and NAP were designated as Category 4 Inactive CCR surface impoundments with exceedance of groundwater protection standards in Section 845.600. This letter is provided in **Attachment M**.

Section 845.220(d)(2): Final closure plan (see Section 845.720(b)), including the closure alternatives analysis required by Section 845.710;

The Final Closure Plan as required by Section 845.720(b) is provided in **Attachment N**. The Final Closure Plan addresses the requirements of Closure by Removal under Part 845.740.

A Closure Alternatives Assessment (CAA) has been completed for the OEAP, NAP, and NEAP. Corrective action is required for OEAP and NAP but not the NEAP. A combined Closure Alternatives Assessment (CAA) and Corrective Measures Assessment (CMA)/Corrective Action Alternatives Assessment (CAAA) has been prepared for all three impoundments. This combined CAA and CMA/CAAA is provided in **Attachment N**.

The Final Closure Plan proposes a new Onsite Landfill to receive onsite wastes. A Feasibility Study (FS) to utilize the new Onsite Landfill is provided in **Attachment Q**.

Section 845.220(d)(3): Groundwater modeling, including:

A. The results of groundwater contaminant transport modeling and calculations showing how the closure 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 closure over time;
D. Capture zone modeling, if applicable; and
E. Any necessary licenses and software needed to review and access both the model and the data contained within the model.

Groundwater modeling results for the Closure Construction is provided in **Attachment K**. Any necessary licenses and software needed to review and access both the models and data contained within the models will be provided by a file share application prior to February 1, 2022.

<u>Section 845.220(d)(4):</u> *Proposed schedule to complete closure; and*

The schedule to complete closure is provided in the Final Closure Plan in **Attachment N**.

<u>Section 845.220(d)(5):</u> *Post-closure care plan specified in Section 845.780(d), if applicable.*

The OEAP and NAP closure is to be completed by removing CCR as specified in Section 845.740.

A post-closure care plan is not required per Section 845.780(a)(2), which states:

"An owner or operator of a CCR surface impoundment that elects to close a CCR surface impoundment by removing CCR as provided by Section 845.740 is not subject to the post-closure care criteria of this Section."

2.10. Training Program

A certification statement in accordance with 415 Illinois Compiled Statutes (ILCS) 5/22.59(b)(4) is provided in **Attachment R**.

ATTACHMENT A

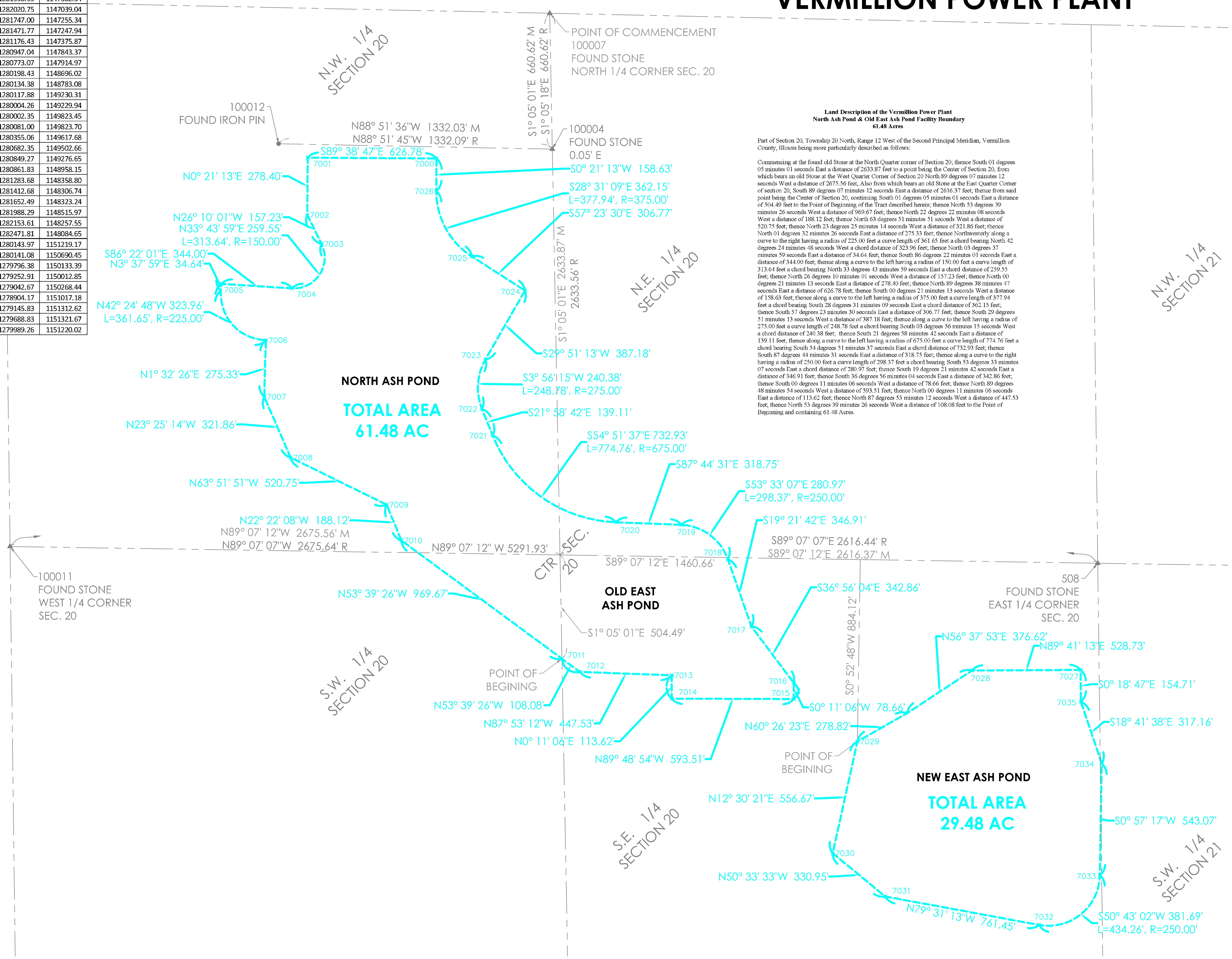
Legal Description (845.210)

CONTROL MONUMENTATION TABLE				
POINT NO.	NORTHING	EASTING	ELEVATION	DESCRIPTION
508	1280662.64	1151302.54	0.00	FOUND STONE
100004	128675.72	1148649.22	588.39	502 FOUND STONE
100007	128336.22	1148636.67	588.21	501 FOUND STONE
100011	1280743.93	1146011.24	700.94	503 FOUND STONE
100012	1282702.02	1147317.5	644.87	FOUND I PIN W/CAP

CCR FACILITY BOUNDARY CORNERS		
POINT NO.	NORTHING	EASTING
7000	1282630.44	1148085.63
7001	1282634.31	1147458.86
7002	1282355.92	1147457.14
7003	1282214.80	1147526.48
7004	1281998.95	1147382.34
7005	1282020.75	1147039.04
7006	1281747.00	1147255.34
7007	1281471.77	1147247.94
7008	1281176.43	1147375.87
7009	1280947.04	1147843.37
7010	1280773.07	1147914.97
7011	1280198.43	1148696.02
7012	1280134.38	1148783.08
7013	1280117.88	1149230.31
7014	1280004.26	1149229.94
7015	1280002.35	1149823.45
7016	1280081.00	1149823.70
7017	1280355.06	1149617.68
7018	1280682.35	1149502.66
7019	1280849.27	1149276.65
7020	1280861.83	1148958.15
7021	1281283.68	1148358.80
7022	1281412.68	1148306.74
7023	1281652.49	1148323.24
7024	1281988.29	1148515.97
7025	1282153.61	1148257.55
7026	1282471.81	1148084.65
7027	1280143.97	1151219.17
7028	1280141.08	1150690.45
7029	1279796.38	1150133.39
7030	1279252.91	1150012.85
7031	1279042.67	1150268.44
7032	1278904.17	1151017.18
7033	1279145.83	1151312.62
7034	1279688.83	1151321.67
7035	1279989.26	1151220.02

Luminant

DYNEGY MIDWEST GENERATION, LLC
VERMILLION POWER PLANT



Land Description of the Vermillion Power Plant
North Ash Pond & Old East Ash Pond Facility Boundary
61.48 Acres

Part of Section 20, Township 20 North, Range 12 West of the Second Principal Meridian, Vermillion County, Illinois being more particularly described as follows:

Commencing at the found old Stone at the North Quarter corner of Section 20; thence South 01 degrees 05 minutes 01 seconds East a distance of 2633.87 feet to a point being the Center of Section 20, from which bears an old Stone at the West Quarter Corner of Section 20 North 89 degrees 07 minutes 12 seconds West a distance of 2675.56 feet, Also from which bears an old Stone at the East Quarter Corner of section 20, South 89 degrees 07 minutes 12 seconds East a distance of 2616.37 feet; thence from said point being the Center of Section 20, continuing South 01 degrees 05 minutes 01 seconds East a distance of 504.49 feet to the Point of Beginning of the Tract described herein; thence North 53 degrees 39 minutes 26 seconds West a distance of 969.67 feet; thence North 22 degrees 22 minutes 08 seconds West a distance of 188.12 feet; thence North 63 degrees 51 minutes 51 seconds West a distance of 520.75 feet; thence North 23 degrees 25 minutes 14 seconds West a distance of 321.86 feet; thence North 01 degrees 32 minutes 26 seconds East a distance of 275.33 feet; thence Northwesterly along a curve to the right having a radius of 225.00 feet a curve length of 361.65 feet a chord bearing North 42 degrees 24 minutes 48 seconds West a chord distance of 323.96 feet; thence North 03 degrees 37 minutes 59 seconds East a distance of 34.64 feet; thence South 86 degrees 22 minutes 01 seconds East a distance of 344.00 feet; thence along a curve to the left having a radius of 150.00 feet a curve length of 313.64 feet a chord bearing North 33 degrees 43 minutes 59 seconds East a chord distance of 259.55 feet; thence North 26 degrees 10 minutes 01 seconds West a distance of 157.23 feet; thence North 00 degrees 21 minutes 13 seconds East a distance of 278.40 feet; thence North 89 degrees 38 minutes 47 seconds East a distance of 626.78 feet; thence South 00 degrees 21 minutes 13 seconds West a distance of 158.63 feet; thence along a curve to the left having a radius of 375.00 feet a curve length of 377.94 feet a chord bearing South 28 degrees 31 minutes 09 seconds East a chord distance of 362.15 feet; thence South 57 degrees 23 minutes 30 seconds East a distance of 306.77 feet; thence South 29 degrees 51 minutes 13 seconds West a distance of 387.18 feet; thence along a curve to the left having a radius of 275.00 feet a curve length of 248.78 feet a chord bearing South 03 degrees 56 minutes 15 seconds West a chord distance of 240.38 feet; thence South 21 degrees 58 minutes 42 seconds East a distance of 139.11 feet; thence along a curve to the left having a radius of 675.00 feet a curve length of 774.76 feet a chord bearing South 54 degrees 51 minutes 37 seconds East a chord distance of 732.93 feet; thence South 87 degrees 44 minutes 31 seconds East a distance of 318.75 feet; thence along a curve to the right having a radius of 250.00 feet a curve length of 298.37 feet a chord bearing South 53 degrees 33 minutes 07 seconds East a chord distance of 280.97 feet; thence South 19 degrees 21 minutes 42 seconds East a distance of 346.91 feet; thence South 36 degrees 56 minutes 04 seconds East a distance of 342.86 feet; thence South 00 degrees 11 minutes 06 seconds West a distance of 78.66 feet; thence North 89 degrees 48 minutes 54 seconds West a distance of 593.51 feet; thence North 00 degrees 11 minutes 06 seconds East a distance of 113.62 feet; thence North 87 degrees 53 minutes 12 seconds West a distance of 447.53 feet; thence North 53 degrees 39 minutes 26 seconds West a distance of 108.08 feet to the Point of Beginning and containing 61.48 Acres.

Land Description of the Vermillion Power Plant
New East Ash Pond Facility Boundary
29.48 Acres

Part of the Southeast Quarter of Section 20 and Part of the Southwest Quarter of Section 21, Township 20 North, Range 12 West of the Second Principal Meridian, Vermillion County, Illinois being more particularly described as follows:

Commencing at the found old Stone at the North Quarter corner of Section 20; thence South 01 degrees 05 minutes 01 seconds East a distance of 2633.87 feet to a point being the Center of Section 20, from which bears an old Stone at the West Quarter Corner of Section 20 North 89 degrees 07 minutes 12 seconds West a distance of 2675.56 feet, Also from which bears an old Stone at the East Quarter Corner of section 20, South 89 degrees 07 minutes 12 seconds East a distance of 2616.37 feet; thence from said point being the Center of Section 20, South 89 degrees 07 minutes 12 seconds East a distance of 1460.66; thence South 00 degrees 52 minutes 48 seconds West a distance of 884.12 feet to the Point of Beginning of the Tract described herein; thence North 60 degrees 26 minutes 23 seconds East a distance of 278.82 feet; thence North 56 degrees 37 minutes 53 seconds East a distance of 376.62 feet; thence North 89 degrees 41 minutes 13 seconds East a distance of 528.73 feet; thence South 00 degrees 18 minutes 47 seconds East a distance of 154.71 feet; thence South 18 degrees 41 minutes 38 seconds East a distance of 317.16 feet; thence South 00 degrees 57 minutes 17 seconds West a distance of 543.07 feet; thence along a curve to the right having a radius of 250.00 feet a curve length of 434.26 feet a chord bearing South 50 degrees 43 minutes 02 seconds West a chord distance of 381.69 feet; thence North 79 degrees 31 minutes 13 seconds West a distance of 761.45 feet; thence North 50 degrees 33 minutes 33 seconds West a distance of 330.95 feet; thence North 12 degrees 30 minutes 21 seconds East a distance of 556.67 feet to the Point of Beginning and containing 29.48 Acres.

LEGEND
- SECTION LINE
- FACILITY BOUNDARY
- ● FOUND SURVEY MARKER AS NOTED
- ▲ FOUND SURVEY STONE
- M DENOTES MEASURED DIMENSION
- R DENOTES RECORD (DEED) DIMENSION

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 15, 2021. SURVEY COORDINATES, BEARINGS & DISTANCES ARE REFERENCED TO ILLINOIS EAST 1201 STATE PLANE COORDINATE SYSTEM NAD 1983.

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

Sept 20, 2021

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

DATE

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

Submissions / Revisions:	Date:
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Project Name & Location:

VERMILLION
POWER PLANT
10188 EAST 2150 NORTH RD
OAKWOOD, IL
61858

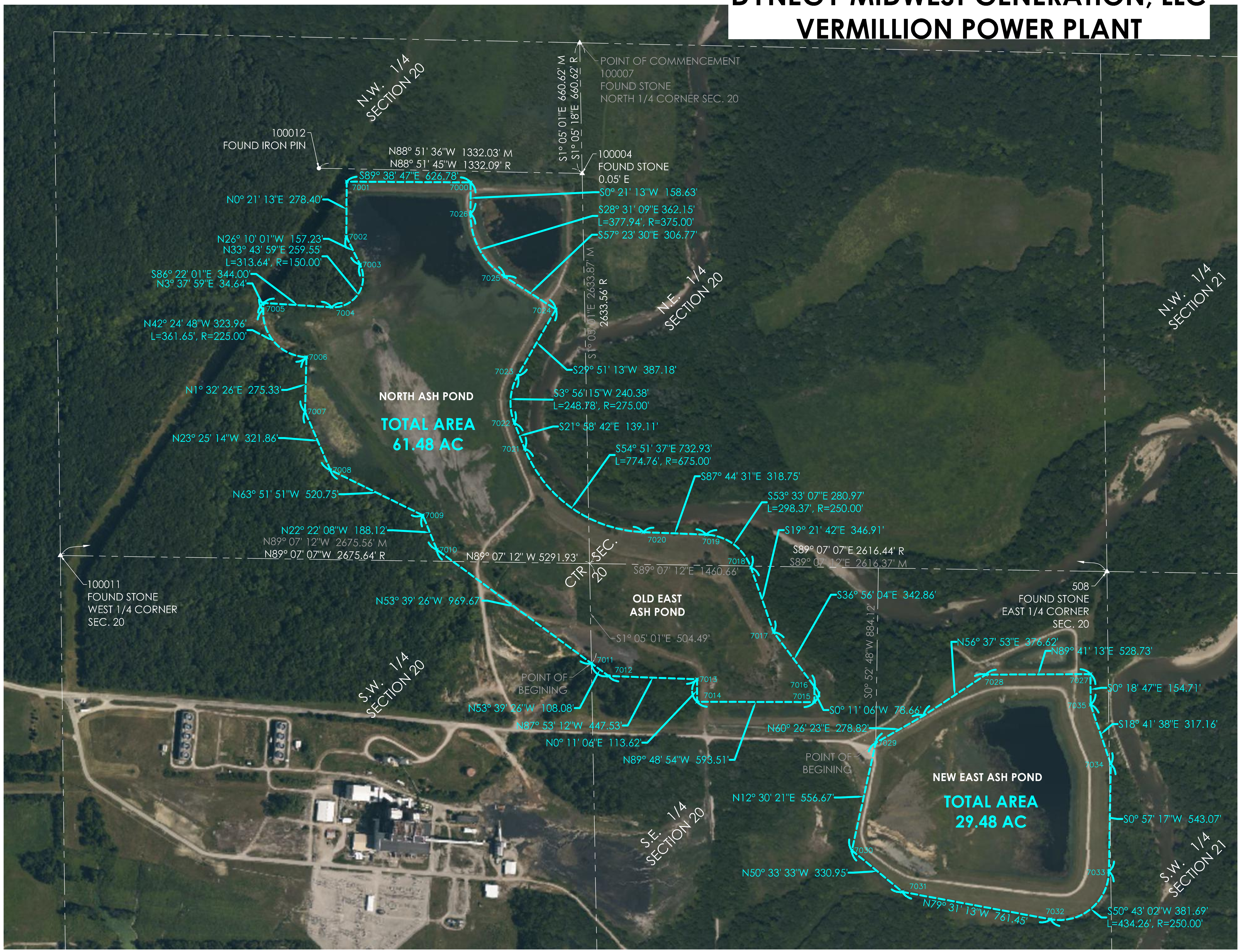
DO NOT SCALE PLANS
Copying, Printing, Software and other processes required to produce these prints can stretch or shrink the actual paper or layout. Therefore, scaling of this drawing may be inaccurate. Contact IngenAE with any need for additional dimensions or clarifications.

Drawing Name:
CCR FACILITY BOUNDARY EXHIBIT

Date:	Project No.
08/06/2021	
Type: SITE	Drawing No.
Drawn By: CB	1
Approved By: MG	
Scale: AS NOTED	

Luminant

DYNEGY MIDWEST GENERATION, LLC
VERMILLION POWER PLANT



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0' 150' 300'

LEGEND
- SECTION LINE
- FACILITY BOUNDARY
- ● FOUND SURVEY MARKER AS NOTED
- ▲ FOUND SURVEY STONE
- M DENOTES MEASURED DIMENSION
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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:

VERMILLION
POWER PLANT
10188 EAST 2150 NORTH RD
OAKWOOD, IL
61858

Drawing Name:
CCR FACILITY BOUNDARY EXHIBIT

Date: 08/06/2021	Project No.
Type: SITE	Drawing No. 2
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

Geosyntec consultants

ATTACHMENT B

History of Construction (845.220)

Prepared for

Dynegy Midwest Generation
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

HISTORY OF CONSTRUCTION REPORT

VERMILION POWER PLANT
OAKWOOD, ILLINOIS

Prepared by

Geosyntec consultants

engineers | scientists | innovators

134 N. Lasalle Street Suite 300
Chicago, IL 60602

Project Number CHE8404A

October 2021

TABLE OF CONTENTS

1. Introduction 1
   1.1. Information Availability 1
2. History of Construction 2
   2.1. Identifying Information Section 2
   2.2 Location 2
   2.3. Purpose 2
   2.4. Watershed 3
   2.5. Foundation and Abutment Materials 3
   2.6. Constructed Materials 4
   2.7. Drawings and Details 6
   2.8. Existing Instrumentation 6
   2.9. Area-Capacity Curves 7
   2.10. Description of Spillway and Diversion Design Features 7
   2.11. Construction Specifications 8
   2.12. Record or Knowledge of Structural Instability 8
3. Limitations 10
4. References 11

TABLE OF CONTENTS

LIST OF APPENDICES

Appendix A. Topographic and Vicinity Map

Appendix B. Vermilion Power Plant Drawings

Appendix C. Boring and Piezometer Location Figures

Appendix D. Operation and Maintenance Plans

Appendix E. Specifications

LIST OF TABLES

Table 1. Engineering Parameters of Foundation Materials

Table 2. Engineering Parameters of Constructed Materials

Table 3. Engineering Detail Drawings

Table 4. Piezometer Summary

LIST OF FIGURES

Figure 1. New East Ash Pond Stage-Storage Graph

Figure 2. North Ash Pond Stage-Storage Graph

Figure 3. Old East Ash Pond GPR Indicated Pipe

Figure 4. North Ash Pond GPR Indicated Pipe

1. INTRODUCTION

Dynegy Midwest Generation (Dynegy) Company's Vermilion Power Plant (the Site) is a retired electric power generating facility with a coal fired unit in Oakwood, Illinois. The facility began operations in the mid-1950s and was retired in November 2011. The Site produced and stored coal combustion residuals (CCRs), a.k.a. "coal ash", as a part of its historical operations in three coal ash surface impoundments (impoundments) located north and east of the power plant (North Ash Pond, Old East Ash Pond, New East Ash Pond) as shown in Appendix A.

Impoundments containing coal in Illinois ash are regulated by the Illinois Environmental Protection Agency (IEPA) Coal Combustion Residual (CCR) Title 35 Environmental Protection, Subtitle G Waste Disposal, Chapter I Pollution Control Board, Subchapter j Coal Combustion Waste Surface Impoundments, Part 845 Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845) [1]. A construction history detailed in Section 845.220(a)(1) is required.

1.1. Information Availability

This report is based on the information available at the time this report was developed. In preparing this report, Geosyntec looked to Section 845.220(a)(1) as guidance to identify what historical information to provide in this report. Consistent with Section 845.220(a)(1), this report provides a summary of the information that was reasonably and readily available and notes any data gaps. Unfortunately, given the age of the plant and the time since it was closed, data gaps exist, which are noted.

2. HISTORY OF CONSTRUCTION

2.1. Identifying Information Section

Section 845.220(a)(1)(A): Identifying Information

i) The name and address of the person or persons owning or operating the CCR surface impoundment;

ii) The name associated with the CCR surface impoundment; and

iii) The identification number of the CCR surface impoundment if one has been assigned by the Agency.

Owner: Dynegy Midwest Generation, LLC

Address: 1500 Eastport Plaza Drive
Collinsville, IL 62234

Facility: Vermilion Power Plant
10188 East 2150 North Rd
Oakwood, IL 61858

CCR Units: New East Ash Pond (NEAP)
Old East Ash Pond (OEAP)
North Ash Pond (NAP)

A secondary or polishing pond is present at both the NAP and EAP as shown in Appendix A. The secondary ponds would not qualify as CCR surface impoundments.

2.2 Location

Locations of the CCR units have been noted on the topographic and vicinity map in Appendix A.

2.3. Purpose

Section 845.220(a)(1)(B): A statement of the purpose for which the CCR surface impoundment is being used, how long the CCR surface impoundment has been in operation, and the types of CCR that have been placed in the CCR surface impoundment.

All CCR units at the Vermilion Power Plant have been inactive since 2011. The purpose of the units was to manage wastewaters using sedimentation to remove settleable matter and turbidity prior to discharging through an NPDES permitted outfall pursuant to an NPDES permit. Fly ash and bottom ash have been placed in the CCR surface impoundments.

2.4. Watershed

> Section 845.220(a)(1)(C): *The name and size in acres of the watershed within which the CCR unit is located.*

All CCR units at the Site are located within the Middle Fork Vermilion River Watershed, which has a drainage area of 17,215 acres. The Environmental Protection Agency (EPA) 12-digit hydrological unit code (HUC) for this watershed is 051201090509 [2].

2.5. Foundation and Abutment Materials

> Section 845.220(a)(1)(D): *A description of the physical and engineering properties of the foundation and abutment materials on which the CCR surface impoundment is constructed.*

Four native soil units comprise the foundation soils for the impoundments at the Site. These are, from shallow to deep, Clay Alluvium, Sand Alluvium, Reworked (weathered) Till and Glacial Till. The engineering properties that have been developed for these are provided in Table 1 [3] [4].

Clay Alluvium

Clay Alluvium consists of clay soils below the coal ash and riverbank berm materials. This soil unit is stream-deposited alluvium placed by the Middle Fork Vermilion River. The soils are generally lean clays and silty clays with varying amounts of sand and gravel. The average moisture content is 19 percent, with a range of 9 to 57 percent. The average total unit weight is 112 pounds per cubic foot (pcf) and the average plasticity index is 11 percent. The SPT N-values range from weight of hammer (WOH) to 37, with an average of 10. The range corresponds to a consistency of very soft to hard with the average value corresponding to stiff. This layer is discontinuous but was found to be up to approximately 50 feet thick.

Sand Alluvium

Sand Alluvium consists of fine to coarse-grained sands and gravels located below the clay alluvium. This soil unit is also stream-deposited alluvium placed by the Middle Fork Vermilion River. Lenses of silt, clay, and cobbles were observed. The average moisture content is 16 percent, with a range of 6 to 30 percent. The average total unit weight is 122 pcf. The SPT N-values range from WOH to 77, with an average of 16. The range corresponds to a consistency of very loose to very dense with the average value corresponding to medium dense. This layer is discontinuous but was found to be up to approximately 20 feet thick.

Reworked Till

Reworked Till consists of weathered glacial till, the uppermost portion of the glacial till. This soil group is generally located below the alluvium and consists of clay and sandy soils. The average moisture content is 14 percent, with a range of 11 to 25 percent. The average total unit weight is

141 pcf and the average plasticity index is 9 percent. The SPT N-values range from 3 to 53, with an average of 13. The range corresponds to a consistency of soft to hard with the average value corresponding to stiff. This layer is discontinuous but was found to be up to approximately 40 feet thick.

Glacial Till

Glacial Till consists of clay and sandy soils. This soil group is generally located below the alluvial soils and reworked glacial till. The average moisture content is 16 percent, with a range of 5 to 37 percent. The average total unit weight is 129 pcf and the average plasticity index is 11 percent. The SPT N-values range from WOH to 100, with an average of 38. The range corresponds to a consistency of very soft to hard with the average value corresponding to hard. This layer is discontinuous but was found to be up to approximately 60 feet thick.

Bedrock

Bedrock encountered onsite consists of moderately to highly weathered limestone, shale, and coal from the Shelburn-Patoka Formations. Rock coring was conducted in 12 borings with an average recovery of 94 percent and an average rock quality designation (RQD) of 62 percent.

2.6. Constructed Materials

Section 845.220(a)(1)(E): 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 surface impoundment; the method of site preparation and construction of each zone of the CCR surface impoundment; and the approximate dates of construction of each successive stage of construction of the CCR surface impoundment.

2.6.1. Constructed Material Properties

The material unit used to construct the CCR units was identified as Fill. Engineering parameters of Fill are summarized in Table 2 [3] [4].

Fill

All fill material used to construct the riverbank berms of the OEAP, NAP, and NEAP, as well as fill used to cover the OEAP, were classified as a single unit referred to as Fill. Fill consists of lean clay, silty clay, and silty sand with varying amounts of sand and gravel. The average moisture content is 15 percent, with a range of 7 to 43 percent. The average total unit weight is 131 pounds per square foot (pcf) and the average plasticity index is 12 percent. The standard penetration test (SPT) N-values range from 2 to 93, with an average of 16. The range corresponds to a consistency of soft to hard, with the average value corresponding to very stiff.

2.6.2 Construction Activities

Construction methods and times of the CCR units at the Site are summarized below.

Old East Ash Pond and North Ash Pond

What is commonly referred to as the OEAP was the first impoundment to accept coal ash beginning around 1955. The eastern berm of the OEAP was constructed and then raised using initial clay berms to approximately elevation 602 feet and raised again to the current elevation ranging from 624 to 636 feet using coal ash with a Fill cover. Overtime, the northern end of the OEAP extended into what is currently referred to as the NAP and the outer berm of the OEAP was extended northward to include what is commonly referred to as the NAP[1]. These units were designed and managed as a single impoundment for purposes of treating and storing coal ash until the area referred to as the OEAP received a Fill cover of varying thickness sometime after 1985 and before 1998 [5].

Over time a surficial berm constructed from coal ash, with an access road on top, was constructed on the surface of the coal ash to the south of the northern perimeter of the OEAP to manage surface water flows and provide vehicle access. The NAP was subsequently designed to incorporate the surficial berm and coal ash located within the OEAP. The NAP was constructed in 1977.

Soil boring records through the surficial berm show coal ash present below the berm and road, demonstrating that the NAP and OEAP had a common operational area on the northern end of the OEAP and southern area of the NAP. A geotechnical boring was drilled off the edge of this road near the center of the OEAP and indicates 13.5 ft of clay fill overlying 9.0 ft of coal ash before native soils were encountered at a depth of 22.5 ft. This boring was completed as part of the 2017 geotechnical investigation to support closure design of the OEAP and NAP. The NAP remained active until the NEAP construction was finished in 1989.

The eastern edge of the OEAP are delineated by berms, while the northwestern edge shares a border with the NAP and the southern edge is bounded by the existing topography. The northern and eastern edges of the NAP are delineated by berms, the southern edge shares a border with the OEAP, and the western edge is bounded by the existing topography. The Secondary NAP is not a CCR surface impoundment and is located at the northeast corner of the NAP. This pond was constructed with the NAP. The NAP has not been covered, but has vegetation growing from the CCR over a majority of the impoundment.

[1] Based on historical aerial photos.

New East Ash Pond

The NEAP was constructed in the late 1980s separate from the OEAP and NAP as a single impoundment for purposes of treating and storing coal ash. The riverbank berm consists of Fill material with a slurry wall to roughly elevation 600 feet. In the 2003, the NEAP was expanded on the western edge with a slurry trench and the existing berms were raised to their current elevation of roughly 620 feet. The slurry wall and slurry trench tied into the bedrock below the berm.

The northern, eastern, and southern edges of the NEAP are delineated by berms, while the western interior slope of the impoundment is bounded by the existing topography. The Secondary NEAP is not a CCR surface impoundment and is located along the northern berm of the NEAP. This pond was constructed with the NEAP.

2.7. Drawings and Details

> *Section 840.220(a)(1)(F): At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR surface impoundment, detailed dimensional drawings of the CCR surface impoundment, including a plan view and cross- sections of the length and width of the CCR surface impoundment, 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 surface impoundment due to malfunction or mis-operation.*

This section documents information related to the existing conditions, design, construction, operation, instrumentation monitoring, cross sections, and maintenance of the impoundments on dimensional drawings, to the extent this information is available. Drawings and figures referenced in Table 3 are located in Appendix B and Appendix C.

2.8. Existing Instrumentation

> *Section 845.220(a)(1)(G): A description of the type, purpose, and location of existing instrumentation.*

A total of 11 vibrating-wire piezometers were installed by multiple consultants in 2013 and 2017 as summarized in Table 4 below. A total of 34 monitoring wells are present at the Site which are actively monitored for groundwater quality and/or groundwater elevation. Piezometer and monitoring well locations are included in Appendix C.

2.9. Area-Capacity Curves

Section 845.220(a)(1)(H): Area-capacity curves for the CCR surface impoundment.

An area-capacity curve for the OEAP was not identified in the documentation available. Area-capacity curves for the NEAP and NAP are presented in **Figures 1 and 2**.

2.10. Description of Spillway and Diversion Design Features

Section 845.220(a)(1)(I): A description of each spillway and diversion design features and capacities and calculations used in their determination.

Old East Ash Pond

The current condition of the OEAP does not include a standing pool of water; therefore, there is no pool elevation. The OEAP is graded to drain from South to North via a pipe and let down structure, leading to the NAP. During the 2014 annual inspection, the following structure was noted: "*A grated stormwater structure was observed along the exterior toe of the southern berm. It is our understanding that this concrete pipe was installed for stormwater control along the southern toe of the pond due to erosion issues. Erosion features from stormwater runoff were not observed along the southern downstream toe.*" [7].

A linear feature was identified using ground penetrating radar (GPR) during a geotechnical exploration in 2017 and is shown on **Figure 2**. It was designated a "potential pipe" in the GPR survey. No additional documentation for this potential pipe is available.

North Ash Pond

The pool level in the NAP is approximately 597.0 feet and maintained with a discharge structure [8]. The discharge structure is a drop inlet that connects the NAP and the Secondary NAP; however, the size and material type of this pipe is unknown [7].

The Secondary NAP has a normal pool elevation of approximately 587.5 feet [8]. This pond discharges to National Pollutant Discharge Elimination System (NPDES) Permitted Outfall 001 through a 30-inch diameter corrugated metal pipe riser connected to an outlet pipe of unknown size and material type at the southeast end of the pond that discharges into a drainage channel to Middle Fork Vermilion River [7]. A 12-inch high-density polyethylene (HDPE) pipe near the riser serves as an emergency spillway for the Secondary NAP that drains to the Middle Fork Vermilion River.

Currently stormwater runoff from the valley, located west of NAP, is managed by a 36-inch diameter pipe network that collects surface water from two inlets located upstream of a berm or "saddle dam" and conveys to a location just north of the north berm. The water is transmitted into a ditch that flows eastward to the Middle Fork of the Vermilion River [8]. Multiple manhole access points are present within the NAP for maintenance.

Capacity calculations for the NAP discharge structure and pipes were not identified in the documentation available.

A linear feature was identified using ground penetrating radar (GPR) during a geotechnical exploration in 2017 and is shown on **Figure 3**. It was designated a "potential pipe" in the GPR survey. No additional documentation for this potential pipe is available.

New East Ash Pond

The pool level in the NEAP and Secondary NEAP is approximately 594.0 feet and maintained with two drop inlet discharge structures to the Secondary NEAP [8]. The first drop inlet near the north embankment is an 18-inch diameter ductile iron pipe (DIP) that outlets at the Secondary NEAP. The second drop inlet within the north embankment is a 36-inch diameter reinforced concrete pipe (RCP) that connects to a manhole on the downstream slope, which then connects to a corrugated metal pipe (CMP) of unknown diameter that outlets to the Secondary NEAP. This pond discharges to NPDES Permitted Outfall 003 through a drop inlet with a 36-inch diameter pipe of unknown material type into a drainage channel to the Middle Fork Vermilion River. The embankment was constructed with a downstream internal blanket drain with a length of 50 feet [7].

Hydraulic and hydrologic calculations for spillway sizing were not identified in the documentation available for the original construction; however, calculations were completed for the expansion using HEC-RAS [6].

2.11. Construction Specifications

> *Section 845.220(a)(1)(J): The construction specifications and provisions for surveillance, maintenance, and repair of the CCR surface impoundment.*

Dynegy conducts annual surveillance and routine maintenance for the impoundments. The associated Operations and Maintenance Plans for each facility are included in Appendix D.

Specifications for construction of the NEAP and the NEAP expansion are included in Appendix E. Specifications for the OEAP and NAP were not identified in the documentation available.

2.12. Record or Knowledge of Structural Instability

> *Section 845.220(a)(1)(K): Any record or knowledge of structural instability of the CCR surface impoundment.*

There is no record or knowledge of structural instabilities of the OEAP, NAP, or NEAP.

3. LIMITATIONS

The observations presented herein are based on information provided by Dynegy using that degree of care and skill ordinarily exercised under similar circumstances by competent members of the engineering profession. Geosyntec has assumed that such information is correct and has not verified and is not responsible for the accuracy of such provided information. No warranties can be made regarding information and documents not presently available.

4. REFERENCES

[1] Illinois Environmental Protection Agency, "Title 35 Environmental Protection, Subtitle G Waste Disposal, Chapter I Pollution Control Board, Subchapter j Coal Combustion Waste Surface Impoundments, Part 845 Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments," 2021.

[2] Environmental Protection Agency (EPA), "Watershed Index Online Tool," 2019. [Online]. Available: https://www.epa.gov/wsio/download-and-use-wsio-tool. [Accessed February 2020].

[3] Geosyntec Consultants, Inc., "North Ash Pond Trench Revetment System Slope Stability Assessment (Draft)," 2020.

[4] Geosyntec Consultants, Inc., "Reliability Assessment of the Old East Ash Pond (Draft)," 2019.

[5] Google, "Google Earth Pro," Google, 1985, 1998. [Online]. Available: earth.google.com/web. [Accessed 24 June 2021].

[6] URS Corporation, "Vermilion Power Station Expansion fo Existing Ash Pond Calculation Book," 2002.

[7] URS Corporation, "Dam Inspections Vermilion Power Station," 2014.

[8] Stantec Consulting Services, Inc., "Privileged and Confidential Attorney Work Product Information - Vermilion Site Unwatering and Dewatering Volumes," 2019.

TABLES

Table 1. Engineering Parameters of Foundation Materials

Soil Unit	Total Unit Weight, γ_T (pcf)	Drained Conditions		Undrained Conditions		Natural Water Content, w (%)	Plasticity Index, PI (%)
		Friction Angle, φ' (deg)	Cohesion, c' (psf)	Friction Angle, φ (deg)	Cohesion, c (psf)		
Clay Alluvium	112	32	50	0	1,500	19	11
Sand Alluvium	122	33	0	-	-	16	N/A
Reworked Till	141	35	0	0	1,700	14	9
Glacial Till	129	37	0	-	-	16	11

Table 2. Engineering Parameters of Constructed Materials

Soil Unit	Total Unit Weight, γ_T (pcf)	Drained Conditions		Undrained Conditions		Natural Water Content, w (%)	Plasticity Index, PI (%)
		Friction Angle, φ' (deg)	Cohesion, c' (psf)	Friction Angle, φ (deg)	Cohesion, c (psf)		
Fill	131	36	50	0	1,000	15	12
Coal Ash[1]	107	34	0	-	-	38	N/A

[1]This includes parameters for all coal ash onsite.

Table 3. Engineering Detail Drawings

Drawings	OEAP	NAP	NEAP
Dimensional Plan View	Sheet 2 of 18	Sheet 2 of 18	C-SK.26869-4, P-04, Sheet 2 of 18
Dimensional Cross Sections	Sheet 11 of 18, Sheet 12 of 18	Sheet 13 of 18, Sheet 14 of 18	TS-05 through TS-12
Foundation Improvements	Not Available	Not Available	Not Available
Drainage Provisions	Not Available	Not Available	SK.26869-4, D-02, D-04
Instrument Locations	Figure No. 1-2, Drawing-01	Figure No. 1-2, Drawing-01	Figure No. 1-2, Drawing-01
Slope Protection	Not Available	Not Available	Not Available
Normal Operation Pool Elevation	Not Available	Sheet 3 of 18[1]	P-04
Maximum Pool Surface Elevation	Not Available	Not Available	Not Available
Expected Maximum Depth of CCR	61 feet	33 feet	21 feet

[1]Normal operating pool not available. Pool elevation from March 26, 2018 survey provided on this drawing sheet.

Table 4. Piezometer Summary

Instrument	Unit	Installation Date
B-13-3	OEAP	2013
B-13-6	OEAP	2013
B-13-9	OEAP	2013
STN-S-18	OEAP	2017
STN-S-22	NAP	2017
STN-S-23	OEAP	2017
STN-S-25	NEAP	2017
STN-S-29	NAP	2017
STN-S-31	NAP	2017
STN-S-35	NAP	2017
B1-2	NAP	2018
B3-2	OEAP	2018

FIGURES

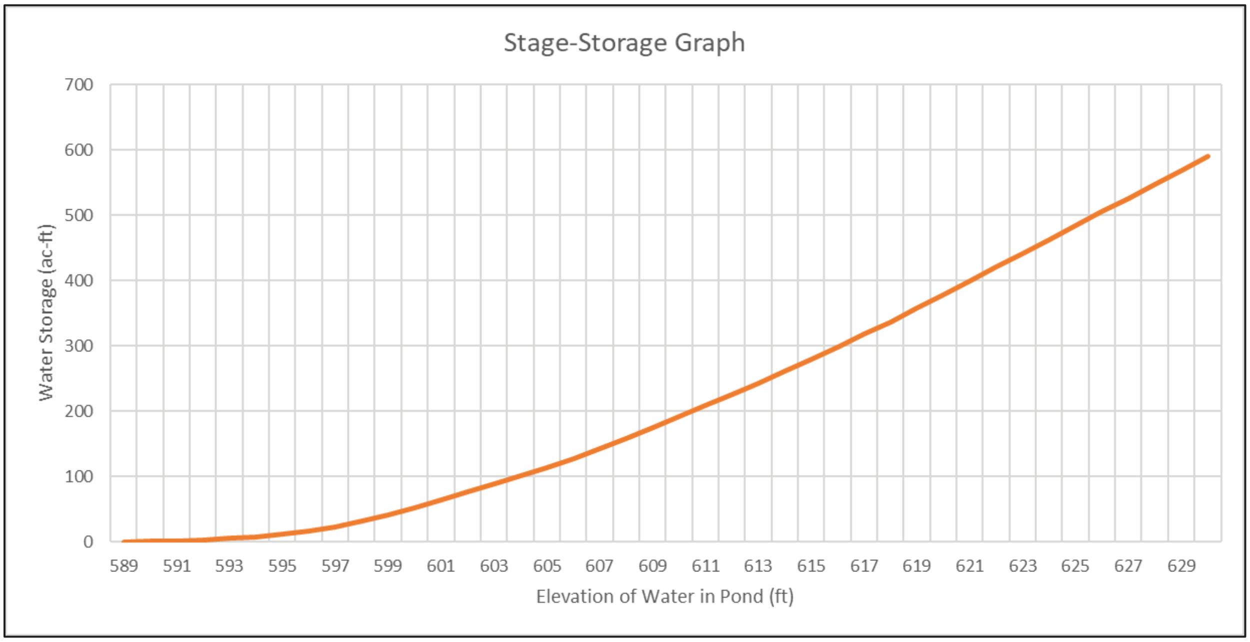


Figure 1. New East Ash Pond Stage-Storage Graph

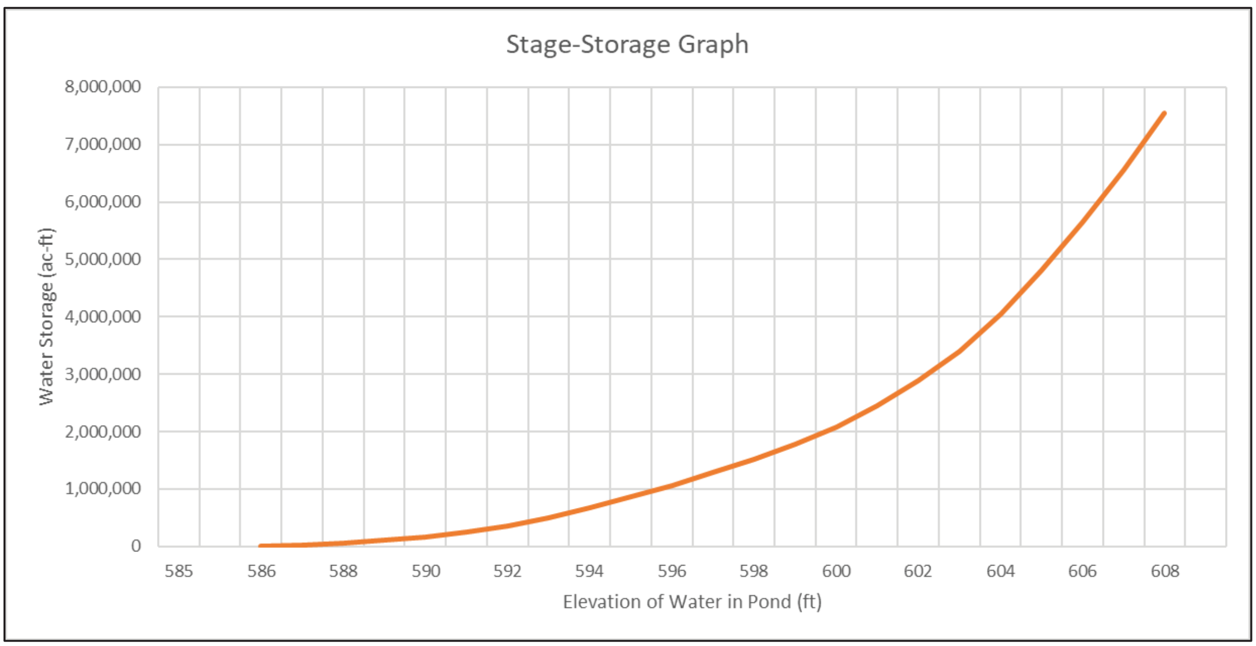


Figure 2. North Ash Pond Stage-Storage Graph

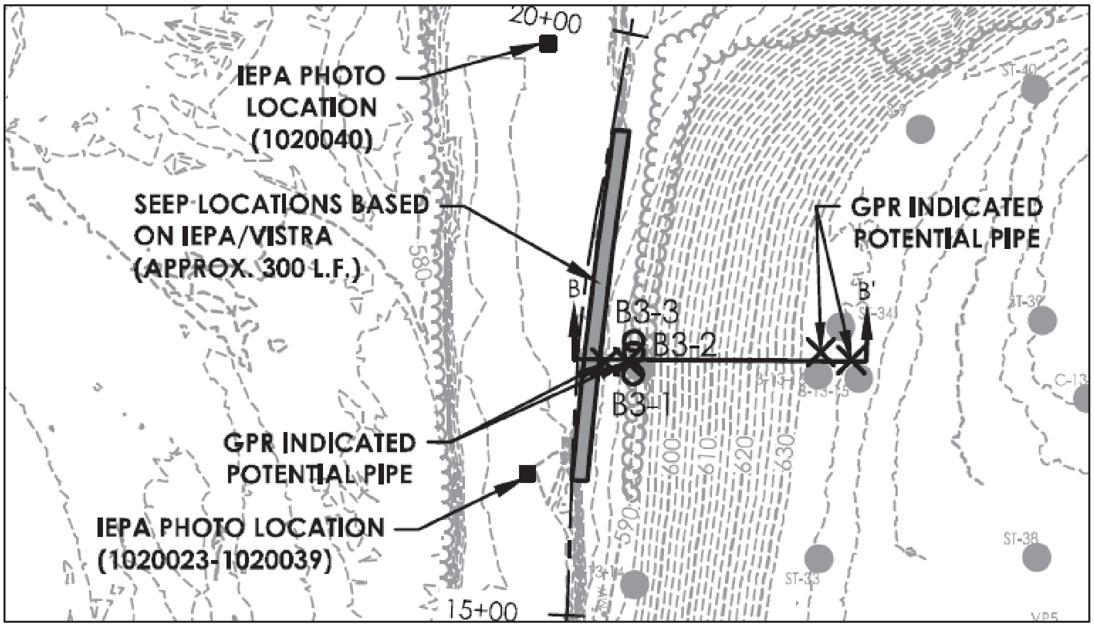


Figure 3. Old East Ash Pond GPR Indicated Pipe

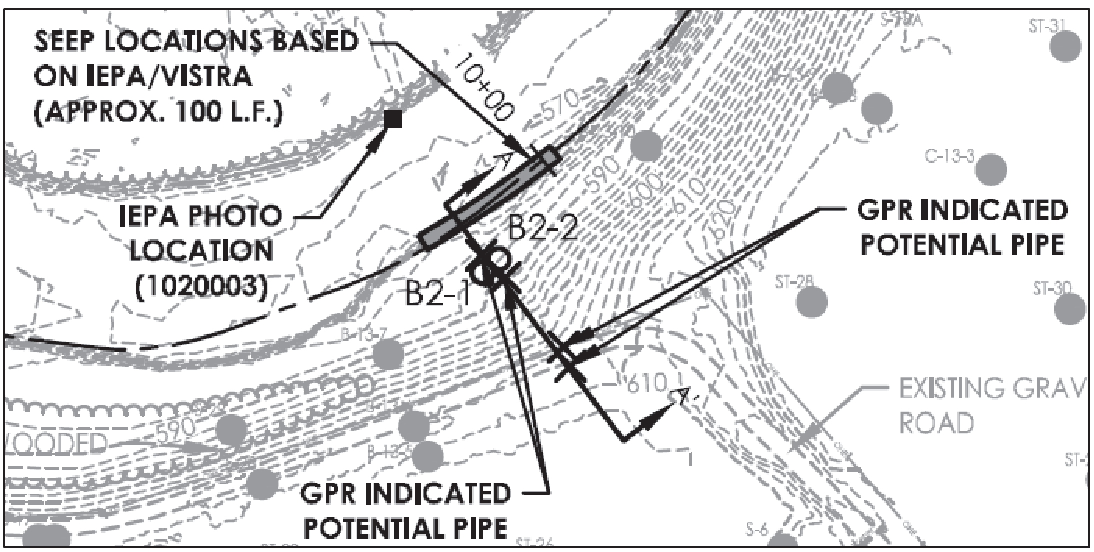
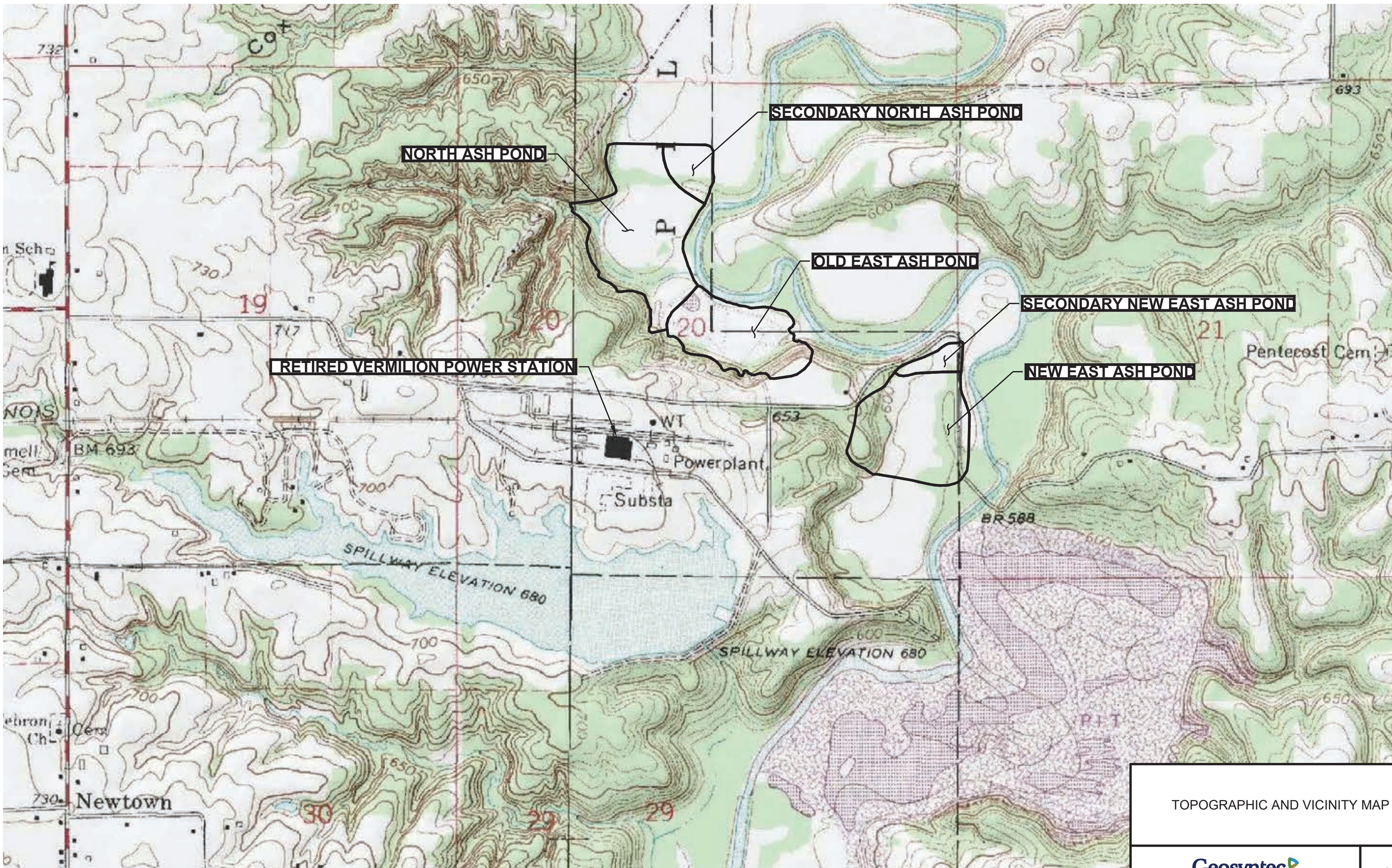


Figure 4. North Ash Pond GPR Indicated Pipe

APPENDIX A. TOPOGRAPHIC AND VICINITY MAP



REFERENCE: THIS MAP WAS PRODUCED IN THE YEAR 1978 AND IT WAS PROVIDED BY WWW.MYTOPO.COM. THIS MAP IS BASED ON THE GRAPHIC 7.5 MINUTE TOPOGRAPHIC MAP OF DANVILLE NW, ILLINOIS QUADRANGLE.

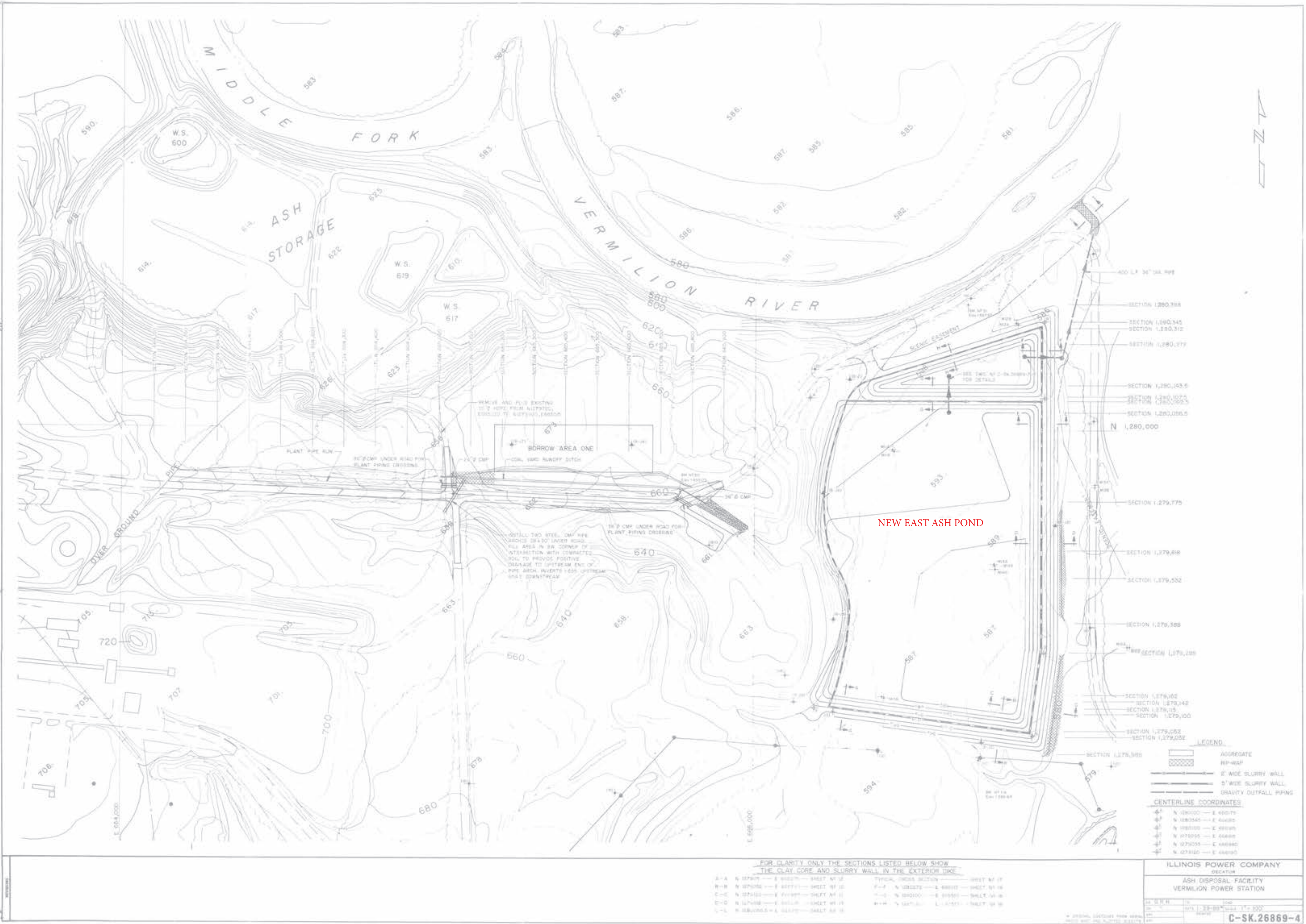
0 1000 2000
SCALE IN FEET

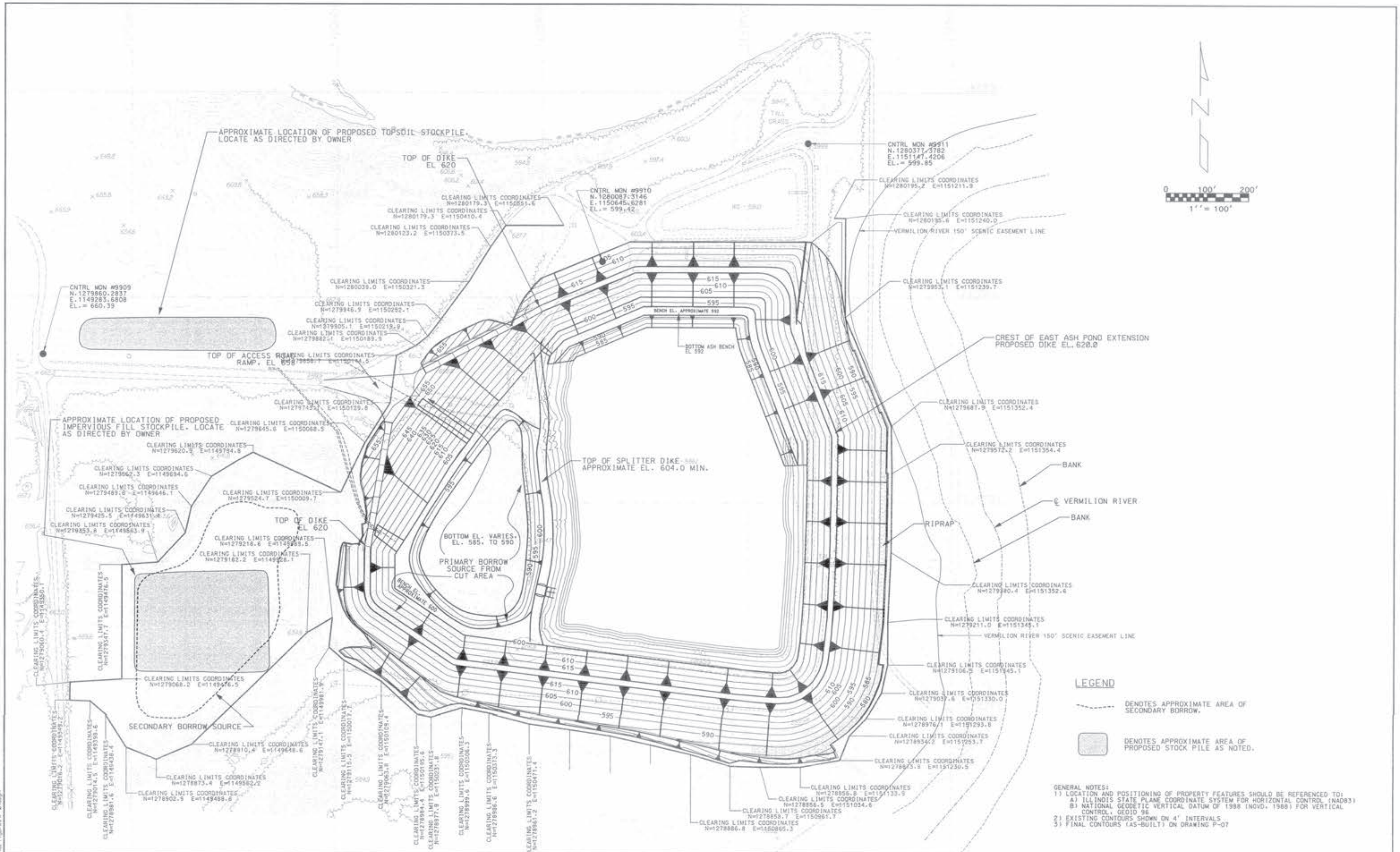
TOPOGRAPHIC AND VICINITY MAP	
Geosyntec consultants	FIGURE 1
PROJECT NO: CHE8404	JUNE 2020

H:\VERMILION - CHE8404\DRAWINGS\FIGURES\8404-001-SITE LOCATION MAP (APRIL 2020) 6/22/20

APPENDIX B. VERMILION POWER PLANT DRAWINGS

- **C-SK.26869-4, ASH DISPOSAL FACILITY VERMILION POWER PLANT**
- **P-04, E-VER1-C128-3, EASH ASH POND EXPANSION**
- **TS-01, E-VER1-C129-1, EASH ASH POND EXPANSION**
- **TS-02, E-VER1-C129-2, EASH ASH POND EXPANSION**
- **TS-03, E-VER1-C129-3, EASH ASH POND EXPANSION**
- **TS-04, E-VER1-C129-4, EASH ASH POND EXPANSION**
- **TS-05, E-VER1-C129-5, EASH ASH POND EXPANSION**
- **TS-06, E-VER1-C129-6, EASH ASH POND EXPANSION**
- **TS-07, E-VER1-C129-7, EASH ASH POND EXPANSION**
- **TS-08, E-VER1-C129-8, EASH ASH POND EXPANSION**
- **D-02, E-VER1-C130-2, EASH ASH POND EXPANSION**
- **D-04, E-VER1-C130-4, EASH ASH POND EXPANSION**
- **SHEET 2 OF 18, VERMILION ASH POND CLOSURE PLAN (DRAFT, NOT CONSTRUCTED)**
- **SHEET 3 OF 18, VERMILION ASH POND CLOSURE PLAN (DRAFT, NOT CONSTRUCTED)**
- **SHEET 11 OF 18, VERMILION ASH POND CLOSURE PLAN (DRAFT, NOT CONSTRUCTED)**
- **SHEET 12 OF 18, VERMILION ASH POND CLOSURE PLAN (DRAFT, NOT CONSTRUCTED)**
- **SHEET 13 OF 18, VERMILION ASH POND CLOSURE PLAN (DRAFT, NOT CONSTRUCTED)**
- **SHEET 14 OF 18, VERMILION ASH POND CLOSURE PLAN (DRAFT, NOT CONSTRUCTED)**
- **FIGURE NO. 1-2, NORTH ASH POND SYSTEM CORRECTIVE ACTION PLAN**


MIDDLE FORK
VERMILION RIVER
ASH STORAGE
W.S. 600
W.S. 619
W.S. 617
BORROW AREA ONE
PLANT PIPE RUN
OVER GROUND PIPE
SCENIC EASEMENT
NEW EAST ASH POND
N 1,280,000
LEGEND
AGGREGATE
RIP-RAP
2' WIDE SLURRY WALL
5' WIDE SLURRY WALL
GRAVITY OUTFALL PIPING
CENTERLINE COORDINATES
FOR CLARITY ONLY THE SECTIONS LISTED BELOW SHOW
THE CLAY CORE AND SLURRY WALL IN THE EXTERIOR DIKE
ILLINOIS POWER COMPANY
DECATUR
ASH DISPOSAL FACILITY
VERMILION POWER STATION
C-SK.26869-4



GENERAL NOTES:
1) LOCATION AND POSITIONING OF PROPERTY FEATURES SHOULD BE REFERENCED TO:
A) ILLINOIS STATE PLANE COORDINATE SYSTEM FOR HORIZONTAL CONTROL (NAD83)
B) NATIONAL GEODETIC VERTICAL DATUM OF 1988 (NGVD, 1988) FOR VERTICAL CONTROL, GEOID 96
2) EXISTING CONTOURS SHOWN ON 4' INTERVALS
3) FINAL CONTOURS (AS-BUILT) ON DRAWING P-07

NO.	DATE	REVISION DESCRIPTION	APPROVED
3	2/28/03	AS-BUILT DWG PROJECT #20965	DAG
2	7/25/02	MODIFIED GENERAL NOTES: 1 & 2	DAG
1	6/14/02	MODIFICATIONS/CLARIFICATIONS AND ADDITIONAL DETAILS FOR BID PACKAGE SUBMITTAL	DAG

PREPARED BY:

URS

2318 Millpark Drive
St. Louis, MO 63043
Tel: 314-429-0100
Fax: 314-429-0462

SEAL 3/6/03

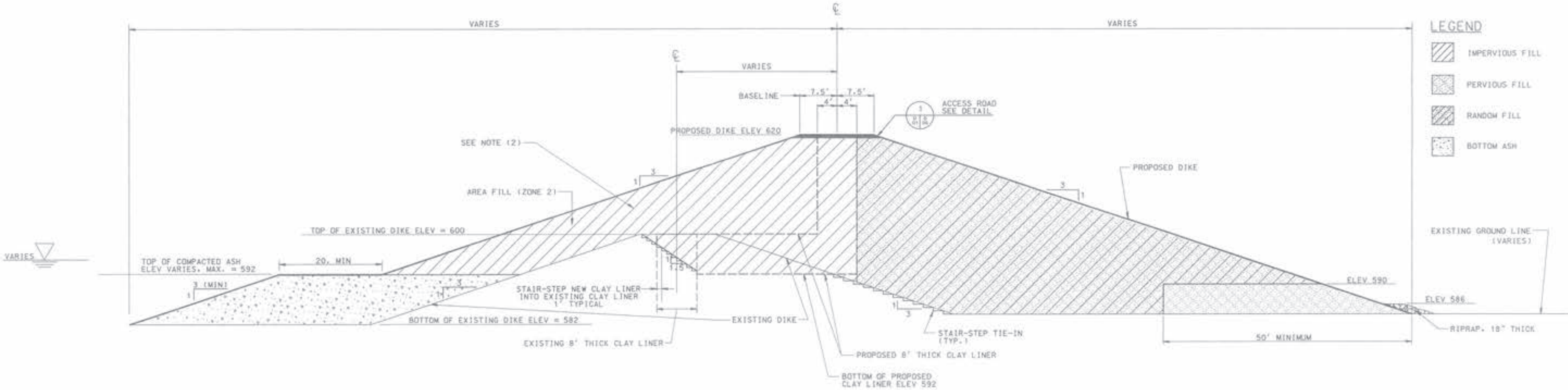
DATE: 4/29/02
SCALE: SEE BAR SCALE
DESIGNED: DAG
DRAWN: DJD
CHECKED: WDL
APPROVED: DAG
SUBMITTED: 3/7/03

DYNEGY
DYNEGY MIDWEST GENERATION
VERMILION POWER STATION
DANVILLE, ILLINOIS

EAST ASH POND EXPANSION

SITE CLEARING, STOCKPILE, BORROW AND EASEMENT PLAN
EAST ASH POND
EXPANSION TO ELEVATION 620
VERMILION POWER STATION

URS PROJECT NO. 23-20020051.00
SHEET NO. P-04
E-VER1-C128-3

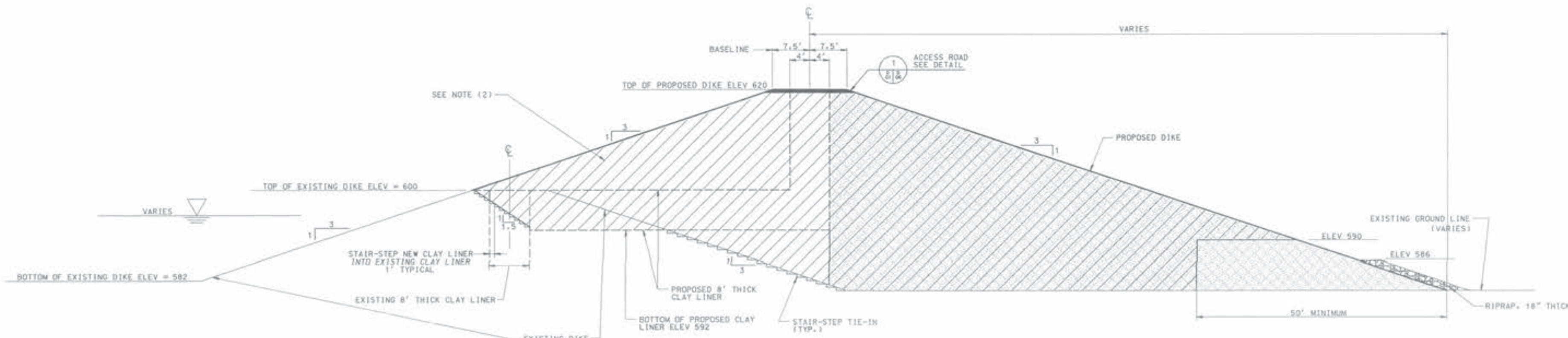


LEGEND

- IMPERVIOUS FILL
- PERVIOUS FILL
- RANDOM FILL
- BOTTOM ASH

TYPICAL SECTION NO 2 (CUT AT APPROXIMATELY STA 29+95)
TRANSITION FROM DOWNSTREAM CONSTRUCTION EAST
TO LINER CROSSOVER CONSTRUCTION NORTHEAST
STA 28+86 TO STA 30+62

GENERAL NOTES:
(1) SEE DRAWING P-06 FOR EXTENT OF TYPICAL SECTIONS.
(2) DUE TO MATERIAL VOLUME LIMITATIONS, IMPERVIOUS FILL MATERIAL WAS NOT EXCLUSIVELY USED FOR THE INSIDE HALF OF THE EMBANKMENT. HOWEVER, IT WAS USED, AT A MINIMUM, FOR THE PROPOSED 8' THICK CLAY LINER LIMITS SHOWN.



TYPICAL SECTION NO 1 (CUT AT APPROXIMATELY STA 25+70)
DOWNSTREAM CONSTRUCTION EAST
STA 22+58 TO STA 28+86

0 10' 20'
1"= 10' H

0 10' 20'
1"= 10' V

NO.	DATE	REVISION DESCRIPTION	APPROVED
2	2/28/03	AS-BUILT DWG PROJECT #20965	DAG
1	6/14/02	MODIFICATIONS/CLARIFICATIONS AND ADDITIONAL DETAILS FOR BID PACKAGE SUBMITTAL	DAG

PREPARED BY:

URS

2318 Millpark Drive
St. Louis, MO 63043
Tel: 314-429-0100
Fax: 314-429-0462

3/6/03
SEAL

DATE: 4/29/02
DESIGNED: DAG
DRAWN: DJD
CHECKED: WDL
APPROVED: DAG
SUBMITTED: 3/7/03

DYNEGY
DYNEGY MIDWEST GENERATION
VERMILION POWER STATION
DANVILLE, ILLINOIS

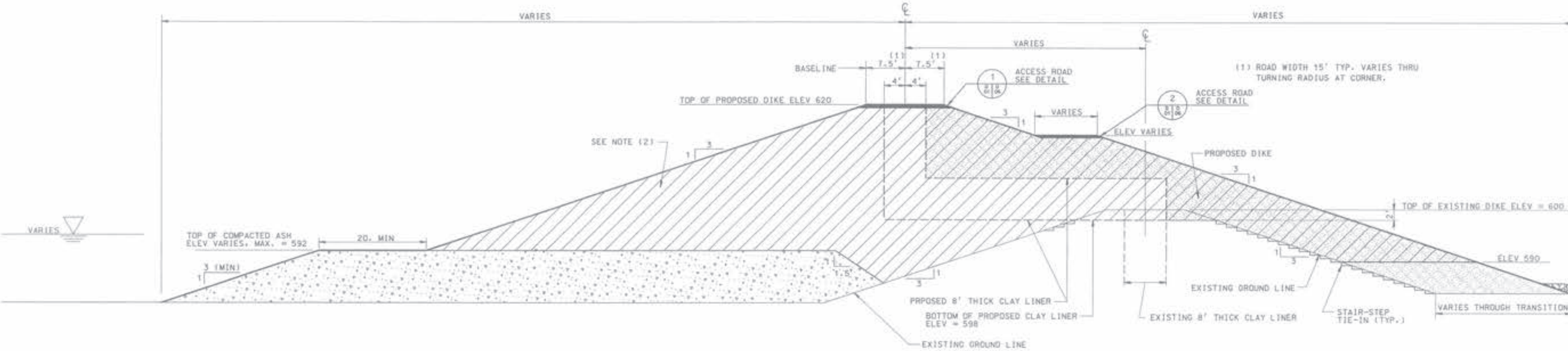
EAST ASH POND EXPANSION

TYPICAL SECTIONS NO.1 AND 2
EAST ASH POND
EXPANSION TO ELEVATION 620
VERMILION POWER STATION

URS PROJECT NO. 23-20020051.00

SHEET NO. TS-01

E-VER1-C129-1

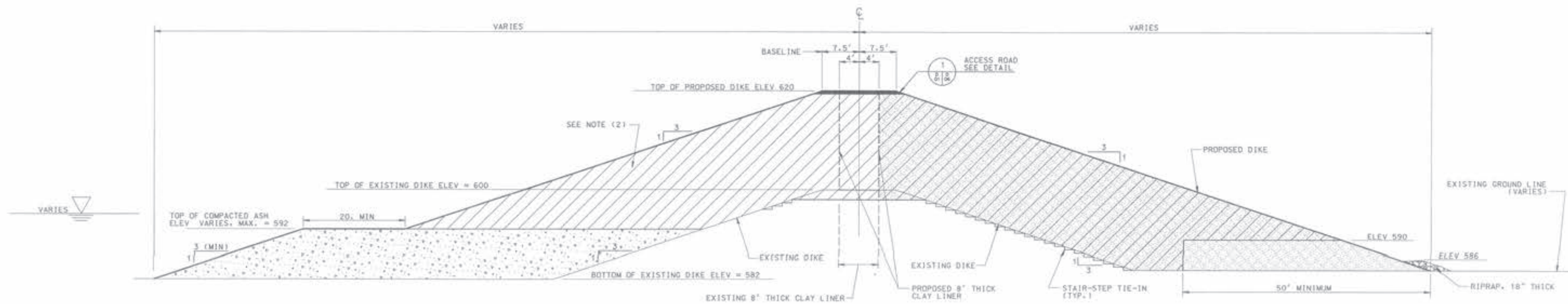


LEGEND

- IMPERVIOUS FILL
- PERVIOUS FILL
- RANDOM FILL
- BOTTOM ASH

TYPICAL SECTION NO 4 (CUT AT APPROXIMATELY STA 32+60)
TRANSITION FROM CROSSOVER CONSTRUCTION NORTHEAST
TO UPSTREAM CONSTRUCTION NORTH
STA 30+65 TO STA 33+12

GENERAL NOTES:
(1) SEE DRAWING P-06 FOR EXTENT OF TYPICAL SECTIONS.
(2) DUE TO MATERIAL VOLUME LIMITATIONS, IMPERVIOUS FILL MATERIAL WAS NOT EXCLUSIVELY USED FOR THE INSIDE HALF OF THE EMBANKMENT. HOWEVER, IT WAS USED, AT A MINIMUM, FOR THE PROPOSED 8' THICK CLAY LINER LIMITS SHOWN.



TYPICAL SECTION NO 3
LINER CROSSOVER CONSTRUCTION NORTHEAST
STA 30+62 TO STA 30+65

0 10' 20'
1''= 10' H

0 10' 20'
1''= 10' V

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2	2/28/03	AS-BUILT DWG PROJECT #20965	DAG
1	6/14/02	MODIFICATIONS/CLARIFICATIONS AND ADDITIONAL DETAILS FOR BID PACKAGE SUBMITTAL	DAG

PREPARED BY:

URS
2318 Millpark Drive
St. Louis, MO 63043
Tel: 314-429-0100
Fax: 314-429-0462

ILLINOIS
3/6/03
SEAL

DATE: 4/29/02
DESIGNED: DAG
DRAWN: DJD
CHECKED: WDL
APPROVED: DAG
SUBMITTED: 3/7/03

DYNEGY
DYNEGY MIDWEST GENERATION
VERMILION POWER STATION
DANVILLE, ILLINOIS

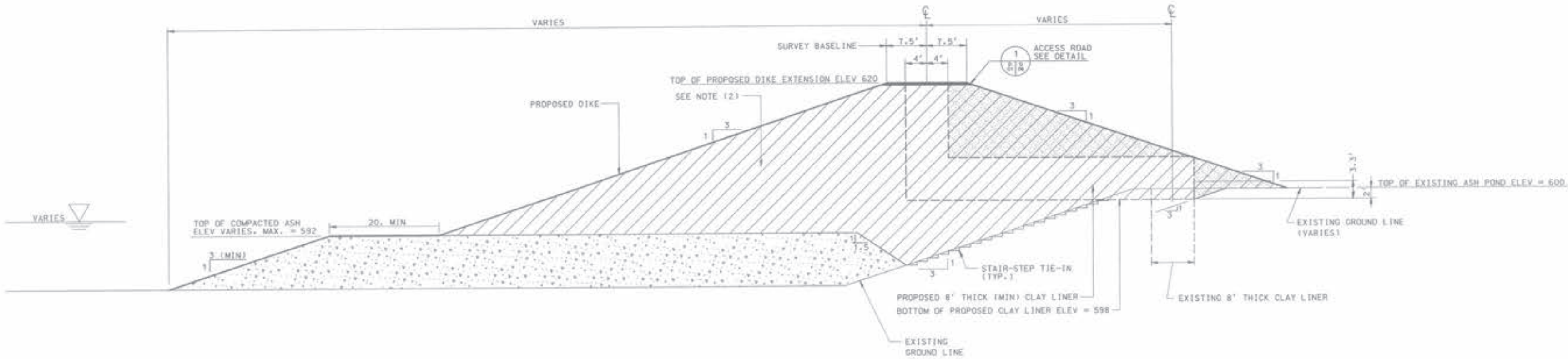
EAST ASH POND EXPANSION

TYPICAL SECTIONS NO.3 AND 4
EAST ASH POND
EXPANSION TO ELEVATION 620
VERMILION POWER STATION

URS PROJECT NO. 23-20020051.00

SHEET NO. TS-02

E-VER1-C129-2

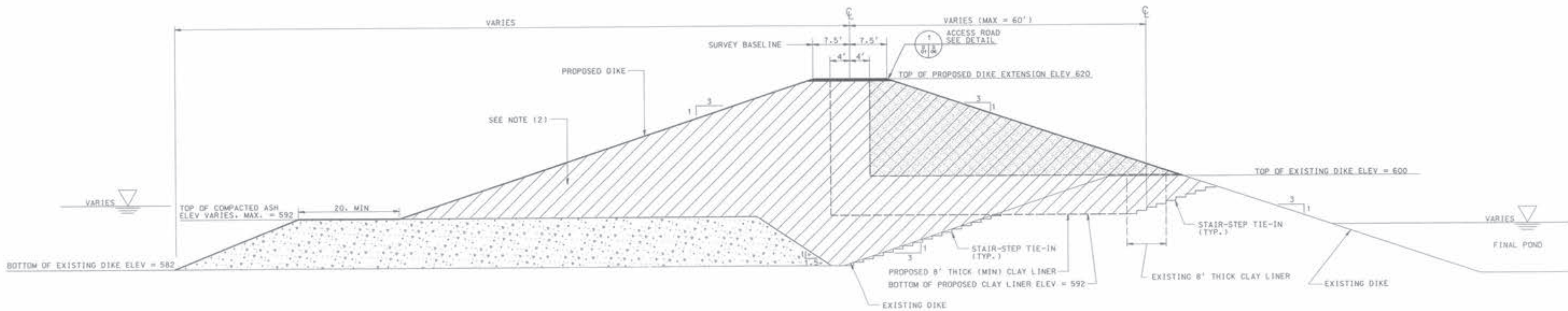


LEGEND

- IMPERVIOUS FILL
- PERVIOUS FILL
- RANDOM FILL
- BOTTOM ASH

TYPICAL SECTION NO 6 (CUT AT APPROXIMATELY STA 0+14)
TRANSITION FROM UPSTREAM CONSTRUCTION NORTH
TO LINER CROSSOVER CONSTRUCTION NORTHWEST
STA 0+00 TO STA 0+14
STA 33+12 TO STA 36+39 (POE)

GENERAL NOTES:
(1) SEE DRAWING P-06 FOR EXTENT OF TYPICAL SECTIONS.
(2) DUE TO MATERIAL VOLUME LIMITATIONS, IMPERVIOUS FILL MATERIAL WAS NOT EXCLUSIVELY USED FOR THE INSIDE HALF OF THE EMBANKMENT, HOWEVER, IT WAS USED, AT A MINIMUM, FOR THE PROPOSED 8' THICK CLAY LINER LIMITS SHOWN.



TYPICAL SECTION NO 5 (CUT AT APPROXIMATELY STA 34+75)
UPSTREAM CONSTRUCTION NORTH
STA 33+12 TO STA 36+39

1'' = 10' H

1'' = 10' V

NO.	DATE	REVISION DESCRIPTION	APPROVED
2	2/28/03	AS-BUILT DWG PROJECT #20965	DAG
1	6/14/02	MODIFICATIONS/CLARIFICATIONS AND ADDITIONAL DETAILS FOR BID PACKAGE SUBMITTAL	DAG

PREPARED BY:

URS

2318 Millpark Drive
St. Louis, MO 63043
Tel: 314-429-0100
Fax: 314-429-0462

SEAL 3/6/03

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DYNEGY
DYNEGY MIDWEST GENERATION
VERMILION POWER STATION
DANVILLE, ILLINOIS

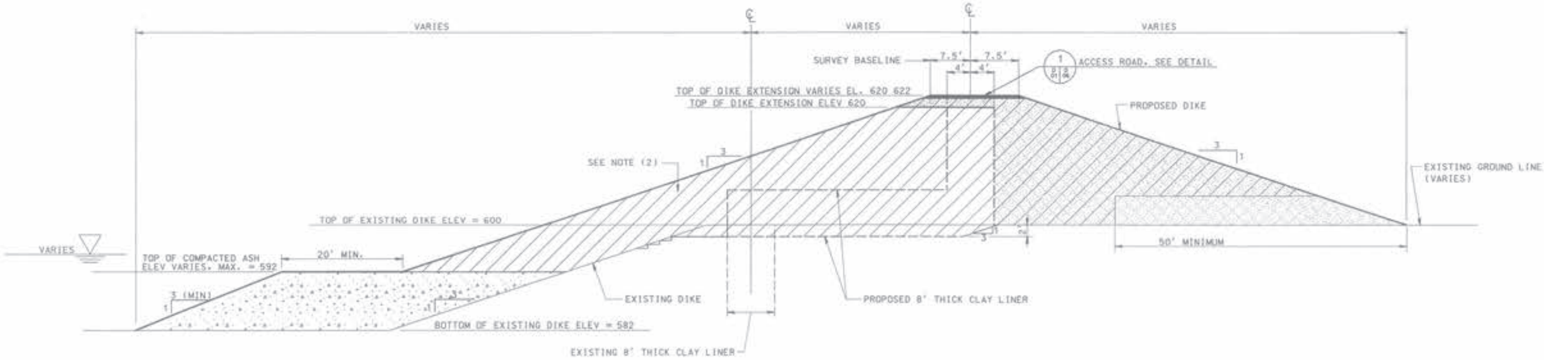
EAST ASH POND EXPANSION

TYPICAL SECTIONS NO.5 AND 6
EAST ASH POND
EXPANSION TO ELEVATION 620
VERMILION POWER STATION

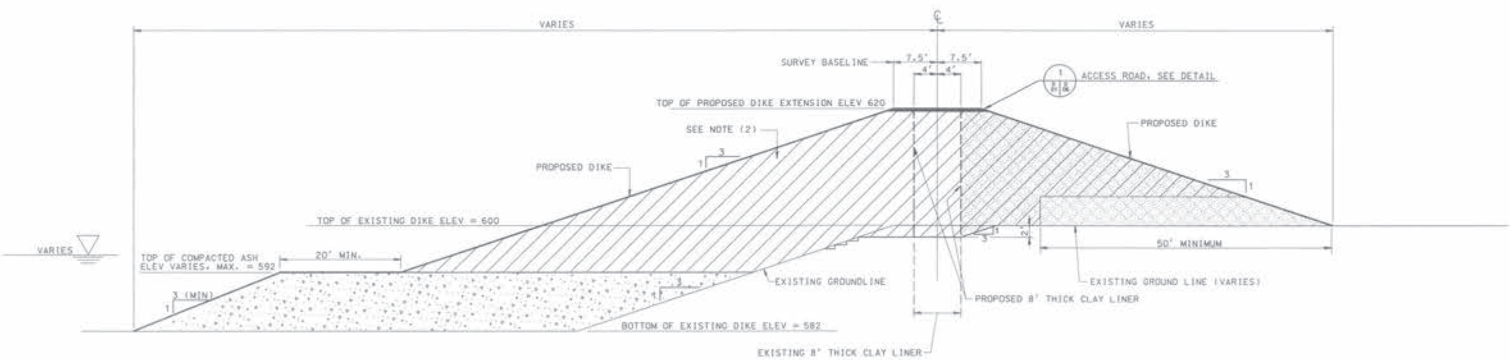
URS PROJECT NO. 23-20020051.00

SHEET NO. TS-03

E-VER1-C129-3



TYPICAL SECTION NO 8 (CUT APPROXIMATELY STA 1+40)
TRANSITION FROM LINER CROSSOVER CONSTRUCTION NORTHWEST
TO BLOCK LINER CONSTRUCTION NORTHWEST
STA 0+18 TO STA 2+60



TYPICAL SECTION NO 7
LINER CROSSOVER CONSTRUCTION NORTHWEST
STA 0+14 TO STA 0+18

LEGEND

- IMPERVIOUS FILL
- PERVIOUS FILL
- RANDOM FILL
- BOTTOM ASH

GENERAL NOTES:
(1) SEE DRAWING P-06 FOR EXTENT OF TYPICAL SECTIONS.
(2) DUE TO MATERIAL VOLUME LIMITATIONS, IMPERVIOUS FILL MATERIAL WAS NOT EXCLUSIVELY USED FOR THE INSIDE HALF OF THE EMBANKMENT. HOWEVER, IT WAS USED, AT A MINIMUM, FOR THE PROPOSED 8' THICK CLAY LINER LIMITS SHOWN.

0 10' 20'
1'' = 10' H

0 10' 20'
1'' = 10' V

NO.	DATE	REVISION DESCRIPTION	APPROVED
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1	6/14/02	MODIFICATIONS/CLARIFICATIONS AND ADDITIONAL DETAILS FOR BID PACKAGE SUBMITTAL	DAG

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URS
2318 Millpark Drive
St. Louis, MO 63043
Tel: 314-429-0100
Fax: 314-429-0462

SEAL
3/6/03

DATE: 4/29/02
SCALE:
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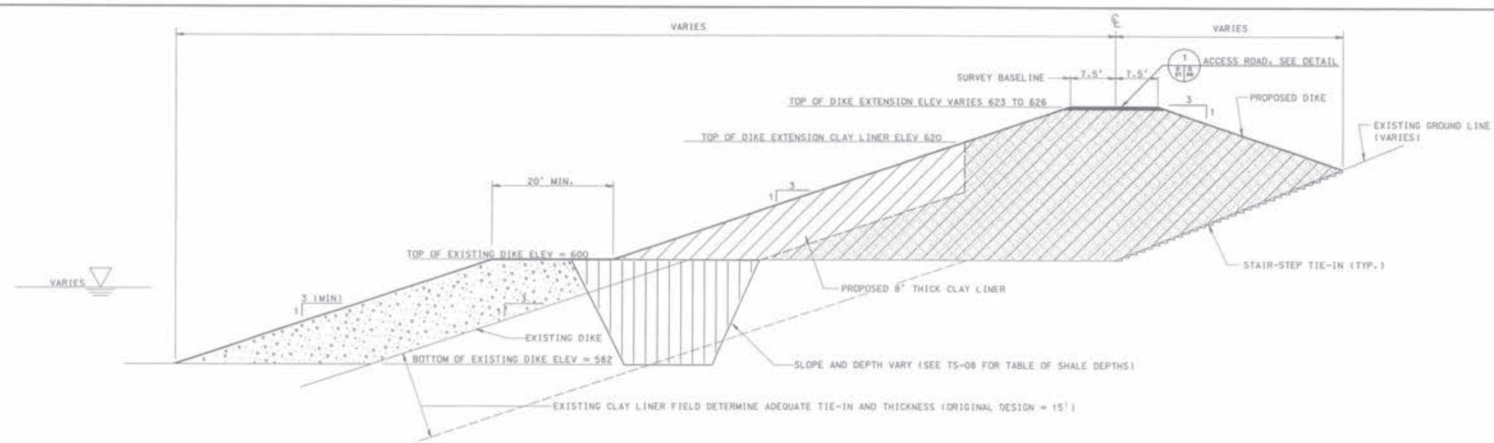
CHECKED: WDL
APPROVED: DAG
SUBMITTED: 3/7/03

DYNEGY
DYNEGY MIDWEST GENERATION
VERMILION POWER STATION
DANVILLE, ILLINOIS

EAST ASH POND EXPANSION

TYPICAL SECTIONS NO. 7 AND 8
EAST ASH POND
EXPANSION TO ELEVATION 620
VERMILION POWER STATION

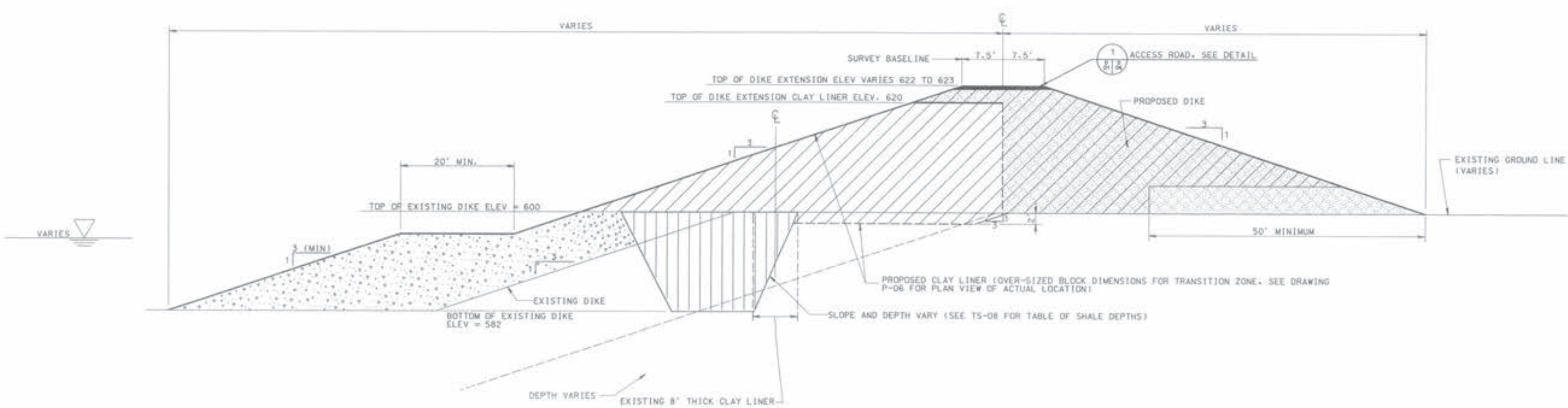
URS PROJECT NO. 23-20020051.00
SHEET NO. TS-04
E-VER1-C129-4



TYPICAL SECTION NO 10 (CUT AT APPROXIMATELY STA 2+75)
START OF ELEVATED CREST
CONSTRUCTION NORTHWEST
STA 2+69 TO STA 2+92

LEGEND

- IMPERVIOUS FILL
- PERVIOUS FILL
- RANDOM FILL
- BOTTOM ASH
- IMPERVIOUS FILL (CLAY LINER TIE-IN TRENCH TO SHALE)



TYPICAL SECTION NO 9
BLOCK LINER CONSTRUCTION NORTHWEST
STA 2+60 TO STA 2+69

0 10' 20'
1'' = 10' H

0 10' 20'
1'' = 10' V

GENERAL NOTES:
(1) SEE DRAWING P-06 FOR EXTENT OF TYPICAL SECTIONS

NO.	DATE	REVISION DESCRIPTION	APPROVED
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1	6/14/02	MODIFICATIONS/CLARIFICATIONS AND ADDITIONAL DETAILS FOR BID PACKAGE SUBMITTAL	DAG

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URS
2318 Millpark Drive
St. Louis, MO 63043
Tel: 314-429-0100
Fax: 314-429-0462

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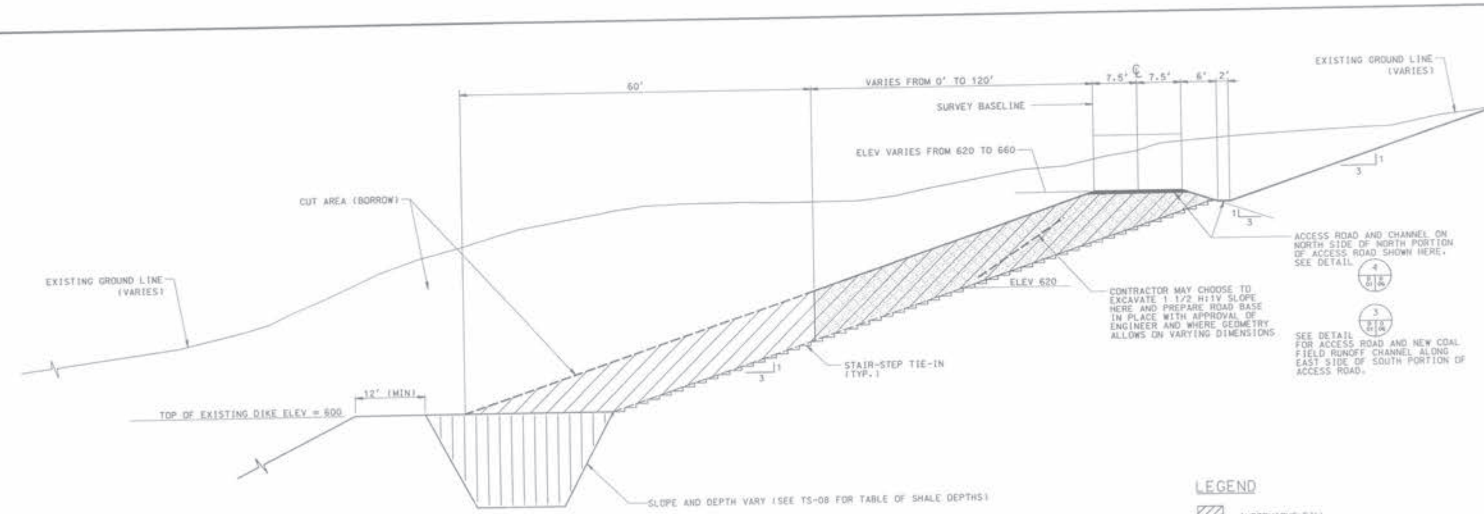
DYNEGY
DYNEGY MIDWEST GENERATION
VERMILION POWER STATION
DANVILLE, ILLINOIS

EAST ASH POND EXPANSION

TYPICAL SECTIONS NO.9 AND 10
EAST ASH POND
EXPANSION TO ELEVATION 620
VERMILION POWER STATION

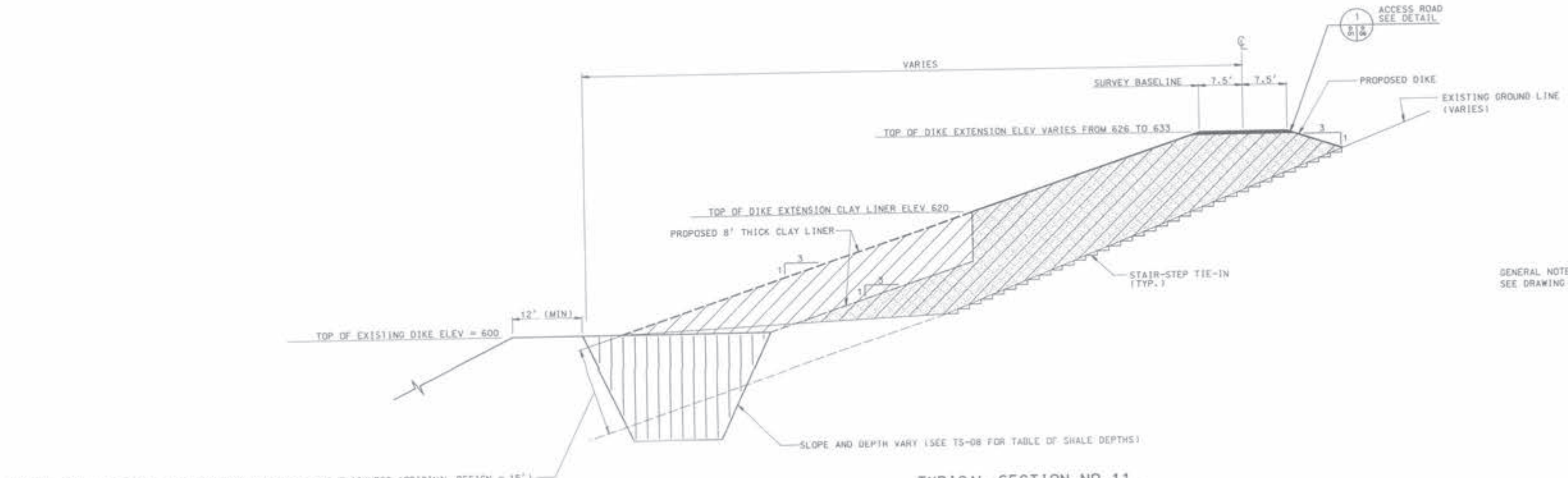
URS PROJECT NO. 23-20020051.00
SHEET NO. TS-05
E-VER1-C129-5



TYPICAL SECTION NO 12
BOTTOM LINER WITH ELEVATED
CREST CONSTRUCTION NORTHWEST
STA 3+39 TO STA 10+38

LEGEND

- IMPERVIOUS FILL
- PERVIOUS FILL
- RANDOM FILL
- BOTTOM ASH
- IMPERVIOUS FILL (CLAY LINER TIE-IN TRENCH TO SHALE)



GENERAL NOTE:
SEE DRAWING P-06 FOR EXTENT OF TYPICAL SECTIONS.

0 10' 20'
1'' = 10' H

0 10' 20'
1'' = 10' V

TYPICAL SECTION NO 11
TRANSITION FROM START OF ELEVATED CREST CONSTRUCTION NORTHWEST
TO BOTTOM LINER WITH ELEVATED CREST CONSTRUCTION NORTHWEST
STA 2+92 TO STA 3+39

2	2/28/03	AS-BUILT DWG PROJECT #20965	DAG
1	6/14/02	MODIFICATIONS/CLARIFICATIONS AND ADDITIONAL DETAILS FOR BID PACKAGE SUBMITTAL	DAG
			APPROVED

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URS
2318 Millpark Drive
St. Louis, MO 63043
Tel: 314-429-0100
Fax: 314-429-0462

SEAL

DATE: 4/29/02
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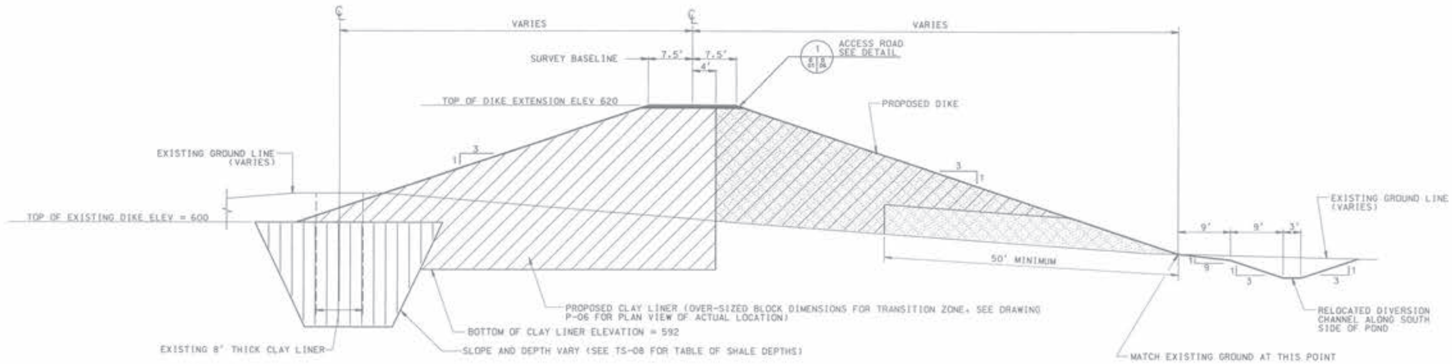
DYNEGY
DYNEGY MIDWEST GENERATION
VERMILION POWER STATION
DANVILLE, ILLINOIS

EAST ASH POND EXPANSION

TYPICAL SECTIONS NO.11 AND 12
EAST ASH POND
EXPANSION TO ELEVATION 620
VERMILION POWER STATION

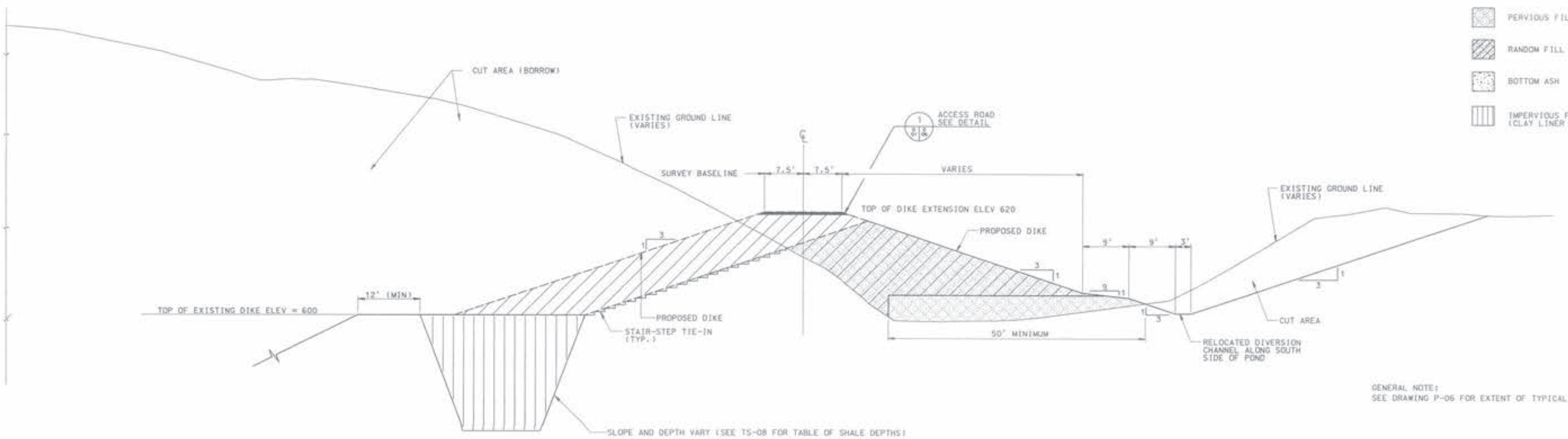
URS PROJECT NO. 23-20020051.00
SHEET NO. TS-06
E-VER1-C129-6



TYPICAL SECTION NO 14
BLOCK LINER CONSTRUCTION SOUTHWEST
STA 15+89 TO STA 15+97

LEGEND

- IMPERVIOUS FILL
- PERVIOUS FILL
- RANDOM FILL
- BOTTOM ASH
- IMPERVIOUS FILL (CLAY LINER TIE-IN TRENCH TO SHALE)



GENERAL NOTE:
SEE DRAWING P-06 FOR EXTENT OF TYPICAL SECTIONS.

TYPICAL SECTION NO 13
BOTTOM LINER CONSTRUCTION SOUTHWEST
STA 10+38 TO STA 15+89

0 10' 20'
1'' = 10' H

0 10' 20'
1'' = 10' V

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URS

2318 Millpark Drive
St. Louis, MO 63043
Tel: 314-429-0100
Fax: 314-429-0462

SEAL

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SUBMITTED: 3/7/03

DYNEGY
DYNEGY MIDWEST GENERATION
VERMILION POWER STATION
DANVILLE, ILLINOIS

EAST ASH POND EXPANSION

TYPICAL SECTIONS NO.13 AND 14
EAST ASH POND
EXPANSION TO ELEVATION 620
VERMILION POWER STATION

URS PROJECT NO. 23-20020051.00

SHEET NO. TS-07

E-VER1-C129-7

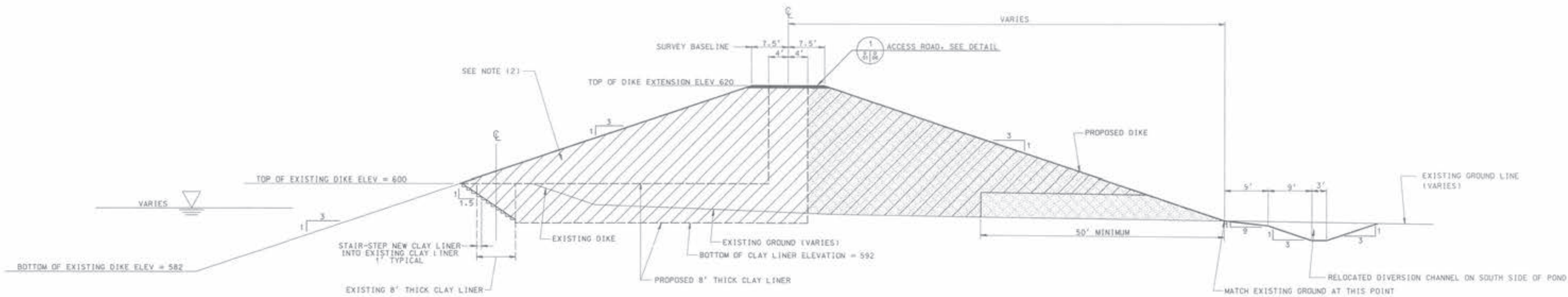
ELEVATION OF SHALE AS MEASURED IN BOTTOM OF CLAY LINER TIE-IN TRENCH
(SEE TS-05, TS-06, AND TS-07 FOR SECTIONS)

ROAD STATION	BOTTOM ELEVATION	OFFSET FT. LEFT *
2+60	592.0	5
3+05	592.0	39
3+55	592.0	83
4+00	582.8	105
4+95	580.3	141
5+25	582.5	152
5+80	583.7	173
6+40	585.5	194
6+95	586.7	182
7+53	584.7	173
8+06	585.0	148
8+63	583.7	124
9+18	585.4	100
9+85	585.6	73
10+25	585.0	56
11+00	584.9	47
11+90	579.0	47
12+40	579.0	47
12+90	577.0	47
13+40	577.5	46
13+90	579.0	46
14+65	580.0	47
15+20	584.3	47
15+98	582.2	48

* PERPENDICULAR FROM ℄ OF TRENCH TO INSIDE EDGE OF ROAD

LEGEND

- IMPERVIOUS FILL
- PERVIOUS FILL
- RANDOM FILL
- BOTTOM ASH



TYPICAL SECTION NO 15
DOWNSTREAM CONSTRUCTION SOUTH
STA 15+97 TO STA 22+58

0 10' 20'
1'' = 10' H

0 10' 20'
1'' = 10' V

GENERAL NOTES:
(1) SEE DRAWING P-06 FOR EXTENT OF TYPICAL SECTIONS.
(2) DUE TO MATERIAL VOLUME LIMITATIONS, IMPERVIOUS FILL MATERIAL WAS NOT EXCLUSIVELY USED FOR THE INSIDE HALF OF THE EMBANKMENT. HOWEVER, IT WAS USED, AT A MINIMUM, FOR THE PROPOSED 8' THICK CLAY LINER LIMITS SHOWN.

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1	6/14/02	MODIFICATIONS/CLARIFICATIONS AND ADDITIONAL DETAILS FOR BID PACKAGE SUBMITTAL	DAG

PREPARED BY:

URS
2318 Millpark Drive
St. Louis, MO 63043
Tel: 314-429-0100
Fax: 314-429-0462

SEAL

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DYNEGY
DYNEGY MIDWEST GENERATION
VERMILION POWER STATION
DANVILLE, ILLINOIS

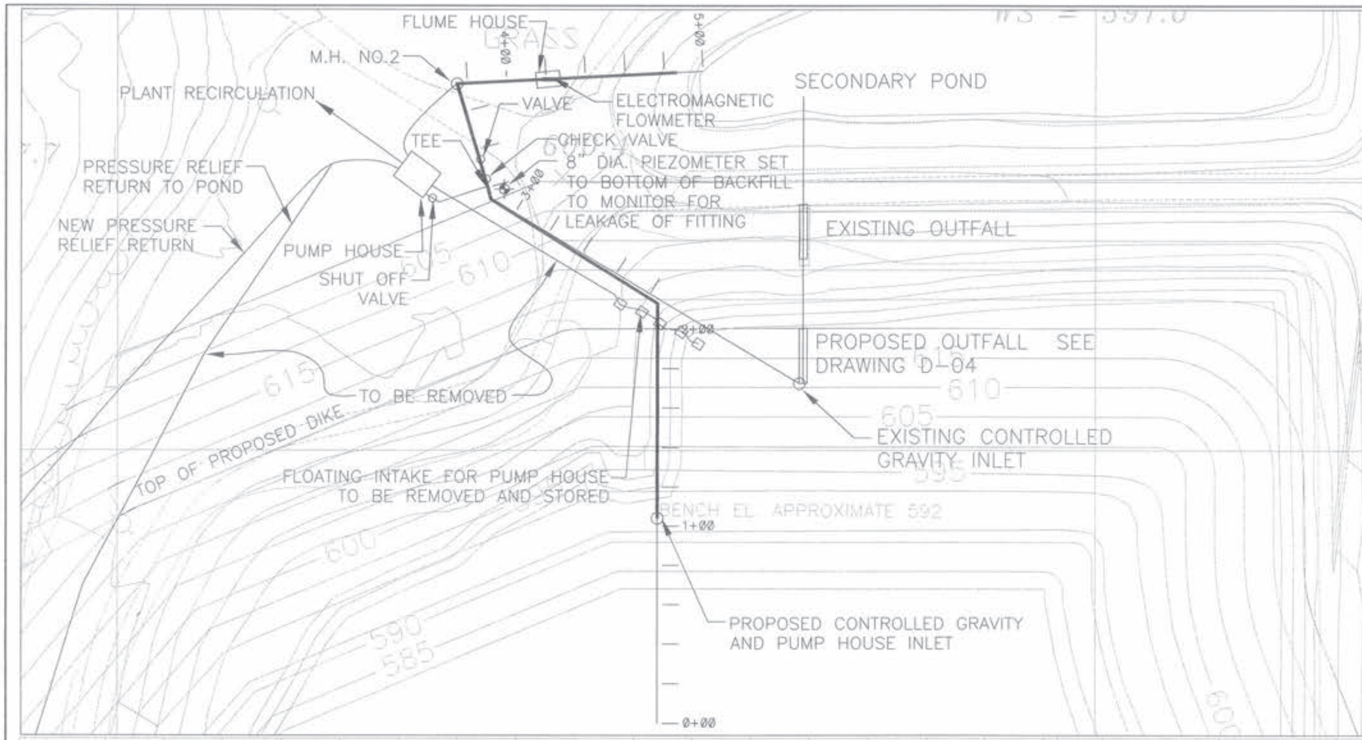
EAST ASH POND EXPANSION

TYPICAL SECTIONS NO. 15
EAST ASH POND
EXPANSION TO ELEVATION 620
VERMILION POWER STATION

URS PROJECT NO. 23-20020051.00

SHEET NO. TS-08

E-VER1-C129-8



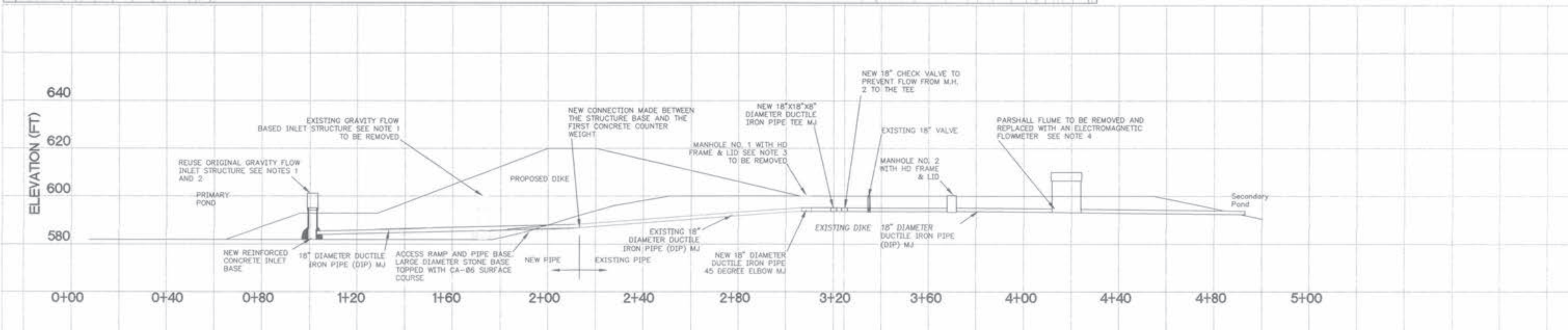
NOTES:

1. REMOVE EXISTING CONTROLLED GRAVITY FLOW INLET STRUCTURE AND SKIMMER. THE INLET SHALL BE DISASSEMBLED TO THE CONCRETE BASE AND SALVAGED. ALL PIPE SECTIONS SHALL BE STORED FOR REUSE AS THE NEW GRAVITY FLOW INLET. THE CORRUGATED METAL SKIMMER SHALL BE REPLACED.

2. THE NEW GRAVITY FLOW INLET SHALL BE CONSTRUCTED REUSING THE OLD INLET PIPE SECTIONS. THE BASE IS TO BE CONSTRUCTED IN THE SAME MANNER AS THE EXISTING BASE AND SET ON SHALE AT ELEVATION 582. SEE DRAWING D-06. A NEW SKIMMER SHALL BE CONSTRUCTED AND IS SHOWN ON DRAWING NUMBER D-06.

3. EXISTING MANHOLE 1 SHALL BE REMOVED AND REPLACED WITH AN 18 INCH 45 DEGREE ELBOW, 18 INCH TEE WITH A 8 INCH BRANCH AND A 18 INCH CHECK VALVE SHALL BE INSTALLED AT THE SAME TIME. THE CHECK VALVE SHALL BE INSTALLED TO ALLOW FLOW FROM THE TEE TO M.H. NO. 2.

4. THE PARSHALL FLUME SHALL BE REMOVED COMPLETELY AND REPLACED WITH AN ELECTROMAGNETIC FLOWMETER.



GENERAL NOTES:
1) LOCATION AND POSITIONING OF PROPERTY FEATURES SHOULD BE REFERENCED TO:
   A) ILLINOIS STATE PLANE COORDINATE SYSTEM FOR HORZONTAL CONTROL.
   B) NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD, 1929) FOR VERTICAL CONTROL
2) EXISTING CONTOURS SHOWN ON 4' INTERVALS.

NO.	DATE	REVISION DESCRIPTION	APPROVED
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PREPARED BY:

URS

2318 Millpark Drive
St. Louis, MO. 63043
Tel: 314-429-0100
Fax: 314-429-0462

3/7/03
SEAL

DATE:	6/14/02
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DRAWN:	DJD
CHECKED:	WDL
APPROVED:	DAG
SUBMITTED:	3/7/03

DYNEGY

DYNEGY MIDWEST GENERATION
VERMILION POWER STATION
DANVILLE, ILLINOIS

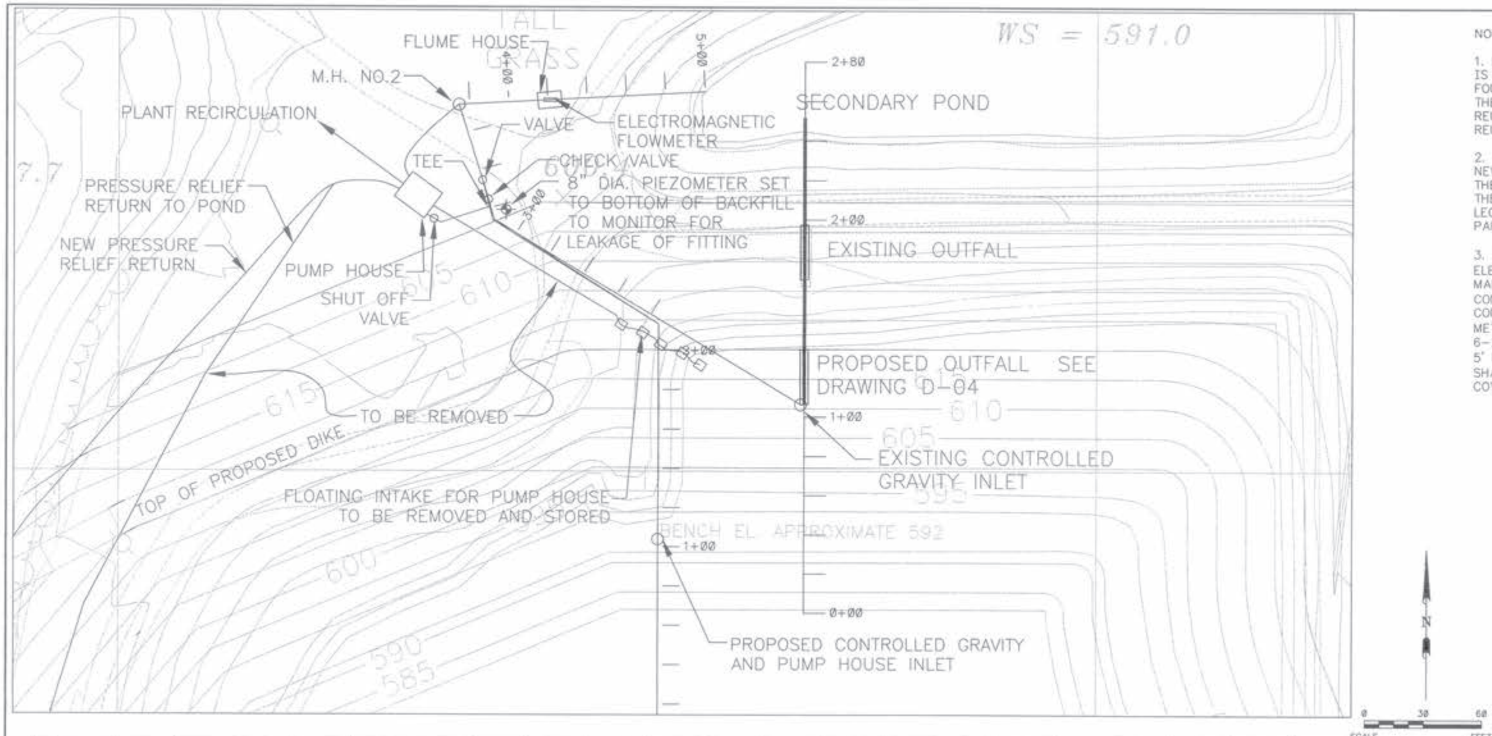
EAST ASH POND EXPANSION

GRAVITY CONTROL SYSTEM
PLAN AND PROFILE
EAST ASH POND EXPANSION TO EL. 620
VERMILION POWER STATION

URS PROJECT NO. 23-20020051.00

SHEET NO. D-02

E-VERI-C130-2

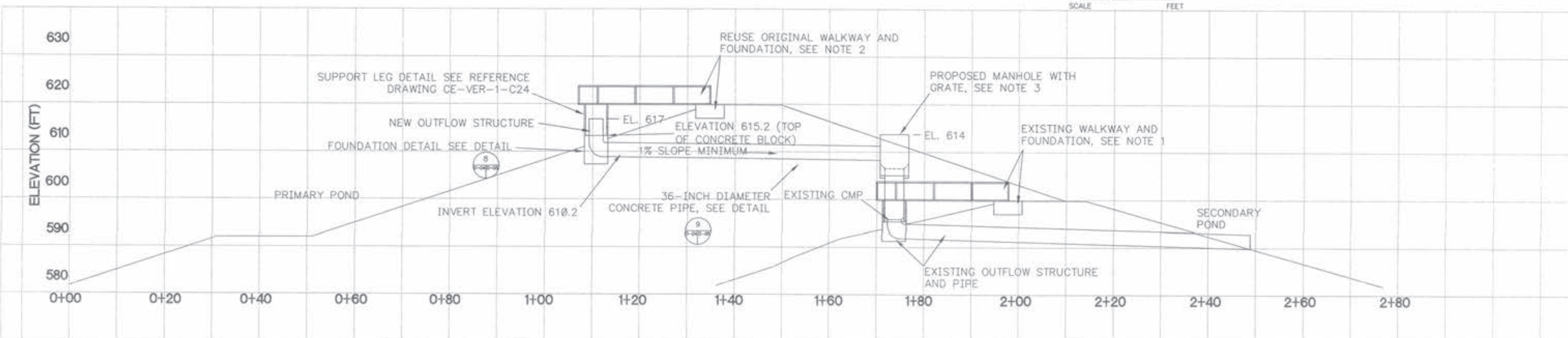


NOTES:

1. EXISTING WALKWAY IS TO BE REMOVED AND REUSED. THE WALKWAY IS TO BE UNBOLTED FROM ITS SUPPORT LEGS AND FROM THE FOUNDATION. THE LEGS SHALL BE CUT OFF AT THE CONCRETE BASE. THE FOUNDATION AT THE TOP OF THE DIKE SHALL BE REMOVED AND REUSED. THE WALKWAY AND THE FOUNDATION SHOULD BE STORED UNTIL REUSED.

2. THE EXISTING WALKWAY AND FOUNDATION SHALL BE REUSED WITH THE NEW OUTFALL. THE FOUNDATION SHALL BE PLACED AT THE CREST OF THE DIKE. NEW SUPPORT LEGS SHALL BE FABRICATED AND SET INTO THE CONCRETE BASE. THE WALKWAY SHALL BE BOLTED TO THE SUPPORT LEG AND FOUNDATION. SEE REFERENCE DRAWINGS FOR SUPPORT LEG PARTS.

3. MANHOLE SHALL BE MADE OF 4' DIAMETER CONCRETE PIPE, TO ELEVATION 603.8. THE REMAINING SECTIONS SHALL BE 5' DIAMETER MANHOLES. THE NEW 36-INCH DIAMETER CONCRETE PIPE SHALL BE CONNECTED TO THE 5' DIAMETER MANHOLE. THE FIRST VERTICAL 4' CONCRETE PIPE IS TO BE PLACED OVER THE EXISTING CORRUGATED METAL PIPE AND THE ANNULUS GROUTED. A FOUNDATION 1' WIDE BY 6-INCHES DEEP SHALL BE POURED AT ELEVATION 602.3 TO SUPPORT THE 5' DIAMETER MANHOLE. THE ANNULUS BETWEEN THE 5' AND 4' PIPES SHALL BE GROUTED (1' MINIMUM). THE TOP OF THE MANHOLE IS TO BE COVERED WITH A GRATE.



GENERAL NOTES:
1) LOCATION AND POSITIONING OF PROPERTY FEATURES SHOULD BE REFERENCED TO:
A) ILLINOIS STATE PLANE COORDINATE SYSTEM FOR HORZONTAL CONTROL.
B) NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD, 1929) FOR VERTICAL CONTROL
2) EXISTING CONTOURS SHOWN ON 4' INTERVALS.

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PREPARED BY:

URS

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St. Louis, MO. 63043
Tel: 314-429-0100
Fax: 314-429-0462

SEAL 3/5/03

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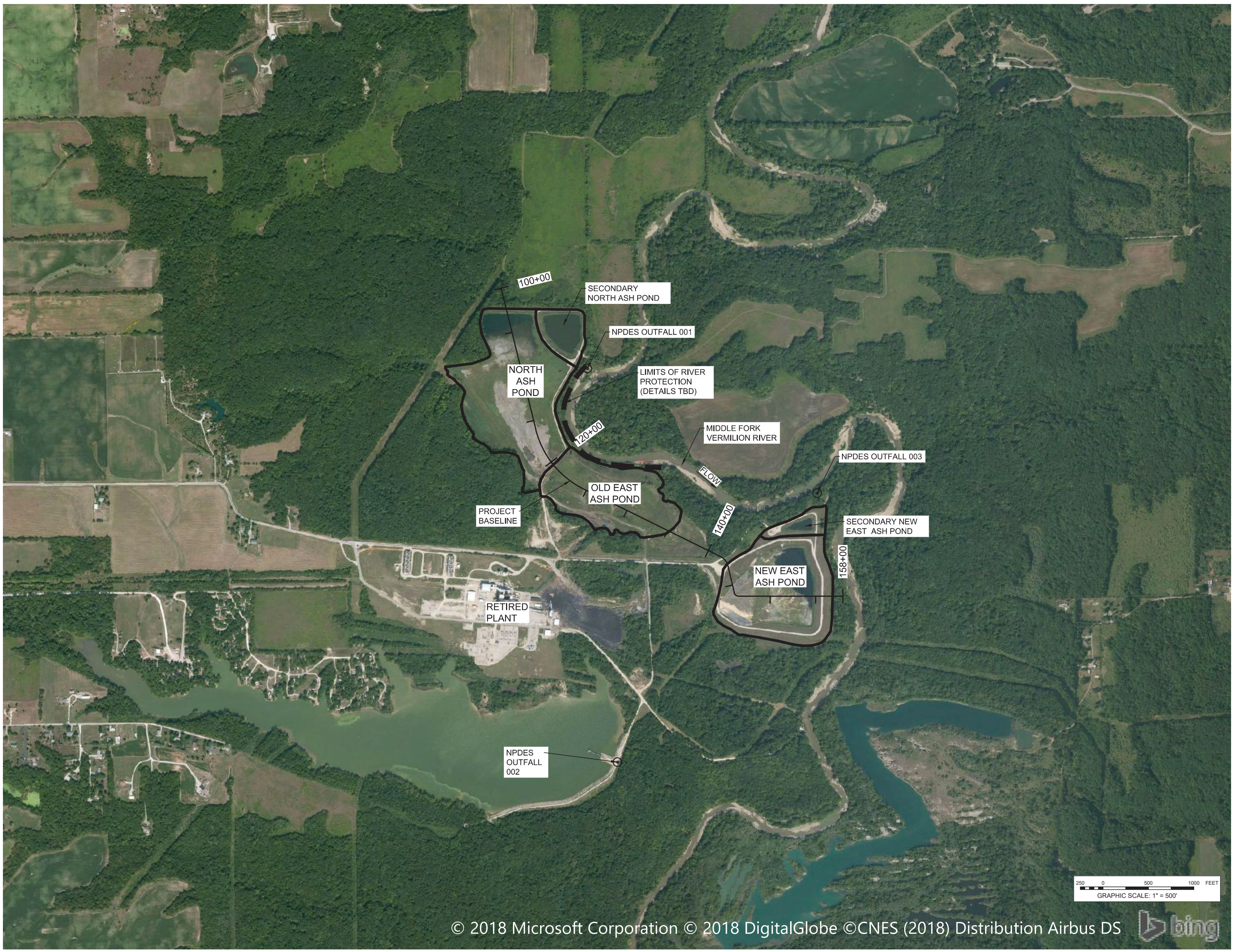
DYNEGY
DYNEGY MIDWEST GENERATION
VERMILION POWER STATION
DANVILLE, ILLINOIS

EAST ASH POND EXPANSION

OUTFALL SYSTEM PLAN AND PROFILE
EAST ASH POND EXPANSION TO EL. 620
VERMILION POWER STATION

URS PROJECT NO. 23-20020051.00
SHEET NO. D-04
E-VERI-C130-4



Stantec
1859 Bowles Avenue, Suite 250
Fenton, Missouri 63026-1944
Tel: (636) 343-3880
www.stantec.com

Consultant

Notes

-

LEGEND

PRO˜ECT BASELINE
APPROXIMATE ASH POND BOUNDARY
LIMITS OF RIVER PROTECTION

Revision	By	Appd	YYYY.MM.DD
0			

Issued	By	Appd	YYYY.MM.DD
A			

File Name: 02-57154_100_SOV	TJ	CJJ	MCV	2019.06.19
	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Permit/Seal

PERMIT DRAWING NOT FOR CONSTRUCTION

Client/Project Logo

Client/Project
DYNEGY MIDWEST GENERATION, LLC

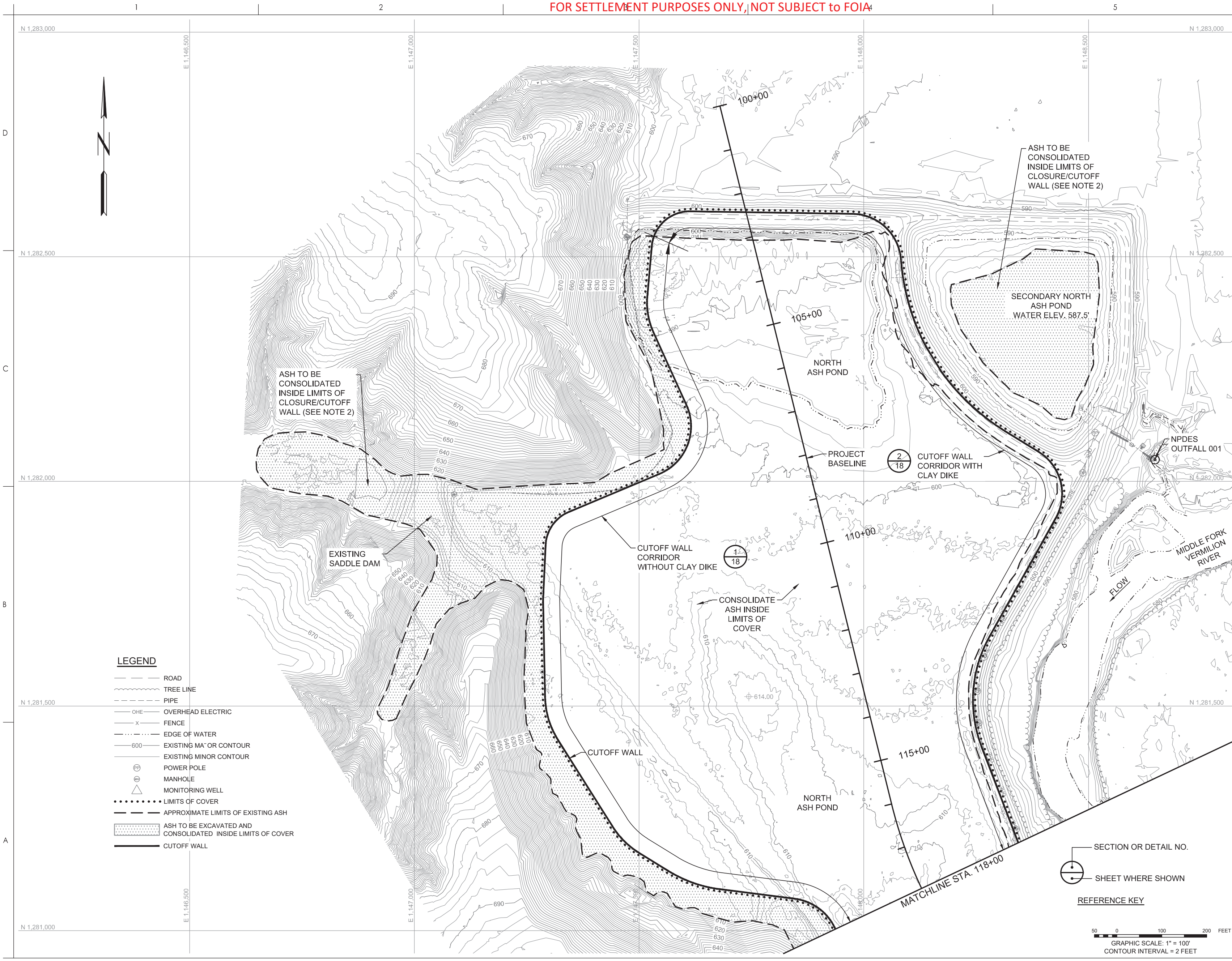
VERMILION ASH PONDS CLOSURE PLAN

OAKWOOD, ILLINOIS

Title
SITE OVERVIEW

Project No. 175657154
Scale 1"=500'

Revision A
Sheet 2 of 18
Drawing No.



Stantec

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1859 Bowles Avenue, Suite 250
Fenton, Missouri 63026-1944
Tel: (636) 343-3880
www.stantec.com

Consultant

Notes

1. DETAILED TOPOGRAPHIC SURVEY WAS COMPLETED ON MARCH 26, 2018 BY INGENAE. PUBLICLY AVAILABLE LIDAR WAS USED TO SUPPLEMENT EXISTING TOPOGRAPHY BEYOND THE LIMITS OF THE DETAILED SURVEY.
2. ASH OUTSIDE OF THE LIMITS OF THE CUTOFF WALL WILL BE EXCAVATED AND PLACED WITHIN THE LIMITS OF THE CUTOFF WALL. EXISTING ASH WILL BE EXCAVATED TO VISIBLE NATIVE GROUND. ONCE VISUALLY EXCAVATED, AN ADDITIONAL ONE FOOT OF MATERIAL WILL BE EXCAVATED. THESE AREAS WILL THEN BE GRADED TO DRAIN.
3. APPROXIMATE LIMITS OF ASH SHOWN ON THIS DRAWING WILL BE VERIFIED DURING CONSTRUCTION.

Issued	By	Appd	YYYY.MM.DD
A			

Dwn.	Dsgn.	Chkd.	YYYY.MM.DD
ACC	CJJ	MCV	2019.06.19

Permit/Seal

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Client/Project Logo

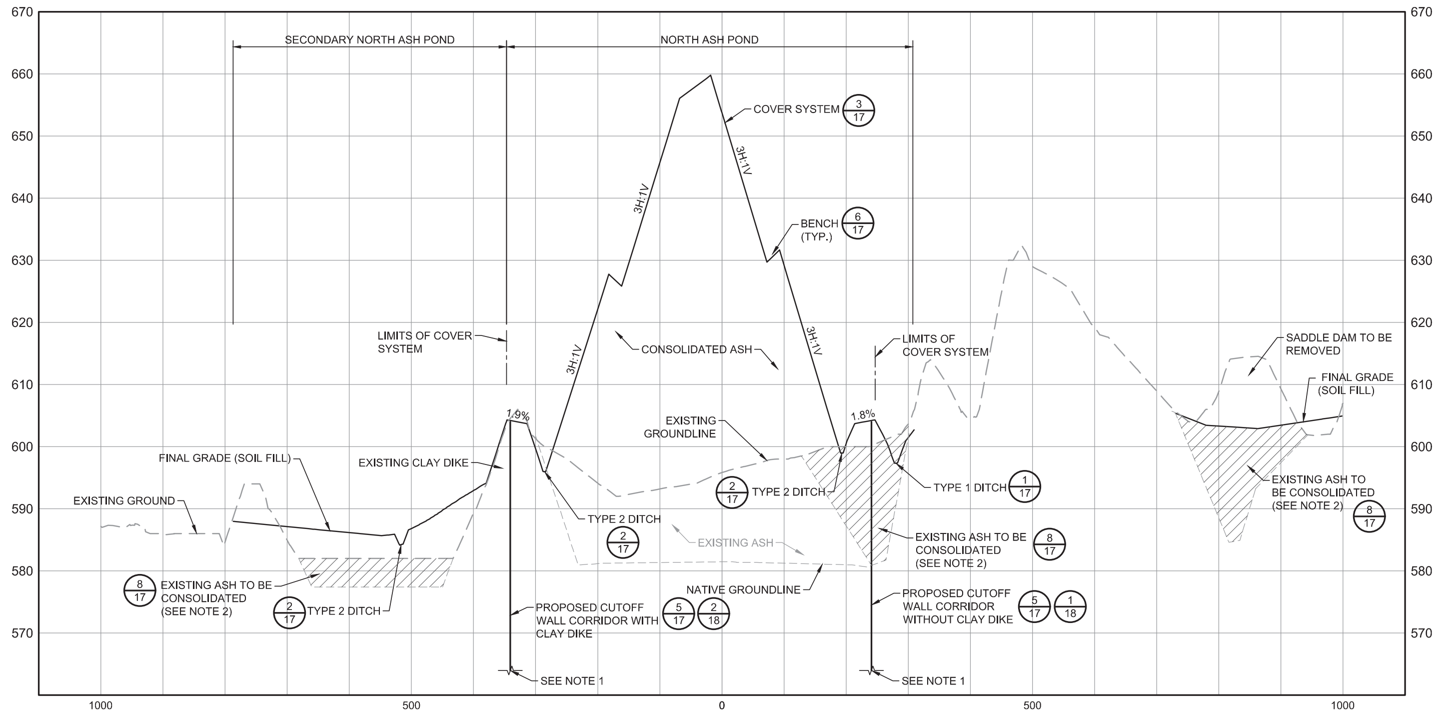
Client/Project
DYNEGY MIDWEST GENERATION, LLC

VERMILION ASH PONDS CLOSURE PLAN

OAKWOOD, ILLINOIS

Title
NORTH ASH POND
PROJECT OVERVIEW

Project No. 175657154
Scale 1"=100'
Revision A
Sheet 3 of 18
Drawing No.



1/11 CROSS SECTION - STATION 107+00
SCALE: 1"=100' (HORIZONTAL)
1"=10' (VERTICAL)

SECTION OR DETAIL NO.
SHEET WHERE SHOWN
REFERENCE KEY

Stantec

Stantec
1859 Bowles Avenue, Suite 250
Fenton, Missouri 63026-1944
Tel: (636) 343-3880
www.stantec.com

Consultant

Notes

1. THE CUTOFF WALL WILL EXTEND TO BEDROCK. THE BOTTOM OF THE WALL IS NOT SHOWN AND WILL BE IDENTIFIED DURING FINAL DESIGN.
2. ASH OUTSIDE OF THE LIMITS OF THE CUTOFF WALL WILL BE EXCAVATED AND PLACED WITHIN THE LIMITS OF THE CUTOFF WALL. EXISTING ASH WILL BE EXCAVATED TO VISIBLE NATIVE GROUND. ONCE VISUALLY EXCAVATED, AN ADDITIONAL ONE FOOT OF MATERIAL WILL BE EXCAVATED.
3. PROPOSED FINAL GRADE CONTOURS SHOWN OUTSIDE OF THE LIMITS OF COVER WILL BE ACHIEVED BY PLACING SOIL FILL.

Revision	By	Appd	YYYY.MM.DD
0			

Issued	By	Appd	YYYY.MM.DD
A			

File Name: 11_16-57154_302_XS1	ACC	CJJ	MCV	2019.06.19
	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Permit/Seal

PERMIT DRAWING NOT FOR CONSTRUCTION

Client/Project Logo

Client/Project
DYNEGY MIDWEST GENERATION, LLC

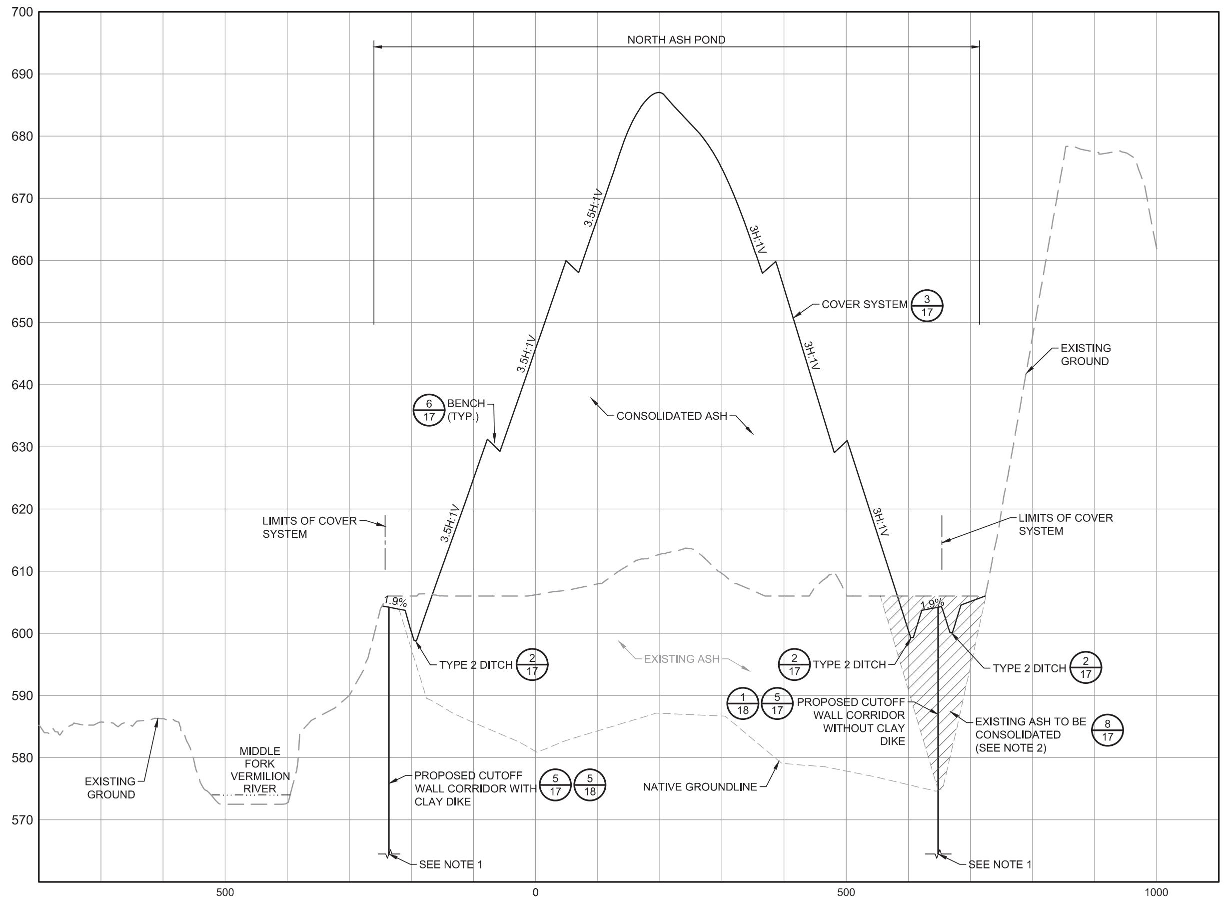
VERMILION ASH PONDS CLOSURE PLAN

OAKWOOD, ILLINOIS

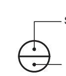
Title
NORTH ASH POND
CROSS SECTION

Project No.	Scale
175657154	AS NOTED

Revision	Sheet	Drawing No.
A	11 of 18	



1/12 CROSS SECTION - STATION 114+00
SCALE: 1"=100' (HORIZONTAL)
1"=10' (VERTICAL)



REFERENCE KEY

Stantec
1859 Bowles Avenue, Suite 250
Fenton, Missouri 63026-1944
Tel: (636) 343-3880
www.stantec.com

Consultant

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Revision	By	Appd	YYYY.MM.DD
0			

Issued	By	Appd	YYYY.MM.DD
A			

File Name: 11_16-57154_302_XS1	ACC	CJJ	MCV	2019.06.19
	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Permit/Seal

PERMIT DRAWING NOT FOR CONSTRUCTION

Client/Project Logo

Client/Project

DYNEGY MIDWEST GENERATION, LLC

VERMILION ASH PONDS CLOSURE PLAN

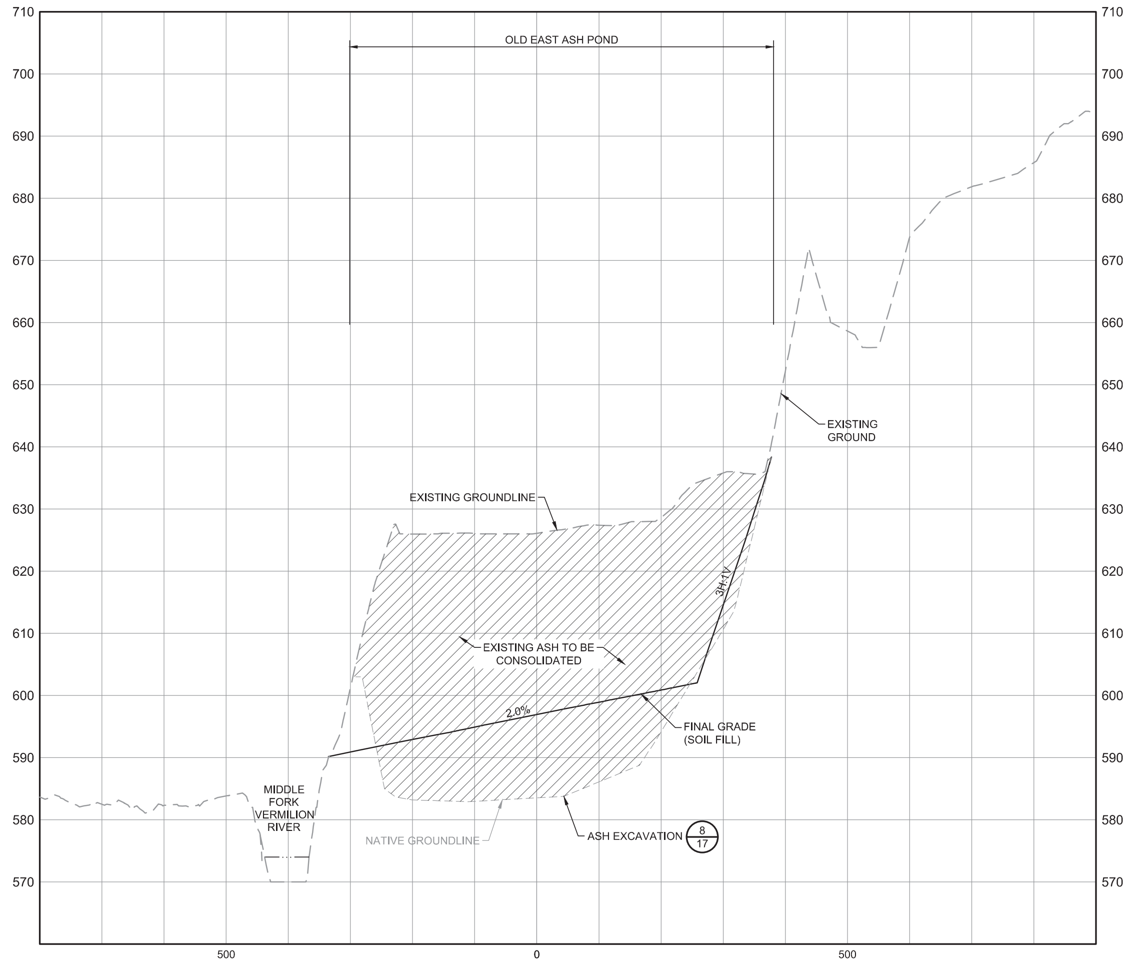
OAKWOOD, ILLINOIS

Title

NORTH ASH POND CROSS SECTION

Project No.	Scale
175657154	AS NOTED

Revision	Sheet	Drawing No.
A	12 of 18	



1 / 13 CROSS SECTION - STATION 124+00
SCALE: 1"=100' (HORIZONTAL)
1"=10' (VERTICAL)

SECTION OR DETAIL NO.
SHEET WHERE SHOWN
REFERENCE KEY

Stantec
1859 Bowles Avenue, Suite 250
Fenton, Missouri 63026-1944
Tel: (636) 343-3880
www.stantec.com

Consultant

Notes
1. ASH OUTSIDE OF THE LIMITS OF THE CUTOFF WALL WILL BE EXCAVATED AND PLACED WITHIN THE LIMITS OF THE CUTOFF WALL. EXISTING ASH WILL BE EXCAVATED TO VISIBLE NATIVE GROUND, ONCE VISUALLY EXCAVATED, AN ADDITIONAL ONE FOOT OF MATERIAL WILL BE EXCAVATED.
2. PROPOSED FINAL GRADE CONTOURS SHOWN OUTSIDE OF THE LIMITS OF COVER WILL BE ACHIEVED BY PLACING SOIL FILL.

Revision	By	Appd	YYYY.MM.DD
0			

Issued	By	Appd	YYYY.MM.DD
A			

File Name: 11_16-57154_302_XS1	ACC	CJJ	MCV	2019.06.19
	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Permit/Seal

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Client/Project Logo

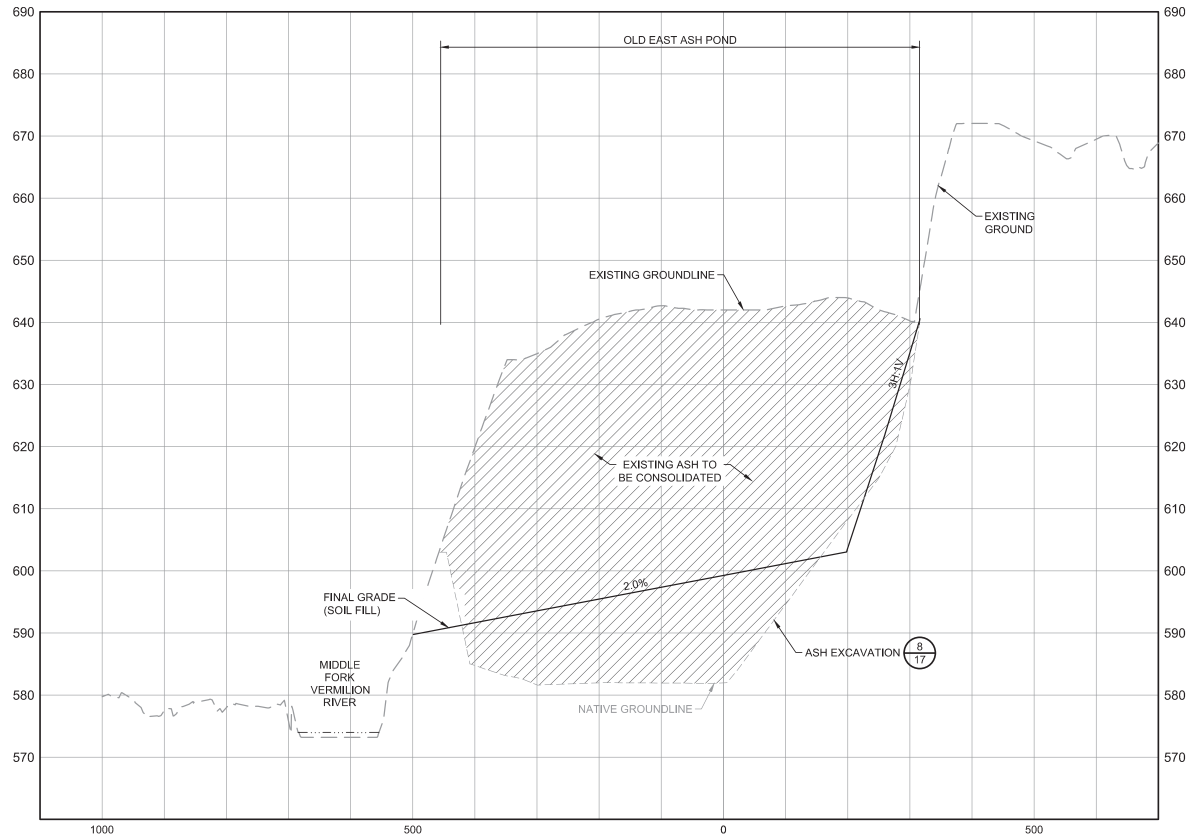
Client/Project
DYNEGY MIDWEST GENERATION, LLC

VERMILION ASH PONDS CLOSURE PLAN

OAKWOOD, ILLINOIS

Title
OLD EAST ASH POND CROSS SECTION

Project No. 175657154
Scale AS NOTED
Revision A
Sheet 13 of 18
Drawing No.



1/14 CROSS SECTION - STATION 130+00
SCALE: 1"=100' (HORIZONTAL)
1"=10' (VERTICAL)

SECTION OR DETAIL NO.
SHEET WHERE SHOWN
REFERENCE KEY

Stantec

Stantec
1859 Bowles Avenue, Suite 250
Fenton, Missouri 63026-1944
Tel: (636) 343-3880
www.stantec.com

Consultant

Notes

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2. PROPOSED FINAL GRADE CONTOURS SHOWN OUTSIDE OF THE LIMITS OF COVER WILL BE ACHIEVED BY PLACING SOIL FILL.

Revision	By	Appd	YYYY.MM.DD
0			

Issued	By	Appd	YYYY.MM.DD
A			

File Name: 11_16-57154_302_XS1	ACC	CJJ	MCV	2019.06.19
	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Permit/Seal

PERMIT DRAWING NOT FOR CONSTRUCTION

Client/Project Logo

Client/Project
DYNEGY MIDWEST GENERATION, LLC

VERMILION ASH PONDS CLOSURE PLAN

OAKWOOD, ILLINOIS

Title
OLD EAST ASH POND
CROSS SECTION

Project No. 175657154
Scale AS NOTED
Revision A
Sheet 14 of 18
Drawing No.

APPENDIX C. BORING AND PIEZOMETER LOCATIONS

VERMILION POWER STATION

NORTH, OLD EAST AND EAST ASH POND CLOSURE
BORING LOCATION MAP
DRAWING-01

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Saint Louis, Missouri 63026-1944
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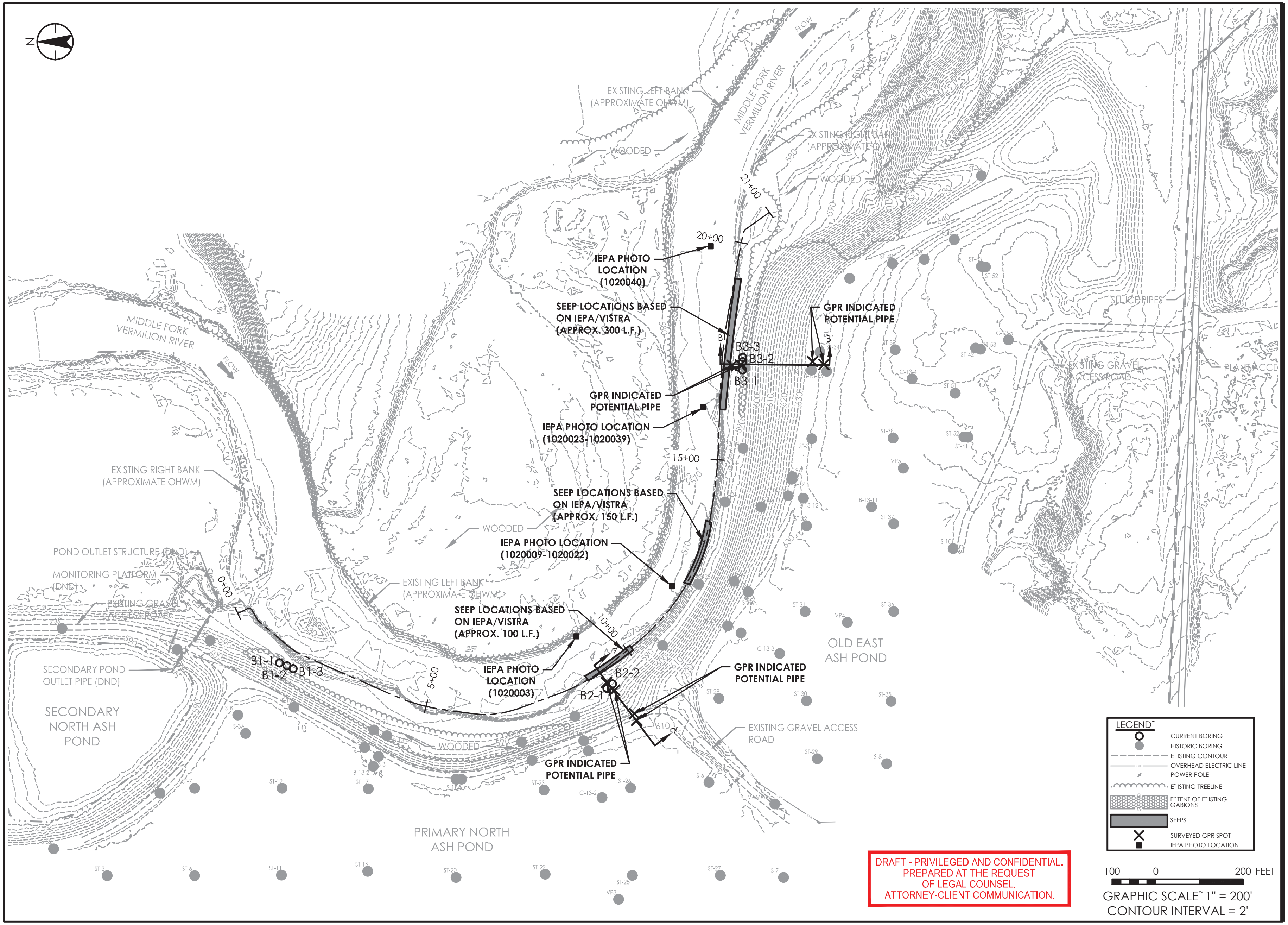
DYNEGY, INC.

MAY 15, 2017



DRAFT - PRIVILEGED AND CONFIDENTIAL. PREPARED AT THE REQUEST OF LEGAL COUNSEL. ATTORNEY-CLIENT COMMUNICATION.

Stantec
3052 Beaumont Centre Circle
Lexington, Kentucky 40513
www.stantec.com

Client/Project
VISTRA ENERGY
MIDDLE FORK VERMILION RIVER
SEEP MITIGATION
OAKWOOD, ILLINOIS

Title
PIPE, SEEPAGE, AND BORING LOCATION PLAN

Permit-Seal

Project Number: 175657154
File Name: Pipe_Plan.dwg

BFS	JSH	TCD	18.10.05
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Drawing No. *
Revision 0
Sheet * of *

Privileged and confidential. Prepared at the request of legal counsel. Attorney-client communication.

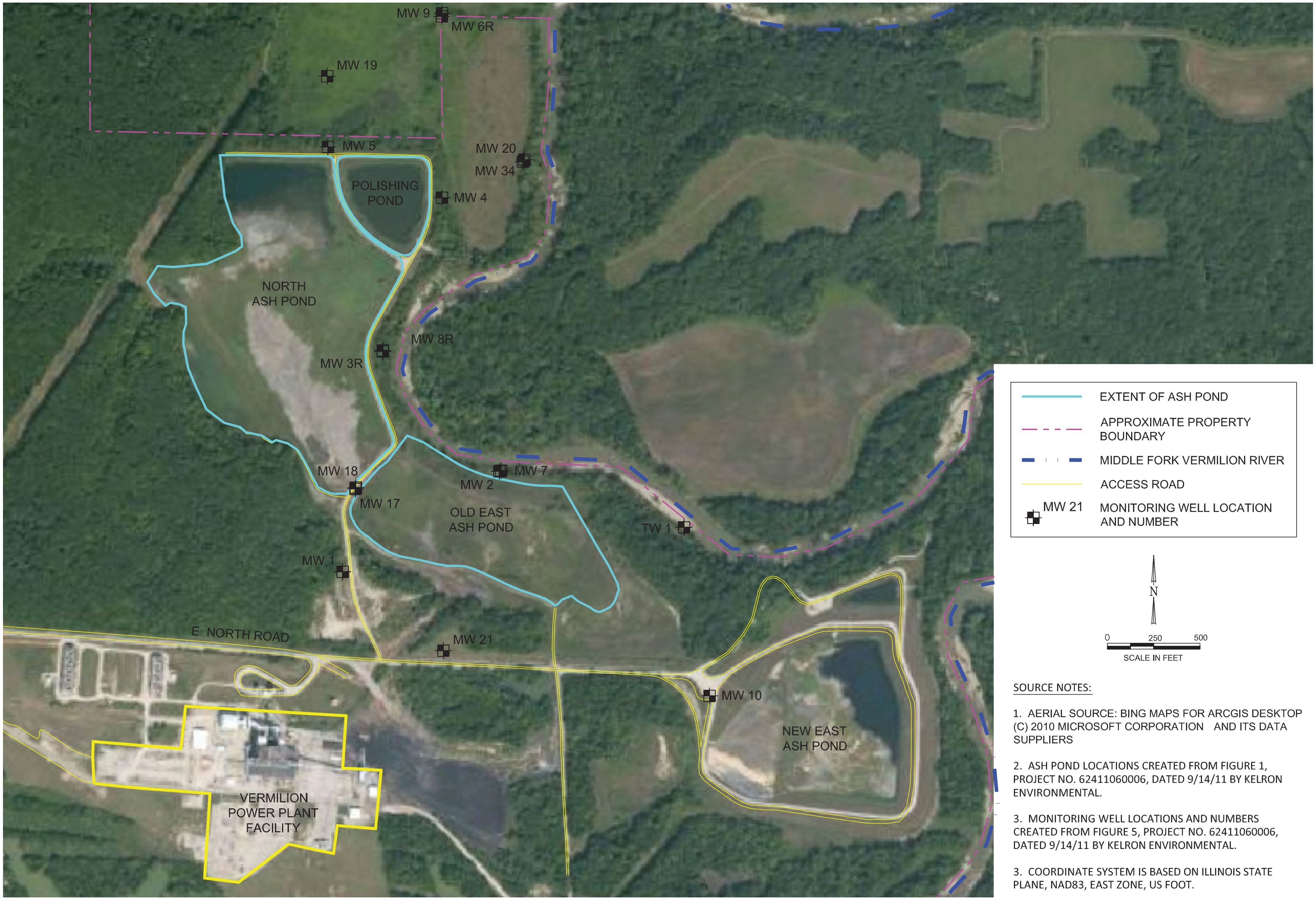
VERMILION POWER STATION

NORTH, OLD EAST AND EAST ASH POND CLOSURE
SUMMARY O˜ STAGE 1 BORINGS AND TEST PITS
DRAWING-01

Stantec

1859 Bowles Avenue, Suite 250
Saint Louis, Missouri 63026-1944
www.stantec.com

DECEMBER 0˜, 201˜



SOURCE NOTES:

1. AERIAL SOURCE: BING MAPS FOR ARCGIS DESKTOP (C) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS

2. ASH POND LOCATIONS CREATED FROM FIGURE 1, PROJECT NO. 62411060006, DATED 9/14/11 BY KELRON ENVIRONMENTAL.

3. MONITORING WELL LOCATIONS AND NUMBERS CREATED FROM FIGURE 5, PROJECT NO. 62411060006, DATED 9/14/11 BY KELRON ENVIRONMENTAL.

3. COORDINATE SYSTEM IS BASED ON ILLINOIS STATE PLANE, NAD83, EAST ZONE, US FOOT.

DRAWN BY: NWD DATE: 03/02/12
CHECKED BY: CAR/BRH DATE: 03/02/12
APPROVED BY: BRH DATE: 03/26/12
DRAWING NO: 20461-12-B01-2C
REFERENCE: .

SITE MAP
NORTH ASH POND SYSTEM
CORRECTIVE ACTION PLAN
DYNEGY MIDWEST GENERATION, LLC
VERMILION POWER STATION
OAKWOOD, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2046.1/1.2

FIGURE NO.
1-2

PROPOSED MONITORED NATURAL ATTENUATION BORING LOCATIONS

Privileged & Confidential

DYNEGY MIDWEST GENERATION
VERMILION SITE
OAKWOOD, ILLINOIS

FIGURE 2

DRAFT

RAMBOLL US CORPORATION
A RAMBOLL COMPANY

APPENDIX D. OPERATION AND MAINTENANCE PLANS

- **VERMILION POWER PLANT NORTH ASH POND (OCT. 2013) OPERATION AND MAINTENANCE PLAN, DRAFT**
- **VERMILION POWER PLANT OLD EAST ASH POND (OCT. 2013) OPERATION AND MAINTENANCE PLAN, DRAFT**
- **VERMILION POWER PLANT EAST ASH POND SYSTEM (NOV. 2014) OPERATION AND MAINTENANCE PLAN**

DYNEGY OPERATING COMPANY

Vermilion Power Station

Oakwood, Illinois

North Ash Pond

IDNR Permit No. (Not permitted)

Dam ID No. (Not permitted)

Operation and Maintenance Plan

October 2013

TABLE OF CONTENTS

Paragraph	Description	Page
1.0	GENERAL	1
2.0	EMERGENCY OPERATIONS	1
2.1	Unusual Conditions	1
2.2	Dewatering	2
3.0	MAINTENANCE	2
3.1	Vegetation	2
3.2	Effluent Discharge Canal	2
3.3	Animal Damage and Repairs	2
3.4	Restriction of Unauthorized Vehicles	3
3.5	Riverbank Erosion	3
3.6	Inspections	3
4.0	REPORTING	4

DYNEGY OPERATING COMPANY
VERMILION POWER STATION
IDAM OPERATION AND MAINTENANCE PLAN

1.0 GENERAL

The following maintenance procedures are provided to insure the structural integrity of the Vermilion reservoir system, which is unclassified by the Illinois Department of Natural Resources, Office of Water Resources (OWR). It should be noted that the station was mothballed in March 2011 and retired in November 2011.

2.0 EMERGENCY OPERATIONS

2.1 Unusual Conditions

Any unusual condition discovered during routine inspection which may constitute an emergency shall be handled as follows. Notice of any type of emergency involving the berms or outfall shall be made to the following:

Project Manager, Engineering and Projects Department: Frank Bielser

office: (217) 762-8291
home: (217) 762-8291
cellular phone: (217) 412-6612
e-mail: frank.bielser@dynegy.com

or

Senior Director, Eng. and Projects Department: Mark Vogt

office: (618) 206-5890
home: (618) 282-6193
cellular phone: (618) 410-6618
blackberry: mark.vogt@dynegy.com

One of the above designated personnel shall notify the following county, state, and federal regulatory authorities, and the consulting engineer of the emergency condition.

Office of Water Resources, Dam Safety Section, Dam Safety Engineers
(217) 782-3863 (Monday - Friday, 8:00 a.m. - 4:30 p.m.)

Illinois Emergency Management Agency, 24-hour service
1-(800) 782-7860

Vermilion County Sheriff
Emergency 911 or (217) 442-4080
Illinois Department of Natural Resources, Kickapoo State Park
(217) 442-4915

Senior Director - Environmental Compliance – Rick Diericx
(618) 206-5912 or Rick.Diericx@dynegy.com

2.2 Dewatering

The Senior Director and Project Manager shall have the responsibility of determining whether dewatering of the disposal facility is necessary. A concrete spillway structure is located at the facility. Dewatering will be accomplished, using portable pumps.

3.0 MAINTENANCE

3.1 Vegetation

Berms 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 the inspections shall be cut and removed from the berms and outfall channel. This shall be done frequently enough that no trees will reach the 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 that will facilitate inspections shall be planted and maintained.

3.2 Spillway

The spillway shall be inspected periodically and identified deficiencies resolved.

3.3 Animal Damage and Repairs

Animal burrows discovered during inspections shall be promptly repaired by backfilling/compacting clay.

3.4 Restriction of Unauthorized Vehicles

Access is controlled by the main plant access gate and security fencing. No unauthorized vehicles are allowed into the site area.

3.5 Riverbank Erosion

The ongoing erosion along the riverbank shall be monitored. Any evidence of significant changes to the erosion rate, as compared to the previous inspection, shall be reported immediately to both the Project Manager and Senior Director.

3.6 Inspections

Routine inspections shall be conducted, looking for seepage and slumping; settlement of the crest; sloughing of embankments; formation of depressions near the toe; embankment erosion; and tree growth. Also, any evidence of significant changes to the ongoing riverbank erosion, as compared to the previous inspection, should be monitored.

If such conditions are observed and those conditions are judged to pose an imminent threat to the integrity of the embankment, the notifications described in Section 2.1 of this plan shall be made. These individuals will then meet to develop a plan to evaluate the cause of the distress and any further action required. As a professional courtesy, IDNR will be informed of the condition and any proposed remediation.

Both weekly and quarterly inspections should be conducted, by qualified station employees, supported by DOC personnel, using the inspection checklists forms listed in Section 4.0.

Annual inspections will also be conducted by a licensed professional engineer (PE). All inspections by the PE shall include observations of the embankment surfaces for signs of settlement or slope failure, animal burrows, tree growth, erosion features on or adjacent to the embankments, and the conditions of the discharge facilities.

The inspections by the PE shall be done in general accordance with “Guidelines and Forms for Inspection of Illinois Dams", 1987 using the standard forms approved by the IDNR.

Any deficiencies noted by the PE, warranting remedial actions, shall be reported to both the Project Manager and Senior Director, as listed in Section 2.1. Corrective action shall be implemented, as required, to assure dam safety. Copies of the PE’s reports will not be provided to the Illinois Department of Natural Resources, Office of Water Resources.

4.0 Reporting

The following inspection checklists should be used during the weekly and quarterly inspections.

WEEKLY DAM INSPECTION FORM

Dam Location: Vermilion Station – North Ash Pond
Owner: Dynegy Operating Company
Permit No.: N/A **Class of Dam:** N/A
Type of Dam: Earthen embankment
Type of Spillway: Drop inlet, for both primary and secondary cells

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: Vermilion Station – North Ash Pond
Owner: Dynegy Operating Company
Permit No.: N/A **Class of Dam:** N/A

Type of Dam: __Earthen embankment__________

Type of Spillway: ______Drop inlet, for both primary and secondary cells_________

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		

DYNEGY OPERATING COMPANY

Vermilion Power Station

Oakwood, Illinois

Old East Ash Pond

IDNR Permit No. (Not permitted)

Dam ID No. (Not permitted)

Operation and Maintenance Plan

October 2013

TABLE OF CONTENTS

Paragraph	**Description**	**Page**
1.0	GENERAL	1
2.0	EMERGENCY OPERATIONS	1
2.1	Unusual Conditions	1
2.2	Dewatering	2
3.0	MAINTENANCE	2
3.1	Vegetation	2
3.2	Riverbank Erosion	2
3.3	Animal Damage and Repairs	2
3.4	Restriction of Unauthorized Vehicles	3
3.5	Inspections	3
4.0	REPORTING	4

DYNEGY OPERATING COMPANY
VERMILION POWER STATION
IDAM OPERATION AND MAINTENANCE PLAN

1.0 GENERAL

The following maintenance procedures are provided to insure the structural integrity of the Vermilion reservoir system, which is unclassified by the Illinois Department of Natural Resources, Office of Water Resources (OWR). It should be noted that the station was mothballed in March 2011 and retired in November 2011.

2.0 EMERGENCY OPERATIONS

2.1 Unusual Conditions

Any unusual condition discovered during routine inspection which may constitute an emergency shall be handled as follows. Notice of any type of emergency involving the berms or outfall shall be made to the following:

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home:	(217) 762-8291
cellular phone:	(217) 412-6612
e-mail:	frank.bielser@dynegy.com

or

Senior Director, Eng. and Projects Department: Mark Vogt

office:	(618) 206-5890
home:	(618) 282-6193
cellular phone:	(618) 410-6618
blackberry:	mark.vogt@dynegy.com

One of the above designated personnel shall notify the following county, state, and federal regulatory authorities, and the consulting engineer of the emergency condition.

Office of Water Resources, Dam Safety Section, Dam Safety Engineers
(217) 782-3863 (Monday - Friday, 8:00 a.m. - 4:30 p.m.)

Illinois Emergency Management Agency, 24-hour service
1-(800) 782-7860

Vermilion County Sheriff
Emergency 911 or (217) 442-4080
Illinois Department of Natural Resources, Kickapoo State Park
(217) 442-4915

Senior Director - Environmental Compliance – Rick Diericx
(618) 206-5912 or Rick.Diericx@dynegy.com

2.2 Dewatering

Not applicable.

3.0 MAINTENANCE

3.1 Vegetation

Berms 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 the inspections shall be cut and removed from the berms. This shall be done frequently enough that no trees will reach the 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 that will facilitate inspections shall be planted and maintained.

3.2 Riverbank Erosion

The ongoing erosion along the riverbank shall be monitored. Any evidence of significant changes to the erosion rate, as compared to the previous inspection, shall be reported immediately to both the Project Manager and Senior Director.

3.3 Animal Damage and Repairs

Animal burrows discovered during inspections shall be promptly repaired by backfilling/compacting clay.

3.4 Restriction of Unauthorized Vehicles

Access is controlled by the main plant access gate and security fencing. No unauthorized vehicles are allowed into the site area.

3.5 Inspections

Routine inspections shall be conducted, looking for seepage and slumping; settlement of the crest; sloughing of embankments; formation of depressions near the toe; tree growth; and embankment erosion.

Also, any evidence of significant changes to the ongoing riverbank erosion, as compared to the previous inspection, should be monitored. If such conditions are observed and those conditions are judged to pose an imminent threat to the integrity of the embankment, the notifications described in Section 2.1 of this plan shall be made. These individuals will then meet to develop a plan to evaluate the cause of the distress and any further action required. As a professional courtesy, IDNR will be informed of the condition and any proposed remediation.

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The inspections by the PE shall be done in general accordance with “Guidelines and Forms for Inspection of Illinois Dams", 1987 using the standard forms approved by the IDNR.

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4.0 Reporting

The following inspection checklists should be used during the weekly and quarterly inspections.

WEEKLY DAM INSPECTION FORM

Dam Location: **Vermilion Station – Old East Ash Pond**
Owner: **Dynegy Operating Company**
Permit No.:N/A **Class of Dam: N/A**
Type of Dam: **Earthen/ash embankment**
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: **Vermilion Station – Old East Ash Pond**
Owner: **Dynegy Operating Company**
Permit No.: **N/A** **Class of Dam: N/A**

Type of Dam: __Earthen/ash embankment______________

Type of Spillway: ____________________

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		

DYNEGY OPERATING COMPANY

Vermilion Site

Oakwood, Illinois

East Ash Pond System

Intermediate Class III Dam

IDNR Permit No. DS2011079

Dam ID No. IL50291

Operation and Maintenance Plan

Revised November 2014

TABLE OF CONTENTS

Paragraph	Description	Page
1.0	GENERAL	1
2.0	EMERGENCY OPERATIONS	1
2.1	Unusual Conditions	1
2.2	Dewatering	2
3.0	MAINTENANCE	2
3.1	Vegetation	2
3.2	Effluent Discharge Canal	2
3.3	Animal Damage and Repairs	2
3.4	Restriction of Unauthorized Vehicles	3
3.5	Riverbank Erosion	3
3.6	Inspections	3
4.0	REPORTING	4

DYNEGY OPERATING COMPANY
VERMILION SITE
IDNR CLASS III DAM OPERATION AND MAINTENANCE PLAN

1.0 GENERAL

The following maintenance procedures are provided to insure the structural integrity of the Vermilion wet ash disposal facility, which is classified as an Intermediate Class III dam by the Illinois Department of Natural Resources, Office of Water Resources (OWR). It should be noted that the station was mothballed in March 2011 and retired in November 2011.

2.0 EMERGENCY OPERATIONS

2.1 Unusual Conditions

Any unusual condition discovered during routine inspection which may constitute an emergency shall be handled as follows. Notice of any type of emergency involving the berms or outfall shall be made to the following:

Project Manager, Engineering and Projects Department: Frank Bielser

office:	(217) 762-8291 (Vermilion trailer)
home:	(217) 762-8291
cellular phone:	(217) 412-6612
e-mail:	frank.bielser@dynegy.com

or

Construction Manager: Steve Bluemner, P.E.

office:	(618) 343-7711
personal cell:	(618) 980-0397
cellular (work):	(618) 343-5822
blackberry:	Steve.Bluemner@dynegy.com

One of the above designated personnel shall notify the following, of the emergency condition:

Office of Water Resources, Dam Safety Section, Dam Safety Engineers
(217) 782-3863 (Monday - Friday, 8:00 a.m. - 4:30 p.m.)

Illinois Emergency Management Agency, 24-hour service
1-(800) 782-7860

Vermilion County Sheriff
Emergency 911 or (217) 442-4080
Illinois Department of Natural Resources, Kickapoo State Park
(217) 442-4915

Senior Director - Environmental Compliance – Rick Diericx
(618) 343-7761 or Rick.Diericx@dynegy.com

2.2 Dewatering

The Senior Director and Project Manager shall have the responsibility of determining whether dewatering of the disposal facility is necessary. A gravity outlet structure is located at the facility. The valve to this structure can be opened to lower the water level. This dewatering shall continue until the desired water level is reached.

3.0 MAINTENANCE

3.1 Vegetation

Berms 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 the inspections shall be cut and removed from the berms and outfall channel. This shall be done frequently enough that no trees will reach the 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 that will facilitate inspections shall be planted and maintained.

3.2 Effluent Discharge Canal

The effluent discharge canal shall be inspected semiannually and repaired as needed. Any replacement of riprap shall be done in a timely manner.

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

Access to the ash pond site area is controlled by the main plant access gate. No unauthorized vehicles are allowed into the site area.

3.5 Riverbank Erosion

The ongoing erosion along the riverbank shall be visually monitored and measured, on a periodic basis. Any erosion rate change and measurements shall be documented in the internal inspection checklists. Any evidence of significant changes to the erosion rate, as compared to the previous inspection, shall be reported immediately to both the Project Manager and Senior Director.

3.6 Inspections

Because a portion of the site is probably undermined by coal workings, there is potential for mine-induced subsidence and damage to the embankment. Therefore, the routine inspections are needed to document the condition of the embankment and potential subsidence related damage.

Indications of subsidence would include settlement of the crest, sloughing of embankments or formation of depressions near the toe. If such conditions are observed and those conditions are judged to pose an imminent threat to the integrity of the embankment, the notifications, described in Section 2.1 of this plan, shall be made. These individuals will then meet to develop a plan to evaluate the cause of the distress and any further action required. IDNR will be informed of the condition and any proposed remediation.

Both weekly and quarterly inspections should be conducted, by qualified station employees, supported by DOC personnel, using the inspection checklists forms listed in Section 4.0. Weekly inspections should be focused on evidence of seepage and slumping, and unusual seepage at and/or blockage of outfall structures. Quarterly inspections will be focused on embankment erosion, tree growth and embankment seepage. Also, any evidence of significant changes to the ongoing riverbank erosion, as compared to the previous inspection, should be monitored.

Annual inspections will also be conducted by a licensed professional engineer (PE). All inspections by the PE shall include observations of the embankment surfaces for signs of settlement or slope failure, animal burrows, tree growth, erosion features on or adjacent to the embankments, and the conditions of the discharge facilities.

The inspections by the PE shall be done in general accordance with “Guidelines and Forms for Inspection of Illinois Dams", 1987 using the standard forms approved by the IDNR.

Any deficiencies noted by the PE, warranting remedial actions, shall be reported to both the Project Manager and Senior Director, as listed in Section 2.1. Corrective action, as required to assure dam safety, will be implemented. Every five years, a copy of the most recent PE report shall be provided to the Illinois Department of Natural Resources, Office of Water Resources.

4.0 Reporting

The following inspection checklists should be used during the weekly and quarterly inspections.

WEEKLY DAM INSPECTION FORM

Dam Location: Vermilion Site – East Ash Pond
Owner: Dynegy Operating Company
Permit No.: DS2011079 **Class of Dam:** III
Type of Dam: Earthen embankment
Type of Spillway: Drop inlet, for both primary and seconday

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: Vermilion Site – East Ash Pond
Owner: Dynegy Operating Company
Permit No.: DS2011079 **Class of Dam:** III
Type of Dam: Earthen embankment
Type of Spillway: Drop inlet, for both primary and secondary cells

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 E. SPECIFICATIONS

- **SPECIFICATIONS FOR AN ASH DISPOSAL FACILITY AT THE VERMILION POWER PLANT W.O. 26869, APRIL 1988 BY ILLINOIS POWER COMPANY**
- **VERMILION POWER PLANT EAST ASH POND EXPANSION SPECIFICATIONS, JUNE 2002 BY URS CORPORATION**

JEL
CS860387

ILLINOIS
IP
POWER

SPECIFICATIONS FOR AN ASH DISPOSAL FACILITY AT THE VERMILION POWER PLANT
W.O. 26869

APRIL, 1988

APPROVED
FOR
CONSTRUCTION
RELEASED BY JEL
DATE 9-13-88

CIVIL/STRUCTURAL ENGINEERING SECTION
HEADQUARTERS ENGINEERING DEPARTMENT
ILLINOIS POWER COMPANY
DECATUR, ILLINOIS

ADDENDUM NO. 1

Specifications for an
Ash Disposal Facility
At the Vermilion Power Plant
W.O. 26869

A. Specifications

1. Construction Schedule

Completion date for the slurry wall shall be deleted. The project completion date shall remain August 1, 1989.

2. Section I - General Requirements

Project Description

The soil-bentonite backfill shall have a maximum permeability of 1×10^{-7} cm/sec.

3. Section VI - Slurry Wall Construction

a. General

The perimeter slurry wall shall provide a combined minimum width of eight feet of soil-bentonite slurry backfill. The soil-bentonite slurry backfill shall have a hydraulic conductivity of less than 1×10^{-7} cm/sec.

b. Specifications and Goals

1. The gradation and materials used for the backfill shall be such that the soil-bentonite slurry backfill barrier(s) achieves an effective, long term hydraulic conductivity of less than 1×10^{-7} cm/sec with Vermilion Ash Pond leachate as the permeant.

2. The minimum long term soil-bentonite slurry backfill barrier(s) width required is eight feet or multiple widths to attain an equivalent thickness.

3. All efforts shall be made to provide a continuous, homogeneous mixture of soil and bentonite within the trench and the occurrence of "windows" of material having a hydraulic conductivity of greater than 1×10^{-7} cm/sec shall not be allowed.

11. Backfill slurry mixture shall include sufficient percentage of bentonite to meet the requirements herein specified.

c. Quality Control

Table 1 - Quality Control Testing Program

Backfill Mix	% Bentonite not less than % specified in the design mix Triaxial hydraulic conductivity test $\leq 1 \times 10^{-7}$ cm/sec.

4. Section VIII - Piping

Corrugated metal pipe/pipe arch culverts shall be formed from precoated galvanized steel sheets. Thickness of the sheets shall correspond to the IDOT specifications for Type 2A CMP for road culverts.

Reinforced concrete pipe shall be used for all ash pond piping. Class V pipe with spigot groove type joints and O-ring gaskets shall be used. A reinforced concrete pipe cradle shall be required under all ash pond dikes as shown on the following detail. (See Section VIII for detail.)

RCC Pipe Class V shall be used for the outfall piping.

5. Section IX - Hydrogeologic Study

Only the boring data from the study will be included in the construction specifications.

6. Section XII - Bid Units

		Est. No. of Units
8a.	Reinforced concrete pipe with reinforced concrete cradle. Ash pond piping 36" diameter. (per lineal foot)	172
8b.	Reinforced concrete pipe. Outfall piping 36" diameter. (per lineal foot)	400
10b.	Four foot thick barrier. (per square yard)	8,400
13.	Reinforced concrete including all labor, materials, equipment, and supervision. (per cubic yard)	12

B. Plans

Sheets C-SK26869-5.3 through C-SK26869-5.16 reflect the change from a five foot wide slurry trench to a minimum width of eight feet for the soil-bentonite slurry backfill system. On the plans this is shown as two four foot wide slurry trenches.

JEL
CS860387

ILLINOIS POWER

SPECIFICATIONS FOR AN
ASH DISPOSAL FACILITY
AT THE VERMILION POWER PLANT
W.O. 26869

APRIL, 1988

CIVIL/STRUCTURAL ENGINEERING SECTION
HEADQUARTERS ENGINEERING DEPARTMENT
ILLINOIS POWER COMPANY
DECATUR, ILLINOIS

STATE OF ILLINOIS

Permit
№ 19333

Department of Transportation

Division of Water Resources
2300 South Dirksen Parkway
Springfield, Illinois 62764

Permission Is Hereby Granted, this 23rd day of August 19 88

To

Illinois Power Company
500 South 27th Street
Decatur, Illinois 62525-1805

To construct, operate and maintain a wet ash disposal facility, classified as a small size Class III structure, within the flood plain of the Middle Fork Vermilion River at the Vermilion Power Plant in the SE 1/4 of Section 20, Township 20 North, Range 12 West of the 2nd Principal Meridian in Vermilion County,

in accordance with an application dated March 29, 1988 , and the specifications and plans entitled

SHEETS C-SK. 26869-4 TO 10(32 SHEETS, RECEIVED 8-23-88)
SPECIFICATIONS FOR AN ASH DISPOSAL FACILITY AT VERMILION POWER PLANT (RECEIVED 8-23-88)
MAINTENANCE PLAN, ILLINOIS POWER CO., VERMILION CLASS III DAM, (RECEIVED 8-11-88)

filed with the Department of Transportation and made a part hereof, and subject to the terms and special conditions contained herein:

Examined and Recommended:

Neil R. Fulton

Chief, Bureau of Resource Management.
Neil R. Fulton

Approval Recommended:

Donald R. Vonnahme

Donald R. Vonnahme Director

APPROVED:

Gregory W. Baise

Secretary
Gregory W. Baise

cc: Louisville District Corps of Engineers (over) Il. Dept. of Conservation

(39193—5M 6-81s—12-83)

Table of Contents

The following data and drawings, attached hereto, are a part of these specifications:

		Page
	Table of Contents	1
	Description of Project	4
Section I	General Requirements	5
Section II	Earthwork Specifications (CS 6-7.1 thru .13)	8
Section III	Foundation Specifications (CS 6-8.1 thru .8)	24
Section IV	Erosion Control Specifications	33
Section V	Seeding	35
Section VI	Slurry Wall Construction	43
Section VII	Raw Water Chemistry	50
Section VIII	Piping	52
Section IX	Hydrogeologic Study	54
Section X	Soil Borings	144
Section XI	Steel Structure Specifications	158
Section XII	Bid Units	159

The following drawings are not attached hereto, but are considered a part of these specifications:

Ash Pond Plan	C-SK.26869-6
Cross Sections 1278988, 1279032, and 1279052	C-SK.26869-5.1
Cross Sections 1279100, 1279115, and 1279142	C-SK.26869-5.2
Cross Section 1279162	C-SK.26869-5.3

Table of Contents (cont.)

Cross Section 1279295	C-SK.26869-5.4
Cross Section 1279388	C-SK.26869-5.5
Cross Sections 1279532, A-A, B-B, and C-C	C-SK.26869-5.6
Cross Section 1279618	C-SK.26869-5.7
Cross Section 1279775	C-SK.26869-5.8
Cross Section 1279825	C-SK.26869-5.9
Cross Section 1280000	C-SK.26869-5.10
Cross Section 1280056.5	C-SK.26869-5.11
Cross Section 1280092.5	C-SK.26869-5.12
Cross Section 1280107.5 and Typical Section	C-SK.26869-5.13
Cross Section 1280143.5, G-G, and H-H	C-SK.26869-5.14
Cross Section 1280175	C-SK.26869-5.15
Cross Sections 1280272, 1280312, 1280345, and 1280398	C-SK.26869-5.16
Cross Sections Roadway	C-SK.26869-6.1
Cross Sections Roadway	C-SK.26869-6.2
Road Profile	C-SK.26869-6.3
Outfall Piping	C-SK.26869-7
Primary Pond Discharge Structure	C-SK.26869-8.1
Steel Schedule - Primary Pond Discharge Structure	C-SK.26869-8.2
Steel Details - Primary	C-SK.26869-8.3
Steel Details - Primary	C-SK.26869-8.4

Table of Contents (cont.)

Steel Details - Primary	C-SK.26869-8.5
Secondary Pond Discharge Structure	C-SK.26869-9.1
Steel Schedule - Secondary Pond Discharge Structure	C-SK.26869-9.2
Steel Details - Secondary	C-SK.26869-9.3
Steel Details - Secondary	C-SK.26869-9.4
Steel Details - Secondary	C-SK.26869-9.5
Foundation Details	C-SK.26869-10

SPECIFICATIONS
ASH DISPOSAL FACILITY
VERMILION POWER PLANT
W.O. 26869

Description of Project

This project consists of excavating, hauling, placing, and compacting borrow material, installing a soil-bentonite slurry backfill, and other facilities at the Vermilion Power Plant to construct a new ash disposal facility.

All of the information contained and referenced to herein is the proprietary and confidential property of Illinois Power Company.

Construction Schedule

A preconstruction conference will be held prior to starting work to coordinate construction activities with plant operations.

The Contractor shall submit a construction schedule to the Company's Supervisor of Construction two weeks prior to the date of the preconstruction conference. Two weeks notice will also be required prior to starting construction. One days notice will be required for restarting work after a delay.

Access to the Company's equipment, material, and property shall be maintained at all times. Interference with daily operations shall be minimized.

The Contractor shall obtain all permits, licenses, and required documents to perform the work. All costs resulting from compliance with these documents shall be considered incidental to the contract and be included in the Contractor's bid.

Slurry wall construction shall be completed before November 1, 1988. The project shall be completed before August 1, 1989. Continued operation of the plant hinges on project completion prior to this date. Failure to meet this date would severely limit the Company's ability to meet load expectations, and the Contractor will be expected to utilize the necessary personnel and equipment to complete the project by August 1, 1989.

Project Location

Illinois Power Company
Vermilion Power Plant
Box 257
Oakwood, Illinois 61858
Six miles north of Rt. I-74 at Oakwood Turnoff
Phone (217) 354-2141
Albert F. Lueck, Plant Manager
Bruce Brown, Supervisor - Results

SECTION I

General Requirements

Introduction

The Contractor shall furnish, at his expense, all supervision, labor, tools, equipment, transportation, materials (unless noted otherwise), and other services as necessary for the construction of this project. The Contractor shall perform the work in a good, workmanlike manner in accordance with these specifications and drawings. All work shall be performed under the personal and constant supervision of a competent Construction Superintendent or Foreman.

A Company Representative will be on the job to assure that the facilities constructed meet the requirements of the Company's specifications.

The Company will cooperate in any way possible with technical or practical construction advice requested by the Contractor. However, the methods used to meet these specifications are the sole responsibility of the Contractor. The Contractor is in charge of the work and is responsible for safety.

The Contractor shall submit a list of subcontractors with his proposal.

Drawings, Data, and Special Agreements

Drawings and data are listed in the Table of Contents of these specifications. Any questions concerning these drawings and data shall be referred to the Company's Representative. The Contractor shall not take advantage of errors and omissions in the plans and/or discrepancies between the plans and specifications. The Company will make corrections and supply information omitted to the plans and specifications, with the Company's interpretation being final. Any addenda issued during the time of bidding are considered a part of these specifications.

Revised or additional drawings and data may be issued after the contract agreement is signed. Within ten days after the receipt of any supplemental information, the Contractor shall advise the Company of any changes in unit costs in writing. No work shall be done on properties on which a cost change is required until a price is agreed to between the Company and the Contractor.

Examination of the Work Site

The Contractor shall examine the job location and job requirements. The Contractor shall be held responsible for any loss or error resulting from ignorance concerning requirements of the work or any difficulties encountered. Contractor shall be familiar with the conditions and difficulties to be encountered in the work.

Project Description

A new wet ash disposal facility is to be constructed at the Vermilion Power Plant. The main construction components will be compacted borrow and a soil-bentonite slurry backfill.

Silty sand borrow material for the outer portions of the dikes will be taken from inside the proposed containment dikes. Silty clay borrow material for the impermeable core of the dike will be taken from Borrow Area One and other borrow areas designated on the plans. A continuous soil-bentonite slurry backfill system will be installed around the ash facility perimeter. The clay core and bluff clay barrier shall have a maximum permeability of 1×10^{-7} cm/sec. The soil-bentonite backfill shall have a maximum permeability of 1×10^{-7} cm/sec. Preconstruction testing of the silty clay and soil-bentonite slurry backfill components to determine the proper construction techniques and mix components to achieve the maximum stated permeability shall be performed by the Contractor. The results of this testing shall be issued in a report(s) to be used during construction of the various components to ensure the desired results are obtained.

Construction areas shall be cleared. All vegetation and deleterious material shall be legally disposed of in an environmentally safe manner. The Contractor shall control and eliminate all fugitive dust caused by the work. The Contractor shall control and eliminate all erosion resulting from the work. No sediments or other material shall be allowed to escape the project site to the Middle Fork of the Vermilion River or adjacent wetlands.

A portion of the ash pond dike shall be built prior to installation of the soil-bentonite slurry backfill to allow keying of the slurry wall into the clay core and bluff clay barrier. The slurry wall shall also be keyed into the shale as shown on the plans, a minimum of four feet into unweathered shale.

The Contractor shall be required to design the soil-bentonite slurry backfill to meet certain performance criteria. A report will be submitted prior to constructing the slurry wall addressing the design and anticipated performance of the soil-bentonite slurry backfill. A quality control program shall be part of the report. Necessary tests, sampling schedule, test reports, and other requirements shall be addressed in the report. The Company shall retain a testing agency to review, comment, and approve the report prior to construction beginning on the soil-bentonite slurry backfill. The same testing firm shall be retained to provide additional construction quality assurance (testing and reporting) for the soil-bentonite slurry backfill. In addition to verifying all components of the soil-bentonite slurry backfill construction, the testing agency will also perform testing of borrow materials, compaction, concrete, and other inspection duties.

Gravity piping and reinforced concrete structures will connect the settling and polishing ponds. Discharge piping will be outletted towards the north.

The Middle Fork of the Vermilion River is bounded by a scenic easement. A line on either side of the stream, 200 ft. from the stream center line (total of 400 ft.), defines the easement. Applicable portions of the easement are shown on the plans. The conditions stated in the easement are to help preserve the stream's natural characteristics. Therefore, the Contractor will not encroach upon the easement and will not be allowed to operate construction equipment within the easement except for construction of the discharge piping, channel, and entrance road.

Any structures, fills, roads, or other facilities built to provide access or protect items on the site shall be removed at the end of the project at the direction of the Company.

The Contractor shall inform the construction work force of the high voltage transmission line located at the south end of the project site. Work operations shall not cause damage to or tripping out of the line.

SECTION II

Earthwork Specifications

Portions of this work require the placement and compaction of soil or aggregate. This work will be covered by the following specification for earthwork operations.

Clearing and stripping of construction areas will be required. The cross sections show the removal of approximately 15 inches over the construction areas to determine approximate quantities of fill that will be required. For clearing and stripping the actual depth will be determined by the Company's contracted soil testing firm and may be more or less than 15 inches depending upon the actual conditions encountered.

Prior to starting construction, designated borrow area zones, four acres in size, shall be laid out on a plan sheet, by coordinates, by the Contractor. The Contractor shall then strip or clear the borrow area to allow cross sectioning of the borrow area by the Company. The Contractor shall not remove any material from the borrow area until the cross sectioning is completed. The Contractor shall notify the Company's Representative one week in advance of the intention to strip or clear an area. The Contractor shall inform the Company's representative when the operations are complete. The Company will cross section the area within five working days after receiving the Contractor's written notification that an area is ready. The bluff areas along the west edge of the pond are to be included in the borrow area designations. After all the suitable material is removed from a borrow zone, the Company will again cross section the area to determine how many cubic yards were removed. The Company's on-site testing agency representative will be responsible for determining suitable materials to incorporate into the work. Small deposits of silt may be encountered in the borrow area. Silt deposits less than five cubic yards in size may be used provided the material is spread in a very thin layer with other suitable material. Deposits larger than five cubic yards or multiple deposits in an area shall remain undisturbed until all other areas in the bottom have been exhausted. Once an area has been exhausted it will be cross sectioned. The Company may then direct the Contractor to remove the remaining material and stockpile it near Borrow Area One. The area will be cross sectioned again to determine the quantity of overburden removed from the ash pond interior.

Contours shown in the bottom (non-dike portion) of the new ash pond, except for the north polishing pond, (592 and lower) are general in nature and the actual "as-built" contours will depend on how much material is removed from a particular area. The north polishing pond bottom shall be excavated to the contours shown on the plans. The Contractor should arrange the borrow area zones to provide positive drainage from the work areas. Positive drainage will be maintained around the dike construction areas. The Contractor will be responsible for pumping excess water from the interior of the dike. The Contractor shall grade the construction area to prevent ponding of water that interferes with the work. The Contractor shall construct sumps to pump from, as necessary, to allow removal of borrow material as part of the work.

The moisture content limits for silty clay used in constructing the clay core and bluff clay barrier shall be -1% to +3% of the optimum moisture content determined by ASTM D698. All compaction tests shall be compared to the combined Proctor curve/permeability chart prepared by the testing agency to ensure the compacted clay core and bluff clay barrier have a maximum permeability of 1 x 10^{-7} cm/sec. The silty clay in these two areas shall be compacted to at least 97% of the maximum dry density (ASTM D698). If a greater degree of compaction is required to meet the permeability requirements, this work shall be done with no increase in the corresponding unit price for this work.

Suitable silty clay (glacial till) from the lower portions of the road cut shall be used to construct the clay core and bluff clay barrier. The upper portion cut material shall be used to form the road embankment. The remainder of the clay core and bluff clay barrier material shall be obtained in Borrow Area One. Unsuitable overburden shall be removed after stripping of the site and stockpiled adjacent to the borrow area. Testing of the upper portion of Borrow Area One is ongoing at the time of this writing and its properties relative to permeability are unknown. Therefore, a bid item will be included for removal and stockpiling. If the soil will meet the permeability criteria set forth, it will be considered silty clay borrow for use in the clay core or bluff clay barrier and deleted from the stockpile bid quantity. Borrow Area One will be initially cross sectioned after stripping and removal of unsuitable overburden.

Excavated material from the bluff area shall be used in areas outside of the clay core and bluff clay barrier shown on the plans. Silty clay suitable for fill areas shall be used adjacent to the clay core material as shown on the typical section. Sand combinations may be used in the outer portions of the dike. Small silt deposits may be distributed through the exterior portions of the dike. Extensive deposits of silt or numerous small deposits that would result in a deposit of silt more than five cubic yards to be placed in the dike will be transported adjacent to Borrow Area One and stockpiled.

Borrow Area One shall not be stripped until material is needed or storage area is required.

Stockpiled material in and adjacent to Borrow Area One shall be tracked in place to stabilize it and remove large voids.

Aggregate shown on the plans is to be placed at the end of construction. Material required to maintain the road in an accessible condition during construction will be incidental to the contract. Rough cutting of some portions of the runoff ditch and pipe run may be necessary to provide material for the dike, but it should be noted that the runoff ditch cannot become operational until the ash pond is operational. Therefore runoff cannot be routed to the ash pond until the dikes are constructed and all outfall piping is in place.

Quantities of fill are approximate and will depend on "as-built" conditions. The contours of the existing ground are from an aerial photo shot and plotted in 1978 and, while generally correct, some modification has taken place due to farming and other activities. Some variation in the final units is to be expected.

The exposed subgrade of all construction areas, particularly the bluff side of the pond, shall be disced and/or scarified prior to compaction of the subgrade and placement of fill. The subgrade of all construction areas shall be compacted to 95% of the maximum dry density of the material (ASTM D698) before placement of fill begins.

Unless otherwise noted, compaction requirements for all phases of the work shall be 95% of the maximum dry density and -1% to +3% of the optimum moisture content as determined by ASTM D698.

Should construction of the ash pond dike and road be delayed by winter weather until the next construction season, the Contractor shall remove, replace, and recompact the following depth of material for each of the noted areas prior to placing new fill. The ash pond dike will require the removal, replacement, and recompaction of 12 inches of material. Roadwork will require the removal, replacement, and recompaction of 6 inches of material. Daily occurrences of frost removal will be determined by the Company's Site Representative. Both daily and seasonal removal and replacement will be considered incidental to the contract.

1. SCOPE

1.1 This specification covers the minimum performance requirements, materials, and references necessary to govern earthwork and related operations. Earthwork is the movement of soil, sand, or rock from one location to another, shaping the materials in accordance with the plans or specifications, and achieving the desired physical condition of the materials by various methods.

2. DEFINITIONS

2.1 Borrow Excavation: Work done in obtaining material for embankments or fills from a source other than required excavation. Included is the excavating, transporting, placing, and compacting of materials from locations furnished by the Contractor necessary for the construction of embankments, subgrade, shoulders, sub-base, intersections, approaches, entrances, and other items indicated on the plans or noted in the specifications.

2.2 Channel Excavation: The removal and satisfactory disposal of all materials encountered in the construction of ditches, stream channels, or swales.

2.3 Clay: An aggregate of microscopic and submicroscopic flake-shaped crystalline minerals characterized by the typical colloidal properties of cohesion, plasticity, and the ability to absorb ions conforming to the gradations set forth in the Unified Classification System.

2.4 Clearing: The removal and disposal of all obstructions such as fences, walls, foundations, buildings, trees, stumps, brush, accumulations of rubbish of whatever nature, and existing structures.

2.5 Construction Inspector: The Owner's on-site representative.

2.6 Contractor: The party or parties proposing to provide all labor, equipment and materials required to perform the work specified herein or on the plans.

2.7 Crushed Gravel: Fractured particles resulting from the crushing of gravel which, prior to crushing, would have been retained on a screen with an opening 1.5 times as large as the maximum size of the resulting crushed material.

2.8 Crushed Stone: Angular fragments resulting from the mechanical crushing of granite, limestone, or dolomite from undisturbed, consolidated deposits: (Dolomite shall be a carbonate rock containing 11.0% or more magnesium oxide (MgO). Limestone shall be a carbonate rock containing less than 11.0% magnesium oxide).

2.9 Engineer: The Owner's project engineer.

2.10 Embankment: Consists of the construction of fill areas (berms, road subgrade) by hauling depositing, placing and compacting the specified material above the natural surface or a specified grade line.

2.11 Footing Excavation: See Structure Excavation.

2.12 Gravel: Coarse, granular, unconsolidated material resulting from the reduction of rock by the action of the elements and having subangular to rounded surfaces conforming to the gradations set forth in the Unified Classification System.

2.13 Impervious Backfill: Fine aggregate (Silty Clay, CL to CL-CH) placed and compacted in excavations, around structures or other items as indicated in the plans and specifications.

2.14 Inorganic Silt: Fine grained soil possessing little or no plasticity or cohesion conforming to the gradations set forth in the Unified Classification System.

2.15 Owner: Illinois Power Company or its designated agent.

2.16 Pipe Excavation: The excavation, removal and satisfactory disposal of all materials encountered constructing a trench for installation of the specified pipe.

2.17 Porous Backfill: Fine aggregate (clean sand) placed and compacted in excavations, around structures or other items as indicated in the plans and specifications.

2.18 Rock: Natural aggregate of mineral grains connected by strong and permanent cohesive forces.

2.19 Sand: Fine granular material resulting from the natural disintegration of rock conforming to the gradations set forth in the Unified Classification System.

2.20 Soil: Natural aggregate of mineral grains, with or without organic constituents, that can be separated by gentle mechanical means such as agitation in water. Gravel and sand are coarse grained soils, while silts and clays are fine grained soils.

2.21 Stripping: The excavation, removal and satisfactory disposal (if required) of all materials taken between the original surface and the top of suitable material for the construction of embankments, subgrade, sub-base, shoulders, intersections, ditches, waterways, entrances, approaches and incidental work.

2.22 Structure Excavation: Removal of any and all materials encountered during installation of any designated structure and the satisfactory disposal of all materials.

2.23 Unclassified Excavation: The removal of any combination of topsoil, earth, rock, muck or obstacle carried out to the lines and grades specified or shown on the plans without regard to percentage of moisture and type of material found.

3. REFERENCES

3.1 The reference to specifications or organizations (such as ASTM) together wit any diagrams, drawings or plans shall be considered as part of this specification. In the event of conflict between this specification and the referenced documents, the requirements of this specification shall take precedence. The following specifications, standards, and codes apply:

3.1.1 American Society for Testing and Materials (ASTM)

3.1.1.1 ASTM D75-82: Practice for Sampling Aggregates

3.1.1.2 ASTM D420-69: Recommended Practice for Investigating and Sampling Soil and Rock for Engineering Purposes

3.1.1.3 ASTM D421-58: Method for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants

3.1.1.4 ASTM D422-63: Method for Particle-Size Analysis of Soils

3.1.1.5 ASTM D653-85: Terms and Symbols Relating to Soil and Rock Mechanics

3.1.1.6 ASTM D698-78: Test Methods for Moisture - Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5-lb (2.49 kg) Rammer and 12- inch (305-mm) Drop

3.1.1.7 ASTM D854-83: Test Method for Specific Gravity of Soils

3.1.1.8 ASTM D1140-54: Test Method for Amount of Material in Soils Finer than the No. 200 (75- m) Sieve

3.1.1.9 ASTM D1452-80: Practice for Soil Investigation and Sampling by Auger Borings

3.1.1.10 ASTM D1556-82: Test Method for Density of Soil in Place by the Sand-Cone Method

3.1.1.11 ASTM D1557-78: Test Methods for Moisture-Density Relations o Soils and Soil-Aggregate Mixture Using 10-lb (4.5 kg) Rammer and 18-inch (457-mm) Drop

3.1.1.12 ASTM D1558-84: Test Method for Moisture Content Penetration Resistance Relationships of Fine Grained Soils

3.1.1.13 ASTM D1586-84: Method for Penetration Test and Split-Barrel Sampling of Soils

3.1.1.14 ASTM D1587-83: Practice for Thin-Walled Tube Sampling of Soils

3.1.1.15 ASTM D2167-84: Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

3.1.1.16 ASTM D2168-80: Methods for Calibration of Laboratory Mechanical-Rammer Soil Compactors

3.1.1.17 ASTM D2216-80: Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock and Soil Aggregate Mixtures

3.1.1.18 ASTM D2217-66: Method for Wet Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants

3.1.1.19 ASTM D2487-83: Test Method for Classification of Soils for Engineering Purposes

3.1.1.20 ASTM D2922-81: Test Methods for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)

3.1.1.21 ASTM D3017-78: Test Method for Moisture Content of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)

3.1.1.22 ASTM D3740-80: Practice for the Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

3.1.1.23 ASTM D4220-83: Practices for Preserving and Transporting Soil Samples

3.1.1.24 ASTM D4318-84: Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

3.1.1.25 ASTM C29-78: Test Method for Unit Weight and Voids in Aggregate

3.1.1.26 ASTM C127-84: Test Method for Specific Gravity and Absorption of Coarse Aggregate

3.1.1.27 ASTM C128-84: Test Method for Specific Gravity and Absorption of Fine Aggregate

3.1.1.28 ASTM C136-84: Method for Sieve Analysis of Fine and Coarse Aggregates

3.1.1.29 ASTM C566-84: Test Method for Total Moisture Content of Aggregate by Drying

3.1.1.30 ASTM C702-80: Methods for Reducing Field Samples of Aggregate to Testing Size

3.1.1.31 ASTM D75-82: Practice for Sampling Aggregates

3.1.1.32 ASTM E11-81: Specification for Wire-Cloth Sieves for Testing Purposes

3.1.1.33 ASTM D3665-82: Practice For Random Sampling of Construction Materials

3.1.2 Standard Specifications for Road and Bridge Construction - Illinois Department of Transportation (IDOT) - October 1, 1983

4. MATERIALS

4.1 Acceptability -

4.1.1 Previous testing data will be considered in determining acceptability. No material will be brought to the construction site until it has been tested by the Owner, or the designated testing agency, and found suitable for the intended application. Material hauled to the site prior to the owner's approval may be rejected, and in such cases must be removed by the Contractor at his own expense.

4.1.2 All material shall come from the same location and exhibit similar characteristics.

4.2 The type of material and gradation to be used at a particular location will be designated in the General portion of the specifications or noted on the plans for a specific project.

4.2.1 In most instances coarse grained material (gravels, crushed stone, sand) will be designated by an IDOT gradation. Materials with these gradations are readily available state wide during the construction season.

4.2.2 Fine grained materials (clay, silty clay) will be designated by a Unified System Classification (ASTM D2487). See Figures 1 and 2.

4.3 Top soil shall be relatively free from large roots, sticks, weeds, brush or stones larger than 1 inch in diameter, or other litter and waste products. Top soil shall be a loamy mixture having the following characteristics:

1. At least 90% passing the No. 10 sieve.

2. Not less than 1% or more than 10 % organic matter.

3. Not less than 12% or more than 50% clay.

4. No more than 55% sand

5. A $_pH$ value between five and eight.

5. CONSTRUCTION REQUIREMENTS

5.1 Unless otherwise noted, compaction requirements for all phases of the work shall be 95% of the Maximum Dry Density and ± 2% of the Optimum Moisture Content as determined by ASTM D698.

5.2 Compaction shall be obtained by mechanical means in a timely manner so as n to delay construction. Lift thicknesses may vary depending upon the condition of the material and equipment used, but should never exceed six inches. Each lift will be tested by the owner or an outside agency.

5.3 Material placed which does not meet the minimum compaction requirements sha be reworked as necessary to obtain the specified compaction at no extra cos to the Owner. No further placement of material will be allowed until the compaction requirements are met. If the material becomes unsuitable for us after placement, even if previously compacted to the specified percentage, will be removed and replaced by suitable material which will be compacted i accordance with the specifications at no extra cost to the Owner.

5.4 No placement of material will be allowed on wet or frozen subgrade.

5.5 The Contractor will maintain his work in such a manner to prevent ponding o water in the project area. In excavations where water may collect the Contractor shall establish and maintain pumping capabilities to keep the excavation free of water. This includes a layer of oversize rock (±4") covered by a layer (±2") of crushed stone (CA-6 or CA-10) or a mud mat to allow work to proceed in the excavation without contamination by mud or water.

5.6 Erosion control is the responsibility of the Contractor.

5.7 Disposal of all unsuitable material in a legal, safe, and satisfactory manne is the responsibility of the Contractor. This includes, but is not limited to, materials resulting from clearing and stripping of a site.

5.8 The Contractor shall be responsible for, and shall take all necessary precautions to preserve and protect, all existing tile drains, sewers, other subsurface drains, underground utilities, above ground utilities, private transmission lines, and appurtenances which may be affected by his operation and shall repair, at his own expense, any and all damages resulting from his actions or negligence.

5.9 The Contractor shall notify the Construction Inspector two days in advance o beginning or resuming work.

5.10 Trenches for pipe installation shall be excavated to an elevation 4 inches below the bottom of the pipe such that the invert of the pipe will be at t depth and grade specified. The trench will be excavated 18 inches wider t the external diameter of the pipe, or more if necessary, to permit through tamping under the haunches and around the pipe. Where a firm foundation i not encountered at the grade established all such unsuitable soil shall be removed for the width of the trench and replaced with well compacted beddi material or suitable compacted aggregate. In areas requiring impervious backfill, the trench bottom will be shaped to conform to the pipe's shape lieu of bedding. In general, areas subject to traffic, right of ways, pub property, load bearing areas and other heavily used areas shall be backfil with porous backfill compacted to the requirements of 5.1.

5.11 Access to the project site will be maintained at all times. If the work i being performed at an existing facility the Contractor shall make the necessary arrangements to maintain access to vital areas of the yard.

5.12 Various portions of the work will require testing by I.P. personnel or an outside testing agency. The Contractor will cooperate with the testing program and make his work accessible at all times.

~~5.13 Stripping and clearing of the borrow site is incidental to the contract. T Contractor shall be responsible for acquiring the legal rights to a borrow site and any ramifications resulting from the removal of the material.~~

5.14 If the work generates sufficient dust to cause complaints to be received by the Owner, the Contractor shall alleviate the situation at no cost to the Owner.

5.15 Unless otherwise specified, the entire subgrade (fill or existing), includi substation sites, shall meet the compaction requirements stated in Section 5.1. All holes, ruts, soft places, and other defects shall be corrected. no case shall the surface course, base course, or other items be placed on soft or unstable material or over areas that are not properly drained.

5.15.1 In cut sections the Contractor will be required to make the following efforts to obtain compaction of the material in accordance with the requirements of 5.1:

1. Cut plan ditches, which drain the area, to grade at least tw weeks prior to starting work on the subgrade.

2. Air dry the top 8 inches of subgrade, including at least two eight-inch depth processings utilizing discs or tillers each day for three consecutive good drying days.

3. Recompact the layer processed in the above paragraphs to achieve compaction results stated in 5.1. When the above wo has failed to produce satisfactory work, contact the Enginee to review the circumstances.

5.15.2 The subgrade shall be constructed so that after being compacted will conform to the alignment, grade, and cross section shown on the plans. Equipment of such weight or used in such a way as to cause a rut in the finished subgrade of one inch or more in dept shall be removed from the work or the rutting shall otherwise be prevented. Rutted areas shall be graded and rerolled with a smooth-wheeled roller.

5.16 A smooth surface is desired at the termination point of each type of mater used whether it is virgin subgrade, embankment material, crushed stone, or other construction materials. When a sheepsfoot roller is used, the area must be leveled at the finished grade. The interface between continuing layers of embankment are not to be leveled and are expected to exhibit a normal amount of "fluff" associated with an ongoing fill operation.

5.17 Unless specifically called out in the plans or specifications no sheet pili will be required. If, as construction proceeds, it becomes apparent sheet piling or a larger area will be needed for excavation contact the Engineer review the situation and determine how to proceed.

5.18 Traffic control, including provisions for the necessary barricades, flagmen and other items, is the responsibility of the Contractor.

5.19 Embankment operations shall comply with the following requirements:

1. Before any embankment is placed, all clearing and stripping over the entire area shall be performed. The top six inches of the exposed surface shall be disced, and then compacted to meet the requirements 5.1. When construction is resumed after any freezing weather the top eight inches of all partially completed embankments will be reworked and compacted to meet the requirements of 5.1 prior to placing more fill.

2. Embankment material will be specified in the General Section of the specifications. If required, the material shall be disced sufficient to break down oversize clods, mix the material, secure a uniform moisture content, and insure uniform density and compaction. Each layer of material shall extend the entire length and width of embankment, if possible, and shall be leveled when placed. Embankmen around structures is not to be placed until the concrete has attained its specified strength. Any rock larger than six inches in diameter will be removed from the fill.

3. If an embankment is to be constructed on an existing slope the existi slope shall have steps cut into it prior to starting construction of the embankment.

5.20 Topsoil shall not be placed until the area to be covered has been shaped, trimmed, and finished. All irregularities in the surface shall be filled o smoothed out before the top soil is placed. If the existing surface has become hardened or crusted it shall be disced or raked until broken up to provide a bond with the top soil. One rolling by a smooth drum of the surface will be required. All unsuitable debris and stones larger than thr inches in diameter shall be removed from the area.

5.21 Base course shall consist of crushed stone aggregate as specified in the General Section, bid units, or on the plans. The aggregate shall be deposited full-lane width directly on the subgrade, geotextile fabric (if specified), or previous layer of compacted base course in such a way to prevent segregation and require a minimum amount of blade work. Immediatel after placement of the material it shall be compacted by a rubber tired roller or vibratory smooth steel drum machine to the requirements of 5.1. I any subgrade material is worked into the base material during the operations all granular material affected will be removed and replaced with new aggregate at no cost to the owner.

6. INSPECTION BY OWNER

6.1 The Owner is responsible for testing the project materials and results of th work performed at regular intervals.

6.2 The Contractor will cooperate with the Owner at all times to provide access to the materials and site for testing purposes.

6.3 The Contractor shall submit the following information for each material within two weeks of the contract award:

1. Supplier's Name, Address and Telephone Number.
2. Pit/Facility Name, Address and Telephone Number.
3. Person in Charge at Pit/Facility.
4. Map, with Directions, Indicating Pit/Facility Location.

7. MEASUREMENT

7.1 The right is reserved to increase or decrease quantities, as required, with no increase in the unit price.

7.2 Items measured in units of weight may be paid for on a dry-weight basis at the discretion of the Engineer if the moisture content is found to be excessive. The bid units will not be affected unless the moisture content o coarse grained soils exceeds 12%, or 20% for fine grained soils.

7.3 Clearing will not be measured for payment and is incidental to the contract.

7.4 Pipe excavation and furnishing, placing, and compacting bedding will not be measured for payment and are to be included in the price bid per lineal foot of the pipe specified.

7.5 Cross section measurements and the average end area method shall be used to determine volumes of excavations or required material for embankments.

7.6 Embankment quantities shall be cubic yards of compacted material at the project site. The plan quantities will be used for bidding purposes. If there is a discrepancy between the successful bidder's take off quantities of more than plus 5% the Contractor shall notify the Engineer in writing prior to starting work. Arrangements will be made to cross section the project area after the embankment work is completed and the volume determined in accordance with these specifications. If the Contractor's quantities are less than 105% of the estimated contract quantities he shall be paid the contract quantities when the project is constructed to the lines and grades shown in the plans and specifications.

7.7 The following items will be measured in cubic yards:

1. Embankment.
2. Channel Excavation.
3. Structure Excavation.
4. Unclassified Excavation.

7.8 The following items will be measured in tons:

1. Sand
2. Gravel
3. Crushed Gravel
4. Crushed Stone Aggregate

7.9 Impervious backfill will not be measured for payment and will be considered incidental to the contract.

7.10 Porous backfill will be measured in tons of the specified material.

7.11 Stripping will be measured in cubic yards. The average depth of material to be removed and use of this material will be noted in the General Section at the beginning of the specification.

7.12 Top soil will be measured in square yards and include furnishing, excavating, transporting, placing, and grading the material as indicated in the plans and specifications. Depth of top soil will be 4 inches.

7.13 Geotextile fabric will be measured in square yards, not including laps or portions anchored in trenches.

D 2487

Soil Classification Chart

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification: Group Symbol	Soil Classification: Group Name[B]
Coarse-Grained Soils More than 50 % retained on No. 200 sieve	Gravels More than 50 % of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5 % fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12 % fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50 % or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5 % fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]	SP	Poorly graded sand[I]
		Sands with Fines More than 12 % fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50 % or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OL	Organic clay[K,L,M,N] / Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OH	Organic clay[K,L,M,P] / Organic silt[K,L,M,Q]
Highly organic soils		Primarily organic matter, dark in color, and organic odor		PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12 % fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12 % fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10} \qquad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15 % sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15 % gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29 % plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30 % plus No. 200, predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30 % plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.

FIGURE 1

D 2487

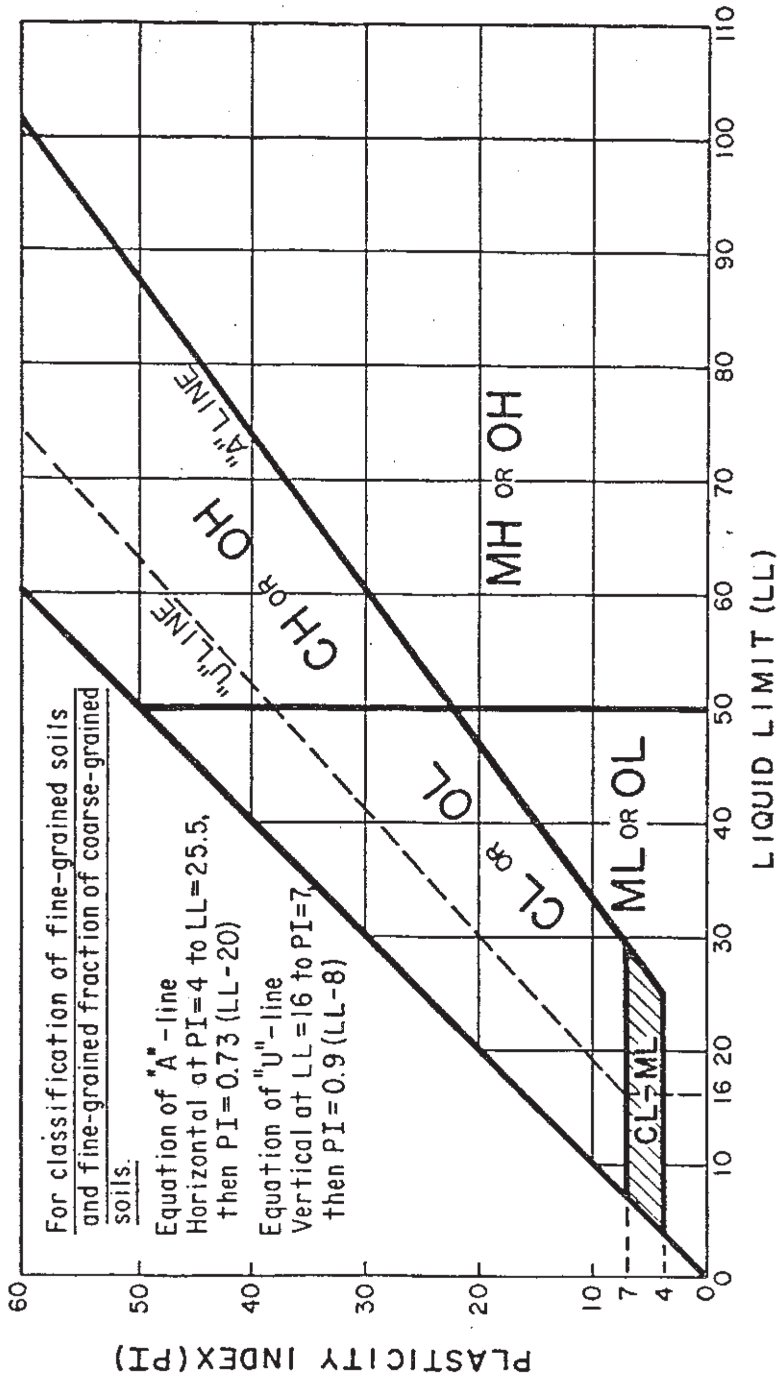


FIGURE 2

SECTION III

Foundation Specifications

Portions of this work require the installation of reinforced concrete for foundations. This work shall be covered by the following specification.

Exposed edges shall be chamferred or rounded.

SPECIFICATION FOR THE INSTALLATION OF CONCRETE FOUNDATIONS

1. SCOPE

1.1 This specification covers the minimum requirements for concrete foundation installation.

1.2 Except as noted otherwise, the Contractor shall furnish all labor, material, tools, and equipment necessary for concrete work shown on the drawings and specified herein.

2. DEFINITIONS

2.1 The term "Contractor", as used in this specification, shall refer to the party of parties proposing to perform the work and provide the material herein specified.

2.2 The term "Owner", as used in this specification, shall refer to Illinois Power Company or its designated agent.

2.3 The term "Engineer", as used in this specification, shall refer to the Owner's Project Engineer.

2.4 All design terms and symbols shall be as defined in ACI 318.

3. REFERENCES

3.1 Any specification or document referred to in this specification is to be considered as part of this specification. In the event of conflict between this specification and referenced documents, the requirements of this specification shall take precedence. The following specifications, standards, and codes apply:

3.1.1 American Concrete Institute (ACI)

3.1.1.1 ACI 305R-77 - Recommended Practice for Hot-Weather Concreting.

3.1.1.2 ACI 306-66 - Recommended Practice for Cold-Weather Concreting.

3.1.1.3 ACI 308-71 - Recommend Practice of Curing Concrete.

3.1.1.4 ACI 315R-80 - Manual of Standard Practice for Detailing Reinforced Concrete Structures.

3.1.1.5 ACI 318-83 - Building Code Requirements for Reinforced Concrete.

3.1.1.6 ACI 347-78 - Recommended Practice for Concrete Formwork.

3.1.2 American Society for Testing and Materials (ASTM)

3.1.2.1 ASTM A82-76 - Cold-Drawn Steel Wire for Concrete Reinforcement.

3.1.2.2 ASTM A615-78 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

3.1.2.3 ASTM C31-69 - Making and Curing Concrete Test Specimens in the Field.

3.1.2.4 ASTM C33-78 - Concrete Aggregates.

3.1.2.5 ASTM C94-78 - Ready-Mixed Concrete.

3.1.2.6 ASTM C150-78 - Portland Cement.

3.1.2.7 ASTM C171-69 - Sheet Materials for Curing Concrete.

3.1.2.8 ASTM C309-74 - Liquid Membrane - Forming Compounds for Curing Concrete.

3.1.2.9 ASTM C494-77 - Chemical Admixtures for Concrete.

3.1.3 Illinois Department of Transportation (IDOT) - 1983 Specifications for Roads and Bridges.

4. <u>WORK NOT INCLUDED IN THIS SECTION</u>

4.1 Illinois Power Company will furnish all anchor bolts (when required), elevation reference stakes, and location stakes.

5. <u>GENERAL REQUIREMENTS</u>

5.1 All concrete work shall conform to ACI 347 unless otherwise specified. This work shall also be performed under the personal and constant supervision of a competent Construction Superintendent or Foreman experienced in concrete work.

5.2 The Contractor shall provide forms for all concrete work above and below ground.

5.3 The Company reserves the right to inspect all materials and make concrete tests.

5.4 If requested, the Contractor shall provide concrete test cylinders in accordance with ASTM C31 (two from each truckload) from the concrete placed for the structure foundations. Cylinders shall be dated and labeled as to the foundation and truckload number.

5.5 If the concrete test cylinders, whether made by the Contractor or a testing agency, fail to meet specified compressive strength, the Contractor shall replace any and all affected areas at his own cost.

6. MATERIALS

6.1 Cement shall be Portland Cement conforming to ASTM C150, Type I.

6.2 Fine aggregate shall be sand - clean, hard, durable, uncoated grains, free from deleterious substances, conforming to ASTM C33.

6.3 Coarse aggregate shall be washed gravel or crushed limestone - clean, hard, durable uncoated particles without flat or elongated pieces. Aggregate shall be free from deleterious materials and shall conform to ASTM C33. Gradation shall be No. 467 (1-1/2 inch) to No. 4 for all foundations except drilled piers. Gradation shall be No. 67 (3/4 inch) to No. 4 for drilled piers.

6.4 Water shall be clean and free from injurious amounts of oils, acids, salts, organic, or other deleterious matter.

6.5 Reinforcing bars shall conform to ASTM A615, Grade 60 unless otherwise noted on the foundation drawings. Reinforcing wire shall conform to ASTM A82. All reinforcing shall be free from hard rust, dirt, and oil.

6.6 Removable forms shall be wood, metal, approved fiber tubes, or other approved materials. Forms for exposed concrete surfaces shall be moisture-resistant concrete form plywood, uniformly thick boards lined with moisture-resistant concrete form plywood, or lined with hard, pressed, treated fiberboard.

6.7 Curing materials shall conform to ASTM C171. Curing compounds shall conform to ASTM C309.

6.8 Water-reducing admixtures shall conform to ASTM C494.

6.9 CA-6 road mix shall conform to IDOT specifications.

7 EXCAVATION

7.1 All excavated material shall be removed from the site and disposed of by the Contractor. Any affected ground area shall be returned to its former condition. Seeding and/or sodding may be required.

When soil conditions demand, casing will be allowed to help excavation. This casing shall be removed during placement of the concrete.

7.2 The actual depth of the foundation dig shall be within ± 6 inches from the required foundation depth given on the drawings. This depth shall be measured from an elevation reference stake provided at each structure.

7.3 If over-excavation occurs, the hole shall be filled with compacted CA-6 road mix up to the required depth.

8. FORMS

8.1 Forms shall conform to the shape, line, and dimensions of the members indicated on the drawings, and shall be substantial and tight to prevent leakage of mortar. They shall be properly braced or tied together so as to maintain position and shape. Lumber, once used in forms, shall have nails withdrawn, and the surfaces to be exposed to concrete shall be carefully cleaned before reuse.

8.2 Forms for exposed surfaces shall be coated with nonstaining mineral oil, applied before the reinforcing steel is placed. Before concrete is placed, surplus oil shall be removed from the contact face of forms and from reinforcing steel and other surfaces requiring bond with the concrete.

8.3 Forms shall not be disturbed until the concrete has adequately hardened and has gone through the first stage of curing, a minimum of 16 hours. Care shall be taken to avoid spalling the concrete surfaces. Wood forms and all particles of wood shall be completely removed.

9. REINFORCING

9.1 All bars shall be bent accurately, placed in position as shown on the drawings, securely tied with #16 gauge black, annealed wire at all intersections, and securely held in place by spacers, chairs, or other approved supports in accordance with ACI 315R. At time of placing concrete, all reinforcing shall be free of loose rust, scale, oil, paint, mud, or other coatings which will destroy or reduce the concrete bond. Unless otherwise shown on the drawings or specified, the spacing, amount of concrete coverage, splicing, and bending of reinforcing steel shall conform to the requirements of ACI 318.

9.2 Reinforcing shall not be welded unless approved by the Engineer.

9.3 Anchor bolts (when used) shall be a minimum of 6" from the bottom of the foundation. All steel shall have a minimum of 3" concrete cover.

9.4 Lap splices for reinforcement shall conform to requirements of ACI 318 Class B splices.

9.5 All anchor bolt threads shall be taped to protect them from dirt or concrete during construction.

10. <u>TOLERANCES</u>

10.1 Formwork shall be set and maintained so as to insure completed concrete work within tolerance limits.

10.2 Forms used for the round tops of drilled piers shall be placed concentric to the structure and to the rest of the foundation, and shall extend at least 6 inches but not more than 18 inches below ground (final grade).

10.3 Anchor bolts shall be secured plumb and true by use of a template at the top. Secure wiring or open steel template shall be used at the bottom of the anchor bolts.

10.4 If templates are not supplied with the anchor bolts, the Contractor shall furnish them. Template anchor bolt spacing shall not vary more than ± 1/16 inch.

10.5 Anchor bolts which are not plumb <u>shall not</u> be corrected by bending the tops of the bolts. Incorrectly located or out-of-plumb anchor bolts shall be corrected by removing and repouring the concrete containing the bolts.

10.6 Centerlines of anchor bolt groups shall not vary more than ± 1/8 inch.

10.7 Anchor bolt elevations shall not vary by more than ± 1/8 inch. The anchor bolts shall extend out of the foundation a distance equal to the thread length unless otherwise specified.

10.8 Top elevation of the finished foundation shall not vary more than
± 1/4 inch from the elevation indicated on the drawings. Foundation elevations for the same structure shall not vary more than ± 1/8 inch.

11. <u>CONCRETE MIX</u>

11.1 All concrete shall have a minimum compressive strength of <u>3500</u> psi at 28 days. The mix shall have a minimum of <u>5 1/2</u> sacks of cement per cubic yard and a maximum water cement ratio of .50 (by weight).

11.2 All concrete shall have 5 to 7 per cent entrained air.

11.3 All concrete except for drilled piers shall have a slump of 4 to 5 inches. Concrete for drilled piers shall have a slump of 5 to 7 inches.

11.4 Water-reducing admixtures may be used to help meet the above concrete mixture specifications, following admixture manufacture recommendations.

12. MIXING CONCRETE

12.1 Unless otherwise approved by Engineer, "Ready-Mixed" concrete shall be used for all concrete. It shall be mixed and delivered in accordance with the requirements set forth in ASTM C94.

13. PREPARATION FOR PLACING CONCRETE

13.1 Water shall be removed from excavations before depositing concrete unless a tremie chute is properly used to avoid mixing of fresh concrete with ground water. Any water flow shall be diverted through a proper side drain to prevent washing over freshly deposited concrete. Hardened concrete, ice, debris, and foreign materials shall be removed from form interiors and from mixing and conveying equipment.

13.2 The Owner shall be notified sufficiently in advance of the scheduled time for concrete placement to permit examination of forms and reinforcement. No concrete shall be poured until the Owner has approved reinforcing and forms. This inspection is a precautionary measure and in no way relieves the Contractor of responsibility for the accuracy of form and reinforcement.

14. PLACING OF CONCRETE

14.1 Equipment for conveying concrete shall be of such size and design as to insure a continuous flow of concrete without material separation at the delivery end.

14.2 Concrete shall be conveyed from the mixer as rapidly as practicable without segregation or loss of ingredients. Concrete shall be placed in forms as nearly as practicable in final position to avoid rehandling. Vibrators shall not be used to transport concrete within forms. The concreting shall be carried on at such a rate that the concrete is at all times plastic and flows readily into the spaces between the reinforcing bars. No concrete that has partially hardened, been contaminated by foreign materials, or retempered shall be used. Immediately after depositing, concrete shall be compacted in an approved manner by spading, rodding, forking, or vibrating to eliminate air pockets. Concrete placed in drilled piers below ten feet is not required to be compacted as previously described. All concrete shall be worked into corners around reinforcement and inserts to prevent voids, trapped water, or stone pockets.

14.3 Care shall be exercised in use of a vibrator to prevent segregation, sand pockets, or bleeding. The vibrator shall be moved continuously in and out of concrete, remaining stationary only a few seconds in any position.

14.4 Concrete shall be placed through a hopper to control the direction of fall and shall not strike the sides of the dig, reinforcement, or anchor bolts during placement. Chutes, if used, must slope sufficiently to insure flow of properly proportioned concrete.

14.5 Once concreting has begun, it shall be carried on as a continuous operation until the placing of the foundation is completed.

14.6 Adjacent surfaces shall be protected from concrete drippings, spillage, or splashes. Damaged surfaces shall be cleaned immediately.

14.7 Care shall be taken during placement of concrete in the forms at the top of each drilled pier such that no concrete ledges, caused by leakage of the mixture from below the forms, will remain below ground when forms are removed. If any such concrete ledges form, they shall be chopped flush with the surrounding pier surface.

14.8 If casing is used, the concrete level shall be maintained above the bottom of the casing until the groundline has been reached.

15. HOT-WEATHER REQUIREMENTS

15.1 All hot-weather concreting shall conform to ACI 305R unless otherwise specified.

15.2 The maximum temperature of mixed concrete shall be 90°F. Temperature of aggregates and mixing water shall be reduced by the use of chilled water or ice.

16. COLD-WEATHER REQUIREMENTS

16.1 All cold-weather concreting shall conform to ACI 306 unless otherwise specified.

16.2 Concrete damaged by freezing shall be removed and replaced.

17. CURING AND PROTECTION

17.1 All curing shall conform to ACI 308 unless otherwise specified.

17.2 After the concrete is placed, the structure shall not be erected for a minimum of 7 days and no load shall be applied to the structure for a minimum of 30 days, unless approved by the Engineer.

18. CONCRETE FINISHES

18.1 Tops of all foundations shall be floated and brought to a true level or sloped slightly, with a 1-inch beveled or rounded edge. Foundation tops shall be steel-troweled to obtain a smooth, dense surface.

18.2 Exposed formed surfaces shall be rubbed to the extent of removing small irregularities. Minor voids may be filled with cement mortar. The surface shall not be brush-coated with a cement paste after rubbing.

19. JOINTS

19.1 Construction joints shall not be allowed unless otherwise shown on the drawings or as directed and approved by the Engineer. Where a joint is to be made, a cross-type impression shall be formed in the concrete before it hardens. The impression length shall be a minimum of 2/3 of the foundation dimension in each direction and shall be 4 inches deep.

19.2 Immediately before the placing of new concrete, the hardened concrete surface shall be thoroughly cleaned, all laitance removed, and the surface slushed with a cost of cement grout.

SECTION IV

Erosion Control Specifications

General

Portions of this work require installation of erosion control measures. This work is governed by the following specification.

A firm base should be provided for the erosion control measures. Cut areas of the subgrade should be rolled to provide a smooth, straight surface. Fill areas should be adequately compacted to provide a firm, smooth surface also.

Temporary erosion controls (type, implementation, and maintenance), necessary to limit erosion from the site, are the responsibility of the Contractor.

Materials

Riprap and bedding material shall meet the following requirements:

1. Description. Riprap shall be stone quarried from undisturbed, consolidated deposits of rock reasonably free of shale and shaly stone. The ledges shall be sufficiently thick to produce the desired dimensions. The stone shall be reasonably free of laminations, seams, cracks, and other structural defects or imperfections tending to destroy its resistance to weather. Field stone or boulders will not be accepted. Bedding material shall be crushed stone, gravel or slag.

2. Quality. The riprap stone shall be quarried from ledges approved for Portland cement concrete quality stone provided the ledges are sufficiently thick to produce the desired dimensions. Ledges not previously approved shall be checked with ledge rock samples crushed to 1 1/2 inch top size. The riprap stone shall conform to Article 704.01, IDOT Specifications, Coarse Aggregate, Class A quality Na_2SO_4 soundness requirement. The bedding material for riprap shall conform to Article 704.01, IDOT Specification, Coarse Aggregate, class A quality Na_2SO_4 soundness requirement.

3. Gradation. The stone for riprap shall have a maximum weight per piece of 150 pounds and not more than 5 percent shall weigh less than 3 pounds per piece. The material shall be evenly graded and 30 to 70 percent of the material shall weigh 60 pounds or more per piece.

   Bedding material shall be well graded between the 3 inch and No. 4 sieves. 100% shall pass the 3 inch sieve with no more than 5 percent passing the No. 4 sieve. It shall be reasonably free from thin, flat and elongated pieces, and shall contain no organic matter nor soft friable particles in quantities considered objectionable by the Engineer.

Installation

This item shall consists of furnishing, transporting, and placing a protective course of stone, laid as riprap on slopes or in channels.

The bed for the riprap shall be trimmed and shaped so that the finished surface shall conform to the lines specified.

A bedding layer will be required for stone riprap. No bedding is required for concrete block riprap, broken concrete riprap or for stone or broken concrete dumped riprap, unless specified.

Bedding material shall be spread uniformly on the prepared base, in a satisfactory manner, to the neat lines specified. Placing of material by methods which will tend to segregate particle sizes within the bedding will not be permitted. Any damage to the surface of the bedding base during placing of the bedding shall be repaired before proceeding with the work. Compaction of the bedding layers will not be required but it shall be finished to present a reasonably even surface free from all mounds, windrows, or depressions. Bedding shall be a minimum of 4 inches in thickness.

Stone shall be placed on the bedding layer in such manner as to produce a reasonably well-graded mass of rock with the minimum practicable percentage of voids and shall be constructed to the lines and grades shown.

The stone riprap shall be placed to its full course thickness at one operation and in such a manner as to avoid displacing the bedding material. Placing of material shall begin at the lower elevations and progress up the slope. The larger stones shall be well distributed and the entire mass of stones in their final position shall be roughly graded to conform to the gradation specified. The finished riprap shall be free from objectionable pockets of small stones and clusters of larger stones. Placing riprap in layers will not be permitted. Placing riprap by dumping into chutes or by similar methods likely to cause segregation of the various sizes will not be permitted. The desired distribution of the various sizes of stones throughout the mass shall be obtained by selective loading of the material at the quarry or other source; by controlled dumping of successive loads during final placing or by other methods of placement which will produce the specified results. Rearranging of individual stones by mechanical equipment or by hand will be required to the extent necessary to obtain a reasonably well graded distribution of stone sizes as specified above. Stone riprap shall be a minimum of 18 inches thick.

SECTION V

Seeding

Scope

This specification covers the minimum requirements for seeding areas disturbed by construction activities, slope protection, and related operations.

General Requirements

All work shall be performed under the personal and constant supervision of a competent Construction Superintendent or Foreman.

The Company reserves the right to inspect all materials and perform all tests necessary to determine compliance with the specifications. If the materials or finished product fail to meet the controlling criteria for these tests, the Contractor shall replace all affected areas at this expense.

Each lot of seed furnished shall be tested by a State Agriculture Department (including states other then Illinois). All seeds shall comply with the requirements of the U.S. Department of Agriculture Consumer and Marketing Service, Rules and Regulations under the Federal Seed Act of August 9, 1939, issued March 1940, reprinted with amendments April, 1968, or any current revisions.

Acceptance of seeds furnished under this specification will be based on receipt and approval of a certification covering tests from each lot of seed. Certification shall consist of test reports showing the required test results of lots corresponding to the shipment and signed by the responsible personnel of the State Seed Laboratory.

Seeds shall be packed for delivery in suitable bags in accordance with standard commercial practice. Each bag shall be tagged or labeled as required by the Illinois Seed Law.

All sloped areas disturbed by construction activities shall be seeded with the Prairie mixture. The dikes, slopes and toe areas, shall be seeded with the Prairie mixture.

Flat areas disturbed by construction shall be seeded with the Grass mixture (borrow area, pipe run from plant to ash pond, and coal yard runoff ditch).

Operations

Seeding

Immediately prior to the seed bed preparation, fertilizer nutrients and agricultural limestone shall be uniformly spread at the designated rate over the areas indicated on the plans.

Agricultural ground limestone, conforming to the requirements of Article 717.06 of IDOT specifications, shall be thoroughly mixed, at the rate of two tons per acre, with surface soil before completion of ground preparations.

Fertilizer shall consist of nitrogen, phosphate, and potassium nutrients.

Fertilizer shall be applied at such rate that each acre will receive the following of available units:

Nitrogen 60 pounds
Phosphate (P_2O_2) 100 pounds
Potassium (K_2O) 100 pounds

Fertilizer can be placed during ground preparation or mixed with, and placed with, seed and mulch during final seeding.

All trimming, shaping, and finishing work on the disturbed area shall be completed prior to starting seed bed preparation. Stones, boulders, debris and similar material larger than two inches in diameter shall be removed from the seed bed area. The seed bed will be worked to a minimum depth of three inches, reducing all soil particles to a size smaller than two inches as the largest dimension. The prepared surface shall be relatively free from weeds, clods, stones, roots, sticks, rivulets, gullies, crusting, and caking.

No seed will be sown during unfavorable climatic conditions or when the ground is not in a proper condition for seeding.

All seeded areas, including slopes up to 3 to 1 or flatter, shall be rolled at right angles within 12 hours of seeding to compact the seed bed and place the seed in contact with the soil. Slopes steeper than 3 to 1 do not need to be rolled.

The optimum depth for seeding shall be 1/4 inch.

All legumes shall be innoculated per the manufacturers recommendations immediately before sowing.

Seeding operations shall be between June 1 and December 1.

Within 24 hours from the time the seeding has been performed, the seed bed shall be given a covering of mulch. On slopes steeper than 3 to 1, mulch shall be applied on the same working day.

Prairie seeding shall be done by hydraulic seeders or with a range land type grass drill. The water application rate for hydraulic seeding shall be greater than 500 gallons per acre. Non-toxic, non-permanent dye shall be added to each hydraulic seed batch to color the seeded area green or blue-green.

Slope Protection

Method A

Hay or straw mulch shall be hand or machine applied loose enough to permit air to circulate, but compact enough to prevent erosion. If baled material is used, care shall be taken that the material is in a loosened condition.

The mulch shall be stabilized by working the area with dull blades or disks. The blades or disks shall be without camber, notched, approximately 20 inches in diameter, spaced at 3($\pm$) inch intervals, and equipped with scrapers. The stabilizer shall weigh approximately 1,000 pounds and be approximately six feet wide.

Method B

Paper mat shall be placed within 24 hours after seeding operations have been completed. Prior to placing the mat, the areas to be covered shall be relatively free of all rocks or clods over 1 1/2 inches in diameter, sticks, or other foreign material which will prevent the close contact of the mat with the seed bed. If the seed bed becomes crusted or eroded, the Contractor will be required to rework the soil until it is smooth and reseed such areas which are reworked. After the area has been properly shaped, fertilized, and seeded, the mat or blanket shall be laid out flat, evenly, and smoothly, without stretching the material.

Paper mat used as a ditch lining shall be applied with the lengths running parallel to the flow of water. Where more than one width is required, a lap joint not less then 4 inches shall be used with the upslope width on top.

An anchor slot shall occur at the upslope edge of the paper mat placement. This is accomplished by burying at least 6 inches of the end of the mat vertically in a slot dug in the soil. The soil shall be firmly tamped against the jute in the slot.

Junction slots shall be used to join the ends of successive lengths. For junction slots, the upslope end of each strip of paper mat shall be buried at least 6 inches in a slot dug in the earth. Soil shall be firmly tamped against the mat in the slot. The ends of the mat shall overlap at least 12 inches with the upslope section on top.

Check slots shall be constructed by placing a tight fold at least 6 inches vertically into the soil. On ditch grades of 4 percent or less, such check slots shall be spaced so that a check or junction slot occurs within each 50 feet. On grades greater then 4 percent, such slots shall occur within each 25 feet.

A terminal fold shall occur at the bottom end of the mat. This end shall be folded under approximately 4 inches and stapled to the ground.

Paper mat shall be held in place by means of wire staples. Staples shall be driven perpendicular to the plane of the soil. Staples shall be spaced not more than three feet apart in three rows for each strip, with a row along each edge and one row spaced alternately in the middle. All ends of mat and check slot locations shall be fastened by staples spaced six inches apart across the width.

When paper mat is used on cuts or fills, the mat may be placed with the length running from top to toe of slop or placed with the length running parallel to the contour. Check slots will not be required when the mat is placed on cuts or fill.

Materials

Seeding Mixtures

Crown Vetch	Seeds	lbs./Acre
Spring	Crown Vetch	20
	Perennial Ryegrass	10
	Lespedeza, Ladino, Alfalfa, White Dutch Clover*	5
Fall	Crown Vetch	20
	Winter Vetch	40

* Lespedeza shall not be sown north of US 136.

Grass	Seeds	lbs./Acre
Spring	Ky. Bluegrass	50
	Perennial Ryegrass	20
	Redtop or Creeping Red Fescue	10
	Ladino or White Dutch Clover	5
Fall	Ky. Bluegrass	50
	Perennial Ryegrass	20
	Redtop or Creeping Red Fescue	10
	Spring Oats	48

Prairie	Seeds	lbs./Acre
Big Bluestem - Andropogon Gerardi		6
Little Bluestem - Andropogon Scoparius		3
Prairie Wild Rye - Elymus Canadensis		1
Side - Oats Grama - Bouteloua Curtipendula		3
Indian Grass - Sorghastrum Nutans		6
Switch Grass - Panicum Virgatum		1
Perennial Ryegrass		20
Prairie Forbs Mixture		2
Amorpha Canescens - Lead Plant and Inoculant		
Aster Laevis - Smooth Aster		
Aster Novae-Angliae - New England Aster*		
Ceanothus Americanus - New Jersey Tea		
Coreopsis Palmata - Prairie Coreopsis*		
Echinacea Pallida - Pale Purple Coneflower*		
Eryngium Yuccifolium - Rattlesnake Master**		
Liatris Pycnostachya - Prairie Blazing Star		
Monarda Fistulosa - Prairie Bergamot		
Parthenium Integrifolium - Prairie Quinine		
Petalostemum Candidum - White Prairie Clover		
Petalostemum Purpureum - Purple Prairie Clover		
Potentilla Arguta - Prairie Cinquefoil		
Ratibida Pinnata - Yellow Coneflower*		
Rudbeckia Hirta - Black-eyed Susan*		
Rudbeckia Subtomentosa - Sweet Coneflower*		
Silphium Laciniatum - Compass Plant**		
Silphium Terebinthinaceum - Prairie Dock**		
Solidago Rigida - Rigid Goldenrod*		

The prairie forbs seed mixture shall be subject to the following requirements:

1. The mix shall contain not more than 15% of any one kind of seed.

2. The mix shall consist of not less than 10% of each species indicated with a single asterisk (*).

3. The mix shall contain not less than 1% of each species indicated with two asterisks (**).

4. The mix may contain not more than 5% of annuals, grasses or other plants not indicated in the above list.

Seed mixture shall be proportioned by weight.

No seeds shall be sown until they have been tested for purity and until such tests indicate that the seeds do not contain any seeds of the noxious weeds classed as "Primary Noxious Weed Seed" in the existing Illinois Seed Law, and not more than the maximum number per ounce sample, specified in Table II, Noxious Weeds classed as "Secondary Noxious Weed Seed" in the existing Illinois Seed Law.

In determining the viable germination percent of legumes, the percent hard seed is to be added to the percent test germination; however, the percent hard seed added shall not exceed the maximum specified in Table II when planted in the fall season.

Seeds having a purity that is below the purity specified in Table II will be rejected. Seeds having a total inert matter and weed seed content greater than 20% of the sample in cases of bluegrass, redtop, orchard grass, brome grass, and creeping red fescue, and greater than 3% in all other agricultural seeds listed in Table II, will be rejected. Any sample containing more than 5% by weight of seed of other cultivated plants will be rejected. Seeds that fail to meet the requirements of Table II, "Maximum Weed Seed Percent" and "Remarks" will be rejected.

Pure, live seed shall be defined as the sproutable seed of a specified variety and calculated as the product of the viable germination times the purity. The seed weights per acre listed are designed to yield specific amounts of pure, live seed per acre based on the pure, live seed percent values listed in Table II. Seed which has actual pure, live seed yield according to tests less than the intended yield will have the specified quantity adjusted to meet the intended pure, live seed yield. The adjusted weight to be sown will be calculated as follows:

Variety of Seeds	Hard Seed Percent Maximum	Purity Percent Minimum	Pure, Live Seed Percent Minimum	Weed Percent Maximum	Secondary Noxious Weeds Number per Ounce Maximum Permitted*	Remarks
Alfalfa	20	92	89	0.50	6	Note 1
Brome Grass	-	75	68	2.00	5	-
Clover, Alsike	15	92	87	0.30	6	Note 2
Clover, Crimson	15	92	83	0.50	6	-
Clover, Ladino	15	92	89	0.30	6	-
Clover, Red	20	92	89	0.30	6	-
Clover, White Dutch	30	92	88	0.30	6	Note 3
Dawson Red Fescue	0	97	85	0.10	3	-
Fescue, Alta or KY. 31	-	92	88	1.00	6	-
Fescue, Creeping Red	-	75	82	1.00	6	-
Fults Salt Grass	0	98	85	0.10	2	-
Kentucky Bluegrass	-	75	72	0.50	7	Note 5
Lespedeza, Korean	20	92	84	0.50	6	Note 3
Oats	-	92	88	0.50	2	Note 4
Orchard Grass	-	75	70	1.50	5	Note 4
Redtop	-	75	78	1.80	5	Note 4
Reed Canary Grass	-	92	63	1.00	5	-
Ryegrass, Perennial, Annual	-	92	88	0.50	5	Note 4
Rye, Grain, Winter	-	92	83	0.50	2	Note 4
Scaldis Hard Fescue	0	97	85	0.10	3	-
Timothy	-	92	84	0.50	5	Note 4
Vetch, Crown	30	92	67	1.00	6	Notes 3 & 6
Vetch, Spring	30	92	88	1.00	2	Note 4
Vetch, Winter	15	92	83	1.00	2	Note 4
Wheat, Hard Red Winter	-	92	89	0.50	2	Note 4

Note 1. Shall be grown in Kansas or farther north; shall be free from any mixture with southern or foreign seeds, blends or adulterations with screenings, frosted or damaged seeds; and shall not contain more than 0.2 percent bur or sweet clover mixture.

Note 2. Shall be free from blends or adulterations with screenings, blasted, shriveled or immature seeds.

Note 3. Shall be hulled and free from blends or adulterations with blasted, shriveled or immature seeds.

Note 4. Shall be recleaned.

Note 5. Shall not contain more than 5 percent adulteration with Canada Blue Grass, Merion Blue Grass or other hybrids or varieties of blue grass.

Note 6. Shall be scarified.

* No primary Noxious Weeds are permitted.

$$\text{Adjusted pounds per acre} = \frac{\text{Intended pure live seed per acre} \times 100}{\text{Actual pure live seed percent}}$$

Intended pure, live seed per acre equals the product of the specified pounds per acre and pure, live seed percent.

$$\text{Actual pure live seed percent} = \frac{\text{Actual germination percent} \times \text{Actual purity percent}}{100}$$

Seeds which meet the noxious weed seed and purity requirements may be sown prior to the completion of the germination test provided 115 percent of the specified amount is sown.

Straw shall be stalks of air-dried wheat, rye, oats, or other approved straw.

Hay shall be air-dried. Hay shall be obtained from fields of timothy, redtop, or mature brome grass.

Staples shall be made from No. 11 gage or heavier wire, width 1 or 2 inches at the throat and 6 inches from top to bottom after bending. The staples shall be packaged in cartons.

Paper mat shall consist of a knitted construction of polypropylene yarn with uniform openings interwoven with strips of biodegradable paper designed to degrade over selected periods of time recommended by the manufacturer and approved by the Engineer for each installation.

The paper mat shall be furnished in rolls which can be easily handled. The rolls shall be packaged with suitable protection for outdoor storage at a construction site in a manner which protects them from biodegradation prior to use.

The weight of the paper mat shall be approximately 0.2 pounds per square yard.

SECTION VI

Slurry Wall Construction

General

A portion of this project requires construction of an impermeable barrier(s) (soil-bentonite slurry backfill) to impede the flow of water from the wet ash disposal facility into the surrounding soil. The perimeter slurry wall system shall provide a combined minimum width of 8 ft. of soil-bentonite slurry backfill. The soil-bentonite slurry backfill shall have a hydraulic conductivity of less than 1×10^{-7} cm/sec. The barrier(s) shall be keyed into the clay core and shale aquaclude.

Soil boring information is located in Sections VI and X of these specifications. Additional borings may be performed by the Contractor if more information is desired at no cost to the Company. The Company anticipates performing 12 more borings (B-J1 to J12) prior to construction. This information will be made available to the Contractor.

Construction of the slurry wall(s) shall be performed after stripping or clearing of the area has been performed. The clay core and other dike material will be placed or cut to the level necessary to start excavating for the slurry wall(s). Material excavated from the trench may be used as a slurry component if it is found to be suitable for this application.

The soil-bentonite slurry backfill is the key component in isolating the groundwater outside the pond from mixing with any of the ash sluice water. Therefore, installation of the soil-bentonite slurry backfill is planned to be continuous around the pond.

Definitions

API - American Petroleum Institute
ASTM - American Society for Testing and Materials
EM - Engineering Manual of the Department of the Army, Corps of Engineers
Owner - Illinois Power Company
Slurry Trench (Slurry Wall) - A narrow vertical-walled trench of specified width excavated by the slurry trench method and backfilled with the specified materials to form a cutoff wall of low permeability.
Slurry Trench Technique - A method of excavating a narrow vertical-walled trench using a specified slurry mixture to support the trench walls, form a filter cake on and in the trench walls, and prevent movement of water through the excavated trench.
Water-Bentonite Slurry - A stable colloidal suspension of powdered bentonite in water.
Soil-Bentonite Slurry Backfill - A homogeneous mixture of specified soil material, bentonite, and water.

Slurry Trench Specialist - An individual or company who has had proven and successful experience in slurry trench construction and is knowledgeable with regards to the following: 1) the use, testing, and control of bentonite as a slurry: 2) the proper mixing methods employed to mix the slurry and backfill methods; 3) excavation and backfill operations; and 4) construction equipment and testing requirements needed for slurry trench construction.

Working Platform - The surface of compacted fill and/or excavated surface on which the slurry wall should be constructed.

Qualification of Contractor

The Contractor shall submit evidence indicating competence and experience in slurry wall construction. This information shall include a list of projects and clients (addresses and phone numbers) served in the last three years. The Contractor shall name the Slurry Trench Specialist who will be charge of this construction. All information will be submitted with the bid package.

Preconstruction Design

The Contractor shall include as part of this project a slurry wall design incorporating all the items mentioned in this specification. The preconstruction investigation will determine the proper blend of material and work to achieve the stated specifications and goals.

Materials shall be tested for compatibility with all waste streams to be routed to the ash pond. Materials to be incorporated into the work shall be compatible with all wastes routed to the ash pond.

Permeability of the soil-bentonite slurry backfill shall be determined by testing of various mixtures of materials and bentonite to determine a range of weights/components needed to achieve the desired results.

The results of the preconstruction testing shall be submitted to the Owner for review prior to beginning any construction on the soil-bentonite slurry backfill. The report will include the following:

1. Soil bentonite slurry backfill mix design
   Trial mix reports including compatibility testing
   Chemical analysis of water supply
   Mix proportions
   Density
   Moisture Content
   Gradations
   Hydraulic conductivity on at least four samples of the proposed mix design
   Porosity of soil-bentonite slurry backfill
   Other parameters necessary to provide a satisfactory design

2. Specifications of the batch plant and layouts showing locations of equipment, ponds, tanks, pumps, valves, hoses, and supply lines.

3. Source of all imported material
(Shipment of materials to the site shall include the shipper's written verification of the quality or specification of the material.)

4. Certification of bentonite quality (API 13A)

5. Capping detail for soil-bentonite slurry backfill barrier(s).

Specifications and Goals

1. The gradation and materials used for the backfill shall be such that the soil-bentonite slurry backfill barrier(s) achieves an effective, long-term hydraulic conductivity of less than 1×10^{-7} cm/sec with Vermilion Ash Pond leachate as the permeant.

2. The eventual height of the embankment will be elevation 660. This will place a significant hydraulic head and earth load on the slurry backfill. Trench stability and elimination of long term deformations are long range goals. The minimum long term soil-bentonite slurry backfill barrier(s) width desired is 8 ft. or multiple widths to attain an equivalent thickness. The Contractor's report shall address this issue and provide a design that will yield a soil-bentonite slurry backfill with the required minimum thickness even after the application of the long term loading.

3. All efforts shall be made to provide a continuous, homogeneous mixture of soil and bentonite within the trench and the occurrence of "windows" of material having a hydraulic conductivity of greater than 1×10^{-7} cm/sec shall not be allowed.

4. The completed soil-bentonite slurry backfill cutoff wall shall not crack, shrink, or undergo other physical changes which may adversely affect the hydraulic conductivity of the barrier over the design life of the facility.

5. The required depth of the trench shall be to the top of competent, solid bedrock but no less than 4 ft. of penetration. Bedrock shall be defined as material of such strength that it satisfies all of the following:

   a. It cannot be excavated or removed by grabbing, scraping, or rotary scraping action under full down pressure of clamshell backhoe rock bucket.

   b. The above tools, when used after chiseling operations, shall consistently recover either rock fragments only or no material at all.

   c. Rock fragments removed shall be geologically consistent with the rock type underlying the site as based on rock cores.

d. After excavating to the required depths, the Contractor shall take all necessary measures to remove all loose material or cuttings from the bottom of the trench with the excavation tools or by other suitable means such as air lift or suction pumps.

6. Slurry shall consists of a stable colloidal suspension of bentonite in water and shall be controlled by the current API Standard 13B - "Standard Procedure for Testing Drilling Fluids". The slurry shall be a mixture of not less than 18 pounds per barrel (42 gallons) of bentonite and water. Additional bentonite may be required depending on the hardness and temperature of the water and the quality of the bentonite.

   The slurry shall have a minimum apparent viscosity of 15 centipose or 40 seconds reading through a Marsh Funnel Viscosimeter, and a maximum filtrate loss of 30 cubic centimeters in 30 minutes at 100 psi.

   The slurry mixture in the trench shall have a unit weight of not less than 64 pcf and not greater than 94 pcf.

7. Bentonite used in preparing slurry shall be pulverized (powder or granular) premium grade sodium cation montmorillonite (unless preconstruction testing finds this material incompatible for the intended use) and shall meet the current API Standard 13A "API Specifications for Oil-Well Drilling-Fluid Materials".

8. Water shall be fresh, free of excessive amounts of deleterious substances that adversely affect the properties of the slurry. It is the responsibility of the Contractor that the slurry resulting from the water shall always meet the standards of this specification.

9. Admixtures or additives shall not be used unless the use of these items was presented and discussed in the preconstruction report.

10. The material for trench backfilling shall be composed of slurry and selected soils obtained from the project site and trench excavation. The soil shall be friable and free from roots, organic matter, or other deleterious materials. The backfill shall be thoroughly mixed and reasonably well graded between the following gradation limits:

Screen Size (US Standard)	Percent Passing By Dry Weight
3"	<95%
#200	>15%

The above limitations are considered minimums and the fines may be increased to provide the necessary impermeability.

11. Backfill slurry mixture shall include sufficient percentage of bentonite to meet the requirements herein specified.

Installation

Excavation of the slurry trench shall be accomplished by the use of any suitable earth moving equipment or combination thereof such as a backhoe and/or clamshell so that the required trench width can be carried to its final depth of cut continuously along the trench line. Special chopping, chiseling, or other suitable equipment may be used as necessary to satisfactorily accomplish the work.

The slurry batching plant shall include the necessary equipment including a mixer capable of producing a colloidal suspension of bentonite in water, pumps, valves, hoses, supply lines, and other appurtenances to adequately supply slurry to the trench. Storage will be the Contractor's responsibility. Slurry shall be agitated or recirculated in the ponds to maintain a homogenous mix. No slurry is to be made in the trench. Mixing shall continue until all bentonite particles are fully hydrated.

Mixing equipment for the backfill may consist of suitable earth moving equipment capable of thoroughly mixing the soil and slurry into a homogenous paste having the required gradation and properties free from large lumps or pockets of fines, sand or gravel. Occasional lumps of up to 6 inches in their largest dimension will be permitted. The backfill shall have a slump of 2 to 6 inches just prior to placing. Backfill materials shall be sluiced with slurry during blending operations, but sluicing with water will not be permitted.

Excavation shall be carried to the final depth of the point where excavation is started and continued along the line of the trench. Excavation shall proceed from the starting point to the finish point. Slurry shall be introduced into the trench at the same time trenching is begun and shall be maintained in the trench during excavation until backfilled. The Contractor shall maintain the stability of the excavated trench at all times for its full depth. The level of the bentonite slurry shall always be maintained within 2 ft. of the top of the excavation and higher if necessary to prevent sloughing of the walls. The Contractor shall be prepared to raise the slurry level at any time. To this end, the Contractor's personnel shall be on call on weekends and/or holidays.

The backfill shall be placed continuously from the beginning of the trench, in the direction of the excavation, to the end of the trench. The toe of the slope of the trench excavation shall precede the toe of the backfill slope so that the toe of the backfill shall not be less than 50 ft. following the toe of the excavation, or as required to permit proper cleaning of the trench bottom and permit inspection and measurement. Placing operations shall proceed in such fashion that the surface of the backfill below the slurry shall follow a reasonably smooth grade and not have hollows which may trap pockets of slurry during subsequent backfilling. Free dropping of backfill material through the slurry will not be permitted. Initial backfill shall be placed by lowering it to the bottom of the backfill rises above the surface of the slurry trench at the end of the trench. Additional backfill may then be placed in such a manner that the backfill enters the trench by sliding down the forward face of the previously placed backfill. To accomplish this, sufficient backfill shall be piled on the edge of the existing backfill to cause a slump and sliding action on the face of the in-place backfill. Methods of placement that cause segregating of the backfill will not be permitted.

The cut-off trench shall be capped upon completion of backfill placement before drying of the backfill can occur.

After the soil-bentonite slurry backfill work has been completed, all remaining excavated material and slurry shall be removed and the working platform cleaned and leveled. All storage ponds shall be pumped dry and destroyed. Excess slurry shall be spread in thin layers in adjacent areas designated by the Company's Representative.

Quality Control

The following schedule (Table 1) shall be considered as a minimum amount of testing to be performed during construction of the slurry wall by the Contractor.

Table 1

Quality Control Testing Program

	Item	Standard	Type of Test	Minimum Frequency	Specified Values
Materials	Water	--	-- pH -- Total hardness	Per water source or as changes occur	As required by bentonite supplier to properly hydrate bentonite with approved additives.
	Additives	--	Manufacturer certificate of compliance with stated characteristics		As approved by Engineer.
	Bentonite	API Std. 13A	Manufacturer certificate of compliance		Premium grade sodium cation** montmorillonite.
Slurry	Prepared for placement into the trench	API Std. 13B	- Unit weight - Viscosity - Filtrate loss	1 set per shift and per batch (pond)	Unit weight - 1.03-1.30 gm/cc V $\geq$ 15 centipose or 40 sec-Marsh @ 20°C Loss $\leq$ 30 cc in 30 min

Item		Standard	Type of Test	Minimum Frequency @ 690 kilopascal	Specified Values
	In trench	API Std. 13B 1	- Unit weight	1 set per shift at point of backfilling	Unit weight - 1.03-1.30 gm/cc
			- Sand content	1 set per shift	
Backfill Mix *	At trench	ASTM C143	- Slump	1 set per 375 M^3	Slump 10 to 15 cm
		ASTM D422	- Gradation	1 test per 375 M^3	Consistent with design mix mix $\geq$ 15% passing #200 sieve, % bentonite not less than % specified in design mix
		ASTM C138	- Density	1 test per 375 M^3	$\geq$ 1.6 gm/cc
		EM1110-2-1906	- Triaxial hydraulic conductivity test	1 test per 2000 M^3	$\leq 1 \times 10^{-7}$ cm/sec

Notes:

* Hydrometer testing of off-site borrow shall be required if said borrow contains greater 0.5% -2 material, for use in computing % bentonite in backfill mix.

** Dependent on compatibility testing.

The above testing shall be performed by the Contractor. Results of all tests will be recorded on forms acceptable to the Owner and signed by the Contractor's Slurry Trench Specialist. Signed copies will be submitted daily to the Company's Representative.

The Company shall retain an independent testing firm to perform additional tests. Any discrepancy between the results of the two tests shall halt work immediately until the discrepancy is resolved. Any loss of productivity or time caused by such a delay shall be considered incidental to the Contract and cannot be claimed by the Contractor against the Company. The independent agency shall also evaluate the overall cutoff wall continuity and hydraulic conductivity of random samples. Failure of the installed soil-bentonite slurry backfill on either of these items will be cause for remedial work by the Contractor at no additional cost to the Company.

SECTION VII

Raw Water Chemistry

The following table contains the results of various tests performed on raw water samples taken from the reservoir adjacent to the plant. This water is pumped from the Vermilion River to the reservoir. While there may be some differences in the water between the river and reservoir the results are provided as a guide to the type of water contained in the river and reservoir. While the information is believed to be representative and accurate, no claim is made that the makeup of the water at the time of construction will be exactly as shown in the table.

It should be noted that water testing is part of the preconstruction report.

<u>APPENDIX A</u>

VERMILION-RAW WATER (RESERVOIR)

DATE	pH	P.ALK.	T.ALK.	HARD.	TURB.	TSS	TDS	TOC	SO4	Cl	T.SiO2	S.SiO2	Ca	Mg	Na	Fe	Al
		mg/l	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
03/86	8.5	5	133	300	7.6	12.0	340	3.2	120	20.2	4.4	3.7	74	28	9.9	0.310	<0.5
04/86	8.3	0	145	317	1.8	6.1	340	2.9	120	20.4	4.8	0.6	76	31	10.0	0.072	<0.5
05/86	7.1	0	142	317	3.0	3.0	360	3.4	120	19.7	14.3	2.2	75	31	8.6	0.098	<0.5
06/86	7.7	0	121	246	0.7	1.1	300	3.2	110	20.4	5.9	1.6	54	27	7.7	0.066	<0.5
07/86	7.9	0	140	276	2.3	4.4	350	3.3	98	18.7	5.2	3.4	63	29	8.0	0.043	<0.5
08/86	8.0	0	110	224	2.8	9.3	320	4.0	85	19.8	6.5	2.9	42	29	8.9	0.035	<0.5
09/86	7.8	0	140	266	2.2	4.2	328	3.6	96	20.5	4.6	4.0	57	30	8.7	0.110	<0.5
10/86	7.8	0	133	254	2.6	3.9	316	3.6	109	19.2	4.4	3.5	54	29	10.0	0.130	<0.5
11/86	8.2	0	144	271	1.7	5.9	350	4.0	109	19.6	5.2	3.9	56	32	10.1	0.089	<0.5
12/86	8.4	8	158	279	4.6	4.7	353	3.8	92	22.0	4.4	4.8	59	32	10.0	0.053	<0.5
01/87	8.0	0	152	321	2.2	2.5	365	3.7	116	20.5	5.0	4.9	66	38	10.1	0.086	<0.5
02/87	8.4	6	166	297	1.7	2.3	376	3.6	120	21.5	5.2	5.2	58	37	10.6	0.040	<0.5
03/87	8.1	0	158	314	3.2	35.2	393	3.2	109	21.1	8.4	4.0	68	35	10.3	0.106	<0.5

SECTION VIII

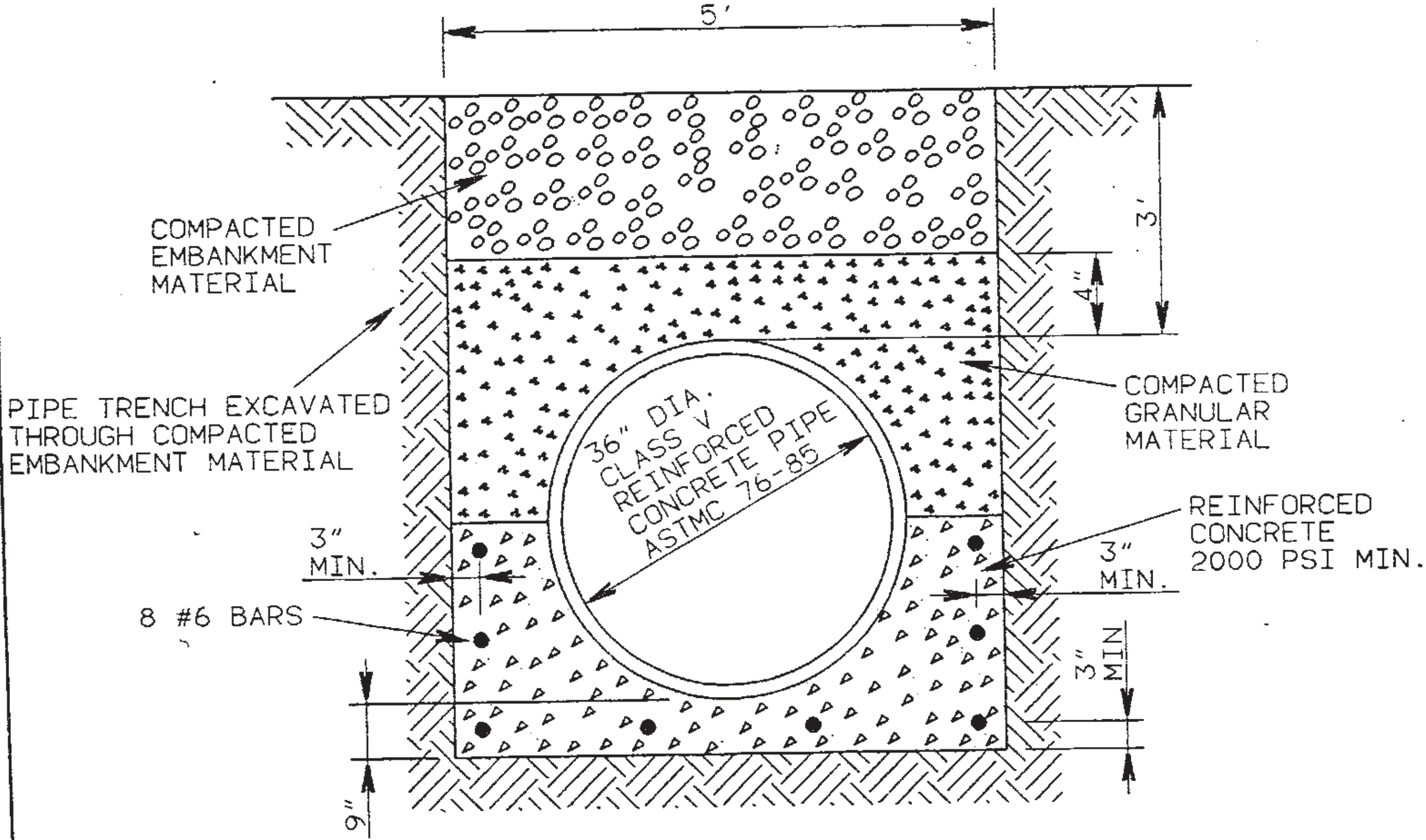
Piping

General

Ash sluice piping material and installation will be performed by others at a later date.

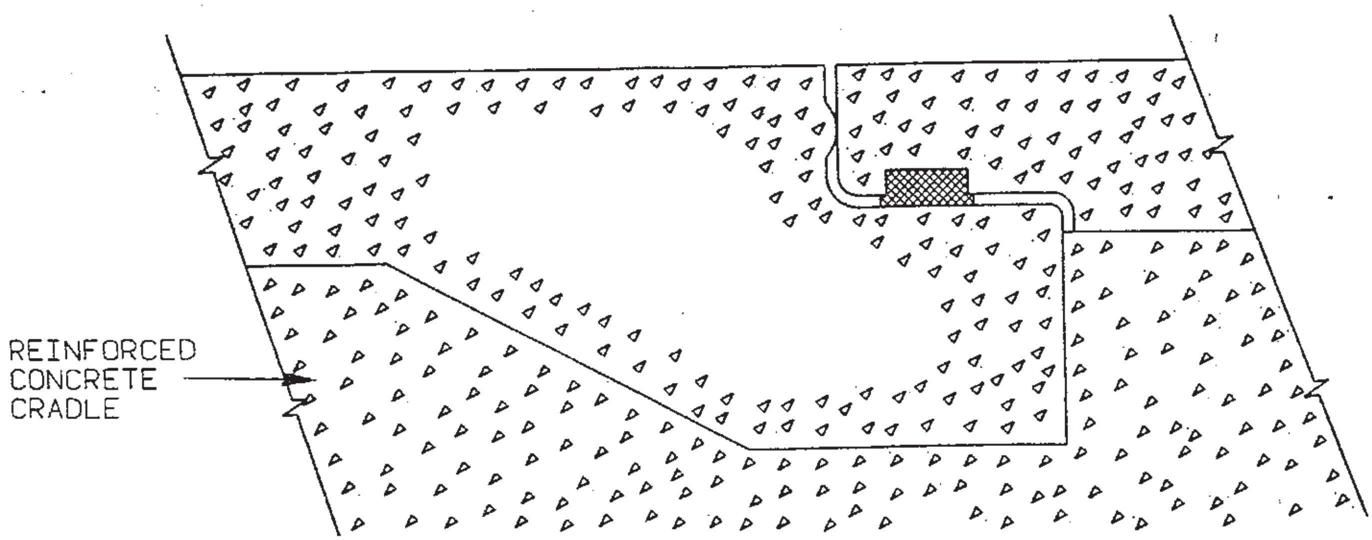
Corrugated metal pipe/pipe arch culverts shall be formed from precoated galvanized steel sheets. Thickness of the sheets shall correspond to the IDOT specifications for Type 2A CMP for road culverts.

Reinforced concrete pipe shall be used for all ash pond piping. Class V pipe with spigot groove type joints and O-ring gaskets shall be used. A reinforced concrete pipe cradle shall be required under all ash pond dikes as shown on the following detail.



TRENCH BEDDING DETAIL

CLASS A TYPE BEDDING - REINFORCED CONCRETE ARCH



TYPICAL CROSS SECTION

SPIGOT GROOVE TYPE JOINT WITH O-RING GASKET ASTMC 443-85

NO	DATE	DRF	DESCRIPTION	E	C	A
0						

ILLINOIS POWER COMPANY
DECATUR

DETAIL - TRENCH BEDDING OF OUTFALL PIPING
VERMILION POWER STATION

DR WJM	CAD WJM	DATE 7-27-88
CK	CKD	SCALE NONE
APP	PRINTED 8-3-88	A-SK.26869-11
APP		

SECTION IX

Hydrogeologic Study

The following study is provided as general information concerning the project. Any interpretation and use of the information by the Contractor is at the Contractor's risk.

APPENDIX D. BORING DATA

Records of Subsurface Exploration
General Notes
Notations Used
Unified Soil Classification System

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-10
SHEET 1 OF 3

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL, Classification) Soil Classification System Unified; Surface Elevation 656.2'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Yellow-Brown Silty CLAY Trace Roots, CL		
	1	HST	60/36		Brown CLAY w/Silt, Roots, CH		103
					Olive-Brown Silty CLAY, TILL, CL		
5					-w/Gravel 6.0-8.0'		
	2	HST	60/12				
10					-w/Gravel 10.0-12.5', & 18.0-21.0'		
	3	HST	60/6				
15							
	4	HST	60/10		-w/Cobbles @ 17.0'		
20					-Brown 20.0-30.0'		111
	5	HST	60/24				
25					-w/Sand, Gravel Seam @ 25.0'		
	6	HST	60/6				
30					-Gray Below 30.0'		
	7	HST	30/6		-Gravel Seam @ 32.5'		
35	8	SS	24/24	1		17-25-23-24	127

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 & Mud Rotary
DATE DRILLED 4/28-29/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO.: 11872803

BORING: B-10
SHEET 2 OF 3

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System: Unified. Surface Elevation: 656.2'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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)
	8	HST	24/24		Gray Silty CLAY Trace Sand, Gravel, TILL, CL	17-25-23-24	127	
40	9	SS	24/24			11-15-30-39		
					-Gray-Brown Below 43.0'			
45	10	SS	22/18			18-24-40-50/4"	127	
					-w/Gravel Seams 49.0-59.0'			
50	11	SS	18/18			23-34-50		
55	12	SS	9/9			48-50/3"		
	13	~~AS~~						
60	14	~~SS~~	5/0			50/5"		
65	15	SS	17/15			26-30-50/5"	120	
70	16	SS	12/12			24-50/6"		

DRILLING METHOD: Hollow Auger & Mud Rotary
DATE DRILLED: 4/28-29/87
DRILLED BY: Schaffer
LOGGED BY: Shively/Jacobi
PIEZOMETER: Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING: B-10
SHEET 3 OF 3

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System: Unified; Surface Elevation: 656.2'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	Shear Strength, tsf (SV△ QP/2□ QU/2○); PL + NMC • LL x; Rock Quality Designation
					Gray Silty CLAY Trace Sand, Gravel, TILL, CL			
75	17	SS	3/3		Gray Clayey SHALE TOB	50/3"		
80								

DRILLING METHOD: Hollow Auger & Mud Rotary
DATE DRILLED: 4/28-29/87
DRILLED BY: Schaffer
LOGGED BY: Shively/Jacobi
PIEZOMETER: Yes

GROUNDWATER LEVELS

Encountered at ___ Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-11A
SHEET 2 OF 2

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (In)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified Surface Elevation 594.7'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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
					Gray SHALE			
40	9	~~SS~~	2/1.5		TOB	~~50/2"~~		
45								

DRILLING METHOD Hollow Auger
DATE DRILLED 4/22/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-11B
SHEET 1 OF 1

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified Surface Elevation 594.9'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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
					Brown Fine SAND, SP			
					Brown Gravelly SAND Trace Silt, SP			
5	1	HST	48/6					
					TOB			
10								
15								
20								
25								
30								
35								

DRILLING METHOD Hollow Auger
DATE DRILLED 4/22/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at - Feet
Hours after completion 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-12A
SHEET 1 OF 2

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL, Classification) Soil Classification System Unified; Surface Elevation 590.0'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Brown Fine SAND w/Silt, SM		
	1	HST	60/20				
5					Olive-Brown Silty CLAY Trace Sand, TILL, CL		
		HST	60/0				
10	2	HST	24/0				
				1	Olive-Gray SHALE		
15	3	SS	9/8			25-50/3"	
20	4	SS	2/2			50/2"	
					-Dark Gray 22.0-32.5'		
25	5	SS	1.5/1.5			50/1.5"	
30	6	SS	1/1			50/1"	
					-Gray Below 32.5'		
35	7	SS	2/1			50/2"	

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 & Mud Rotary
DATE DRILLED 4/23/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at - Feet
____ Hours after completion ____ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-12A
SHEET 2 OF 2

Soil Classification System: Unified
Surface Elevation: 590.0'

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)	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)
					Gray SHALE			
40	8	~~SS~~	2/0			~~50/2"~~		
45	9	~~SS~~	1/0		TOB	~~50/1"~~		

Remark:

1. Mud Rotary Techniques Used Below 12.0'

DRILLING METHOD Hollow Auger & Mud Rotary
DATE DRILLED 4/23/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-12B
SHEET 1 OF 1

Soil Classification System: Unified
Surface Elevation: 590.2'

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
0					Brown Fine SAND, SP		
					Brown Gravelly SAND, SP		
5							
	1	SS	24/18		Yellow Brown Silty CLAY, CL	5-16-25-40	111
	2	SS	24/24			7-17-25-31	
10					Olive-Gray Silty CLAY, TILL, CL		
	3	SS	24/18			4-13-20-35	
	4	SS	24/12			10-17-28-35	
	5	SS	23/24		Olive-Gray SHALE	10-20-36-50/5"	
15					TOB		
20							
25							
30							
35							

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 4/23/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ Feet
___ after completion ___ Feet
___ after completion ___ Feet

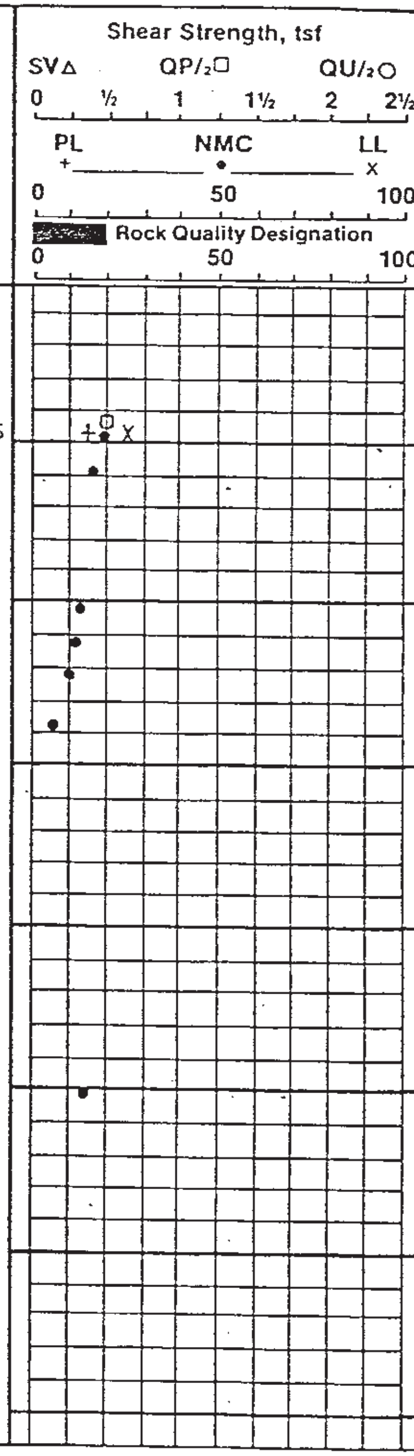
NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-13A
SHEET 1 OF 2

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL, Classification) Soil Classification System Unified Surface Elevation 581.9'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Brown Silty CLAY w/Sand, CL		
	1	HST	60/60				
5							116
	2	HST	60/18		Brown Fine SAND Trace Silt, SP		
10					-w/Gravel Below 9.5'		
	3	HST	60/36		Gray SHALE		
					-Dark Gray Below 13.5'		
15							
	4	HST	60/0				
20	5	SS	2/2	1		50/2"	
25	6	SS	2/0			50/2"	
30	7	SS	2/0			50/2"	
35	8	SS	1/1			50/1"	



DRILLING METHOD Hollow Auger
DATE DRILLED 4/27/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeologic Study Number One
Vermilion Power Plant

JOB NO. 11872803

BORING B-13A
SHEET 2 OF 2

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System: Unified; Surface Elevation: 581.9'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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)
					Dark Gray SHALE			
						~~50/2"~~		
					TOB			
40	9	~~SS~~	2/1					
					Remark:			
					1. Mud Rotary Techniques Used Below 20.0'			
45								

DRILLING METHOD: Hollow Auger
DATE DRILLED: 4/27/87
DRILLED BY: Schaffer
LOGGED BY: Shively/Jacobi
PIEZOMETER: Yes

GROUNDWATER LEVELS
Encountered at - F
___ Hours after completion ___ F
___ after completion ___ F
___ after completion ___ F

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

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-13B
SHEET 1 OF 1

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified Surface Elevation 581.9'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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
					Brown Silty CLAY w/Sand, CL			
5								
	1	SS	24/17		Brown Fine-Medium SAND w/Gravel Trace Silt, SP-SM	3-2-4-3		
10	2	SS	22/8		Brown Silty CLAY w/Sand, CL	6-6-12-50/4"		
					Gray SHALE			
					TOB			
15								
20								
25								
30								
35								

DRILLING METHOD Hollow Auger
DATE DRILLED 3/27/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at - Fe
Hours after completion Fe
after completion Fe
after completion Fe

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

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-14A
SHEET 1 OF 3

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified; Surface Elevation 586.1'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
	1	HST	60/30		Brown Fine-Medium SAND Trace Silt, Clay Pockets, SP -w/Roots to 4" Brown Gravelly SAND Trace Cobbles, Silt, SP		
5	2	HST	60/18				
10	3	HST	60/54		Dark Gray SHALE		137
15							
20	4	HST	60/36				141
25	5	HST	60/6				
30	6	HST	60/15				
35	7	HST	30/20				

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

DRILLING METHOD Hollow Auger & Mud Rotary
DATE DRILLED 4/14-15/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at - F
___ Hours after completion ___ F
___ after completion ___ F
___ after completion ___ F

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

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-14A
SHEET 2 OF 3

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified; Surface Elevation 586.1'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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
	7	HST	30/20		Dark Gray SHALE			
40	8	SS	3/3			100/3"		
45	9	SS	4/4			100/4"		
	10	AS						
50								
55	11	SS	3/2			100/3"		
60								
65	12	SS	4.25/6			50/4"-50/.25"		
70								

DRILLING METHOD Hollow Auger & Mud Rotary
DATE DRILLED 4/14-15/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at - Fe
___ Hours after completion ___ Fe
___ after completion ___ Fe
___ after completion ___ Fe

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

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant

JOB NO. 11872803

BORING B-14A
SHEET 3 OF 3

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified; Surface Elevation 586.1'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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
					Dark Gray SHALE			
75	13	SS	5.5/5.5	1		50/5"-50/0.5"		
80					TOB			
					Remark: 1. Wet Rotary 75.0-80.0'			

DRILLING METHOD Hollow Auger & Mud Rotary
DATE DRILLED 4/14-15/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at -
___ Hours after completion ___
___ after completion ___
___ after completion ___

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

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-14B
SHEET 1 OF 1

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (In)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified; Surface Elevation 586.0'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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
					Brown Fine-Medium SAND, SP			
5					-w/Gravel Below 4.0'			
					-w/Coarse Gravel @ 7.0'			
					Dark Gray SHALE			
10	1	SS	8/8			24-50/2"		
15	2	SS	5/5		-w/Clay Seams @ 14.5'	50/5"		
20	3	SS	4.5/4.5		TOB	50/4.5"		
25								
30								
35								

DRILLING METHOD Hollow Auger
DATE DRILLED 4/21/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at - Fe
__ Hours after completion __ Fe
__ after completion __ Fe
__ after completion __ Fe

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

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-14C
SHEET 1 OF 1

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (In)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified Surface Elevation 586.2'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	Shear Strength, tsf SV△ QP/2□ QU 0 ½ 1 1½ 2; PL + NMC ● 0 50; Rock Quality Designation 0 50
					Brown Fine-Medium SAND, SP			
					Brown Gravelly SAND Trace Silt, SP			
5	1	SS	18/8			2-3-6		
	2	SS	18/10		Gray SHALE	7-13-26		●
					TOB			
10								
15								
20								
25								
30								
35								

DRILLING METHOD Hollow Auger
DATE DRILLED 4/21/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at -
___ Hours after completion ___
___ after completion ___
___ after completion ___

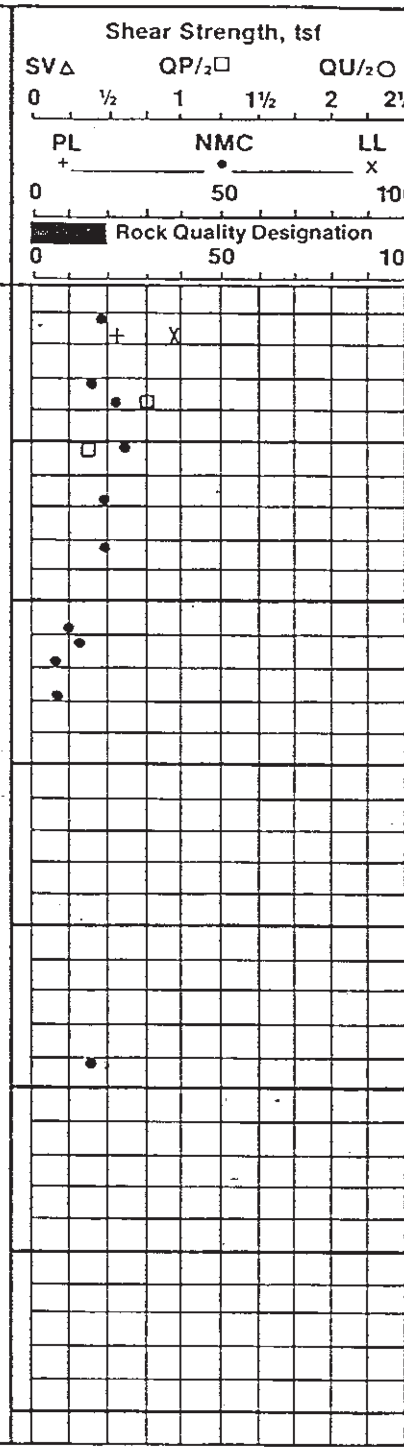
NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLOR
for abbreviations, explanations, and qualifications relative to this log.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-15A
SHEET 1 OF 2

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified; Surface Elevation 589.0'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Brown Silty CLAY Trace Sand, CL		
	1	HST	54/48		-Dark Brown Below 3.0'		101
5							99
	2	HST	60/46		-w/3" Clayey Sand Seam @ 7.0'		
					Brown Clayey Fine SAND, SC		
10					-Gravelly Below 10.5'		
	3	HST	60/42		Dark Gray SHALE		
15				1			
	4	SS	1/1			50/1"	
20							
	5	SS	3/3			50/3"	
25							
30							
	6	SS	1/1			50/1"	
35							

Shear Strength, tsf


DRILLING METHOD Hollow Auger & Mud Rotary
DATE DRILLED 4/21/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-15A
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) Soil Classification System Unified; Surface Elevation 589.0'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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)
					Dark Gray SHALE			
40								
	7	SS	2/0		TOB	50/2"		
					Remark:			
45					1. Mud Rotary Techniques Used Below 14.5'			

DRILLING METHOD Hollow Auger & Mud Rotary
DATE DRILLED 4/21/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-15B
SHEET 1 OF 1

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified Surface Elevation 589.0'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	Shear Strength, tsf SV△ QP/2□ QU/2 0 ½ 1 1½ 2; PL + NMC • L 0 50; Rock Quality Designation 0 50
					Brown Silty CLAY w/Sand, CL			
5								
	1	SS	24/12		Brown Silty Fine SAND, ML	PUSHED		
10	2	SS	12/6			PUSHED		
					TOB			
15								
20								
25								
30								
35								

DRILLING METHOD Hollow Auger
DATE DRILLED 4/22/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at -
____ Hours after completion
____ after completion
____ after completion

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

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-16A
SHEET 1 OF 2

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified; Surface Elevation 578.5'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Dark Brown Sandy SILT w/Clay, ML		
	1	HST	60/20				
5					Brown Medium SAND w/Fine Trace Clay, SW-SC		
	2	HST	60/10				
10					Brown Gravelly SAND Trace Clay, SP		
	3	HST	30/3				
					Dark Gray SHALE		
15	4	SS	4/4			50/4"	
20	5	SS	3.5/3.5	1		50/3.5"	
25	6	SS	3/3			50/3"	
30	7	SS	3/1			50/3"	
35	8	SS	2/2			50/2"	

Shear Strength, tsf: SV△ QP/2□ QU/2○ — 0, ½, 1, 1½, 2, 2
PL + NMC ● LL x — 0, 50, 10
Rock Quality Designation — 0, 50, 1

DRILLING METHOD Hollow Auger & Mud Rotary
DATE DRILLED 4/28/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at 8.5 Fe
___ Hours after completion ___ Fe
___ after completion ___ Fe
___ after completion ___ Fe

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

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-16A
SHEET 2 OF 2

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified; Surface Elevation 578.5'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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)
					Dark Gray SHALE			
					-Rock Seam 37.0-37.5'			
40								
	9	~~SS~~	2/0		TOB	~~40/2"~~		
45								

Remarks:

1. Mud Rotary Techniques Used Below 19.5'

DRILLING METHOD Hollow Auger & Mud Rotary
DATE DRILLED 4/28/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at 8.5 Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-16B
SHEET 1 OF 1

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL Classification) Soil Classification System Unified; Surface Elevation 578.5'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	Shear Strength, tsf (SV△ QP/2□ QU/2) 0 ½ 1 1½ 2; PL NMC LL 0 50; Rock Quality Designation 0 50
					Gray-Brown Silty CLAY, CL			
5								
	1	SS	24/20		Gray Fine-Medium SAND Trace Silt, SM	2-5-4-6		
	2	SS	24/14		Brown Fine Sand w/Clay, Gravel, SC	2-2-3-9		
10					-Becoming Coarser w/Depth			
	3	SS	17/14	1		10-29-50/5"		
					TOB			
					Remark:			
15					1. Hit Shale @ 11.5'±			
20								
25								
30								
35								

DRILLING METHOD Hollow Auger
DATE DRILLED 4/28/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at -
___ Hours after completion ___
___ after completion ___
___ after completion ___

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

SECTION X

Soil Borings

The following soil boring logs were performed during May and June, 1988.

The information provided is general in nature and should not be extended to other areas. Interpretation and use of the information by the Contractor is at the Contractor's risk.

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring J-1 Sheet 1 of 2

Project Name: Ash Pond Facility Date of Boring: May 26 & 27, 1988

Site: Vermillion Power Plant, Oakwood, Illinois Project No.: 001-85018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
El. 612.37* SURFACE							
Brown Silty CLAY, Trace Sand		1-AU	-	-	-	-	
Reddish Brown Silty CLAY, With Sand, Trace Gravel		2-SS	6	-	-	-	
Brown Sandy Silty CLAY, Trace Gravel, (TILL)	5	3-SS	6	-	-	-	
		4-SS	16	-	-	-	
Brown Silty CLAY, With Sand, Trace Gravel, (TILL)	10	5-SS	20	-	-	-	
Sand Seam at 13'		6-SS	62	-	-	-	
Sand Seam at 18'	15	7-SS	38-50/5"	-	-	-	
		8-SS	50/4"	-	-	-	
Brown Fine SAND	20	9-SS	52/6"	-	-	-	▽
Gray Fine Silty SAND		10-SS	50/5"	-	-	-	Water on split-spoon at 20
	25	11-SS	50/5"	-	-	-	Bore Hole washed out at 25'
		12-SS	50/5"	-	-	-	
Gray Sandy SILT	30	13-SS	50/3"	-	-	-	
		14-SS	50/4"	-	-	-	
Brown & Gray Weathered SHALE	35	15-SS	50/6"	-	-	-	
Gray Clayey SILT, With Sand, Trace Gravel, (TILL)		16-SS	50/6"	-	-	-	
	40						
		C-1	-	-	-	-	
	45						

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring J-1 Sheet 2 of 2

Project Name: Ash Pond Facility   Date of Boring: May 26 & 27, 1988

Site: Vermillion Power Plant, Oakwood, Illinois   Project No.: 001-85018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
Gray Clayey SILT, With Sand, Trace Gravel, (TILL)		C-1	-	-	-	-	
Gray Weathered SHALE, COAL FRAGMENTS	50	17-SS	67/6"	-	-	-	
		18-SS	50/5"	-	-	-	
Gray SHALE Core Run - 57'3" - 67'3" Recovery - 95% RQD - 90% Relatively solid core throughtout entire length	55	19-SS	66/6"	-	-	-	
				364			Mohs Hardness = 3
	60	C-2	-	-	-	-	Mohs Hardness = 3
	65						Mohs Hardness = 3
				123			
End of Boring at 67' NOTE: Attempted SS sample at 57½', N = 50/1" *Elevation from survey marker							

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring J-2

Project Name: Ash Pond Facility Date of Boring: June 2, 1988

Site: Vermillion Power Plant, Oakwood, Illinois Project No.: 001-85018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
El. 581.79* SURFACE							
Dark Brown Silty CLAY		1-AU	-	-	-	-	
Dark Brown Silty CLAY, Mottled Brown, With Sand		2-SS	5	-	-	-	
Dark Brown Clayey SAND	5						
Brown & Gray Weathered SHALE		3-SS	52	-	-	-	
Gray SHALE		4-SS	62/6"	-	-	-	Mohs Hardness = 3
Core Run - 9' - 19' REcovery - 93% RQD - 92% Relatively solid core throughout entire length	10	C-1	-	285	-	-	Mohs Hardness = 3
	15						Mohs Hardness = 3
				231			

*Elevation from survey marker

End of Boring at 19'

PSI A-100-9

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring J-3

Project Name: Ash Pond Facility — Date of Boring: May 25, 1988

Site: Vermillion Power Plant, Oakwood, Illinois — Project No.: 001-85018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
El. 584.66* SURFACE							
Light Brown Silty CLAY, Trace Sand & Gravel		1-AU	-	-	-	-	
		2-SS	7	-	-	-	
Dark Brown & Brown Fine to Medium SAND, Trace Silty Clay	5	3-SS	4	-	-	-	
		4-SS	19	-	-	-	
Brown & Gray Weathered SHALE	10	5-SS	50/6"	-	-	-	Water on split-spoon at 10'
		6-SS	50/6"	-	-	-	Washed out cobbles at 12½'
Gray SHALE Core Run 15' - 24'9" Recovery - 76% RQD - 71% Slight fractures in upper 1' of core Remainder relatively solid	15						Mohs Hardness = 3
				309			Mohs Hardness = 3
	20	C-1	-		-	-	Mohs Hardness = 3
				321			

NOTE: Sample 2-SS, No Recovery
Sample 4-SS, No Recovery
Sample 5-SS, No Recovery

*Elevation from survey marker

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring J-4

Project Name: Ash Pond Facility — Date of Boring: June 7 & 8, 1988

Site: Vermillion Power Plant — Project No.: 001-85018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
El. 609.5*							
SURFACE							
Reddish Brown Silty CLAY, Trace Sand		1-SS	13	-	-	-	
Brown Silty CLAY, With Sand, Trace Gravel, (TILL)	5	2-SS	30	-	-	-	
		3-SS	50/6"	-	-	-	
Gray Silty CLAY, Trace Sand and Gravel, (TILL)	10	4-SS	38-50/6"	-	-	-	
		5-SS	22-50/6"	-	-	-	
	15	6-SS	23-50/6"	-	-	-	
		7-SS	78	-	-	-	
	20	8-SS	90	-	-	-	
		9-SS	90	-	-	-	
Gray Weathered SHALE, Trace Coal Fragments	25	10-SS	73	-	-	-	
Gray SHALE		11-SS	40-50/3"	-	-	-	
Core Run 30' - 39'6" Recovery - 89% RQD - 68%	30			195			Mohs Hardness = 2
NOTE: Core barrel broke at 34½' - This section of core severly damaged during removal Core from 34½' to 39½' relatively solid	35	C-1	-		-	-	Mohs Hardness = 3 Mohs Hardness = 3
	40			210			

*Elevation approximated to be 4½' below survey marker, 614.01

PSI A-100-9

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring J-5

Project Name: Ash Pond Facility   Date of Boring: June 7, 1988

Site: Vermillion Power Plant, Oakwood, Illinois   Project No.: 001-85018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
El. 611.71* SURFACE							
Brown Silty CLAY, Trace Sand		1-AU	-	-	-	-	
Brown Clayey SAND		2-SS	10	-	-	-	
Brown Fine SAND	5	3-SS	33	-	-	-	
Brown Silty CLAY, With Sand, Trace Gravel, (TILL)		4-SS	60	-	-	-	
	10	5-SS	52	-	-	-	
Sand Seam at 13'		6-SS	45-50/5"	-	-	-	
Sand Seam at 15'	15	7-SS	50/5"	-	-	-	
Brown-Gray Weathered SHALE		8-SS	75	-	-	-	
Gray SHALE	20	9-SS	34-50/6"	-	-	-	
Core Run - 26'8" - 35'6"		10-SS	50/5"	-	-	-	
Recovery - 80%							
RQD - 38%							
Top 6½' of core highly fractured	25	11-SS	50/4"	-	-	-	
Remainder fairly solid							Mohs Hardness = 3
				162			
	30	C-1	-		-	-	Mohs Hardness = 3
							Mohs Hardness = 3
	35			191			
*Elevation from survey marker							

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring J-6

Project Name: Ash Pond Facility Date of Boring: June 3, 1988

Site: Vermillion Power Plant, Oakwood, Illinois Project No.: 001-85018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
El. 595.0* SURFACE							
Brown Silty CLAY, Trace Sand		1-AU	-	-	-	-	
		2-SS	17	-	-	-	
	5	3-SS	23	-	-	-	
Brown-Gray Silty CLAY, With Sand, Trace Gravel, (TILL)		4-SS	17	-	-	-	
	10						
Gray Weathered SHALE		5-ST	-	-	-	-	
		6-SS	72/6"	-	-	-	
Gray SHALE Core Run 15' - 25' Recovery - 59% RQD - 19% Upper 2'10" of core highly fractured Remainder fairly solid	15						Mohs Hardness = 3
							Mohs Hardness = 3
	20	C-1	-	285	-	-	
	25			294			Mohs Hardness = 3

NOTE: Attempted ss sample at 15' - N = 55 to seat

*Elevation approximated to be 8' below survey marker - 603.02

PSI A-100 9

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring J-7

Project Name: Ash Pond Facility Date of Boring: May 25, 1988

Site: Vermillion Power Plant, Oakwood, Illinois Project No.: 001-85018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
El. 665.27* SURFACE							
CINDERS & ASH		1-AU	-	-	-	8.1	
Brown Silty CLAY, With Sand		2-SS	8	-	-	16.7	
Brown Clayey Fine to Coarse SAND	5	3-SS	13	-	-	16.0	
Gray Silty CLAY, Trace Sand & Gravel, (TILL)		4-SS	16	-	-	14.1	
	10	5-SS	17	-	-	15.4	
		6-SS	22	-	-	14.3	
	15	7-SS	23	-	-	16.0	
		8-SS	30	-	-	14.6	
	20	9-SS	26	-	-	14.3	

*Elevation from survey marker

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring J-8

Project Name: Ash Pond Facility Date of Boring: May 25, 1988

Site: Vermillion Power Plant, Oakwood, Illinois Project No.: 001-85018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
El. 663.49* SURFACE							
Brown Silty CLAY, Trace Sand		1-AU	-	-	-	19.6	
		2-SS	3	-	-	29.5	
	5	3-SS	8	-	-	17.9	
Brown Silty CLAY, Trace Sand & Gravel, (TILL)		4-SS	17	-	-	17.0	
	10	5-SS	18	-	-	17.4	
Gray Silty CLAY, Trace Sand & Gravel, (TILL)		6-SS	23	-	-	15.5	
Brown & Gray Mottled Silty CLAY, Trace Sand & Gravel, (TILL)	15	7-SS	38	-	-	14.7	
		8-SS	50/3"	-	-	-	
Gray Silty CLAY, Trace Sand & Gravel, (TILL)	20	9-SS	50/5"	-	-	11.3	

NOTE: Sample 8-SS, No Recovery
*Elevation from survey marker

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring J-9

Project Name: Ash Pond Facility   Date of Boring: May 24, 1988

Site: Vermillion Power Plant, Oakwood, Illinois   Project No.: 001-85018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
El. 666.55* SURFACE							
CINDERS & ASH		1-AU	-	-	-	-	
Brown Silty CLAY, With Sand & Gravel		2-SS	12	-	-	17.8	
Brown Silty CLAY, Trace Sand & Gravel, (TILL)	5	3-SS	22	-	-	18.2	
Gray Silty CLAY, Trace Sand & Gravel, (TILL)		4-SS	18	-	-	15.5	
	10	5-SS	15	-	-	15.6	
		6-SS	21	-	-	12.8	
	15	7-SS	16	-	-	15.0	
		8-SS	16	-	-	15.7	
	20	9-SS	16	-	-	15.5	

*Elevation from survey marker

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring J-10

Project Name: Ash Pond Facility   Date of Boring: May 25, 1988

Site: Vermillion Power Plant, Oakwood, Illinois   Project No.: 001-85018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
El. 657.49* SURFACE							
Brown SAND & GRAVEL - Cinders Ash		1-AU	-	-	-	13.3	
Brown Silty CLAY, Trace Sand & Gravel, (TILL)		2-SS	20	-	-	22.6	
	5	3-SS	27	-	-	14.3	
		4-SS	23	-	-	17.1	
	10	5-SS	25	-	-	17.1	
		6-SS	30	-	-	18.5	
Brown Fine to Coarse SAND & Small GRAVEL	15	7-SS	21	-	-	9.3	
		8-SS	32	-	-	9.3	
	20	9-SS	25-50/3"	-	-	9.1	

*Elevation from survey marker

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring J-11

Project Name: Ash Pond Facility
Date of Boring: June 8, 1988
Site: Vermillion Power Plant, Oakwood, Illinois
Project No.: 001-85018

DESCRIPTION	DEPTH	SAMPLE*	N	Q_u	Q_p	M_c	REMARKS
SURFACE							
Dark Brown Silty CLAY							▽
Brown Sandy Silty CLAY	5						
Gray SHALE	10						
	15						
	20						
*No Samples taken							

PSI A-100-9

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring J-12

Project Name: Ash Pond Facility   Date of Boring: June 8, 1988

Site: Vermillion Power Plant, Oakwood, Illinois   Project No.: 001-85018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
SURFACE							
Dark Brown Silty CLAY, Trace Sand		1-AU	-	-	-	-	
Brown Fine to Medium SAND, Trace Small GRAVEl		2-SS	8	-	-	-	
	5	3-SS	27	-	-	-	
Brown Silty CLAY, Trace Sand, & Gravel, (TILL)		4-SS	50/6"	-	-	-	
	10	5-SS	50/6"	-	-	-	
Gray Silty CLAY, Trace Sand & Gravel, (TILL)		6-SS	40	-	-	-	
Gray SHALE	15	7-SS	40	-	-	-	
		8-SS	50/5"	-	-	-	
	20	9-SS	50/6"	-	-	-	

SECTION XI

Steel Structure Specifications

Portions of this work require the fabrication and erection of steel structures. This work will be covered by the following specification.

Steel shall be A-36.

All members and hardware shall be hot-dip galvanized after fabrication.

Steel members shall be marked as indicated on the plans for ease of erection.

SECTION XII

Bid Units

	Unit Price	Est. No. of Units	Est. Total Price
1. Clearing construction and borrow areas including legal disposal of all vegetation and deleterious material, labor, equipment, and supervision (per acre).		11	
2. Stripping construction and borrow areas including legal disposal of all vegetation and deleterious material, labor, equipment, and supervision (per acre).		16	
3. Embankment including all labor (excavating, hauling, depositing, grading, and compacting), equipment, and supervision (per cubic yard).			
A. Ash Pond			
1. Dike Borrow From Interior of Ash Pond (exclusive of clay core).		30,000	
2. Dike Embankment From Bluff Area		21,000	
3. Clay Core/Bluff Clay Barrier Borrow - Borrow Area One		61,000	
4. Clay Core/Bluff Clay Barrier Embankment - Road Construction		10,000	
5. Overburden Removal - Borrow Area One		15,000	
6. Overburden Removal - Ash Pond Interior		25,000	
B. Road Work/Pipe Run/Ditch			
1. Road Embankment.		6,000	

	Unit Price	Est. No. of Units	Est. Total Price
4. Top Soil on dike slopes including all material, labor, equipment, and supervision (per acre, four inches thick).		2.1	
5. Aggregate base course including material, labor, equipment, and supervision.			
a. CA-1 (per ton)		400	
b. CA-6 (per ton)		2,900	
6. Riprap including all material, labor, equipment, and supervision (per square yard, 18 inches thick).		3,500	
7. Seeding and straw mulch including all material, labor, equipment,and supervision			
a. Prairie Seed Mixture (per acre)		3	
b. Grass Seed Mixture (per acre).		4	
8. Piping including all material (connections, fittings, bolts, blocking, etc.), labor, equipment, and supervision.			
a. Reinforced concrete pipe with reinforced concrete cradle. Ash pond piping 36" diameter (per lineal foot).		172	
b. Reinforced concrete pipe. Outfall piping 36" diameter (per lineal foot).		400	
c. Road CMP 24" diameter Type 2A (per lineal foot).		60	
d. Road CMP 36" diameter Type 2A (per lineal foot).		450	
e. Road CMP Arches 28" x 20" Type 2A (per lineal foot).		260	
9. Slurry Wall Preconstruction Report including all material, labor, equipment, and supervision (each).		1	

	Unit Price	Est. No. of Units	Est. Total Price
10. Slurry Wall Construction including all material, labor, equipment, supervision, testing, and reporting.			
a. 2 foot thick barrier (per square yard).		950	
b. 4 foot thick barrier (per square yard).		8,400	
11. Fabrication and Erection of Effluent Structures including all material, labor, equipment, and supervision.			
a. Main Pond Structure (each).		1	
b. Polishing Pond Structure (each)		1	
c. Outfall Manhole (each).		1	
12. Channel Excavation including all material, equipment, labor, and supervision (per cubic yard).		725	
13. Reinforced Concrete including all labor, materials, equipment, and supervision (per cubic yard).		12	
14. Other (Bidder to specify).			
a.			
b.			
c.			
TOTAL COST OF PROJECT			

TABLE OF CONTENTS

BID FORM v

SECTION 1: PROJECT DESCRIPTION 1

BIDDING 6

SECTION 2: GENERAL CONDITIONS 8

DEFINITIONS 8

INTERPRETATION OF CONTRACT 9

CONTRACTOR’S PERFORMANCE 11

VERIFICATION OF DIMENSIONS 12

CONTRACTOR’S INSPECTION 12

CONTRACTOR’S DRAWINGS AND DATA 13

SAMPLES 13

INSPECTION, TESTING AND EXPEDITING 14

MATERIALS, CORRECTION OF WORK AND WARRANTY 14

PROGRESS REPORTS 16

DOCUMENTATION 16

DELAYS 17

SUSPENSION 18

OVERTIME 19

ROUTING OF SHIPMENTS 19

CLEANING UP 20

PERMITS AND PUBLIC REGULATIONS 20

COMPLIANCE 21

ERECTION 22

FIRE PROTECTION 24

STORAGE AND TEMPORARY BUILDINGS 25

MATERIAL SAFETY DATA SHEETS 25

CHANGES IN THE WORK 26

COMPANY’S RULES AND REGULATIONS 27

COMPANY’S RIGHT TO ORDER 28

TERMINATION 28

LOSS OR DAMAGE AND INSURANCE 29
INDEMNIFICATION 29
INSURANCE 30
ADVANCE SHIPMENTS 33
PUBLICITY 33
COST BREAKDOWN 33
TAXES 34
PAYMENTS 34
RELEASE OF MECHANICS' LIENS 35
ASSIGNMENT OF CONTRACT 36
PATENTS 36
NOTICES 37
STATE LAW 37
ARBITRATION 37
LITIGATION 38
TIME OF THE ESSENCE 38
DATE OF CONTRACT 38
NON-WAIVER OF RIGHTS 38
HEADINGS 39
SEVERABILITY 39
SMOKING 39
DRUGS, ALCOHOL AND FIREARMS 39

SECTION 3: SAFETY 41

PRE-MOBILIZATION REQUIREMENTS 41
CONTRACTOR SAFETY PERFORMANCE 41
SAFETY ACCOUNTABILITY 42
BUSINESS PERMIT/LICENSES 42
ACCIDENT/DAMAGE 42
SAFETY EQUIPMENT, MATERIAL & TOOLS 43
SYSTEM WIDE SAFETY REQUIREMENTS 43
ENVIRONMENTAL CONCERNS 46

RIGHT TO TERMINATE 47
STATEMENT OF CONTRACTUAL COMPLIANCE 47
SECTION 4: SUBSTANCE ABUSE TESTING PROGRAM 48
SCOPE 48
PURPOSE 48
RESPONSIBILITY 48
DEFINITIONS 49
PROCEDURE 50
General Requirements 50
Pre-Access Screening 51
Paperwork 52
Test Results 52
Random- Sample Screening 53
Reasonable Cause Substance Abuse Testing 54
Post Accident Substance Abuse Screening 54
REFERENCES 55
APPENDICES 55
AUTHORIZATION FORM 56
'MOST' PROTOCOLS 57
SECTION 5: SUBMITTALS 58
SECTION 6: EARTHWORK 59
SCOPE 59
DEFINITIONS 62
REFERENCES 64
MATERIALS 66
CONSTRUCTION REQUIREMENTS 67
INSPECTION BY COMPANY 71
MEASUREMENT 67
SECTION 7: CONCRETE 73
SCOPE 73
DEFINITIONS 73

REFERENCES 73
GENERAL REQUIREMENTS 74
MATERIALS 75
EXCAVATION 76
FORMS 76
REINFORCING 76
TOLERANCES 77
CONCRETE MIX 77
MIXING CONCRETE 78
PREPARATION FOR PLACING CONCRETE 78
PLACING OF CONCRETE 78
HOT-WEATHER REQUIREMENTS 79
COLD-WEATHER REQUIREMENTS 79
CURING AND PROTECTION 79
CONCRETE FINISHES ON EXPOSED SURFACES 79
JOINTS 80

SECTION 8: SEEDING 81
SECTION 9: MISCELLANEOUS STEEL 87
SECTION 10: MANHOLES 92
SECTION 11: RIPRAP 93
SECTION 12: REINFORCED CONCRETE PIPE 97
SECTION 13: DUCTILE IRON PIPE AND FITTINGS 102
SECTION 14: PVC PLASTIC PIPE 108
SECTION 15: HIGH DENSITY POLYETHYLENE PIPE 116
SECTION 16: CORRUGATED STEEL PIPE 121
SECTION 17: INSTRUMENTATION 126

BID FORM

Bid Submitted by:

Contractor: ________________________ Date: ________________

Address: ________________________

________________________ Phone: ________________

____

Fax: ________________

This bid is for all work indicated in the plans and Specifications for the Vermilion Power Station, East Ash Pond Expansion. The unit prices given below are for installed work and include all materials, labor, equipment, and taxes.

Item No.	Description	Est. Qty	Unit	Unit Price	Total Price
1	Mobilization/demobilization	1	L.S.		
2	Clearing and grubbing	20	Acre		
3	Stripping	20	Acre		
4	Dike construction with on-site soil	360,600	Cu yd		
5	Excavate and waste excess cut	54,500	Cu yd		
6	Topsoil	20	Acre		
7	Seeding	20	Acre		
8	Aggregate base course (CA-1) for roads	1250	Ton		
9	Aggregate base course (CA-6) for roads	625	Ton		
10	Riprap on dike	2,700	Sq. yd		
11	Riprap at inflow	440	Sq. yd		
12	Outfall conduit	1	L.S.		

Bid Submitted By: ______________________ (Page 2)

13	Remove and re-erect existing walkway	1	L.S		
14	New 10” HDPE pipe to pond	200	Ft		
15	New 14” HDPE pipe to pond	100	Ft		
16	Culvert, 36” CSP	1	LS		
17	Flow meter	1	Ea		
18	Pump suction modifications	1	L.S.		
19	Movement monuments	6	Ea		
20	8” PVC recirculation line	1000	Ft		
21	18” pond level control pipe extension/intake structure	1	L.S.		
22	Pumping incidental site water	1	L.S.		
				SUBTOTAL	
				Add for Performance/Payment Bond	
				TOTAL PRICE	

Bid Submitted By: ______________________________ (Page 3)

Proposed Schedule

Bidders shall propose a schedule assuming that a notice of award will be given not later than 30 calendar days after receipt of bids, submittals will be reviewed and returned within 2 weeks after date of receipt of submittal, and normal weather. Bids submitted without a proposed schedule will be considered non-responsive.

Activity	Description	Calendar days after notice of award		Duration (cal. days)
		Start	End	
1	Mobilization			
2	Clearing, grubbing, and stripping			
3	Extend Pond Level Control Pipe			
4	Construct Dike			
5	Reroute piping from plant, place riprap at inflow point			
6	Topsoil and Seeding			
7	Place riprap on river side of dike			
8	Cleanup and demobilization			
TOTAL ESTIMATED TIME TO COMPLETE PROJECT[1]				

[1] The total time to complete the project is not necessarily the sum of the durations in the last column.

SECTION 1: PROJECT DESCRIPTION

1.0 SCOPE OF WORK

1.1 General

1.1.1 The overall goal for Dynegy Midwest Generation (DMG) is to increase the water storage capacity of their Vermilion Power Station East Ash Pond. The East Ash Pond is an existing coal ash and water storage facility permitted by the IDNR and IEPA. The existing facility consists of an approximately 15-acre Primary Pond and 2-acre Secondary Pond located at the base of a "bluff" adjacent to the Vermilion River. Three sides of the Primary Pond were formed with approximately 15-foot high earth dikes to El. 600 (MSL). The west side of the Primary Pond was formed by a cut slope into the adjoining "bluff".

1.1.2 Fly ash and bottom ash are sluiced to the Primary Pond through piping from the plant. In addition, coal pile runoff and other miscellaneous plant water streams are channeled and piped, respectively, from the plant for discharge into the Primary Pond. The Primary and Secondary Ponds are hydraulically connected through three conduits/structures: a controlled discharge, a primary outfall structure and a 500-gpm fixed or permanent pump. The Secondary Pond discharges through a secondary outfall structure draining ultimately to the Vermilion River. Modification and enhancements will be made to the hydraulic structures (channels, pipes, intake risers, etc.) to accommodate the expanded Primary Pond. Hydraulic details are discussed below.

1.1.3 Increasing the capacity of the East Ash Pond will be made by extending the dikes 20 feet vertically and expanding the pond limits laterally to the west. The dike for the pond expansion shall be constructed of on-site soil obtained from the cut required to expand the pond approximately 5 acres on its west side into the "bluff". Earthwork details are discussed below.

1.2 Earthwork

1.2.1 Bottom Ash

Bottom ash (sand-like coal ash) will be moved from near the existing pipe discharge into the pond to the north area of the pond and used to create a work pad for construction of the raised dike in this area. In this area, the dike expansion will be founded on the inside of the current dike. The bottom ash should be placed to the bottom of the existing pond and will be monitored to assure that most, if not all, existing fly ash (silt-like coal ash) at the bottom has been displaced during placement.

1.2.2 Impervious, Pervious and Random Fill

An essential element of the pond dike is an 8-foot thick liner constructed of low-permeability clay soils (impervious fill). On the west side of the pond the liner will consist of 8 feet of clay placed on a 3H:1V slope on the inside face and horizontally over the bottom of the pond. In other areas the liner will consist of an 8-foot thick clay core liner within the new raised dikes. It is essential that the new liner be adequately tied into the existing liner to provide a continuous barrier between the ash pond water and the ground water adjacent to and under the pond. The existing 8-foot thick clay liner zone is labeled on the Drawings and delineated by dashed lines. In many areas the liner lies within a larger zone of impervious fill making up more than half of the dike. The impervious fill specifications are such that any of this material will also meet the requirements of the 8-foot thick core liner. Identification of the 8-foot core in these areas is made for clarification that the liner has been tied-in and continuous through this zone. Material and placement specifications for clay liner core and impervious fill are the same. The tie-in between existing and new clay liner will be observed and confirmed during construction by the Company's representative.

1.2.2.1 Due to the variable nature of the on-site soils available for fills, it will be necessary to constantly monitor the materials being excavated for dike fill. The Drawings show the types of materials acceptable for each zone within the dike. Summary boring logs have been provided on the Drawings showing the materials available in the primary borrow area and in the existing dike cut. The classification of the borrow materials encountered in these borings (impervious, pervious or random fill) is also shown. It should be noted the borings indicate that the soil types are variable throughout the borrow area. The Owner will provide full-time technical assistance during borrow excavation and dike construction to identify the type of fill being excavated from the cut areas and/or borrow area and evaluate where its use is acceptable. Due to the variability noted in the borings and potential for variation between borings, the Owner's Representative's evaluation of fill type at the time of excavation will be considered final.

1.2.2.2 Small amounts of unsuitable materials may need to be spoiled as part of the work. The Owner will designate a location within 1,000 feet of the pond for such spoil. The work associated with excavating, moving and placing the spoil material will be considered incidental to the project.

1.2.2.3 It is anticipated that some temporary stockpiling of fill materials may be required during the course of the project. The Contractor is responsible for properly sorting all materials that are temporarily stockpiled as well as all costs associated with this activity. It is estimate that there will be about 50,000 cy of excess fill materials available after all excavation and fill is complete.

1.2.2.4 As mentioned above, the western expansion area liner will consist of 8 feet of impervious fill placed on a 3H:1V slope on the inside face and horizontally over the bottom of the pond to form the liner. In this area, excavation to the liner subgrade will be necessary prior to placement of the 8-foot thick liner. The Contractor is free to use his own means/methods. One suggested sequence is given below:

1. This sequence is based on the assumption that the Contractor will install the western expansion liner near the time of completion of the project since nearly all other fill materials lie within the excavation above this area.

2. The Contractor will create a stockpile of approximately 50,000 cy of impervious fill during cut of this area and construction of the raised dikes. The material in this stockpile will be used to supplement the excavation in the west area expected to have pervious fill zones not acceptable for impervious clay liner fill. The stockpile will increase efficiency by keeping equipment used in the cut area operating if caught up with the fill operation on the dikes.

3. Starting on the east side of the horizontal portion of the liner, excavate to liner subgrade in a 100-foot wide "strip" running north and south. Haul all the cut from this area to the stockpile area, separating impervious from pervious and random fill. Throughout this sequence in this area, the control of stormwater run-on and management of stormwater will be imperative since this work will be done below surrounding grade.

4. Excavate a second 100-foot wide "strip" adjacent to the "strip" excavated in 3., above. Use excavation material meeting the requirements for impervious fill to construct the liner in the first "strip" and supplement any shortfall with impervious fill from the stockpile.

5. Continue with strips until pond liner expansion is complete to the west limits.

1.2.2.5 Based on borings completed in the borrow area, the materials appear to generally have water contents near or below optimum. The Contractor should anticipate that the fills will require addition of water to obtain compaction requirements. A hydrant has been identified for the Contractor's water source on the Drawings.

1.3 Hydraulics

1.3.1 The Primary and Secondary Ponds are hydraulically connected through three conduits/structures at the north end of the Primary Pond: a controlled discharge, a primary outfall structure and a 500-gpm pump and piping.

1.3.2 The existing 48-inch reinforced concrete pipe riser at the existing primary outfall will be removed, as well as the existing walkway bridge to it. A new 48-inch RCP riser extending up to the outboard slope of the dike raise will be installed at that location with a 48-inch by 48-inch by 36-inch tee at the top. A slab with a manhole frame and grate will be installed at the top of the outboard riser for inspection purposes. A 36-inch diameter RCP bedded on a concrete cradle will be installed from the new 48 inch by 48 inch by 36 inch tee to the inboard slope of the dike and a new 48-inch RCP riser will be installed extending up to Elev. 595 feet (MSL). When the dike has been completed, the existing walkway bridge will be reinstalled from the crest of the dike to the new intake pipe.

1.3.3 The controlled discharge structure is a gravity drainage structure which drains water from the primary to secondary ponds through a valved ductile iron pipe. This structure will be relocated further south into the Primary Pond to allow construction of the raised dike. The old structure will be partially salvaged and re-used. New piping will be installed and connected to the existing piping near the current location of the structure. The ductile iron pipe within the existing dike runs to a manhole (Manhole No. 1). The manhole will be excavated, removed, and a wye fitting and check valve will be installed at this location. The manhole must be removed since the piping at this location will be under the additional head of the raised pond (20 feet). An open manhole would allow the pond to drain at this location. The purpose for the wye fitting and check valve is discussed below with the pump system. Note that the flow of water via gravity through this pipe is controlled by a valve downstream of existing Manhole No. 1.

1.3.4 The pump system currently has a floating suction line in the Primary Pond connected at the dike to a buried PVC pipe running to the pump house. This floating structure will be removed and stored on site but will not be re-used. The pump will be connected via new PVC buried piping to the wye that will be installed at the location of Manhole No. 1. Therefore, the ductile iron pipe and gravity discharge structure will feed both the pump system and the gravity discharge system through Manhole No. 2 and into the secondary pond. A check valve will be installed just downstream of the wye fitting to avoid reverse flow and possible loss of suction through the pipe section connecting the wye fitting to Manhole No. 2.

1.4 Access Roads

1.4.1 Gravel access roads will be constructed on the top of the raised dikes and up the slope of the west cut area for access.

1.5 Vermilion River Easement

1.5.1 The Contractor should note that there is a 150-foot easement line from the center of the Middle Fork of the Vermilion River (shown on Drawings) beyond which no disturbance of any kind can be made. The easement is also clearly marked by survey in the field (white PVC pipe on T-posts).

1.6 Time and Materials Work

1.6.1 Time is of the essence on this project. Work on the site has already been started by a contractor under a Time and Materials contract. This work is being done in accordance with the Drawings and Specifications making up these bid documents and under the supervision of the Project Manager. Work was started prior to bidding the remainder of the project to help meet the construction schedule. The work that has been started includes:

- Clearing and grubbing.

- Stripping and stockpiling of topsoil.
- Removal and stockpiling of riprap from the outside of the east dike slope.
- Placement of Bottom Ash to El. 596 in the "upstream raise" portion of the dike on the north end of the pond.
- Placement of Impervious Fill to El. 600 in the "upstream raise" portion of the dike at the north end of the pond.
- Removal of the Controlled Outlet Structure at the north end of the pond.
- Removal of the Primary Outfall Structure at the north end of the pond.

1.6.2 Those items included in these Drawings/Specifications that will have been completed upon accrual of Contract will be deleted from the Contract.

2.0 BIDDING

2.1 A pre-bid meeting will be held at the Vermilion Power Station at a time and date to be announced. All bidders are required to attend this meeting. Check in at the Security Gate and main plant office upon arriving for the meeting.

2.2 Bid will be due at a time and date to be announced. Dynegy Midwest Generation Purchasing Department will receive bids. Bids should be directed to:

Alona Campbell-Walker
Buyer/Contract Administrator
Dynegy Midwest Generation
2828 N. Monroe Street
Decatur, IL 62526
Ph.: (217) 876-3911
Fax: (217) 876-3905

2.3 Bids may be faxed and received in total by 2:00 p.m. on the due date, but a hardcopy must be delivered no later than two working days afterward.

2.4 For technical questions regarding the design or bidding of this project, contact:

Joe Kimlinger, P.E.
Project Manager, Ash Manager
Dynegy Midwest Generation
2828 N. Monroe Street
Decatur, IL 62526
Ph: (217) 876-3943
Fax: (217) 876-7475

2.5 For arrangement of site access during the bidding period, contact:

Mike Dodge
Dynegy Midwest Generation
Vermilion Power Station
Box 250
Oakwood, IL 61858
Ph: (217) 354-2141 (Ext. 221)
Fax: (217) 354-2169

2.6 Tax Exempt Status

As a pollution control facility, items incorporated into the construction of the pond are exempt from Illinois sales tax. Such items include pipe, concrete, stone, etc. Items purchased for construction, but not incorporated into the finished work are not exempt. The Company will provide the necessary documentation to the successful bidder.

2.7 Subsurface Information

It is strongly emphasized that the subsurface information is made available to the Contractor without guarantee or obligation of any kind whatsoever on the part of the Company. The Company does not guarantee the correctness of the designations of any materials shown on the Drawings, nor any interpretations, deductions, or conclusions shown on any drawings, logs, reports, or other documents relative to subsurface conditions. Conditions affecting the Contractor's performance and schedule may differ from those indicated or described. Bidders will be deemed to have inspected the site and satisfied themselves on all matters affecting the Contract and Specifications. Bidders may, at their own expense and with the approval of the Company, make additional investigations if they so desire. The Bidders and Contractor must assume all responsibility for deductions and conclusions as to the nature or condition of soil, and other materials to be excavated, the difficulties of making and maintaining the required excavation, and of doing other work affected by the geology of the job site.

SECTION 2: GENERAL CONDITIONS FOR ERECTED MATERIALS AND EQUIPMENT, AND LABOR CONTRACTS

1.0 DEFINITIONS

1.1 "Company" means Dynegy Midwest Generation, Inc.

1.2 "Contract" consists of the Purchase Order, these General Conditions, the Specifications, and Drawings and Data (if any), and all other Exhibits specified in the Purchase Order, and such documents shall take precedence in the order stated, unless the Company at any time gives written notice to the contrary.

1.3 "Contractor" means the entity, identified as such in the Contract documents, entering into this Contract with the Company for performance of the WORK, and any other specific requirements described in this Contract intended to be an obligation and duty of said party.

1.4 "Engineer" means URS Corporation.

1.5 "On-Site Representative" means the Company's On-Site Construction Representative.

1.6 "Tester" means the Company's designated testing agency (including concrete and soil testing).

1.7 "Governmental Authorities" means federal, state or local bodies which may exercise regulatory authority or control over the WORK or the Company's Project Site or plant of which the WORK is to be a part, or the design, construction, operation, use or environmental conditions thereof.

1.8 "Indemnified Parties" mean the Company, Engineer, their respective officers, directors, partners, shareholders, agents and employees (and each of their heirs, successors and assigns).

1.9 "Project," "Project Site," "Site," and "Premises," mean the Company's site or a site controlled by the Company (including one in which the Company has only a partial interest, such as an easement) where the WORK is to be performed or installed and includes all places contiguous thereto and in the vicinity thereof, where materials, equipment, tools, appliances or other facilities required for the performance of the WORK are or are to be located or stored.

1.10 "Reviewed," "approved," "acceptable," "satisfactory," "or equal," or other similar terms used in any Specification to this Contract shall, unless otherwise expressly stated, mean as reviewed and as commented thereon by the Company.

1.11 "Subcontractor" means any individual, partnership, firm, corporation or business entity, other than an employee of the Contractor, who contracts or agrees with the Contractor (or another subcontractor or any tier thereof) to furnish any services, labor, materials or equipment for, or in connection with, the performance of the WORK.

1.12 "WORK" includes, and the Contractor shall furnish, unless the context clearly indicates otherwise, all or any part of such labor, services, methods, material, equipment and transportation or other facilities as may be necessary to complete this Contract, and normally considered part of the type of project covered by this Contract, whether or not fully detailed on the Drawings (if any) or listed in detail in the Specifications.

2.0 INTERPRETATION OF CONTRACT

2.1 Except as noted otherwise, the Contractor shall furnish all tools, equipment, transportation, materials, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, other incidentals and supervision necessary for the construction of the project described in this Specification and on the Drawings listed in the Table of Contents

2.2 The Company will furnish necessary benchmarks and control points for the layout of the work. Alignment, grade and other construction staking are the responsibility of the Contractor.

2.3 The Contractor shall coordinate his work with any and all other contractors and/or Company personnel working on the project.

2.4 Contractor employees are not allowed in Company Buildings, i.e., office, lunchroom, rest rooms, and locker areas unless special arrangements are made. Contractor employees are expected to remain in their assigned work areas. The Contractor shall provide portable toilets for his employees.

2.5 Contractor shall furnish performance and payment bonds, each in an amount at least equal to the contract price as securities for the faithful performance and payment of all the contractor's obligations under the contract documents. These bonds shall remain in effect at least until one year after the date when final payment becomes due, except as otherwise provided by law or regulation. All bonds shall be in the forms prescribed by law or regulation or by the contract documents and be executed by such sureties as are named in the current list of “Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies” as published in Circular 570 (amended) by the Audit Staff Bureau of Accounts, U.S. Treasury Department. All bonds signed by an agent must be accompanied by a certified copy of the authority to act. If the surety on any bond furnished by the contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the project is located or it ceases to meet any of the requirements set forth above, contractor shall within five days thereafter substitute another bond and surety, both of which must be acceptable to the owner

2.6 No Company review or comments shall relieve the Contractor of any of the Contractor’s obligations under this Contract.

2.7 The Company is not the designer of the WORK purchased hereunder or any part thereof, and its review and/or comments as to any Drawings, specifications or other documents furnished by the Contractor or any other party shall not be evidence that the Company is the designer of the WORK or any part thereof.

2.8 The Contractor is an independent contractor and not an agent or employee of the Company. Nothing contained in this Contract shall be construed as inconsistent with the Contractor’s status as an independent Contractor.

2.9 The Company shall interpret this Contract and any Specifications and Drawings pertaining to this Contract. In case of conflict between the specifications and the Drawings and data, the Company shall resolve such conflict, and its decision shall be binding on the Contractor.

2.10 Any item not included in the Drawings, data or specifications, but which is necessary to complete the WORK as intended, shall be supplied in place. WORK described in words which so applied have a well-known technical or trade meaning shall be held to refer to such recognized standards. In case of any ambiguity or doubt as to the meaning of the drawings, data or specifications or of any discrepancy or conflict between the two, or between different parts of either, the matter shall be brought to the attention of the Company by the Contractor before the WORK is installed or fabricated. The Company will issue written instructions or interpretations as required, and the Contractor shall be bound by the decision of the Company. The Contractor shall assume full responsibility for its failure to request such instructions or interpretations. Where dimensions are given on Drawings, they are to be followed without regard to scale.

2.11 Particular care shall be taken not to disturb or damage the property or facilities of the Company or others. In the event the Contractor causes trouble or damage to any facility, he shall immediately notify the On-Site Representative of the cause, nature and extent of the problem. The Contractor at his expense shall repair any damage done to Company or private property.

2.12 This Contract represents and incorporates the entire understanding of the parties hereto, and each party acknowledges that there are no warranties, representations, covenants or undertakings of any kind, nature or description, except as expressly set forth in this Contract. This Contract supersedes all prior agreements, whether written or oral, with respect to the WORK and the subject matter of this Contract. This Contract shall not be changed or modified except by another instrument in writing executed by a duly authorized representative of each of the parties hereto and entitled “Change Order,” “Amendment to Contract,” or document titles of like meaning.

3.0 CONTRACTOR’S PERFORMANCE AND RIGHT TO ACHIEVE COST SAVINGS

3.1 The Company acknowledges the Contractor’s right to achieve cost savings for its own benefit through the proposal of alternate construction methods and/or materials unless specific requirements are stated in this Contract, provided that the Company agrees in writing and provided that the general quality, integrity or operational parameters of the WORK are not compromised.

3.2 The Contractor shall have exclusive control of the manner and means of performing the WORK, subject only to the right of the Company to generally observe the WORK at all times during construction, to assure compliance with the terms of this Contract, but such observation shall not relieve the Contractor of any obligation or responsibility under this Contract.

3.3 Nothing in this Article shall limit or affect any warranty of the Contractor or any other provisions of this Contract.

3.4 The Contractor shall submit a list of subcontractors (if any) with his bid. The Company reserves the right to reject specific subcontractors but will cover the cost differential required for the use of an alternate subcontractor.

4.0 VERIFICATION OF DIMENSIONS ON DRAWINGS, AND MEASUREMENTS AT SITE

4.1 The Contractor shall make a thorough field check for the purpose of verifying existing conditions that may affect the WORK, such as possible errors in work previously done by others, difficulties that might be encountered in the execution of the WORK for any other reason, and dimensions and other questions relating to interconnection of the WORK with the work of others.

4.2 The Contractor shall satisfy itself as to the accuracy of the above dimensions as such dimensions relate to the dimensions given on any Drawings issued by the Company or others, it being understood that the Company does not guarantee the exactness of such dimensions.

4.3 Should the Contractor discover any variation in the dimensions of existing conditions and those dimensions given on any Drawings issued by the Company, the Contractor shall give immediate notice thereof to the Company, and the Contractor shall not proceed with the WORK until such variation is resolved. In the event that the Contractor fails to so notify the Company of such variation or in the event that the Contractor notifies the Company after the Contractor should have discovered such variation, the Contractor shall be fully responsible for all extra material, labor, and other expenses arising out of the Contractor's failure to notify the Company in a timely manner.

4.4 No allowance will be made to the Contractor for any extra material, labor or other expenses due to difficulties caused by its failure to comply fully with the preceding paragraphs.

5.0 CONTRACTOR'S INSPECTION AND KNOWLEDGE OF PLANS AND THE PREMISES; COST OF PERFORMANCE

By becoming a party to this Contract, the Contractor represents that it has:

5.1 Carefully and completely examined the Drawings, data and specifications in this Contract affecting the WORK and is fully informed as to all existing conditions and limitations, including laws and regulations of any Governmental Authority affecting the Contractor, the WORK or the Premises, and has included in its proposal all items implied or required to attain the conditions and performance contemplated by this Contract.

5.2 Satisfied itself as to existing construction, labor conditions, working space, storage space, access facilities and all other Site conditions in any way relating to the conduct of the Contractor's WORK by inspection of the Project Site or otherwise.

5.3 Made due allowance in its proposal for any possible increase in cost of performance of the WORK, including increases in the cost of materials and labor.

5.4 Any questions concerning the Drawings and specifications shall be directed to the On-Site Representative. The Contractor shall not take advantage of errors and/or omissions in these documents and/or discrepancies between the plans and specifications. The Company will make corrections and supply information omitted to the plans and specifications with the Company's interpretation being final. Any addenda issued during the time of bidding are considered a part of these Specifications.

6.0 CONTRACTOR'S DRAWINGS AND DATA

All drawings and data required to be submitted to the Company for review shall be submitted in accordance with the schedule provided in this Contract and, if such drawings and data are not covered by such schedule, such drawings and data shall be submitted by the Contractor without unreasonable delay, and no WORK affected thereby shall be started until the Contractor is notified that the Company has no objection to proceeding with the WORK. No such notification shall relieve the Contractor from fulfilling all obligations of the Contractor under this Contract, including obligations relating to design and detailing. As far as practicable, each drawing shall bear a cross-reference note referring to the sheet number(s) of the Company's drawing(s) showing the same WORK.

7.0 SAMPLES

The Contractor shall furnish to the Company approval samples of the WORK reasonably required by the Company.

8.0 INSPECTION, TESTING AND EXPEDITING

8.1 The Company may appoint such inspectors/expeditors as it deems proper, who, in addition to the Company, shall have the right at all reasonable times to inspect the WORK and observe production tests and any other tests specified in this Contract for compliance herewith. The Company will have a Tester check any concrete properties, soil compaction, or other material/performance requirements at the Company's expense. The Contractor shall make all necessary arrangements, and provide all reasonable facilities and proper and safe access for such inspection and testing on the Company's Premises, at the Contractor's shop, or at the mills or shops of any manufacturer where any part of the WORK is being fabricated or manufactured. The Contractor shall ascertain the scope of any inspection which may be contemplated, and shall give ample notice as to the time and place when each part of the WORK will be ready for such inspection. The Company's designated inspector may reject any WORK found to be defective or not in accordance with this Contract, regardless of the stage of its completion or the time or place of discovery of such errors, and regardless of whether such WORK has been previously accepted through oversight or otherwise. Should the Contractor object to any rejection of the WORK by an inspector, the Contractor shall make a written appeal to the Company within ten days of notice of the rejection, and the Company's decision upon the appeal shall be binding upon the Contractor. Such inspection shall in no way relieve the Contractor from its obligations under this Contract.

8.2 When any portion of the WORK must be uncovered for the purpose of inspection or testing, the Contractor shall bear all expense incident to such uncovering, inspection and/or testing when (a) any part of the said WORK is found to be not in accordance with this Contract, or (b) the WORK is found to be in accordance with this Contract, but the Contractor did not provide opportunity to inspect or test the WORK. Except as provided in the preceding sentence and in the event that all the WORK is found to be in accordance with this Contract, the Contractor will be entitled to payment of the cost incident thereto on a cost-plus basis as provided in this Contract, if any, or as may be subsequently agreed in writing.

9.0 MATERIALS, CORRECTION OF WORK AND WARRANTY

9.1 The Contractor warrants that the WORK performed under this Contract shall: (a) be free from defects in design, materials and workmanship, (b) be suitable for its intended purpose as specified in this Contract, (c) include all materials furnished or purchased by the Contractor under this Contract to be new and unused in all cases, unless otherwise specified, (d) be of the best quality and be in full compliance with the Contract documents, and (e) not be subject to any encumbrance, lien, security interest or other defect in title.

9.2 In addition to any other remedy provided by law, if any of the WORK does not comply with the warranties contained in this Article 9 and the Company gives the Contractor notice of noncompliance within one year (or such longer period specified in this Contract for any identified equipment or portion of the WORK) after the WORK is placed in commercial service, or, if there is no commercial service date, regular operating service (excluding any period the WORK or facility of which the WORK is a part is not available for operation because of breach or nonconformity with any of the Contractor's warranties), the Contractor shall at its sole expense promptly correct by repair or replacement any noncomplying WORK. Any equipment furnished as a permanent part of the WORK shall be considered defective or otherwise unsuitable if it shall not comply with this Contract, or if, among other things, it shall develop an undue amount of noise, vibration, heat, deterioration, strain or wear during the first year of actual use in service, provided that said equipment shall be kept in good condition and be properly operated and maintained during said year. The decision to repair or replace shall be made with the concurrence of the Company, and the repair or replacement shall be scheduled consistent with the Company's operating requirements so as to minimize loss of production or use of the WORK or of any plant or equipment of which the WORK is a part. All costs and expenses associated with access to or repair or replacement of the WORK, including transportation costs and all expenses of restoring work of other contractors damaged by any such removal, remedying or replacement, shall be paid by the Contractor. The warranties for any repaired or replaced WORK shall be extended for one year (or such longer period specified in this Contract for any identified equipment or portion of the WORK) from the date of completion of the repair or replacement under the same provisions as contained herein.

9.3 If the Company shall deem it necessary, or if the Contractor fails to perform its obligations under Section 9.2 above in a timely manner, the Company may correct WORK not done in accordance with this Contract, or damaged work of other contractors as provided in this Article 9, or WORK lost or damaged which should be repaired or restored under the provisions of Article 27 hereof, and all charges and costs associated therewith shall be either deductible from the Contract price or payable to the Company on demand.

9.4 If the Contractor does not remove, remedy and/or replace any such WORK within a reasonable time after written notice by the Company, then the Company may remove, remedy and/or replace it at the Contractor's expense.

9.5 The Contractor shall be responsible for completely fulfilling all performance specifications contained in this Contract, and its compliance with any material or design specifications, even though furnished by the Company, shall not alter or diminish such responsibility.

9.6 The Contractor shall be solely responsible for advising the Company in writing of any conflicts between the specifications and the Contractor's design, including performance and levels of quality. The Contractor agrees that its obligations, liabilities and warranties shall not be diminished or extinguished even if it meets the requirements of the Specifications.

10.0 PROGRESS REPORTS

If requested by the Company, the Contractor shall submit to the Company, on or about the twenty-fifth day of each month, a report stating the progress being made in fulfillment of this Contract up to the fifteenth day of said month, including cost/schedule reports, or such other reports which may be required by the Company to monitor costs and construction progress of the WORK. Any such reports shall conform to the format of, and contain the information requested by, the Company. The Contractor also shall attend and participate in any meetings requested by the Company to monitor progress of the WORK.

11.0 DOCUMENTATION; PROPRIETARY INFORMATION

11.1 The Contractor shall provide the Company with the necessary number of copies (as determined by the Company) of all information and documentation (including drawings and data, original manufacturer part number, reports and design) within the Contractor's scope of WORK and which is required for the design, construction, licensing, quality assurance, operation or maintenance of the WORK, the Premises or of a facility for which the WORK is intended.

11.2 No information, drawings or other documents transmitted or furnished by the Contractor to the Company under this Contract shall be deemed proprietary or confidential unless specifically designated as such. The Company shall not be prohibited from disclosure or use of proprietary or confidential information or documents relating to the WORK which is (are) required for the design, construction, operation and maintenance of the WORK or the Premises or other facility for which the WORK is intended, or which is (are) required by the Company for securing or maintaining in effect any license or permit from any Governmental Authority for the Premises or other facility for which the WORK is intended.

11.3 Except as may be required by the Contractor for the performance of its obligations under this Contract, the Company is not obligated under the terms of this Contract to provide the Contractor with any information which the Company considers proprietary. If the Company transmits any information to the Contractor which the Company considers proprietary, the information will be designated as proprietary. The Contractor shall use any such proprietary information exclusively in connection with the WORK, and shall not publish or otherwise disclose it to any third party.

12.0 DELAYS IN COMPLETION AND EXTENSION OF TIME

12.1 It is understood that the Contractor, in determining its price for and completion date of the WORK, contemplated that delays might occur in the prosecution of the WORK.

12.2 The Company shall not be liable to the Contractor for delays of any kind whatsoever, and the Contractor shall be fully responsible for making up time lost by all delays except only to the extent that extensions of time are granted under this Section. If completion of the WORK is delayed by any act or neglect of the Company, or other contractor in the employ of the Company, by strikes, or by other exceptional conditions over which the Contractor has no reasonable control, the time for completion shall, upon receipt of the Contractor’s written request, be extended by such period as the Company may consider reasonable. No such extension shall be allowed unless a claim therefore is presented in writing to the Company within seven days of the commencement of such delay. In the case of a continuing cause of delay, only one claim is necessary. Nothing in this Section shall be construed to release the Contractor from the obligation to perform, at its own expense, all overtime WORK necessary to maintain Contract completion dates where delays have occurred which are not excused by the foregoing provisions of this Section.

12.3 No delays of any kind whatsoever in the prosecution or completion of the WORK, whether or not extended by the Company, shall result in any price adjustment.

12.4 Without limiting any rights or remedies which the Company may have under this Contract or under any law, the Contractor shall be liable for all failures, delays and interruptions in performing any of its obligations under this Contract which are within its reasonable control.

12.5 If this Contract contains no schedule of dates on which drawings and data will be delivered to the Contractor by the Company, such drawings will be delivered in accordance with the Company's customary practice, subject to delays resulting from conditions over which the Company has no control.

13.0 SUSPENSION

13.1 The Company shall have the right to extend schedules, suspend the Contractor's performance hereunder, or delay any shipment required hereby, in whole or in part, at any time upon written notice to the Contractor. The Contractor shall, upon receipt of such written notice, have a maximum of three calendar days to suspend or delay its performance hereunder. Any WORK done after such three-day period will be at the Contractor's sole expense and risk. The Contractor and/or its suppliers shall resume any WORK so suspended or delayed when directed in writing by the Company to do so. The effect of such suspensions or delays upon the Contract price, payment schedules, and delivery schedules may be mutually discussed for the purpose of determining the nature and extent of any adjustments thereto, though the Company shall have the final determination as to whether adjustments will be made.

13.2 In addition to the foregoing, (a) if the WORK to be done under this Contract shall be abandoned by the Contractor, (b) if this Contract or any portion thereof shall be assigned by operation of law or otherwise, (c) if the WORK or any portion thereof is sublet by the Contractor without the permission of the Company, (d) if the Contractor is placed in bankruptcy or if a receiver is appointed for its properties, (e) if the Contractor shall make an assignment for the benefit of creditors, (f) if at any time the necessary progress of WORK is not being maintained, (g) if the Contractor is violating any of the conditions or agreements of this Contract, or (h) if the Contractor is executing this Contract in bad faith or not in accordance with the terms hereof, the Company may, without prejudice to any other rights or remedies it may have as a result thereof, notify the Contractor in writing to discontinue all WORK under this Contract. Within three calendar days from the date of such notice, the Contractor shall discontinue the WORK, whereupon the Company shall then have the power to complete the WORK herein described by this Contract or otherwise, as it may determine, and the Contractor agrees that the Company shall have the right to take possession of and use any and all of the materials, tools, equipment, supplies and property, wherever located, including without limitation the Contractor's plants, subcontractors' plants, or in transit, of any and every kind provided by the Contractor for the purpose of the WORK. The Contractor shall cooperate with the Company and cause the Contractor's subcontractors to so cooperate so that possession can be effected. The expense of so completing the WORK in excess of the unpaid portion of the Contract price due under this Contract shall be charged to the Contractor, and the Contractor shall pay such amount upon demand. The Contractor shall not, in any event, be entitled to any unpaid portion of the Contract price due under the terms of this Contract. The Company will attempt to obtain the lowest figures for completing the WORK but may make such expenditures which in its sole judgment shall best accomplish such completion.

14.0 OVERTIME

14.1 If the Company gives the Contractor written instructions to complete any portion or all of the WORK in advance of Contract completion dates, or to make up time lost by delays caused by exceptional conditions over which the Contractor had no reasonable control as defined in Article 12 above, the Contractor shall comply with such instructions and shall be paid only the actual excess wage, insurance and taxes for overtime occasioned thereby. This provision for reimbursement of overtime does not apply to that overtime arising under Article 12 hereof for which the Contractor is responsible, or to occasional overtime normally required by the nature of the WORK, which charges are deemed included in the Contract price.

14.2 Except in an emergency endangering life or property, no claim for compensation for overtime, in addition to the Contract price, will be honored by the Company, unless advance written permission has first been obtained.

14.3 All claims for payment for overtime must be shown separately on the Contractor's invoices, and not included with amounts applicable to the original Contract price. Further, any invoices covering additions to this Contract must refer to the specific changeorder or similar written authorization issued by the Company approving such additions, and will not be honored unless such reference is included.

15.0 ROUTING OF SHIPMENTS

In the event that this Contract includes the furnishing of equipment and/or material, the Company shall have the option of specifying the routing of shipments. If such specified routing increases the Contractor's shipping cost, it shall immediately notify the Company and, should the Company still specify the more expensive routing, then the Contractor shall be reimbursed by the Company for the increase actually incurred thereby.

16.0 CLEANING UP

16.1 The Contractor shall at all times prevent the accumulation of debris in the construction area, buildings and Premises of the Company, or at the Project Site if not on the Company's Premises affected by the WORK.

16.2 On a daily basis, the Contractor shall remove from the buildings, Premises and Site, all debris caused by the WORK, and shall maintain the buildings in broom-clean condition. To eliminate fire hazards, the Contractor shall remove all combustible or explosive materials from the buildings, immediately upon becoming scrap or otherwise unusable. The Contractor shall remove all such debris and materials to an area designated by the Company.

16.3 The Contractor shall, unless otherwise mutually agreed, remove from the Site all of its offices, racks, surplus materials, erection and construction equipment, tools and supplies, immediately upon termination of their usefulness to the WORK.

16.4 The Contractor shall promptly remove from the Company's Premises or the Project Site all items declared to be nonconforming by the Company on account of failure to conform to this Contract, whether or not actually incorporated in the WORK. Such items may be stored at the Contractor's risk at such place or places either on or off the Site as the Company may determine.

16.5 In the event that the Company determines that the Contractor is failing to fulfill satisfactorily any of the above requirements, the Company shall give the Contractor detailed written notice. If the Contractor fails to comply with said notice within twenty-four hours after receipt of same, the Company may arrange to have such work performed by others, and the cost thereof shall be chargeable to the Contractor and may be deducted from any monies due the Contractor.

17.0 PERMITS AND PUBLIC REGULATIONS

17.1 All necessary permits for the construction of any buildings and completion of the WORK shall be obtained by the Contractor (except for the three permits identified below) and shall be paid by the Company. The Contractor shall not be reimbursed for licenses or other charges prerequisite to performing the WORK or otherwise imposed upon it. The Contractor shall give all required notices with respect to the foregoing. If the Contractor discovers that any Specifications or Drawings forming a part of this Contract are at variance with any legal requirements, it shall promptly notify the Company in writing. If the Contractor performs any WORK which is contrary to any laws, ordinances or regulations, without giving such notice to the Company, it shall bear all penalties and costs arising therefrom. The WORK shall also comply with the regulations of the National Fire Protection Association, or other such board as shall perform similar functions, except as may be otherwise specified in this Contract.

1.7.2 Dynegy Midwest Generation shall obtain the permits required from the Illinois Historical Preservation Agency, Illinois EPA and Illinois DNR-Office of Water Resources.

18.0 COMPLIANCE WITH LAWS, ORDINANCES, REGULATIONS AND CODES

18.1 The Contractor shall at all times be solely responsible for complying with all applicable laws, ordinances, regulations and codes, including those relating to safety of all persons and property, in connection with the WORK. No obligation of the Company shall impose upon it any duty to review the Contractor's compliance with safety measures.

18.2 Wherever a standard or code is referenced within these Specifications or on the plans, it shall be understood to be the latest edition unless specifically noted otherwise.

18.3 The Contract price is predicated upon the Contractor's compliance with applicable laws, ordinances, regulations and codes in effect as of the date of this Contract and as in effect thereafter. If any changes shall be made to such applicable laws, ordinances, regulations and/or codes subsequent to date of this Contract, such changes shall be considered to be changes ordered by the Company under Section 23.2 hereof, but only to the extent that the Company becomes legally required to order such changes for the WORK.

18.4 The Contractor agrees that the WORK covered by this Contract shall be or have been manufactured or performed, priced and sold in accordance with all federal, state and local laws, including without limitation, the Fair Labor Standards Act, the Equal Opportunity Clause set forth in 41 CFR Section 60-1.4(A), and the Affirmative Action Clauses set forth in 41 CFR Sections 60-250.44 - 741.4.

19.0 ERECTION

19.1 The Contractor shall keep all its tools, equipment and material, etc., in such condition that the WORK can be carried on with safety to employees of the Company and the Contractor, and also to other persons and property at or near the Project Site.

19.2 The Contractor shall maintain a competent superintendent at the Site at all times to supervise the WORK and conduct it in cooperation with the Company and in coordination with all other WORK being done on the Premises. The superintendent shall be acceptable to the Company and may not be changed except by the request of the Company unless said superintendent proves to be unsatisfactory to the Contractor or ceases to be in the Contractor's employ. Without limiting the Contractor's responsibility to perform the WORK in accordance with this Contract, it is understood that the Contractor shall employ a competent engineer to determine lines and elevations.

19.3 The Contractor shall prepare detailed construction schedules when requested by the Company containing, at a minimum, designated activities necessary to perform the WORK and the date(s) on which each activity will be started and completed. The Contractor is solely responsible for determining the sequence and time estimates of each activity. The Company may require the Contractor to modify any schedule, including any part thereof (a) in the event that the Company determines the schedule or any part thereof to be impracticable or unreasonable, (b) as required by the schedules of other contractors or vendors, (c) to avoid undue interference with Site operations, and (d) to complete the WORK when required by this Contract. The Contractor shall be solely responsible for complying with the detailed construction schedules, including modifications thereof by the Company. In the event that the Contractor cannot maintain any schedule for a reason other than one excused by the Contractor, the Company may require the Contractor to furnish new detailed construction schedules.

19.4 The Contractor shall arrange, schedule and carry on the WORK so as not to interfere with the delivery and erection of the WORK of others or with the operation of any of the Company's existing facilities. To facilitate the erection of such other WORK, the Contractor shall, without cost to the Company, cease WORK at any point, when so directed by the Company, and complete the unfinished WORK at such time as the Company may designate. Materials and equipment shall be delivered to the Site in the order required for erection, and shall be stored as directed by the Company. The Contractor shall ascertain in advance what facilities are available for its use in the delivery, unloading, storing and erection of materials and equipment at the Site.

19.5 The Contractor shall do such cutting, fitting and patching of existing structures as may be required to install the WORK and shall, at all points of contact, properly fit it to existing WORK. The Contractor shall not endanger any WORK by cutting, digging or otherwise, and shall not cut or alter existing structures or the work of any other contractor except with the authorization of the Company.

19.6 The Contractor shall be responsible for determining what temporary shoring and bracing must be provided to support loads to which the WORK may be subjected, including construction equipment and the operation of such equipment. The Contractor shall be solely responsible for the adequacy and safety of such shoring and bracing.

19.7 The Contractor shall be completely responsible for the adequacy of any temporary attachments to the Company's structure or other facilities, whether or not such attachments may be required for the Contractor's cranes, hoists, scaffolds or other construction equipment or devices. Where the Specifications require the Company to review any such temporary attachment, such review shall be solely for the purpose of determining its potential impact on the Company's structure or other facilities, and in no way shall such review be interpreted as constituting approval of the adequacy of such attachments for their intended use.

19.8 The Contractor shall be solely responsible for, and shall have control and charge of, construction means, methods, techniques, sequences and procedure, and for safety precautions and programs in connection with the WORK, and shall carry out the WORK in accordance with the Contract documents. The Company will not be responsible for, or have control or charge over, the acts or omissions of the Contractor, subcontractors or any of their agents or employees, or any other persons performing any of the WORK.

19.9 The Contractor shall perform the WORK in a proper, safe and secure manner to prevent loss, injury or damage to the Company's property, the property on the Premises and to lives of persons, and shall comply with all applicable safety laws, rules and regulations of any Governmental Authority, including those contained in, or issued pursuant to, the Occupational Safety and Health Act of 1970, as amended, and with all safety procedures which the Company may prescribe in connection with the performance of the WORK. The Contractor shall designate a responsible representative at the Project Site who shall be responsible for, and oversee, loss prevention and loss control activities on behalf of the Contractor. This person shall be the Contractor's superintendent unless otherwise designated in writing by the Contractor to the Company.

19.10 The Company may suspend WORK which interferes or threatens to interfere with the operation of the Company's equipment or general safety of personnel or operations until the interference is eliminated. All equipment used by the Contractor on the Premises shall be in first class condition. Any equipment which the Company determines is inadequate or unsafe shall be removed immediately from the Premises at the Contractor's expense after notice from the Company.

19.11 The Contractor shall provide and maintain all passageways, guard fences, lights, barricades and other facilities for protection required by Governmental Authorities or rendered reasonably necessary by local conditions, and shall erect shelters sufficient to protect the WORK from damage. All barricades shall be arranged to ensure the safety of the workers and passersby, and shall be removed by the Contractor upon completion of the WORK.

19.12 The Contractor shall comply strictly with the Company's regulations in effect at any time governing the admittance of the Contractor's employees to the Premises and their identification while there. The Contractor shall bind each subcontractor, and all persons directly or indirectly subject to its direction or that of any subcontractor, to strict compliance with these regulations and with such supplemental, precautionary requirements which the Company may issue during the performance of the WORK.

20.0 FIRE PROTECTION

20.1 The Contractor shall provide its own temporary fire protection facilities for the equipment and materials furnished by it or the Company for its temporary construction buildings and structures. The equipment shall be maintained and inspected in accordance with applicable NFPA codes.

20.2 The Contractor's employees shall not remove the Company's installed fire extinguishers from their mountings unless they are needed to fight an actual fire or unless required to complete the WORK. In the event that the fire equipment is used to fight a fire, the fire extinguishers shall be returned to a location designated by the Company for recharging. In the event that the equipment is removed to complete the WORK, the removed equipment shall be relocated by the Contractor to an area as close to the equipment's original mountings as possible.

21.0 STORAGE AND TEMPORARY BUILDINGS

21.1 Outdoor space for the location of the Contractor's offices, shops or warehouses and for the storage of materials will be provided by the Company without charge. The Company will designate the area that will be available for such use at the time the Contractor visits the Site or when the plant layout is finalized. All temporary facilities required by the Contractor must be provided by the Contractor.

21.2 All temporary buildings required by the Contractor, including associated electrical work and heating facilities, shall be erected and maintained by it and shall be removed by the Contractor at the termination of their usefulness or termination of the WORK. Any temporary construction office to be erected within the main power station building shall be of sheet metal construction with a steel frame.

21.3 Prior to erection of any temporary building, the Contractor shall submit plans to the Company for general approval of construction and appearance before the building(s) may be erected.

21.4 All the Contractor's office furniture, equipment, material and consumables shall be provided by the Contractor at no additional cost to the Company.

21.5 Temporary shelves, bins, boxes, stands, racks, etc., required for the performance of the WORK shall be furnished by the Contractor, and the type(s) and location(s) will be subject to approval by the Company. These shall be removed by the Contractor when they are no longer required for the WORK.

21.6 The Contractor shall be responsible for all actions required by the manufacturers or vendors for the proper storage of equipment or material supplied by them and as instructed by the Company. These include such actions as maintaining warm or dry conditions, rotating shafts, coverings, dunnage, and the like.

21.7 All pressurized gas cylinders shall be stored or used in the upright position, chained or clamped to an adequate support and have the protective caps in place when not in use. The storage and maintenance of such cylinders shall be the sole responsibility of the Contractor.

22.0 MATERIAL SAFETY DATA SHEETS

The Contractor shall submit to the Company, along with any materials provided for the

WORK, applicable and current Material Safety Data Sheets (MSDS) for substances used during WORK to comply with the Toxic Substance Disclosure to Employee Act 83-240. The Contractor shall provide Material Safety Data Sheets at or prior to delivery of the items.

23.0 CHANGES IN THE WORK

23.1 Subject to the Company's prior written approval, the Contractor may make changes in the WORK without any change in the Contract price or the time(s) by which the Contractor must perform its obligations under this Contract, if such changes are made to meet the Contractor's warranties or other obligations under this Contract. In connection with the foregoing, the Contractor agrees promptly to advise the Company in writing of all improvements, whether owned or developed by the Contractor or others, which may come to the attention of the Contractor and which may be made in or to the WORK.

23.2 Revised or additional drawings and data may be issued after the contract is signed. Within 10 (ten) days after the receipt of any supplemental information, the Contractor shall advise the Company of any changes in unit costs in writing. No work shall be done on properties on which a cost change is required until a price is negotiated that is acceptable to the Company and Contractor.

23.3 The Engineer or On-Site Representative shall approve any material, procedures or specifications that the Contractor proposes to substitute for those specified herein, in advance. Any adjustment in price must be agreed to prior to the use of the item in the project.

23.4 The Contractor shall make changes in the WORK ordered by the Company in writing and, if any such change shall affect the Contract price or schedule dates, the Contract price shall be increased or decreased accordingly. The charge or credit for any such changes affecting the Contract price shall be determined, at the Company's option, by any of the following methods: (a) agreed lump sum price, (b) unit prices specified in this Contract or subsequently agreed in writing, (c) actual cost and agreed fixed fee, or (d) cost-plus provision if specified in this Contract. In those instances where the Company elects to order changes on a lump sum price basis, the Contractor shall submit for approval a quotation covering any change which affects the Contract price, and, if any change does not affect the Contract price, the Contractor shall so acknowledge in writing. Such quotation shall be submitted in writing within five days of receipt of the notification of the change, provided that under no circumstances shall the Contractor be entitled to an increase in the Contract price for such changes if the Contractor does not submit its quotation within five days or such period as agreed by the Company in advance. Failure by the Contractor to submit a quotation for changes decreasing the Contract price within the five-day period shall not affect the Company's right to a decrease in the Contract price. A price adjustment, where appropriate, will be mutually agreed in writing. Where such changes may adversely affect the Contractor's ability to meet performance schedules under this Contract or meet other obligations under the provisions of this Contract, an adjustment of such schedules and any other pertinent provisions, including payment schedules, shall be granted by the Company only if the Contractor notified the Company in writing of such effects and where the Company instructs the Contractor to proceed. In any event, the Contractor will receive price adjustments to this Contract only if such adjustments are agreed by the Company prior to commencing the WORK on such changes. The Contractor shall make necessary changes before any agreed price adjustment, if requested to do so by the Company.

23.5 When work is required that falls outside the scope and requirements of these Specifications, the Contractor shall obtain an "Extra Work Authorization" from the On-Site Representative or Engineer. The authorization may be initially oral, but must be in writing before compensation can be made.

23.6 Except in an emergency endangering life or property, no claim for compensation for extra WORK, in addition to the Contract price, will be honored by the Company, unless advance written permission has first been obtained.

23.7 All claims for payment for extra WORK must be shown separately on the Contractor's invoices, and not included with amounts applicable to the original Contract price. Further, any invoices covering additions to this Contract must refer to the specific change order or similar written authorization issued by the Company approving such additions, and will not be honored unless such reference is included.

24.0 COMPANY'S RULES AND REGULATIONS

The Contractor shall abide by any and all rules which the Company may have in effect or hereafter put into effect at the Site of the WORK pertaining to workmen, safety, use of cameras, security procedures or requirements, lighting of fires, and to the handling of equipment, materials, or any other part of the WORK. If, in the Company's judgment, it is desirable, the Contractor shall at the Company's request remove any employee from the WORK.

25.0 COMPANY'S RIGHT TO ORDER ADDITIONAL EFFORT

If the Contractor fails to carry on the WORK with the diligence necessary to complete any portion of the WORK in accordance with the schedule provided in this Contract (or if no such schedule is provided, then within a reasonable time), the Company may in writing order the Contractor to, and the Contractor shall, at its sole cost and expense, use such overtime, including extended shifts, employ such additional personnel, machinery, construction equipment, tools, etc., as shall be specified in such order necessary to maintain schedules and ensure timely completion. In the absence of bad faith, all orders given by the Company hereunder shall be conclusively binding upon the Contractor.

26.0 TERMINATION

26.1 The Company may terminate this Contract, in whole or in part, for its own convenience by written notice at any time. In such event, the Company shall pay the Contractor all labor and material costs incurred in the WORK prior to such notice and reasonable and normal overhead and profit with respect to such costs, less salvage value.

26.2 If either of the following events shall occur: (a) if the Contractor fails to make delivery of the material and/or equipment or to perform the WORK within the time specified herein or any extension hereof, or (b) if the Contractor fails to perform any other provision of this Contract and does not cure such failure within a period of ten days after notice thereof, then the Company may by written notice terminate in whole or in part any uncompleted WORK under this Contract, whereupon the Company may procure the material, equipment and services which, but for such termination, the Contractor would have been required to furnish hereunder; the Contractor shall be liable to the Company for all costs of such material, equipment and services in excess of that portion of the Contract price attributable thereto; and the Contractor shall continue the performance of this Contract to the extent not terminated under the provisions of this Section.

26.3 To the extent permitted by applicable law and in recognition of the nature of the WORK provided hereunder, (a) the insolvency of the Contractor, (b) the filing of a voluntary petition in bankruptcy by the Contractor, (c) the filing of an involuntary petition to have the Contractor declared bankrupt, (d) the appointment of a receiver or trustee for the Contractor, or (e) the execution by the Contractor of an assignment for the benefit of creditors shall entitle the Company to terminate this Contract.

27.0 LOSS OR DAMAGE AND INSURANCE

27.1 Until accepted in its entirety by the Company, the WORK shall be at the Contractor's risk and, if any loss of or damage to the WORK occurs from whatever cause(s) occurs prior to acceptance, the Contractor shall, without cost to the Company, promptly repair or replace the WORK so lost or damaged. In case this Contract provides for the unloading and/or erection of materials and/or equipment, the Contractor shall be fully responsible for all loss of, or damage to, said materials and equipment from whatever cause(s) occurring prior to acceptance of the WORK in its entirety, such responsibility to commence when the equipment or materials is (are) available for such unloading or erection. The Contractor waives and relinquishes all claims against the Company for loss or damage to the Contractor's property, and shall secure a waiver of subrogation by its insurer against the Company. The Contractor shall protect the Company's property from, and shall be responsible for, any loss or damage arising out of the execution of the WORK. In case the Contractor shall use any of the Company's facilities, it shall be the Contractor's duty before such use to ascertain that said facilities are in safe operating condition, and the Contractor shall be responsible for and indemnify the Company against any loss or damage resulting from such use.

27.2 In the event that this Contract calls for equipment or material to be shipped to the Contractor by the Company or others, and which the Contractor is required by this Contract to incorporate in, or attach to, the WORK, then the Contractor shall, upon receipt of said equipment or material, assume full responsibility for loss or damage thereto but shall have no interest in title of same.

27.3 Before commencement of the WORK, the Contractor shall procure insurance covering the above liabilities under policies in forms, in amounts, and with insurance carriers acceptable to the Company. All such policies shall name the Company as an additional named insured and Engineer as an additional insured as their interests may appear and said policies or certificates thereof shall be delivered to the Indemnified Parties.

28.0 INDEMNIFICATION

Contractor agrees to indemnify and hold harmless Dynegy Midwest Generation, Inc., the Engineer, and their respective officers, agents and employees from and against any and all claims, demands, losses, attorneys' fees and expenses arising out of, relating to, or resulting from the services provided by Contractor, its agents, its employees, it subcontractors, and any person or entity having a contract with any of its subcontractors.

This indemnity agreement specifically excludes any obligation to indemnify or hold Dynegy Midwest Generation, Inc. harmless for damages or claims to the extent attributable to any act or omission of Dynegy Midwest Generation, Inc. In addition, this Agreement specifically includes a waiver of any defenses (including, but not limited to, the *Kotecki* limitation defense, 146 Ill.2d at 160) which the Contractor may have as to damages or claims attributable to the fault of the Contractor or its agents, employees, or subcontractors as described herein. Contractor also agrees to reimburse Dynegy Midwest Generation, Inc. and Engineer for all costs and expenses, including but not limited to attorneys' fees, incurred by Dynegy Midwest Generation, Inc. and Engineer in enforcing, or attempting to enforce, any aspect of this indemnification agreement.

29.0 INSURANCE

29.1 The Contractor must provide insurance in accordance with items a-g set forth below in Section 29.2, as applicable. Evidence of compliance therewith is to be in the form of a certificate of insurance indicating that the required coverages are in full force and effect at the required limits. The Company may prohibit the Contractor from commencing or completing the WORK under this Contract until such time as the Contractor has provided the Company with the said certificate of insurance. The Company is under no obligation to pay any invoices submitted for any WORK under this Contract until its Purchasing and Material Control Department is in receipt of said certificate. The failure of the Company to enforce any provision of this Section, however, in no way relieves the Contractor of its obligation to provide the required insurance at the required policy limits.

29.2 Insurance policies written on a "claims made" basis shall be maintained by the Contractor for a minimum period of five years after the completion of this Contract and shall maintain retroactive dates, which are effective on, or before, the beginning of this Contract. The Contractor shall designate the Company as an additional named insured and Engineer as an additional insured on all policies specified below.

a. Workers' Compensation and Occupational Disease Coverage for statutory limits in accordance with applicable law. The policy shall also include Employers' Liability Coverage (Coverage B) at a minimum limit of $500,000.

The Contractor shall determine if the WORK to be performed under this Contract is covered by any Federal Compensation statutes, including, but not limited to, the Longshoremens' and Harbor Workers' Compensation Act. The Contractor shall arrange, pay for, and maintain proper insurance coverage as required by such statute.

b. Commercial General Liability ("CGL") Insurance to cover claims which may arise from the performance of any obligations arising under this Contract. This policy will include protection for the following hazards:

i. Premises - Operations.

ii. Independent Contractors' Coverage.

iii. Products and Completed Operations Liability - Coverage to apply for one year beyond completion and acceptance of the WORK specified by this Contract.

iv. Deletion of explosion, collapse and underground exclusions (where this Contract provides for any excavation or related services).

v. Personal Injury Liability.

vi. Broad Form Property Damage.

vii. Contractual Liability - Covering the indemnity Agreement in Article 28 of this Contract.

The above policy will be written at limits of at least One Million Dollars ($1,000,000) for each occurrence, One Million Dollars ($1,000,000) aggregate. The general aggregate limit under the CGL policy is to apply as a separate aggregate to the WORK under this Contract.

c. Business Automobile Policy (Commercial Automobile Liability Insurance) providing coverage for all owned, non-owned and hired vehicles. Minimum Limits of Liability shall be at least One Million Dollars ($1,000,000) each occurrence, Bodily Injury and Property Damage Liability combined single limit.

d. (Applicable for an architect, engineer, surveyor, Contractor or other contractor providing professional services.)

Professional Errors and Omissions Liability Insurance, with limits of at least One Million Dollars ($1,000,000) each occurrence, One Million Dollars ($1,000,000) aggregate. The Contractor shall also require all professional subcontracators to obtain and maintain similar insurance with similar minimum limits in connection with subcontracted WORK. All Professional Errors and Omissions Insurance shall be endorsed to provide contractual liability coverage.

e. (Applicable if the Contractor or its subcontractors will use a helicopter or airplane for any reason at the Site or to perform any Contract obligations.)

Aircraft liability (including passenger liability) insurance with a combined limit for bodily injury and property damage of not less than Five Million Dollars ($5,000,000) each occurrence. Such policy shall be in effect prior to the first use of such aircraft and shall continue in effect, at all times, until after such aircraft completes its work and lands at its final destination.

f. (Applicable if the Contractor or its subcontractors will use any marine vessel or floating euqipment for any reason at the Site or to perform any Contract obligations.)

Protection and Indemnity, including Jones Act liability insurance, with limits of liability of not less than Five Million Dollars ($5,000,000) each occurrence.

29.3 The failure of the Company to enforce any provision of this Section, however, in no way relieves the Contractor of its obligation to provide the required insurance at limits not less than the minimums required policy limits as specified above.

29.4 All the above policies shall be written by companies satisfactory to the Company. These policies shall not be changed or cancelled except within 30 days' written notice to the Company from the insurance carrier(s). Notification of cancellation or other changes must be mailed to:

Dynegy Midwest Generation, Inc.
Attn: Director, Business Center
2828 North Monroe Street
Decatur, IL 62526

29.5 The Company should receive confirmation that the Contractor has requested its insurance carrier to submit a certificate of insurance and provide Umbrella Coverage limits, if purchased, prior to the execution of any WORK.

30.0 ADVANCE SHIPMENTS

The Contractor shall make no shipments in advance of the required shipping date, unless there is adequate storage area at the site of the WORK, or such area is provided by the Contractor, and provided such shipment does not interfere with the progress of the WORK in any way. Any such advance shipment shall not entitle the Contractor to any payment prior to the time when such payment would otherwise be due if the shipment were made on the scheduled shipping date.

31.0 PUBLICITY

31.1 The Contractor shall not disclose any details of the WORK to any person(s) except those engaged in its performance, and only then to the extent required for the particular portion, of WORK being done. The Contractor shall not give any information concerning details of the WORK to the press or news disseminating agency without the Company's prior written consent.

31.2 The Contractor shall not display any sign, poster or other advertising matter in or on any part of the Site without the prior written consent of the Company.

31.3 No photographs of the WORK or at the Project Site are to be taken without prior written approval of the Company.

32.0 COST BREAKDOWN

The Contractor shall furnish the Company an itemization of the Contract price, including any changes thereto, according to the system of accounts required by the Company. All invoices submitted for payment, including payments for extra WORK, shall be itemized according to these accounts. This provision shall not be construed as an obligation on the part of the Company to make progress payments in compliance with this breakdown, but such payments shall be based on the value of WORK performed as provided in this Contract.

33.0 TAXES

The Contract price shall be net of any taxes however designated. The Company shall pay to the Contractor only those taxes which the Contractor is required under federal, state, local law, or foreign law to collect from the Company; the Company will not pay or reimburse the Contractor for any occupation, gross receipts, income, franchise, property or other taxes imposed upon the Contractor. If the Company claims exemption from any tax that the Contractor would otherwise be required to collect from the Company, the Company will furnish the Contractor with the documentation, if any, necessary to establish such exemption. Any tax which the Company is required to pay under this Section shall be identified in the Contract documents and shown separately by the Contractor on an appropriate invoice.

34.0 PAYMENTS

34.1 Unless noted otherwise, compensation will be made in accordance with bid units listed in this Specification. While the Company reserves the right to adjust quantities, any change in quantity of an item (or resultant total cost of that item) of ± 25% will require an adjustment of unit cost that is acceptable to the Company and Contractor.

34.2 Progress payments will be made, if requested, on a monthly basis based on the cost of completed bid units. More frequent progress payments can be arranged on large projects if desired. The Contractor shall submit all requests for payment directly to the On-Site Representative.

34.3 Pursuant to the Illinois sales tax exemption for this project, separate documentation shall be provided with each invoice that shows the cost of all materials that are included on the invoice and normally would have been subject to Illinois sales tax. Also, if any Illinois sales tax is paid by the Contractor, the amount, along with a description of the materials on which the tax was paid and an explanation of why the tax was paid will be provided with the invoice.

34.4 Unless noted otherwise, the Company will retain 10% of the total cost of payment requests pending satisfactory completion of the project. After all equipment, surplus material and debris have been removed form the site and the Company accepts the completed project, the Contractor must submit a request for payment for the retained funds. On large projects, the Contractor may bill for a portion of the retainage as major divisions of the project are completed; however, the Company shall retain the final decision as to the appropriateness of such requests.

34.5 The Contractor is specifically cautioned to immediately notify the On-Site Representative when requests for project changes come from outside parties (such as landowners, state agencies, etc.) AND OTHER DYNEGY MIDWEST GENERATION EMPLOYEES. Any project changes made at the request of these individuals, without the approval of the On-Site Representative or Engineer, will not be compensated as part of this contract. The Contractor may make individual payment arrangements with these unauthorized individuals at his own risk.

34.6 No certificates given or payments made shall be considered as evidence of satisfactory or acceptable performance of this Contract, either wholly or in part, nor shall any certificate or payment be construed as acceptance of any defective part of the WORK. The Contractor shall, if requested by the Company, at the time of any application for a partial or final payment, furnish the Company with a verified certificate showing names of subcontractors hereunder, the WORK done by, and the amount payable to, each. The Contractor shall furnish waivers in full or in sufficient amount to justify the requested payment, and shall in all other respects comply and cause all subcontractors to comply with the requirements of applicable local laws to the end that the Company shall be fully protected against claims for all WORK covered by such payments. Acceptance by the Contractor of final payment on the Contract price shall constitute a waiver of all claims against the Company.

35.0 RELEASE OF MECHANICS' LIENS

Pursuant to Section 5 of the Illinois Mechanics' Lien Act, the Contractor must submit a sworn statement of Subcontractors and suppliers furnishing materials and/or labor before any payments are required to be made to the Contractor. The Contractor agrees and acknowledges, therefore, that it shall not be entitled to any payments from the Company until such time that the Contractor has furnished the Company with a sworn statement setting forth the names of all Subcontractors and suppliers furnishing materials and/or labor pursuant to this Contract, and the amounts to become due to each. If Subcontractors are not being utilized, the Contractor shall so certify. Additionally, where Subcontractors are being utilized, the Contractor shall furnish to the Company partial and final lien releases which include all Subcontractors and material suppliers, when applying for Contract payments. No such payments shall be made until the Contractor has furnished the Company with all partial and final lien releases covered by the payment being sought. The Company reserves the right to apply any amount specified as retainage toward payment of unpaid Subcontractors/suppliers.

36.0 ASSIGNMENT OF CONTRACT

This Contract shall inure to the benefit of, and be binding upon, the successors and assigns of the respective parties. No rights, interests or obligations under this Contract shall be transferable or assignable by the Contractor or the Company without the prior written consent of the other party, which consent shall not be unreasonably withheld; however, each party shall have the right, without the prior consent of the other, to transfer or assign this Contract to any successor to all or a significant portion of the transferors' properties, whether by merger, consolidation, liquidation, corporate reorganization, sale, mortgage or otherwise, provided that such transferee or assignee, by written agreement or by operation of law, assumes the obligations of the transferor under this Contract.

If the successor or assignee of the Contractor or the Company shall so covenant and agree, in a writing delivered to the other party, to assume the obligations of such party so assigning and transferring its duties, rights or interests under this Contract, the party so assigning and transferring shall thereupon be released from all liability thereafter arising under this Contract.

37.0 PATENTS

The Contractor shall pay all liability, including all royalties, damages, or license fees, which may be payable on account of the WORK or any part thereof. The Contractor shall, at its own expense, defend any claim brought by others against the Company, its successors, assigns or those using the WORK, because the sale or use of the WORK infringes or is alleged to infringe, directly or contributory, or induce others to infringe rights in, to or under patents, trade secrets, trademarks, or copyrights, and will hold the Company harmless from any liability of any nature or kind (including all costs and expenses) arising out of any such infringement or alleged infringement. In the alternative, and at the Company's option, the Contractor shall reimburse the Company for all costs and expenses, including reasonable attorneys' fees incurred by the Company in defending any such suits or proceedings. In addition to the foregoing, the Contractor shall save the Company harmless against, and shall pay, all awards of damages assessed and all costs of suit adjudged against the Company in such suits or proceedings, provided the Company gives the Contractor reasonable advance notice in writing of the institution of any such suit or proceeding, permits the Contractor to defend it, and gives the Contractor all such information, assistance and authority as shall be necessary to enable the Contractor to do so. In case any part of the WORK is held in any such suit to constitute infringement and its use is enjoined, the Contractor shall, within a reasonable time, and at the election of the Company, either (a) secure for the Company the perpetual right to continue the use of such part of the WORK by procuring for the Company a royalty-free license or such other permission as will enable the Contractor to secure the suspension of any injunction, or (b) replace, at the Contractor's own expense, such part of the WORK with an adequate non-infringing part, or modify it so that it becomes non-infringing.

38.0 NOTICES

38.1 All notices hereunder shall be in writing and delivered in person, or sent by certified or registered mail.

38.2 Such notices to the Company shall be delivered or mailed to:

Dynegy Midwest Generation, Inc.
Attn: Director, Business Center
2828 North Monroe Street
Decatur, Illinois 62526
Purchase Order No. ________________________

39.0 STATE LAW GOVERNING CONTRACT

This Contract shall be governed and construed in all respects in accordance with the internal laws of the State of Illinois without reference to its conflict of law provisions, and the parties agree that the Sixth Judicial Circuit of Macon County, Illinois, shall be the sole and exclusive venue for any dispute or litigation arising under this Contract.

40.0 ARBITRATION

Any dispute arising out of, or relating to, this Contract or the breach, termination or validity hereof, which has not been resolved by mutual negotiation of the parties within 90 days, shall be settled by arbitration in accordance with the then-current rules of the American Arbitration Association by a single independent and impartial arbitrator with knowledge of, or experience in, the subject matter of this Contract. The arbitration shall be governed by the Federal Arbitration Act, 9 U.S.C. §§1-16 to the exclusion of state laws inconsistent therewith, and judgment upon the award rendered by the arbitrator may be entered by any court having jurisdiction thereof. The place of arbitration shall be Chicago, Illinois. The arbitrator is not empowered to award damages in excess of compensatory damages, and each party hereby irrevocably waives any right to recover such damages with respect to any dispute resolved by arbitration. The parties also agree that the fact and outcome of any arbitration shall be strictly confidential, and that a disclosing party shall be liable for $10,000 in liquidated damages. The statute of limitations of the State of Illinois applicable to the commencement of a lawsuit shall apply to the commencement of arbitration hereunder, except that no defenses shall be available based upon the passage of time during any settlement negotiations specified herein.

41.0 LITIGATION

If any dispute is not submitted to, and resolved by, arbitration as provided in Article 40, then either party may initiate litigation upon 60 days' written notice to the other party; provided, however, if one party has requested the other to participate in arbitration and the other has refused or failed to participate, the requesting party may initiate litigation before expiration of the above period. In any such litigation, the prevailing party shall be entitled to an award of attorneys' fees plus costs.

42.0 TIME OF THE ESSENCE

Time is of the essence of this Contract.

43.0 DATE OF CONTRACT

This Contract shall commence on the date and year of execution by the last party to sign the Purchase Order Acknowledgment.

44.0 NON-WAIVER OF RIGHTS

44.1 The failure of the Company to insist upon strict performance by the Contractor or the Company's failure or delay in exercising any rights or remedies provided in this Contract or by law shall not be deemed or construed as a waiver of any claims. No waiver by the Company of a breach of any provision of this Contract shall constitute or be construed as a waiver of any other breach or of that provision. No purported oral modification, waiver or recision of this Contract by an employee or agent of the Company shall operate as a modification, waiver or rescission of any of the provisions of this Contract.

44.2 No certificate given, nor payment made under this Contract, nor partial or entire occupancy of the Premises by the Company shall be construed as an acceptance of defective WORK or of improper materials, or as waiving or condoning any omission or default. No payment or certificate, final or otherwise, shall be construed as relieving the Contractor of its obligations to make good any defects or consequences for which the Contractor may be responsible, nor as a waiver of any obligations of the Contractor under this Contract. Payment by the Company shall not constitute or be construed as a release of any rights or remedies the Company may have against the Contractor under this Contract, at common law or otherwise. Acceptance by the Contractor of final payment on This Contract shall operate as a waiver of all claims against the Company.

45.0 HEADINGS

The heading of Articles and Sections of this Contract are for convenience only and do not define, limit or construe the contents hereof.

46.0 SEVERABILITY

In the event that any provision of this Contract, including the General Conditions, is determined to be invalid or contrary to existing applicable law, the enforceability of the remaining provisions of this Contract shall not be affected and will be given full force and effect unless the Company determines that such invalidity materially affects the basic consideration of this Contract. In that event, the Company may terminate this Contract in accordance with Article 26.

47.0 SMOKING

Effective as of October 1, 1993, the Company has banned smoking in all of its buildings and vehicles. The Contractor will be required to comply with this policy.

48.0 DRUGS, ALCOHOL AND FIREARMS

48.1 The Contractor shall at all times enforce strict discipline and good order among its employees and the employees of any subcontractor of any tier. The Contractor shall not permit or suffer the introduction or use of any weapons, firearms, ammunition, explosives, illegal drugs or intoxicating liquor during performance of the WORK under this Contract, or upon any of the grounds occupied or controlled by the Contractor or the Company.

48.2 The Contractor shall immediately remove from the WORK, whenever requested by the Company, any person considered by the Company to be incompetent, insubordinate, careless, disorderly, in violation of the above restriction on weapons, firearms, ammunition, explosives, drugs or liquor, or under the influence of illegal drugs or intoxicating liquor, and such person shall not again be employed in the performance of the WORK hereunder without the prior written consent of the Company.

IN WITNESS WHEREOF, this Contract has been executed by the parties' duly authorized representatives effective as of the date(s) of the Purchase Order Acknowledgment(s) to which this Contract is appended and of which it is a part.

Dynegy Midwest Generation, Inc.

_______________________________ By:____________________________

Contractor

Alona J. Campbell-Walker
Buyer/Contract Administrator

SECTION 3: SAFETY

Contractual Safety Requirements for Performing Work at Dynegy Midwest Generation, Inc Fossil Stations:

This document describes minimum safety requirements, in addition to all OSHA regulations, required by Dynegy for work performed at any Dynegy fossil station. This document is to be carefully reviewed and agreed to via signed attached *Statement of Compliance* prior to commencing work at any Dynegy fossil station. As used herein, the term “Contractor” shall include all subcontractors of the Contractors.

1.0 PRE-MOBILIZATION REQUIREMENTS

1.1 Safety Orientation

Prior to the start of any work or mobilization, contract employees shall attend a mandatory Safety Orientation conducted by Dynegy, unless based on scope of work, orientation is waived by the Plant Safety Coordinator/Plant Management.

1.2 Substance Abuse Testing

All contract employees shall comply with the Dynegy Substance Abuse Prevention Policy which includes pre-employment, reasonable suspicion, and random testing. All substance abuse testing shall conform to the requirements of the Fossil Power Plant Contractor Substance Abuse Testing Program. Any Contractor representative, vendor, or craft worker refusing to test under this testing procedure shall be prohibited access to the work site.

2.0 CONTRACTOR SAFETY PERFORMANCE

All contract work, including materials and equipment utilized, shall be in compliance with the applicable Federal, State, County, and local rules and regulations including, but not limited to the rules and standards established by OSHA. If a local plant work rule or work practice is more stringent than the OSHA requirements or the contractor’s general requirements, the contractor shall adhere to the local safety practice.

Contractors are expected to demonstrate safe work behaviors that fully comply with the contractor’s and Dynegy’s plant safety requirements and stated expectations. Contractor management is responsible for ensuring that said requirements and expectations are understood and exercised by contract employees.

3.0 SAFETY ACCOUNTABILITY

The contractor, as an independent business, retains the obligation to control the manner and means by which it performs its work, pursuant to the provisions of the contract, so long as it does not violate Federal, State, County, local, or site regulations. The contractor therefore is responsible for contract employees' compliance with all applicable safety rules and accepts any liability associated with such non-compliance, including but not limited to costs born by Dynegy as a result of a contractor's failure to comply with the contractor's, the plant's, or regulatory safety requirements. Dynegy reserves the right to observe work performance of contractors and instruct contractor management to correct any identified deficiencies. Also, Dynegy also reserves the right to stop any work where there is perceived imminent danger to any personnel on site.

4.0 BUSINESS PERMIT / LICENSES

Contractor shall obtain, at its own expense, all business licenses and business permits that may be needed in connection with this work. It is the contractor's responsibility to determine the license/permit needs at the site.

5.0 ACCIDENT/DAMAGE TO PROPERTY REPORTS AND PROCEDURES

The contractor shall immediately report to the Dynegy Plant Safety Representative/Plant Management, all accidents, occupational injuries and illnesses involving its employees relating to the work to be performed hereunder, or causing damage to the property of Dynegy.

- Contractor shall promptly furnish the Dynegy Plant Safety Representative/Plant Management with copies of the State of Illinois First Report of Injury form and the Accident Investigation Report relative to any injury incurred on site.

- Contractor agrees to assist Dynegy personnel in any investigation it may conduct of any such accident, injury or illness.

6.0 SAFETY EQUIPMENT, MATERIAL & TOOLS

Unless otherwise agreed to, in writing by Dynegy, contractor shall provide all safety equipment, material, tools, and personal protective equipment necessary to perform the work in a safe, healthful manner.

7.0 SYSTEM WIDE SAFETY REQUIREMENTS

7.1 No Smoking Policy

Smoking is prohibited in all Dynegy facilities and in all Dynegy Company vehicles.

7.2 Parking/Access Policy

All locations have specific entry gates and specific parking areas for contractors and contractors' employees. Contractors shall not use the Main Dynegy access gates.

7.3 Firearms

No personal firearms or ammunition are permitted on Dynegy property.

7.4 Personnel Qualifications

The contractor is responsible for ensuring that only qualified personnel perform work at Dynegy fossil stations. This includes ensuring that all OSHA required training is current for each individual and that employees are physically capable to safely execute any task assigned to him/her. The contractor is responsible for maintaining documentation of required training, physicals, medical surveillance examinations, etc.

7.5 Substance Abuse

No alcohol use or unauthorized use of a controlled substance or use of an illegal substance shall be tolerated. Workers shall report to work fit for duty. (See Attached Fossil Plant Contractor Substance Abuse Testing Program.)

7.6 Hazardous Chemical Reporting

The contractor shall report all chemicals brought on to Dynegy plant property to the Dynegy Plant Environmental Coordinator/Plant Management. Material Safety Data sheets will be required to be maintained for all chemicals used at the plant and made readily available to contract employees.

7.7 Radioactive Materials

Use of radioactive materials by contractor shall be in strict accordance with Federal and State law. Dynegy Plant Management shall be notified prior to bringing radioactive material on site, and before commencement of any radiographic work.

7.8 Personal Protective Equipment

Use of personal protective equipment shall comply with applicable OSHA requirements and the work rules at the site. Standard personal protective equipment required at all fossil plants include:

- Hard hat meeting ANSI Z89.1 - 1986 "American National Standard for Personnel Protection - Protective Headwear for Industrial Workers - Requirements" design criteria (Class B).
- Industrial safety glasses with side shields, meeting ANSI Z87.1 - 1989 "American National Standard Practice for Occupational and Educational Eye and Face Protection" design criteria.
- Work shirts (providing shoulder protection), and full length pants.
- Work shoes, hard soled with leather uppers, appropriate for the task being performed. All plants prohibit the wearing of tennis shoes in the work areas.
- Safety goggles, face shields, safety harness and other fall protection/arrest equipment, metarsal guards, respiratory protection, various types of gloves, etc. may also be required dependent upon the type of work contractors are engaged in. Personal protective equipment is to be provided by the contractor.

7.9 Tagout Policy

All system isolation in conjunction with lockout/tagout is administered by the Dynegy local plant Operations Department. Contractors will adhere to the requirements of the local Plant's Tagout procedure. Contractor responsibilities relative to this procedure will be communicated prior to commencement of work.

7.10 Equipment Lifts

Contractor shall supply a detailed lifting procedure, including a plot plan to scale indicating adjacent hazards/concerns and describing the methods for each major lift to the Dynegy Plant Safety Representative/Plant Management. Major lifts are defined as the use of multi-cranes, or more than 200 feet of boom or greater than 85% of crane capacity.

- The procedure shall include specific equipment to be used, position of equipment and existing obstructions, route of the load into/out of the plant, high wind restrictions, rigging methods, earth conditions under the lifting equipment, and required road closing to make the lift.

- Contractor is solely responsible for the design, calculations, selection of equipment, location of equipment, and procedures for every crane lift, as required.

7.11 Scaffold Policy

The contractor shall provide a "Competent Person" for all scaffold-building activities, in accordance with OSHA regulations.

7.12 Excavation/Trenching Policy

The contractor shall provide a "Competent Person" to oversee all excavation work, in accordance with OSHA regulations.

7.13 Fall Protection Policy

The contractor shall ensure that all workers, under their direction, comply with all the OSHA regulations for fall protection.

7.14 Confined Space Entry Policy

It is the duty of the contractor to ensure that all workers entering confined spaces are properly trained and the contractor's entry supervisor is fully trained in all of the requirements as set forth in OSHA Standard 1910.146, Confined Space Entry.

The contractor, when required by OSHA standards and/or Dynegy safety procedures shall provide calibrated, intrinsically safe combustible gas and oxygen monitors for monitoring of all confined space work or hazardous atmospheres. Other equipment necessary for the safe performance of confined space work will also be provided by the contractor, e.g. ventilation equipment, communication devices, etc. Rescue team provisions are the responsibility of the contractor unless negotiated otherwise by Dynegy local plant management.

7.15 Hot Work

All hot work will be administratively controlled via Flame Permits, which are required to be completed for all welding, cutting, brazing and other spark producing work. The contractor is responsible for providing fire watches, as required per OSHA and as noted on the Flame Permit. Personnel assigned fire watch duty shall be trained and thoroughly familiar with the use of hoses, nozzles, and fire extinguishers. Contractor shall provide training for fire watches. Contractor shall provide fire-fighting equipment, as required.

7.16 Industrial Hygiene Testing

Contractors are responsible for ensuring that contract employees are protected against airborne hazards, e.g. asbestos, arsenic, welding fumes, paint vapors, etc. and necessary atmospheric monitoring is conducted by qualified personnel to quantify exposures.

A certified laboratory shall perform analysis of industrial hygiene monitoring. Contractor shall supply documentation of such certification to the plant's Safety Representative.

8.0 ENVIRONMENTAL CONCERNS

8.1 Leaks or Spills

The contractor shall immediately report all chemical spills, including but not limited to oils, solvents, and fuels spills to the Dynegy's Site Environmental Coordinator/Plant Management. Contractor shall be constantly alert for unexpected hazards from leaks or spills, and shall be prepared to stop work and evacuate the area. Any unexpected chemical hazard shall be immediately brought to Plant Management's attention.

8.2 Chemical Disposals

The use of any hazardous chemical on plant property shall be coordinated with the local plant's Environmental Coordinator. Notify the plant prior to bringing the chemical on the property.

NO WASTE FLUIDS OR MATERIALS ARE TO BE PUT INTO ANY OF THE FLOOR DRAINS AT ANY LOCATION. COORDINATE ALL CHEMICAL DISPOSALS WITH THE LOCAL DYNEGY ENVIRONMENTAL COORDINATOR.

9.0 RIGHT TO TERMINATE

Dynegy reserves the right to stop any contractor activity which Dynegy considers unsafe. In addition, Dynegy reserves the right to immediately terminate the contract, without liability, except to pay for work already performed, should contractor or its subcontractor(s) fail to comply with the safety provisions, as stated herein.

10.0 STATEMENT OF CONTRACTUAL COMPLIANCE

As a pre-requisite for consideration as a potential contractor to perform work at any of Dynegy's fossil fueled generation stations, the contractor hereby agrees to comply with all requirements as identified in the document entitled "Safety Requirements For Performing Work at Dynegy Fossil Facilities." Contractor further acknowledges that it has received this document, and fully understands its content. This statement of compliance will remain in effect and contractor agrees to comply with all safety requirements until such time as contractor provides written notification to Dynegy that it will no longer comply with all safety requirements as referenced above, in which case Dynegy may exercise its right to terminate the agreement.

Company Name____

Signed by____

Title____

Date____

SECTION 4: SUBSTANCE ABUSE TESTING PROGRAM

1.0 SCOPE

This procedure establishes substance abuse testing requirements for all contract employees engaged by Dynegy Midwest Generation, Inc (DMG), Coal Engineering & Maintenance (CE&M) or by one DMG, Inc.'s Fossil Power Plants (Plant).

The prohibited substances for which contract employees must be tested are marijuana, cocaine, opiates, amphetamines, and phencyclidine (PCP). Tests may include additional substances, at DMG, Inc discretion.

2.0 PURPOSE

The purpose of this procedure is to establish substance abuse test requirements for contract employees performing work on DMG, Inc fossil plant premises or facilities.

Nothing in this procedure shall affect the Independent Contractor status of the Contractor, as deemed by DMG, Inc; the purpose of this procedure being to ensure that the work performed by contract employees while on DMG, Inc fossil plant premises is in accordance with Dynegy's Substance Abuse Policy, as documented in Corporate Safety and Health Standards SH2.00, Dynegy Substance Abuse Policy; and SH2.01, Dynegy Substance Abuse Plan and Testing, respectively.

Substance abuse tests shall be performed utilizing the Department of Transportation Guidelines; with the exception that the initial screening shall be performed utilizing on-site chemo-assay test kits. All non-negative tests shall be confirmed utilizing a Substance Abuse and Mental Health Service Administration (SAMHSA) approved laboratory and Gas Chromatography Mass Spectroscopy (GCMS) testing technology.

3.0 RESPONSIBILITY

The CE&M Manager, Plant Manager, or his/her designee is responsible for the overall implementation of the Fossil Plant Contractor Substance Abuse Testing Program. Each Plant Manager, or his/her designee, will assign responsibility for substance abuse testing and data management to a Site Coordinator and an Alternate Site Coordinator.

The Site Coordinator and/or Alternate Site Coordinator are responsible for supervising the actual test, selecting substance abuse testing collectors, coordinating the on-site testing of all contract employees at their respective location, and maintaining the pre-access screening database at their respective location.

The CE&M Regional Projects Director and the CE&M Director of (Plant) Engineering shall coordinate with the local Site Coordinators the pre-access portion of the Fossil Plant Contractor Substance Abuse Testing Program. The CE&M Directors and Plant personnel shall ensure that all Contractors are advised and understand the requirements of this procedure.

CE&M safety representatives, in conjunction with the Plant safety staff, are responsible for coordinating post-accident and for-cause substance abuse testing.

The Contractor is responsible for strict adherence to these conditions. Any costs associated with rehabilitation programs for employees shall be the exclusive responsibility of the individual in question, and/or the Contractor. Under no circumstances shall DMG, Inc bare said costs of such rehabilitation.

Dynegy shall not be responsible in any way for arranging or providing rehabilitation services, or be responsible to any third party for the Contractor's negligence in performing or failing to perform any act pursuant to said program.

The Corporate Substance Abuse Prevention Program Administrator (SAPPA) is responsible for maintaining the pre-access screening database; record-keeping; coordinating the purchase and distribution of supplies; and selecting vendors, as needed, for the substance abuse testing program.

4.0 DEFINITIONS

A non-negative test is an initial, on-site substance abuse test that requires confirmatory analysis by both a SAMHSA-certified laboratory, and a Medical Review Officer (MRO).

A confirmed positive test is a test result which was non-negative in the initial screening, and confirmed by a certified laboratory and a Medical Review Officer.

The pre-access screening database is an electronic database containing records of the pre-screening test results. The database is maintained by the SAPPA, and used by Site Coordinators to ensure contract employees are in compliance with this procedure.

5.0 PROCEDURE

This section identifies the specific requirements necessary for fossil plant Contractor (Contractor) compliance with the Dynegy Substance Abuse Policy.

5.1 General Requirements

All contract employees scheduled to perform work on fossil plant premises for (2) two or more continuous working days should receive a pre-access substance abuse screening prior to beginning work. Depending on the risks associated with a job activity, CE&M or the local Plant leadership DMG, Inc may require a substance abuse screening for tasks involving less than two working days.

5.1a As of January 1, 2000 The MOST Program will be accepted as an acceptable Substance Abuse Program for DMG contractors. Participants must provide proof of current status in the MOST program. (See attached MOST Protocols)

5.1.1 Dynegy, or agents hired by DMG, Inc, shall perform all substance abuse screens.

5.1.2 An on-site substance abuse test kit, approved by the SAPPA, may be used for screening.

5.1.3 If the test kit indicates a non-negative test, the specimen will be sent to an approved laboratory for confirmation. The tested contract employee will not be allowed to begin work until the laboratory and the MRO assess the data.

NOTE: Dynegy is not responsible for any possible loss of wages associated with any waiting period created by the use of the on-site screening method.

5.1.4 The pre-access substance abuse screening is valid for 30 days. If a contract employee is screened for a job, released, then rehired for work at any DMG, Inc fossil plant facility within 30 days of the release, a second screening will not be required.

5.1.5 If a contract employee is absent from a fossil plant facility for less than 30 days and is selected for a random substance abuse screening, the employee will be tested upon return to work.

5.1.6 All contract employees performing work on fossil plant property will be placed in the random pool database after they are pre-access screening. All contract employees in the pool are subject to unannounced, random substance abuse screening. All contract employees will be removed from the random pool database upon release from a fossil plant job site.

5.1.7 Refusal to provide a specimen shall be considered the same as a confirmed positive. Adulteration of a sample will be considered the same as a confirmed positive.

5.1.8 The Site Coordinator and/or Alternate site Coordinator can schedule an On-Site Testing representative for non-routine situations, by calling 800.759.7243, and entering PIN# 8405305. After the beep, enter your area code and phone number, press the (*) button, then if necessary, enter your extension. Concorde will return your call, and advise that a testing representative will be on site within two (2) hours.

5.2 Pre-Access Screening

The Contractor shall arrange with DMG, Inc for substance abuse screening to be administered on the first day the contract employee reports to work at a fossil plant facility. In the event that the testing representative is not on-site the first day a contract employee arrives at the plant, screening will be conducted on the next available day when the testing representative is at the plant.

5.2.1 The Contractor will arrange through the Site Coordinator to use the on-site screening as part of the mobilization process.

5.2.2 The Contract Superintendent, or his designee, must inform either CE&M or the Plant Site Coordinator, in advance, of the number of contract employees to be screened, and the times the employees will arrive for screening.

5.2.3 The local Site Coordinator shall call and schedule the On-Site Testing Representatives for the agreed-upon times for the screening.

5.3 Paperwork

5.3.1 The Contractor will complete the AUTHORIZATION FOR SUBSTANCE ABUSE SCREENING FORM (Attached Appendix A) for each contract employee requiring a substance abuse screen.

5.3.2 The form shall contain the name and the Social Security number of the contract employee to be screened.

5.3.3 The form shall be signed by the Contract Superintendent, or his designee. In addition, the form shall list a designated person to receive the results of a non-negative screening.

5.3.4 The Contract Superintendent, or his designee, shall escort the person(s) requiring the screening to the collection site.

5.3.5 Each contract employee shall provide a completed AUTHORIZATION FOR SUBSTANCE ABUSE SCREENING FORM, and present a photo ID to the On-Site Testing Representative.

NOTE: Once notified, individuals have two hours to provide a urine specimen. If the person cannot provide the necessary amount of urine, or if he/she leaves the premises, it will be considered a confirmed positive test.

5.4 Test Results

5.4.1 If the test kit indicates a negative result, the contract employee may begin work. The test results will be entered into the pre-access screening database as negative, and the contract employee will be entered into the Contractor random selection database.

5.4.2 If a contract employee tests non-negative, the following conditions apply:

5.4.3 If a non-negative test result is obtained, the On-Site Testing Representative will notify the Site Coordinator. The Site Coordinator will inform the Contractor's designated representative; the representative and the Contractor's designee, upon receipt of the notification, shall escort the individual off-site. The Contract Superintendent should provide transportation to the employee's home, if deemed appropriate. The contract employee shall not perform any work when a non-negative test result is obtained.

5.4.4 If the substance abuse screening results are confirmed positive by the MRO, the contract employee will not be eligible for access to any DMG, Inc fossil plant facility for one year from the date of the confirmed positive test.

5.4.5 If the non-negative substance abuse test screening is confirmed negative, the contract employee will have immediate access to DMG, Inc fossil plant facilities.

NOTE: The Corporate SAPPA shall maintain all written records and reports involving substance abuse screening activities. The Corporate SAPPA shall administer the pre-access screening, and maintain a current list of contract employees with restricted

5.5 Random-Sample Screening

The SAPPA shall select contract employees from the Fossil Plant Contractor Random Pool for screening. The SAPPA will notify the Site Coordinator, and schedule the appropriate On-Site Testing Representative. The Site Coordinator will notify the Contract Superintendent. The Contract Superintendent will notify his/her employees of the time and place for the random substance abuse screening.

5.5.1. If a contract employee tests non-negative on a random-sample screening, the employee will be removed from DMG, Inc fossil plant property.

NOTE: If the Contract Superintendent believes the contract employee exhibits job behaviors that indicate he/she may pose a danger to themselves or others, the Superintendent shall provide transportation for the employee to be taken home.

5.5.2 If the non-negative test is confirmed positive by the MRO, the contract employee will be granted access to DMG, Inc fossil plant property, upon completion of the following three conditions:

5.5.2.1 The passage of 15 working days;

5.5.2.2 Proof of a professional assessment obtained by the contract employee or by the Contractor, and proof of compliance with the assessment recommendations. It is the employee's responsibility to provide verification of continuous compliance with the assessment recommendations; and

5.5.2.3 An on-site negative substance abuse screen.

NOTE: The professional assessment shall include recommendations for follow-up testing, and shall be submitted to the Corporate SAPPA. A contract employee who provides a second confirmed positive will be denied access to DMG, INC, fossil plant properties for life.

5.6 Reasonable Cause Substance Abuse Testing

A contract employee shall be tested for substance abuse when there is reasonable cause to believe, from his or her job behavior, that he/she may pose a danger to themselves or others in their job performance.

NOTE: The decision to perform reasonable cause substance abuse screening shall follow the requirements listed in Dynegy's SH2.01 Substance Abuse Plan and Testing, Section 3.5.5.

5.6.1 If the suspected employee tests non-negative, the employee shall follow the steps listed in Section 5.5.2, above, for re-access to DMG, Inc fossil plants property, and the Contractor shall provide transportation for the contract employee to be taken home.

5.6.2 If the suspected employee's test is negative, the employee will be returned to work, or taken for medical evaluation, pursuant to site safety standards.

5.7 Post-Accident Substance Abuse Screening

All contract employees whose actions may reasonably be believed to have been related to any significant accident on DMG, Inc fossil plant premises, or involving fossil plant facilities, as a general standard, must be tested for prohibited substances within eight (8) hours after such accident.

An accident should be considered significant if it results in serious injury or death of any person, substantial damage to property, release of any environmentally-damaging substance, or other accidents which the CE&M Manager or the local Plant Managers consider worthy of a post-accident substance abuse test.

5.7.1 If the suspected employee tests non-negative, the employee shall follow the steps listed in Section 5.5.2, above, for re-access to DMG, Inc fossil plant properties.

5.7.2 If the employee's test indicates non-negative, and the employee exhibits job behaviors that indicates he/she may pose a danger to themselves or others, the Contractor shall provide transportation for the employee to be taken home.

6.0 REFERENCES

6.1 SH 2.00 Dynegy Substance Abuse Policy

6.2 SH 2.01 Dynegy Substance Abuse Plan and Testing

6.3 MOST Policy and Procedures on Drug Screening

7.0 APPENDICES

7.1 Appendix A – “Authorization for substance Abuse Screening

7.2 MOST protocols at DMG's Facilities

Dynegy Midwest Generation, Inc

Authorization for Substance Abuse Screening

Date: __________________

You are requested to perform collection and substance abuse screening for the following employee:

Name:____
(Please Print - Last, First, Middle Initial)

Social Security Number: ____

Company: ____

________________________________ ________________________
Project Superintendent **Date**

- -

THESE SCREENINGS ARE CONFIDENTIAL

Results are to be released to: ____

Title: ____

- -

COLLECTION DATA

Date of Test: ____

Time of Test: ____

____ __________________________
On-Site Testing Representative **Date**

Attach the Chain of Custody Form

cc: **Site Coordinator/SAPPA, E-05**

MOST Protocols at DMG's Facilities

On January 1, 2000 the MOST Program implemented a Random program whereas 4% per month, per local will be tested at random.

This program will be administered by PMC for all boilermakers employed at DMG Facilities.

Upon Arrival for work at DMG facilities the Boilermaker contractor is required to provide his/her MOST Card to the PMC Superintendent or designee. The card will be verified to ensure it is current.

If the card is not current, the Boilermaker will be asked to return to his/her local to update their card. If it is decided by Plant Management to not send the boilermaker to their local to update the card they may choose to utilize DMG's Fossil Power Plant Contractor Substance Abuse Testing Program PG 1.6 and an On-site test will be conducted.

With the exception of Baldwin Energy Complex " Random"," For Cause" and "Post Accident" testing will be implemented at the designated Certified Laboratory.

The Plant Nurse can conduct Random testing at Baldwin Energy Complex.

PMC will be required to send a list of all Boilermakers employed at each of the DMG facilities by facility monthly to the MOST Programs. This list will be utilized to generate the 5% by facility random selection. PMC Safety will send this list to MOST and will administer the random testing coordination.

DMG's Senior Safety Consultant will periodically Audit PMC's records for adherence to these requirements.

SECTION 5: SUBMITTALS

1.0 Contractor shall provide submittals for the items listed below prior to their use on this project. Installation of these items will not start until after the Owner has approved their submittals.

2.0 Submittals shall be made in a timely manner to insure the job is not delayed. The Contractor must allow the Engineer at least two weeks to approve submittals. Submittals are to be sent directly to the Engineer.

3.0 The Engineer will keep two copies of all submittals and return the rest to the Contractor. The Contractor shall submit three or more copies based on his needs for marked copies to be returned by the Engineer.

4.0 Items requiring submittals include but are not limited to the following. Submittals are also required for items called out in the technical specifications but not listed below:

4.1. Riprap

4.2. Seed and Fertilizer

4.3. Pipe and Fittings

4.4. Flow Meter and Fittings

4.5. Manholes & Accessories

4.6. Stormwater Management Plan

Sediment and erosion control plans meeting the requirements of the Federal and State EPA

4.7 Concrete

SECTION 6: EARTHWORK

1.0 SCOPE

1.1. This Specification covers the minimum performance requirements, materials, and references necessary to govern earthwork and related operations. Earthwork is the movement of soil, sand, or rock from one location to another, shaping the materials in accordance with the plans and specifications, and achieving the desired physical condition of the materials by various methods.

1.2. Earthwork associated with this project includes, but is not necessarily limited to, the following:

1.2.1. Stripping topsoil for later dressing out of dikes and other disturbed areas.

1.2.2. Temporary stockpiling of dike materials.

1.2.3. Dike construction.

1.2.4. Clay liner and core construction. The terms “clay liner” and “clay core” will be used interchangeably within this Specification unless specifically indicated otherwise.

1.2.5. Grading and ditch construction.

1.2.6. Excavation and backfill for manhole(s).

1.2.7. Stone surfacing.

1.3. The borrow site is adjacent to the pond. All work required for access to the borrow area, staging, stockpiling, and the like shall be considered incidental to the project.

1.4. Topsoil shall be stripped from the existing dikes and borrow areas and stockpiled in an area designated by the Owner’s Representative. At the completion of dike construction, the topsoil shall be spread on the outside slope of the dike and prepared for seeding as required elsewhere in the project specification.

1.5. The Contractor shall separate materials encountered in the borrow area as required to place material with the proper gradations and permeability in the dike zones as described below:

1.5.1. Impervious Fill

Impervious fill shall be used to construct the clay liner, clay core, and other portions of the dike as shown on the Drawings. Materials available for construction of impervious fill shall be obtained from on-site excavations and borrow areas and shall include only materials meeting the following classifications of ASTM D 2487, "Classification of Soils for Engineering Purposes," placed as described in the Specifications or as approved by the Engineer.

Clays: CL, CH, CL-ML

Combinations of the above

Materials estimated to meet the requirements of impervious fill are shown on the Summary Boring Logs provided in the Drawings.

The maximum particle size in fill compacted with large, self-propelled rollers, shall be 6 inches and the maximum particle size in other fill shall be 3 inches. Oversize material shall be removed from the fill. The material shall be placed in maximum 8-inch thick loose lifts for fill compacted with large, self-propelled rollers and 4-inch thick loose lifts for fill compacted by other methods, at a moisture content between optimum and 3% above the optimum moisture content as determined by ASTM D 698 and shall be compacted to at least 95% of maximum density as specified in ASTM D 698.

1.5.2. Pervious Fill

Pervious fill shall be used to construct the portion of the downstream dike as shown on the Drawings. Materials available for construction of pervious fill shall be obtained from on-site excavations and borrow areas and shall include materials meeting the following classifications of ASTM D 2487 placed as described in the Specifications or as approved by the Engineer.

Sands: SM, SP-SM
Gravels: GM, GP-GM
Combinations of the above

The maximum particle size in fill compacted with large self-propelled rollwers shall be 6 inches and the maximum particle size for other fill shall be 3 inches. Oversize material shall be removed from the fill. Fill compacted with large, self-propelled rollers shall be placed in maximum 8-inch thick loose lifts at a moisture content between 2% below and 3% above the optimum moisture content specified in ASTM D 698 and shall be compacted to at least 95% of maximum density as specified in ASTM D 698. The maximum lift thickness for fill compacted by other methods shall be 4 inches.

1.5.3. Random Fill

Random fill shall be used to construct the portion of the dike as shown on the Drawings. Materials available for construction of random fill shall be obtained from on-site excavations and borrow areas. Impervious and pervious fill materials may be used as random fill.

Inorganic soils not meeting the requirements of impervious or pervious fill may be used as random fill. Random fill shall be placed as described in the Specifications or as approved by the Engineer.

The maximum particle size fill compacted with large self-propelled rollers shall be 6 inches and the maximum particle size in other fill shall be 3 inches. Oversize material shall be removed from the fill. The material shall be placed in maximum 8-inch thick loose lifts for fill compacted with large, self-propelled rollers and 4-inch thick loose lifts for fill compacted by other methods, at a moisture content between 2% below and 3% above the optimum moisture content specified in ASTM D 698 and shall be compacted to at least 95% of maximum density as specified in ASTM D 698.

1.6. Contractor shall be responsible for dust control around the pond and borrow areas.

1.7. Payment for earthwork shall be as indicated on the Bid Form and as specified in this section.

2.0 DEFINITIONS

2.1 Excavation: Work done in obtaining material for dikes, liners, or fills.

2.2 Channel Excavation: The removal and satisfactory disposal or reuse of all materials encountered in the construction of ditches, stream channels, or swales.

2.3 Clay: Soils meeting the classifications of ASTM D 2487 for CL, CH and combination thereof.

2.4 Clearing: The removal and disposal of all obstructions such as fences, walls, foundations, buildings, trees, stumps, brush, accumulations of rubbish of whatever nature, and existing structures.

2.5 Construction Inspector: The Owner's on-site representative.

2.6 Contractor: The party or parties proposing to provide all labor, equipment and materials required to perform the work specified herein or on the plans.

2.7 Crushed Gravel: Fractured particles resulting from the crushing of gravel which, prior to crushing, would have been retained on a screen with an opening 1.5 times as large as the maximum size of the resulting crushed material.

2.8 Crushed Stone: Angular fragments resulting from the mechanical crushing of granite, limestone, or dolomite from undisturbed, consolidated deposits: (Dolomite shall be a carbonate rock containing 11.0% or more magnesium oxide (MgO). Limestone shall be a carbonate rock containing less than 11.0% magnesium oxide).

2.9 Dike: Consists of the construction of fill areas by hauling, depositing, placing and compacting the specified material above the natural surface to a specified grade line..

2.10 Engineer: URS Corporation

2.11 Footing Excavation: See Structure Excavation.

2.12 Gravel: Coarse, granular, unconsolidated material resulting from the reduction of rock by the action of the elements and having subangular to rounded surfaces conforming to the definitions set forth in the Unified Soil Classification System.

2.13 Inorganic Silt: Fine-grained soil possessing little or no plasticity or cohesion conforming to the definitions set forth in the Unified Classification System for ML.

2.14 Owner: Dynegy Midwest Generation, Vermilion Power Station, or its designated agent.

2.15 Pipe Excavation: The excavation, removal and satisfactory disposal or reuse of all materials encountered constructing a trench for installation of the specified pipe.

2.16 Porous Backfill: Fine aggregate (clean sand) placed and compacted in excavations, around structures or other items as indicated in the plans and specifications.

2.17 Rock: Natural aggregate of mineral grains connected by strong and permanent cohesive forces.

2.18 Sand: Fine granular material resulting from the natural disintegration of rock conforming to the gradations set forth in the Unified Soil Classification System.

2.19 Soil: Natural aggregate of mineral grains, with or without organic constituents that can be separated by gentle mechanical means such as agitation in water. Gravel and sand are coarse-grained soils, while silts and clays are fine-grained soils.

2.20 Stripping: The excavation, removal and satisfactory disposal (if required) of all materials taken between the original surface and the top of suitable material for the construction of dikes, subgrade, sub-base, shoulders, intersections, ditches, waterways, entrances, approaches and incidental work.

2.22 Structure Excavation: Removal of any and all materials encountered during installation of any designated structure and the satisfactory disposal or reuse of all materials.

2.23 Unclassified Excavation: The removal of any combination of topsoil, earth, rock, muck or obstacles carried out to the lines and grades specified or shown on the plans without regard to percentage of moisture and type of material found.

2.24 Bottom Ash: The portion of the ash generated during coal combustion formed of angular particles ranging from sand to gravel-size. Bottom ash is free draining and has essentially no cohesion.

3.0 REFERENCES

3.1 The reference to specifications or organizations (such as ASTM) together with any diagrams, drawings or plans shall be considered as part of this specification. In the event of conflict between this specification and the referenced documents, the requirements of this specification shall take precedence. The latest editions of the following specifications, standards, and codes apply:

3.2 American Society for Testing and Materials (ASTM)

ASTM D 75: Practice for Sampling Aggregates

ASTM D 420: Recommended Practice for Investigating and Sampling Soil and Rock for Engineering Purposes

ASTM D 421: Method for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants

ASTM D 422: Method for Particle-Size Analysis of Soils

ASTM D 653: Terms and Symbols Relating to Soil and Rock Mechanics

ASTM D 698: Test Methods for Moisture - Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5-lb (2.49 kg) Rammer and 12- inch Drop

ASTM D 854: Test Method for Specific Gravity of Soils

ASTM D 1140: Test Method for Amount of Material in Soils Finer than the No. 200 (0.074-mm) Sieve

ASTM D 1452: Practice for Soil Investigation and Sampling by Auger Borings

ASTM D 1556: Test Method for Density of Soil in Place by the Sand-Cone Method

ASTM D 2168: Methods for Calibration of Laboratory Mechanical-Rammer Soil Compactors

ASTM D 2216: Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock and Soil Aggregate Mixtures

ASTM D 2217: Method for Wet Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants

ASTM D 2487: Test Method for Classification of Soils for Engineering Purposes

ASTM D 2922: Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)

ASTM D 3017: Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

ASTM D 3740: Practice for the Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

ASTM D 4220: Practices for Preserving and Transporting Soil Samples

ASTM D 4318: Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM C 29: Test Method for Unit Weight and Voids in Aggregate

ASTM C 127: Test Method for Specific Gravity and Absorption of Coarse Aggregate

ASTM C 128: Test Method for Specific Gravity and Absorption of Fine Aggregate

ASTM C 136: Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C 566: Test Method for Total Moisture Content of Aggregate by Drying

ASTM C 702: Methods for Reducing Field Samples of Aggregate to Testing Size

ASTM D 75: Practice for Sampling Aggregates

ASTM E 11: Specification for Wire-Cloth Sieves for Testing Purposes

ASTM D 3665: Practice for Random Sampling of Construction Materials

3.3 Standard Specifications for Road and Bridge Construction - Illinois Department of Transportation (IDOT)

4.0 MATERIALS

4.1 Acceptability -

4.1.1 The clay liner and clay core shall be constructed of impervious fill with a permeability of not more 10^{-7} cm/sec as placed and compacted. The clay soils in the borrow area have been tested and shown to meet this requirement.

4.1.1.1 Additional soil tests may be made by the Engineer to confirm that actual materials used meet the permeability requirements. If the soil proves unsatisfactory, one or more of the following measures shall be taken:

4.1.1.1.1. The unsatisfactory material will not be used in the liner, but may be used in other portions of the dike as shown on the Drawings.

4.1.1.1.2. The compaction and/or moisture content requirements for the clay liner may be adjusted in some cases to reduce the permeability and allow its use in the liner. If there are extra costs associated with this measure, it shall be agreed upon by the Owner and Contractor prior to its implementation.

4.2 The type of material and gradation to be used at a particular location will be as designated in this section, other portions of the specifications, and on the plans for the project.

4.2.1 Unsatisfactory material used in any portion of the dike (or other parts of this work) shall be removed and replaced at the Contractor's expense.

4.2.2 The Company's On-Site Representative will determine with the Contractor's assistance acceptable locations for the various types of soil that will be encountered during excavation for dike fill. The Contractor remains solely responsible for proper placement and compaction.

4.2.3 In most instances, coarse-grained material (gravels, crushed stone, sand) will be designated by an IDOT gradation. Materials with these gradations are readily available statewide.

4.2.4 Fine-grained materials (clay, silty clay) will be designated by a Unified Soil System Classification Symbol (ASTM D 2487).

4.3 Topsoil shall be relatively free from large roots, sticks, weeds, brush or stones larger than 2 inches in size, or other litter and waste products. Topsoil shall be a loamy mixture having the following characteristics:

- At least 90% passing the No. 10 sieve.
- Not less than 1% or more than 10% organic matter.
- Not less than 12% or more than 50% clay.
- Not more than 55% sand
- A pH value between 5 and 8

5.0 CONSTRUCTION REQUIREMENTS

5.1 Unless noted otherwise below, compaction requirements for all phases of the work shall be at least 95% of the maximum dry density and within -2% to +4% of the optimum moisture content as determined by ASTM D 698 (commonly referred to as the Standard Proctor test).

5.1.1 The clay liner shall be compacted to at least 95% of the maximum dry density at a moisture content between 0% and +4% of optimum moisture content as determined by ASTM D 698.

5.2 Compaction shall be obtained by mechanical means in a timely manner so as not to delay construction. Loose lift thickness may vary depending upon the condition of the material and equipment used, but shall never exceed 8 inches. Each lift will be tested by the Engineer or an outside agency.

5.3 Material placed that does not meet the minimum compaction requirements shall be reworked as necessary to obtain the specified compaction at no extra cost to the Owner. Reworking may include removal, rehandling, reconditioning (including drying or adding water), rerolling, or combination of these procedures. A source of water (hydrant) for the Contractor’s use has been identified on the Drawings. No further placement of material will be allowed until the compaction requirements are met. If the material becomes unsuitable for use after placement, even if previously compacted to the specified percentage, it shall be modified (or removed and replaced by suitable material) and compacted in accordance with the specifications at no extra cost to the Company.

5.4 No material shall be placed on wet or frozen subgrade.

5.5 The Contractor shall maintain his work in such a manner to prevent ponding of water in the project area. In foundation excavations where water collects the Contractor shall pump as required to keep the excavation free of water. A layer of oversize rock (±4 inches) covered by a layer of crushed stone (IDOT CA-6 or CA-10) or a mud mat shall be placed to allow work to proceed in the excavation without contamination by mud or water.

5.6 Erosion control is the responsibility of the Contractor.

5.6.1 Contractor shall submit sediment control plans meeting the requirements of the Federal and State EPA to the Owner for approval prior to the start of work. The plans shall clearly show routing of stormwater discharge and sediment control measures such as settling basins, silt fences, etc. The plans shall be fully implemented and maintained throughout the project at both the pond and borrow site locations.

5.6.2 The Contractor shall provide the Owner plans for control of sediment in stormwater runoff meeting the requirements for a construction-related stormwater discharge permit for both the pond and borrow sites. The Owner will submit these plans to the State for the permit. The Contractor shall provide and maintain sediment control systems that meet the State requirements. If the Owner requires additional sediment control measures beyond those required by the State, the Contractor will be reimbursed at cost for the additional measures. The contractor may submit with his bid an estimate of the cost of the materials to be used for sediment control.

5.6.3 Installation of sediment and erosion control measures shall be paid for as lump sum items. Maintenance of sediment and erosion control measures shall be considered incidental to the earthwork and not paid for separately

5.6.4 Contractor shall repair all erosion damage that occurs during the project at no additional cost to the Owner.

5.6.5 The borrow area shall be left in a condition that will minimize erosion and promote the natural revegetation of the area. Cut slopes shall not be left any steeper than 1 vertical to 4 horizontal. Disturbed areas shall be seeded.

5.7 Disposal of all unsuitable material in a legal, safe, and satisfactory manner is the responsibility of the Contractor. This includes, but is not limited to, materials resulting from clearing and stripping.

5.8 The Contractor shall be responsible for, and shall take all necessary precautions to preserve and protect all existing tile drains, sewers, other subsurface drains, underground utilities, above ground utilities, private transmission lines, and appurtenances which may be affected by his operations and shall repair, at his own expense, any and all damages resulting from his actions or inactions.

5.9 The Contractor shall notify the Engineer two days in advance of beginning or resuming work.

5.10 Unless shown differently on the Drawings or called for in these Specifications, trenches for pipe installation shall be excavated at least 18 inches wider than the outside diameter of the pipe in order to permit thorough tamping of the soil against the pipe. Where a firm foundation is not encountered at the grade established all such unsuitable soil shall be removed for the width of the trench and replaced with well-compacted bedding material or suitable compacted aggregate. In areas requiring impervious backfill, the trench bottom shall be shaped to conform to the pipe's shape in lieu of bedding. Alternatively, the pipe trench can be backfilled with "flowable fill." Flowable fill shall be a flowable, hand-excavable mixture of cement, pozzolan, coarse and fine aggregate, and water mixed in accordance with ASTM C 94. Contractor shall submit details for approval if he intends to use flowable fill, including mix proportions, entrained air, density range, slump, and compressive strength at 28 days.

5.11 Maintain access to the project site at all times. If the work is being performed at an existing facility the Contractor shall make the necessary arrangements to maintain access to vital areas.

5.12 Various portions of the work will require testing by Engineer or an outside designated testing agency. The Contractor will cooperate with the testing program and make his work accessible at all times.

5.13 If the work generates sufficient dust to cause complaints to be received by the Company, the Contractor shall remedy the situation to the satisfaction of the Company at no cost to the Owner.

5.14 All holes, ruts, soft places, and other defects shall be corrected. In no case shall the surface course, base course, or other items be placed on soft or unstable material or over areas that are not properly drained.

5.15 In cut sections where excessively wet soil is encountered, the Contractor will be required to dry the soil and to obtain compaction of the material in accordance with the requirements of paragraph 5.1.

5.16 The subgrade shall be constructed so that after being compacted it will conform to the alignment, grade, and cross section shown on the Drawings. Ruts in the finished subgrade of one inch or more in depth shall be removed from the work or the rutting shall otherwise be prevented. Rutted areas shall be graded and re-rolled with a smooth-wheeled roller.

5.17 A smooth surface is desired at the termination point of each type of material used whether it is virgin subgrade, dike material, crushed stone, or other construction materials. When a sheepsfoot roller is used, the area must be leveled at the finished grade. The interfaces between continuing layers of dike are not to be leveled and are expected to exhibit a normal amount of “fluff” associated with an ongoing fill operation.

5.18 Traffic control, including provisions for the necessary barricades, flagmen and other items, is the responsibility of the Contractor.

5.19 Earthwork operations shall comply with the following requirements:

5.19.1 Before any dike material is placed, all clearing and stripping over the entire area shall be performed. The top six inches of the exposed surface shall be disced, and then compacted to meet the requirements of 5.1 and 5.1.1. When construction is resumed after any freezing weather the top eight inches of all partially completed dikes will be reworked and compacted to meet the requirements of 5.1 and 5.1.1 prior to placing more fill.

5.19.2 Dike material will be as specified in Section 1 of this specification, other portions of the specifications, or on the Drawings for the project. If required, the material shall be disced sufficiently to break down oversize clods, mix the material, secure a uniform moisture content, and insure uniform density and compaction. Each layer of material shall extend the entire length of dike, if possible, and shall be leveled when placed. Earth around structures is not to be placed until the concrete has attained its specified strength.

5.20 Topsoil shall not be placed until the area to be covered has been shaped, trimmed, and finished. All irregularities in the surface shall be filled or smoothed out before the topsoil is placed. If the existing surface has become hardened or crusted it shall be disced or raked until broken up to provide a bond with the topsoil. All unsuitable debris and stones larger than 2 inches in size shall be removed from the area.

5.21 Road surfaces shall consist of crushed stone aggregate shown on the plans. The aggregate shall be deposited full-lane width directly on the subgrade, geotextile fabric (if specified), or previous layer of compacted base course in such a way to prevent segregation and require a minimum amount of blade work. Immediately after placement of the material it shall be compacted by a rubber-tired roller or vibratory smooth steel drum roller to the requirements of 5.1. If any subgrade material is worked into the base material during the operations all granular material affected will be removed and replaced with new aggregate at no cost to the Company.

6.0 INSPECTION BY COMPANY

6.1 The Company is responsible for testing the project materials and results of the work performed at regular intervals. Materials that fail to meet the specified requirements shall be reworked or replaced at the Contractor's expense.

6.2 The Contractor will cooperate with the Company at all times to provide access to the materials and site for testing purposes.

7.0 MEASUREMENT

7.1 The Company reserves the right to increase or decrease quantities, as required, with no increase in the unit price except as noted in the General Conditions.

7.2 Items measured in units of weight may be paid for on a dry-weight basis at the discretion of the Engineer if the moisture content is found to be excessive. The bid units will not be affected unless the moisture content of coarse-grained soils exceeds 12%.

7.3 Stripping, clearing and grubbing will be measured in acres.

7.4 Pipe excavation and furnishing, placing, and compacting bedding will not be measured for payment and are to be included in the bid price for the pipe.

7.5 Cross section measurements and the average end area method shall be used to determine volumes of excavations of required material for dikes unless otherwise approved by the Engineer.

7.6 Borrow material and dike quantities shall be in net cubic yards of material moved. The plan quantities will be used for bidding purposes. If there is a discrepancy between the successful bidder's take off quantities of more than plus or minus 5% of the plan quantities, the Contractor shall notify the Engineer in writing prior to starting work. The Company will make arrangements to cross-section the project areas before and after earthwork is done to determine the amount of material moved in accordance with these specifications.

7.6.1 In determining the volumes, no allowance will be made for settlement, consolidation, or similar factors. Volumes will be based on before and after topographies at the pond and borrow site.

7.7 The following items will be measured in cubic yards:

7.7.1 Dike Construction

7.7.2 Excavation and disposal of excess cut

7.8 The following items will be measured in tons only if imported from off site. On-site sand and gravel shall be measured in cubic yards.

7.8.1 Sand

7.8.2 Gravel

7.8.3 Crushed Gravel

7.8.4 Crushed Stone Aggregate

7.10 Porous backfill will be measured in tons of the specified material only if it is brought in from off site. On-site sand and gravel shall be measured in cubic yards.

7.11 Topsoil 4 inches thick will be measured in acres and will include excavating, transporting, placing, and grading the material as indicated in the Drawings and Specifications. Minimum thickness of topsoil on the outside and inside of dikes shall be 4 inches.

SECTION 7: CONCRETE

1.0 SCOPE

1.1 This specification covers the minimum requirements for concrete foundations and slabs on grade.

1.2 Except as noted otherwise, the Contractor shall furnish all labor, material, tools, and equipment necessary for concrete work shown on the Drawings and specified herein.

1.3 Exceptions to the requirements of this specification will be considered only if submitted in writing with the bid and an increase (or decrease) in cost for complying with the requirements of this specification is provided.

2.0 DEFINITIONS

2.1 All design terms and symbols shall be as defined in ACI 318.

3.0 REFERENCES

3.1 Any specification or document referred to in this specification is to be considered as part of this specification. In the event of conflict between this specification and referenced documents, the requirements of this specification shall take precedence. The following specifications, standards, and codes apply:

3.1.1 American Concrete Institute (ACI)

ACI 305R: Recommended Practice for Hot-Weather Concreting.

ACI 306: Recommended Practice for Cold-Weather Concreting.

ACI 308: Recommend Practice of Curing Concrete.

ACI 315R: Manual of Standard Practice for Detailing Reinforced Concrete Structures.

ACI-318: Building Code Requirements for Reinforced Concrete.

ACI 347: Recommend Practice for Concrete Formwork.

3.1.2 American Society for Testing and Materials (ASTM)

ASTM A 82: Cold Drawn Steel Wire for Concrete Reinforcement.

ASTM A 615: Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

ASTM C 31: Making and Curing Concrete Test Specimens in the Field.

ASTM C 33: Concrete Aggregates.

ASTM C 94: Ready-Mixed Concrete.

ASTM C 150: Portland Cement.

ASTM C 171: Sheet Materials for Curing Concrete.

ASTM C 309: Liquid Membrane - Forming Compounds for Curing Concrete.

ASTM C 494: Chemical Admixtures for Concrete.

3.1.3 Illinois Department of Transportation (IDOT) - 2002 Specifications for Roads and Bridges.

4.0 GENERAL REQUIREMENTS

4.1 All concrete work shall conform to ACI 347 unless otherwise specified. This work shall also be performed under the personal and constant supervision of a competent Construction Superintendent or Foreman experienced in concrete work.

4.2 The Contractor shall provide all forms required for concrete work above and below ground.

4.3 The Company reserves the right to inspect all materials and make concrete tests. A Tester will be on-site the day of the pour to test the concrete.

4.4 If requested, the Contractor shall provide concrete test cylinders in accordance with ASTM C 31 (two from each truckload) from the concrete placed for the structure foundations. Cylinders shall be dated and labeled as to the foundation and truckload number.

4.5 If the concrete test cylinders, whether made by the Contractor or a testing agency, fail to meet specified compressive strength, the Contractor shall replace any and all affected areas at his own cost.

4.6 The On-Site Representative will schedule the Tester.

5.0 MATERIALS

5.1 Cement shall be Portland Cement conforming to ASTM C 150, Type I.

5.2 Fly ash shall be Class C or Class F conforming to AASHTO M-295

5.3 Fine aggregate shall be sand - clean, hard, durable, uncoated grains, free from deleterious substances, conforming to ASTM C 33. Gradation shall conform to IDOT specifications.

5.4 Coarse aggregate shall be natural rock or crushed limestone - clean, hard, durable uncoated particles without flat or elongated pieces. Aggregate shall be free from deleterious materials and shall conform to ASTM C 33. Gradation shall conform to IDOT specifications.

5.5 Water shall be clean and free from injurious amounts of oils, acids, salts, organic, or other deleterious matter.

5.6 Reinforcing bars shall conform to ASTM A 615, Grade 60 unless otherwise noted on the foundation Drawings. Reinforcing wire shall conform to ASTM A 82. All reinforcing shall be free from loose rust, dirt and oil.

5.7 Removable forms shall be wood, metal, approved fiber tubes, or other approved materials.

5.8 Curing materials shall conform to ASTM C 171. Curing compounds shall conform to ASTM C 309.

5.9 Water-reducing admixtures shall conform to ASTM C 494.

5.10 IDOT CA-6 road mix for backfill material shall conform to IDOT specifications.

6.0 EXCAVATION

6.1 All excavated materials shall be reused or properly disposed of on site by the Contractor, unless otherwise noted on the plans or in the specifications. Any affected ground area shall be returned to its former condition.

6.2 The actual depth of the foundation excavation shall be within ±1 inches from the required foundation depth given on the Drawings.

6.3 If over-excavation occurs, the hole shall be filled at Contractor's expense with compacted CA-6 road mix or additional concrete up to the required level.

7.0 FORMS

7.1 Forms shall conform to the shape, line, and dimensions of the members indicated on the Drawings, and shall be substantial and tight to prevent leakage of mortar. They shall be properly braced or tied together so as to maintain position and shape. Lumber, once used in forms, shall have nails withdrawn, and the surfaces to be exposed to concrete shall be carefully cleaned before reuse.

7.2 Forms for exposed surfaces shall be coated with nonstaining mineral oil, applied before the reinforcing steel is placed. Before concrete is placed, surplus oil shall be removed from the contact face of forms. All oil shall be removed from reinforcing steel and other surfaces requiring bond with concrete.

7.3 Forms shall not be disturbed until the concrete has adequately hardened and has gone through the first stage of curing, a minimum of 16 hours. Care shall be taken to avoid spalling the concrete surfaces. Wood forms and all particles of wood shall be completely removed.

8.0 REINFORCING

8.1 All bars shall be bent accurately, placed in position as shown on the Drawings, securely tied with #16 gauge black, annealed wire at all intersections, and securely held in place by spacers, chairs, or other approved supports in accordance with ACI 315R. At time of placing concrete, all reinforcing shall be free of loose rust, scale, oil, paint, mud, or other coatings which will destroy or reduce the concrete bond. Unless otherwise shown on the

Drawings or specified, the spacing, amount of concrete coverage, splicing, and bending of reinforcing steel shall conform to the requirements of ACI 318.

8.2 Reinforcing shall not be welded unless approved by the Engineer.

8.3 Anchor bolts (when used) shall be a minimum of 6 inches from the bottom of the foundation. All steel shall have a minimum of 3 inches concrete cover.

8.4 Lap splices for reinforcement shall conform to requirements of ACI 318 Class B splices.

8.5 All anchor bolt threads shall be taped to protect them from dirt and concrete during construction.

8.6 Foundation anchor bolts shall be connected to the reinforcing cage as detailed on the plans. If no details are shown, the Contractor shall provide a minimum of four No. 4 bar cross ties, two at the top and two at the bottom of the anchor bolt cage, wired to diagonal anchor bolts, each other, and the reinforcing cage per 9.0 tolerances. For foundations with only two anchor bolts, only two No. 4 bars will need to be wired to the reinforcement and anchor bolts (one at the top and one at the bottom).

9.0 TOLERANCES

9.1 Formwork shall be designed, constructed and maintained so as to insure completed concrete work within tolerance limits.

9.2 Top elevation of the finished slab or foundation shall not vary more than + 1/4 inch from the elevation indicated on the Drawings.

10.0 CONCRETE MIX

10.1 The concrete mix design(s) to be used on the project shall be submitted to the Company by the Contractor two weeks prior to any concrete placement at the job site or at the preconstruction meeting. All materials incorporated into the concrete mix shall be identified by brand name, gradation, and the supplier.

10.2 All concrete shall have a minimum compressive strength of 3500 psi at 28 days. The mix shall have a minimum of 5 1/2 sacks of cement per cubic yard and a maximum water cement ratio of 0.50 (by weight). Concrete mixes incorporating fly ash are strongly recommended. Fly ash from DMG facilities are preferred but not required.

10.3 All concrete shall have 5 to 7 percent entrained air.

10.4 All concrete shall have a slump of 4 to 5 inches unless otherwise approved by the Engineer.

10.5 Water-reducing admixtures may be used to help meet the above concrete mixture specifications, following admixture manufacturer recommendations.

11.0 MIXING CONCRETE

11.1 Unless otherwise approved by Engineer, "Ready-Mixed" concrete shall be used for all concrete. It shall be mixed and delivered in accordance with the requirements set forth in ASTM C 94.

12.0 PREPARATION FOR PLACING CONCRETE

12.1 Water shall be removed from excavations before depositing concrete. Hardened concrete, ice, debris, and foreign materials shall be removed from form interiors and from mixing and conveying equipment.

12.2 The On-Site Representative shall be notified sufficiently in advance of the scheduled time for concrete placement to permit examination of forms and reinforcement. No concrete shall be poured until the On-Site Representative has approved reinforcing and forms. This inspection is a precautionary measure and in no way relieves the Contractor of responsibility for the accuracy of form and reinforcement.

13.0 PLACING OF CONCRETE

13.1 Equipment for conveying concrete shall be of such size and design as to insure a continuous flow of concrete without material separation at the delivery end.

13.2 Concrete shall be conveyed from the mixer as rapidly as practical without segregation or loss of ingredients. Concrete shall be placed in forms as nearly as practical in final position to avoid rehandling. Vibrators shall not be used to transport concrete within forms. The concreting shall be carried on at such a rate that the concrete is at all times plastic and flows readily into the spaces between the reinforcing bars. No concrete that has partially hardened, been contaminated by foreign materials, or retempered shall be used. Immediately after depositing, concrete shall be compacted in an approved manner by spading, rodding, forking, or vibrating to eliminate air pockets. All concrete shall be worked into corners around reinforcement and inserts to prevent voids, trapped water, or stone pockets.

13.3 Care shall be exercised in use of a vibrator to prevent segregation, sand pockets, or bleeding. The vibrator shall be moved continuously in and out of concrete, remaining stationary only a few seconds in any position.

13.4 Once concreting has begun, it shall be carried on as a continuous operation until the placement is completed.

13.5 Adjacent surfaces shall be protected from concrete drippings, spillage, or splashes. Damaged surfaces shall be cleaned immediately.

14.0 HOT-WEATHER REQUIREMENTS

14.1 All hot-weather concreting shall conform to ACI 305R unless otherwise specified.

14.2 The maximum temperature of mixed concrete shall be 90°F. Temperature of aggregates and mixing water shall be reduced by the use of chilled water or ice.

15.0 COLD-WEATHER REQUIREMENTS

15.1 All cold-weather concreting shall conform to ACI 306 unless otherwise specified.

15.2 Concrete damaged by freezing shall be removed and replaced.

16.0 CURING AND PROTECTION

16.1 All curing shall conform to ACI 308 unless otherwise specified.

17.0 CONCRETE FINISHES ON EXPOSED SURFACES

17.1 Tops of all slabs shall be floated and brought to a true level with a 3/4-inch beveled or rounded edges. Top surface shall be given a rough broom finish.

17.2 Exposed, formed surfaces shall be left unfinished except that larger voids shall be filled in with an approved concrete patching material. The On-site Representative will determine the voids that require filling. Small “bug holes” need not be filled.

18.0 JOINTS

18.1 Construction joints shall not be allowed unless otherwise shown on the Drawings or as directed and approved by the Engineer. Where a joint is to be made, it shall be formed with a keyway.

18.2 Immediately before the placing of new concrete, the hardened concrete surface shall be thoroughly cleaned, all laitance removed, and the surface dampened with clean water.

SECTION 8: SEEDING

1.0 SCOPE

1.1 This specification covers the minimum requirements for seeding construction areas.

1.2 Use the seed mixture herein specified. Compositions of seed mixtures are given in Part 3 of this Section. Fertilizer requirements are given in Part 4.0, Fertilization of this Section.

1.3 Seed all disturbed areas at the pond site not covered with stone or concrete. This includes, but is not limited to, the following areas:

1.3.1 The outside and inside faces of the dike.

1.3.2 Disturbed areas adjacent to the outside toe of the dike.

1.3.3 Disturbed areas around pipe and roadwork.

1.3.4 The borrow area(s).

2.0 GENERAL REQUIREMENTS

2.1 All work shall be performed under the supervision of a competent Construction Superintendent or Foreman.

2.2 The Owner reserves the right to inspect all materials and perform all tests necessary to determine compliance with the specifications. If the materials or finished product fail to meet the controlling criteria for these tests, the Contractor shall replace all affected areas at the Contractor's expense.

2.3 Each lot of seed furnished shall be tested by a State Agriculture Department (including states other than Illinois).

2.4 Each bag shall be tagged or labeled as required by the Illinois Seed Law.

3.0 SEEDS

3.1 Rate of Application

Seed	lbs./Acre
Brome	30
Alfalfa	0
Oats	40

3.2 Seed mixtures shall be proportioned by weight.

3.3 No seeds shall be sown until they have been tested for purity and until such tests indicate that the seeds do not contain any seeds of the noxious weeds classed as "Primary Noxious Weed Seed" in the existing Illinois Seed Law, and not more than the maximum number per ounce sample, specified in Table 1 of this specification, "Secondary Noxious Weed Seed."

3.4 In determining the viable germination percent of legumes, the percent hard seed is to be added to the percent test germination; however, the percent hard seed added shall not exceed the maximum specified in Table 1 of this specification when planted in the fall season.

3.5 Seed having a purity that is below the purity specified in Table 1 of this specification will be rejected. Seeds that fail to meet the requirements of Table 1, "Maximum Weed Seed Percent" and "Remarks" will be rejected.

3.6 Pure, live seed shall be defined as the sproutable seed of a specified variety and calculated as the product of the viable germination times the purity. The seed weights per acre listed are designed to yield specific amounts of pure, live seed per acre based on the pure, live seed percent values listed in Table 1 of this specification. Seed which has actual pure, live seed yield according to tests less than the intended yield, will be rejected.

4.0 FERTILIZER

4.1 Fertilizer shall be applied at the rates given below. Fertilizer will be measured by weight (in pounds) of actual nutrients supplied. Weight of each nutrient shall be determined by the following formula: *(total wt. of fertilizer)x(percent of nutrient in fertilizer)=(wt. of nutrient provided).*

4.2 Fertilizer shall be supplied in either liquid or granular form. It shall be properly incorporated into the soil during application or immediately afterwards.

4.3 Fertilizer shall contain the following nutrients: Nitrogen (N), Phosphorus (P_2O_5), and Potassium (K_2O).

4.3.1 From 30 to 40% of the total nitrogen provided shall be in a slow-release form.

4.4 Provide 90 pounds of nitrogen (N) per acre, 30 pounds of phosphorus (P_2O_5) per acre, and 60 pounds of potassium (K_2O) per acre for all areas to be seeded.

4.5 No lime is required.

5.0 MULCH

5.1 Straw shall be stalks of air-dried wheat, rye, oats, or other approved straw.

5.2 Hay shall be air-dried. Hay shall be obtained from field of timothy, redtop, or mature brome grass.

6.0 OPERATIONS

6.1 Seed Bed Preparation

6.1.1 Immediately prior to the seed bed preparation, fertilizer nutrients shall be uniformly spread at the designated rate over the areas indicated on the plans.

6.1.2 Stones, boulders, debris and similar material larger than two inches in diameter shall be removed from the seed bed area. The seed bed will be worked to a minimum depth of three inches, reducing all soil particles to a size smaller than two inches in the largest dimension. The prepared surface shall be relatively free from weeds, clods, stones, roots, sticks, rivulets, gullies, crusting, and caking.

6.2 Seeding

6.2.1 No seed shall be sown during unfavorable climatic conditions or when the ground is not in a proper condition for seeding.

6.2.2 All seeded areas, including slopes up to 3H:1V or flatter, shall be rolled at right angles within 12 hours of seeding to compact the seed bed and place the seed in contact with the soil. Slopes steeper than 3H:1V do not need to be rolled.

6.2.3 Seeding shall be done in a way that incorporates the seed at the optimum depth of 1/4 inch.

6.2.4 All legumes shall be inoculated per the manufacturer's recommendations immediately before sowing.

6.2.5 Seeding shall be done between April 1 and December 1.

6.2.6 Within 24 hours from the time the seeding has been performed, the seedbed shall be given a covering of mulch. On slopes steeper than 3H:1V, mulch shall be applied on the same working day.

6.3 Mulch shall be used on all seeded area not specified otherwise.

6.3.2 Hay or straw mulch shall be hand or machine applied loose enough to permit air to circulate, but compact enough to prevent erosion. If baled material is used, care shall be taken that the material is in a loosened condition.

6.3.3 The mulch shall be stabilized by working the area with dull blades or disks.

TABLE 1

SEED SPECIFICATIONS

				Secondary		
		Pure,		Noxious Weeds		
Hard		Live		Number/Oz		
Seed	Purity	Seed	Weed	Maximum		
Variety of Seeds	% Max.	% Min.	% Min.	% Max.	Permitted	Remarks
Alfalfa 20	92	89	0.50	6	Note 1	
Brome Grass	--	75	68	2.00	5	--
Dawson Red Fescue	0	97	85	0.10	3	--
Fescue, Alta or KY. 31	--	92	88	1.00	6	--
Fescue, Creeping Red	--	75	82	1.00	6	--
Fults Salt Grass	0	98	85	0.10	2	--
Kentucky Bluegrass	--	75	72	0.50	7	Note 5
Lespedeza, Korean	20	92	84	0.50	6	Note 3
Oats --	92	88	0.50	2	Note 4	
Orchard Grass	--	75	70	1.50	5	Note 4
Redtop --	75	78	1.80	5	Note 4	
Reed Canary Grass	--	92	63	1.00	5	--
Ryegrass, Perennial, Annual	--	92	88	0.50	5	Note 4
Rye, Grain, Winter	--	92	83	0.50	2	Note 4
Scaldis Hard Fescue	0	97	85	0.10	3	--
Timothy	--	92	84	0.50	5	Note 4
Wheat, Hard Red Winter	--	92	89	0.50	2	Note 4

Note 1. Shall be grown in Kansas or farther north; shall be free from any mixture with southern or foreign seeds, blends or adulterations with screenings, frosted or damaged seeds; and shall not contain more than 0.2 percent bur or sweet clover mixture.

Note 2. Shall be free from blends or adulterations with screenings, blasted, shriveled or immature seeds.

Note 3. Shall be hulled and free from blends or adulterations with blasted, shriveled or immature seeds.

Note 4. Shall be recleaned.

Note 5. Shall not contain more than 5 percent adulteration with Canada Blue Grass, Merion Blue Grass or other hybrids or varieties of blue grass.

*No primary Noxious Weeds are permitted

SECTION 9: MISCELLANEOUS STEEL

1.0 SCOPE

1.1 This specification covers the minimum requirements for the design, material, fabrication, inspection, protective coating, drawings, and delivery of miscellaneous steel. Corrugated steel and ductile iron pipe are not included in the scope of this section.

1.2 In the event of discrepancies between the Vendor's proposal and this Specification, the terms of this Specification shall govern unless written exception is provided by the Vendor and approved by the Engineer.

2.0 DEFINITIONS

2.1 The term "Vendor", as used in this Specification, shall refer to the party or parties proposing to perform the work and provide the material herein specified to the Contractor.

2.2 All design terms and symbols shall be as defined in the AISC - Steel Construction Manual (latest edition).

3.0 REFERENCES

3.1 The reference to specifications of organizations (such as ASTM), together with any diagrams, drawings, and loading schedules, shall be considered part of this Specification. In the event of conflict between this Specification and referenced documents, the requirements of this Specification shall take precedence. The following specifications, standards, and codes apply:

3.1.1 American Society for Testing and Materials (ASTM)

ASTM A 6 - General Requirements

ASTM A 143 - Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.

ASTM A 194 - Carbon and Alloy Steel Nuts for Bolts for High Pressure and High-Temperature Service.

ASTM A 325 - High Strength Bolts for Structural Steel Joints.

ASTM A 384 - Safeguarding Against Warpage and Distortion during Hot-Dip Galvanizing of Steel Assemblies.

3.1.2 American Institute of Steel Construction (AISC)

AISC - Steel Construction Manual (latest edition)

3.1.3 Steel Structures Painting Council Surface Preparation Specification (SSPC-SP)

SSPC-SP6 - No. 6 Commercial Blast Cleaning (latest edition)

3.1.4 American National Standards Institute (ANSI)

3.1.5 National Electrical Safety Code (NESC) Part 2

ANSI C135.1 - American National Standard for Galvanized Steel Bolts and Nuts for Overhead Line Construction

4.0 GENERAL CONSIDERATIONS

4.1 All steel is to be hot dipped galvanized after fabrication.

4.2 All steel shall be either ASTM A 36 or A 992 material.

4.3 Welds shall be with E70 electrodes. Bolts shall be hot dipped galvanized A325 bolts.

4.4 Concrete anchors and other accessories and manufactured components shall be as shown on the plans.

5.0 DRAWINGS

5.1 After acceptance of a proposal, the Contractor shall submit to the Engineer three prints of each detail drawing. One set of these Drawings will be returned to the Contractor marked as “approved” or “approved as noted” or “not approved”. Fabrication shall not begin until the appropriate detail drawings have been approved.

5.2 Engineer's approval of the Vendor's drawings is approval of intent of design and detail only, and in no way relieves the Vendor of responsibility for adequacy or the correctness of dimensions and details.

5.3 Each detail drawing shall include, as a minimum, the following information:

- Dimensions.
- Description and strength of material.
- Weld locations and sizes.
- Size, description, quantity, and location of all holes and hardware.
- Any other special information.

6.0 MATERIAL

6.1 All structural plate material shall be selected with sufficient ductility to avoid brittle fracture.

6.2 The Vendor shall use suitable quality control procedures to insure that the correct steel strength is used in the fabrication of the hardware.

6.3 Materials the Vendor proposes to substitute for those stated herein shall be identified with the applicable ASTM or ANSI designation and shall be subject to the approval of the Engineer.

6.4 Fasteners

6.4.1 All bolts shall conform to ASTM A325 or ANSI C135.1. Nuts shall conform to ASTM A 194 Grade 2, and shall be tapped 0.020 inches oversize for pitch and major diameter. All nuts, bolts, and washers shall be hot dipped galvanized.

6.4.1.1 For galvanized hardware, nuts and bolts shall be galvanized in accordance with ASTM standards, but hot-dip galvanizing will not be allowed for any material with a yield strength greater than 100 ksi.

6.4.2 All bolts of any one diameter and similar length shall be of the same type and strength.

6.4.3 All bolt locations shall permit easy wrench access to both the bolt head and the nut.

7.0 FABRICATION AND QUALITY CONTROL

7.1 Fabrication tolerances will be in accordance with ASTM A 6.

7.2 Fabrication shall be in strict accordance with shop detail drawings prepared by the Vendor and approved by the Engineer.

7.3 Straightening Material - Before being laid out or worked in any manner, structural material shall conform to ASTM A 6 for permissible variations in straightness. If straightening is necessary, it shall be done by methods that will not injure the metal. Members that are bent or warped or otherwise improperly fabricated will be rejected by the Owner.

7.4 Bending - All forming or bending during fabrication shall be done by methods that will prevent embrittlement or loss of strength in the material being worked.

7.5 Holes for connection bolts shall be 1/16 inch larger than the nominal diameter of the bolts. The details of all connections and splices shall be subject to the approval of the Engineer. Connections shall be detailed in accordance with AISC 1.1.5.2 to avoid rust expansion (pack-out).

7.6 All holes shall be cylindrical, perpendicular to the member, clean-cut, and chamfered (when specified). Where necessary to avoid hole distortion, holes close to the points of bends shall be made after bending. The use of a burning torch for cutting holes will not be permitted without approval from the Engineer.

8.0 PROTECTIVE COATINGS

8.1 Surface preparation

8.1.1 For galvanized structures, all fabricated steel components shall be blast cleaned in accordance with SSPC-SP6, or cleaned with an acid-pickling procedure with approval from the Owner.

8.2 Galvanizing

8.2.1 Hardware shall be galvanized in accordance with the applicable ASTM standard and shall remain corrosion-free for 10 years.

8.2.2 Precautions shall be taken against embrittlement, warping, and distortion in accordance with ASTM A143 and in accordance with ASTM A384.

9.0 SHIPPING

9.1 Steel shall be suitably protected to prevent damage to the surface finish during shipment.

9.2 Each shipment shall be accompanied by a checklist of all parts on that particular shipment. Bolts, nuts, and other hardware shall be either boxed or bundled.

10.0 INSPECTION BY OWNER

10.1 Materials and workmanship shall, at all times, be open to inspection and acceptance or rejection by the Owner either at the Vendor's plant or at the point of delivery. Any omission or failure on the part of the Owner to disapprove or reject any work or materials at the time of inspection shall not be construed as an acceptance of any defective work or materials.

10.2 The Owner shall have free entry to all parts of the Vendor's plant at all times while work is being carried on. The Vendor shall afford the Owner reasonable facilities, without charge, to satisfy Owner that the materials are being furnished strictly in accordance with this Specification. The Owner will comply with the Vendor's safety rules.

10.3 The Owner reserves the right to make additional tests and/or inspections deemed necessary to verify compliance with this Specification. Generally, the cost of these tests and inspections shall be borne by the Owner. However, the direct cost of all tests directly related to, and indicating noncompliance with this Specification shall be borne by the Vendor.

SECTION 10: MANHOLES

1. All manholes shall be constructed of precast reinforced concrete. The design, fabrication, modifications, and installation of manholes shall comply with Section 602 of the Illinois Dept. of Transportation "Standard Specifications for Road and Bridge Construction," adopted January 1, 2002. Alternately, the manholes may be constructed using reinforced concrete pipe meeting the requirements of Section 12 of this Specification, with cast iron steps added as described in Paragraph 3 below and a flat slab top as described in Paragraph 4 below.

2. Overall dimensions of manhole rings and flat slab tops shall be as shown in the plans. Minimum thickness and reinforcement shall be as shown in the Illinois Dept. of Transportation "Highway Standards." In addition to these minimums, the fabricator of precast concrete manholes and tops shall design and construct the products to support the anticipated loads and meet industry standards.

3. Precast manholes and extension rings shall have 12-inch wide cast iron manhole steps spaced at 12 inches. Steps shall be as manufactured by Neenah Foundry or an approved equal.

4. The flat slab top for the 48-inch diameter manhole above the existing 36-inch diameter outfall pipe shall have a round Neenah medium or light-duty frame (or approved equal) cast into it. The frame shall be equipped with a Neenah Type G Grate (or an approved equal). Minimum clear opening of frame shall be 20 inches.

5. Submittals for manholes shall include all precast concrete products, frames, and grates.

SECTION 11: RIPRAP

1.0 SCOPE

1.1 This Specification covers the minimum requirements for furnishing, transporting, and placing a protective course of stone as riprap on slopes or in channels.

1.2 Except as noted otherwise, the Contractor shall furnish all labor, material, tools, and equipment necessary for riprap work shown on the Drawings and specified hereinch

2.0 REFERENCES

2.1 The reference to specifications or organizations together with any diagrams, drawings, or plans shall be considered as a part of this Specification. In the event of conflict between this Specification and the referenced documents, this Specification shall take precedence. The following specifications, standards, and codes apply:

2.1.1 American Society for Testing and Materials (ASTM)

2.1.2 ASTM D-751-79: Standard Methods of Testing Coated Fabrics

2.1.2.1 ASTM D-1682-64: Standard Test Methods for Breaking Load and Elongation of Textile Fabrics

2.1.2.2 ASTM D-1777-64: Standard Method for Measuring Thickness of Textile Materials.

2.1.2.3 ASTM D-3776-85: Standard Test Methods for Mass Per Unit Area (Weight) of Woven Fabric

2.1.2.4 ASTM D-3786-87: Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Non-woven Fabrics – Diaphragm Bursting Strength Tester Method

2.1.2.5 ASTM D-3884-80: Standard Test Method for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)

3.0 GENERAL REQUIREMENTS

3.1 This work shall be performed under the personal and constant supervision of a competent Construction Superintendent or Foreman experienced in this type of work.

3.2 The Owner reserves the right to inspect all materials and reject all substandard materials and workmanship.

4.0 MATERIALS

4.1 Riprap shall be rock that is sound, dense, durable, angular, hard, free from cracks, seams, clay, and other defects that would lead to deterioration under water and/or frost action. Rounded boulders or cobbles will not be accepted as riprap. Neither the breadth nor the thickness of any piece of riprap shall be less than one-third of its length.

4.1.1 The riprap stone shall be quarried from ledges for Portland cement concrete quality stone provided the ledges are sufficiently thick to produce the desired dimensions. The riprap stone and bedding shall conform to Coarse Aggregate, Class A quality. The riprap shall be obtained from sources and locations that are approved by the Company. The following tests shall be performed by the Contractor and submitted in advance of placing the proposed riprap, using the services of an independent testing laboratory acceptable to the Company:

Na_2S0_4 Soundness – 5 cycle	
Max % Loss	10
Los Angeles Abrasion	
Max % Loss after 100 revolutions	10
Max % Loss after 500 revolutions	40
Minus No. 200 Sieve Material 1%	2.5
Max % Deleterious	
Shale Max %	1.0
Clay Lumps Max %	0.25
Coal & Lignite Max %	0.25
Soft & Unsound Fragments Max %	4.0
Other Deleterious Max %	4.0
Total Deleterious Max %	5.0
Max % freeze-thaw loss (AASHTO T103)	5

4.3 Gradation: The stone for 150-pound riprap shall be reasonably well graded, from a minimum weight of 25 lbs. to a maximum piece weight of 150 lbs. with at least 50% weighing more than 100 lbs.

4.4 A non-woven geotextile meeting the following specifications shall be placed on the subgrade for the riprap:

Weight, oz./sq.yd.	ASTM D-3776	8
Thickness, mils	ASTM D-1777	80
Tensile Strength, lbs.	ASTM D-1682	350
Puncture Strength, lbs.	ASTM D-751	150
Mullen Burst Strength	ASTM D-3786	450
Minimum Coefficient of Permeability, cm/sec	Constant Head (50 mm)	0.22
Minimum Permittivity, sec^{-1}	(Coeff. of Permeability/Thickness)	0.96
Abrasion Resistance, lbs.	ASTM D-3884	150

5.0 CONSTRUCTION REQUIREMENTS

5.1 The area to be riprapped shall be cleared of vegetation and other debris. The subgrade for the riprap shall be trimmed and shaped so that the finished surface shall conform to the lines specified.

5.2 Riprap Placement

Geotextile shall be placed on the subgrade and anchored in accordance with the manufacturer's recommendations.

5.2.1 Stone shall be placed on the geotextile to produce a reasonably well-graded mass of rock with a minimum percentage of voids and constructed to the lines and grades shown.

5.2.2 Stone riprap shall be placed to its full course thickness at one operation and in such a manner as to avoid damage to the geotextile. Placing of the material shall start at the lower elevations and progress up the slope. The larger stones shall be well distributed and the entire mass of stones in their final positions shall be roughly graded to conform to the gradation specified. The finished riprap shall be free from objectionable pockets of small stones and clusters of larger stones. Placing of material by methods that segregate particle sizes will not be permitted.

Rearranging individual stones by mechanical equipment or by hand will be required to the extent necessary to obtain a reasonably well graded distribution of stone sizes as specified.

5.2.3 Thickness: All riprap shall be a minimum of 18 inches thick.

5.3 Surplus or excess material resulting from clearing the work area and shaping of the subgrade shall be hauled off and legally disposed of by the Contractor. This work shall be incidental to the contract.

5.4 Any ruts, depressions, mounds, or other damage caused by the Contractor shall be repaired by the Contractor at no cost to the Owner. Repairs to improved areas shall be with like materials and workmanship as the adjacent areas.

6.0 MEASUREMENT

6.1 Riprap shall be measured in units of square yards along the slope.

6.2 Geotextile fabric shall not be measured and shall be included in the unit price per square yard for the riprap.

SECTION 12: REINFORCED CONCRETE PIPE

1.0 Scope

The work consists of furnishing and installing reinforced concrete pipe, fittings, and appurtenances as shown on the Drawings.

2.0 Material

Reinforced concrete pipe and fittings shall conform to the following requirements.

2.1 Pipe Reinforced concrete pipe and fittings shall conform to the requirements of ASTM Standard Specification C 76 (latest revision), Class V, Wall B. The maximum laying length of individual pipe sections shall be 8-feet.

2.2 Gaskets The pipe joint gaskets shall be endless rubber gaskets having circular cross section. The cross-sectional diameter of the gaskets shall conform to the pipe manufacturer's recommendation for the type and size of pipe furnished.

2.3 Joints Joints shall conform to ASTM Standard Specification C 443 (latest revision).

2.4 Joint Sealing Compound The compound shall be a cold-application material unless otherwise specified and shall be a single component or multiple component type. The sealing compound shall conform to the requirements of one of the following specifications:

2.4.1 ASTM Specification C 990 - Joints for concrete pipe, manholes, and precast box sections using preformed flexible joint sealants.

2.4.2 ASTM Specification C 877 - External sealing bands for noncircular concrete sewer, storm drain, and culvert pipe.

2.4.3 ASTM Specification D 1190 - Concrete joint sealer, hot poured elastic type.

2.4.4 ASTM Specification C 920 - Elastomeric joint sealants for cold applied sealing and caulking of joints on mortar and concrete structures not subject to fuel spills. Use type S or M, grade NS for vertical joints; type S or M, grade P or NS for horizontal joints. For class 25, use M, quality materials shall be used for both vertical and horizontal joints unless otherwise specified.

The sealing compound if used with other joint material, such as fillers or gaskets, shall be compatible.

2.5 Fittings

Contractor shall submit shop drawings for approval from his pipe fabricator detailing dimensions of all fittings and certifications that the working pressures and strengths of the fittings equal or exceed the requirements of ASTM Standards C 76 (Class V, Wall B) and C 443.

3.0 LAYING AND BEDDING THE PIPE

3.1 Laying the Pipe

The pipe shall be set to the specified line and grade and temporarily supported on precast concrete blocks or wedges. Concrete blocks and wedges used to temporarily support the pipe during placement of concrete bedding or cradle, or both, shall be a class of concrete equal to or stronger than the concrete used to construct the bedding or cradle. Bell and spigot pipe shall be laid with the bells or grooves facing upstream unless shown otherwise on the Drawings. When precast pipe risers and other similar precast pipe structures are installed before pipe installation, pipe may be installed in the downstream direction with the belled end upstream. Just before each joint is connected, the connecting surface of the bell and spigot or spigots and sleeve shall be thoroughly cleaned and dried. Also, the rubber gasket and the inside surface of the bell or sleeve shall be lubricated with a light film of soft vegetable soap compound (flax soap). The rubber gasket shall be stretched uniformly as it is placed in the spigot groove to ensure a uniform volume of rubber around the circumference of the pipe. The joint shall be connected by means of a pulling or jacking force so applied to the pipe that the spigot enters squarely into the bell, or the joint shall be connected in accordance with the manufacturer's instructions. When the spigot has been seated to within 0.5 inches of its final position, the position of the gasket in the joint shall be checked around the entire circumference of the pipe by means of a metal feeler gauge. In any case where the gasket is found to be displaced, the joint shall be disengaged and properly reconnected. After the position of the gasket has been checked, the spigot shall be completely pulled into the bell and the section of pipe shall be adjusted to line and grade.

3.2 Concrete Cradle

The horizontal pipe for the 36-inch conduit shall be bedded on a concrete cradle as shown on the Drawings throughout the entire horizontal length of the pipe section. The cradle shall terminate at the end of a pipe length. A compressible material with a minimum thickness of 0.5 inches shall be installed in the joint to accommodate slight foundation deflections. Cradle shall be continuously reinforced longitudinally.

4.0 FILLING JOINTS

4.1 Before the placement of the bedding or cradle, the exterior annular space between the ends of the pipe sections shall be cleaned and completely filled with joint sealing compound. Before the compound is applied, the surface against which it is to be placed shall be cleaned of all dust, lubricant, and other substances that would interfere with a bond between the compound and the pipe. If recommended by the manufacturer of the compound, the concrete surface shall be coated with a primer in accordance with the manufacturer's recommendations. Primers shall be applied to the concrete surface only and shall not come in contact with the gasket or gasket sealing surface. Unless the compound or primer is specifically recommended for use on moist concrete, the surface shall be dry when the compound or primer is applied.

4.2 The joint sealing compound shall be allowed to cure until it is sufficiently firm to prevent the entry of concrete or earth into the joint. Before placing bedding or earth backfill (excluding concrete) containing particles larger than 0.25 inch in maximum dimension within 6 inches of the joint sealing compound, the compound shall be covered with a strip of 16-gauge to 24-gauge metal at least 2 inches wider than the space between the ends of the pipe sections.

5.0 HANDLING THE PIPE

The contractor shall furnish all equipment and facilities needed to handle, store, and place the pipe without damaging the pipe.

6.0 PRESSURE TESTING

Before placing any concrete or earthfill around the conduit or filling the pipe joints, the conduit shall be air tested in accordance with ASTM C 924 at a maximum pressure equal to the pressure rating of the pipe joints. The conduit shall be braced on each end to prevent slippage. All end plugs used for the air test shall be capable of resisting the internal pressure and must be securely braced.

7.0 BACKFILL

Backfill shall be accomplished as follows and as described in Paragraph 10, Items of Work and Construction Details, of this Specification:

7.1 Compacted backfill shall be placed to its final depth as shown on the Drawings at vertical and horizontal deflection points, road crossings, and thrust blocks. Backfill shall be placed so that conduit and joint displacement does not occur.

7.2 All joints and connections shall be completely exposed for visual observation during testing.

8.0 CORRECTIONS OF LEAKS

The contractor shall be fully responsible for any and all work required to correct any leakage disclosed by the pressure testing.

9.0 MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the quantity of each size, and thickness class of pipe is determined to the nearest foot by measurement of the installed length of pipe along the crown centerline of the conduit. Payment for each size and thickness class of pipe is made at the contract unit price for that size and thickness class of pipe. Such payment constitutes full compensation for furnishing, transporting, handling, and installing the pipe, concrete cradle, and necessary fittings and appurtenances complete in place. Compensation for any item of work described in the contract, but not listed, is included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Paragraph 10 of this Specification.

10.0 ITEMS OF WORK AND CONSTRUCTION DETAILS

10.1 Backfill or fill immediately adjacent to the pipe and/or its cradle shall be placed in 4 inch lifts and carefully compacted with appropriately sized equipment to at least 95% of the maximum dry density as determined by ASTM D 698 at a moisture content between 0% to +4% of optimum moisture. Care shall be taken in the compaction process to completely break down clods and remold the backfill material so that it is in intimate contact with the pipe and cradle throughout the length of the pipe. Compacted backfill or fill shall extend from the pipe or concrete cradle out to either natural soil (if the pipe is laid in a trench) or to compacted dike (if the pipe is laid in the dike).

10.2 Contractor shall survey horizontal position and elevation of the top of the existing 36-inch diameter pipe and its foundation and prepare shop drawings showing the proposed lengths of pipe and dimensions of fittings to be furnished for the proposed new outlet pipe.

10.3 No separate payment will be made for reinforced concrete pipe. Compensation for reinforced concrete pipe is included in the bid items for the 36-inch outfall and the pond level control pipe.

SECTION 13: DUCTILE IRON PIPE AND FITTINGS

1.0 SCOPE

The work consists of furnishing and installing ductile-iron pipe, fittings, and appurtenances as specified in 9.0 Items of Work and Construction Details and as shown on the Drawings.

2.0 MATERIAL

Ductile-iron pipe and fittings shall conform to the following requirements. Thickness class of pipe and rated working pressure shall be as specified in 9.0 Items of Work and Construction Details or as shown on the Drawings.

2.1 Pipe Ductile-iron pipe shall conform to the requirements of ANSI/AWWA C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids, and ANSI/AWWA C115/A21.15, Flanged Ductile-Iron Pipe with Threaded Flanges.

2.2 Fittings Ductile-iron pipe fittings shall conform to the requirements of ANSI/AWWA C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and Other Liquids, and ANSI/AWWA C153/A21.53, Ductile-Iron Compact Fittings, 3-inch through 12-inch, for Water and Other Liquids.

2.3 Joints Rubber-gasket joints for ductile-iron pipe and fittings where either mechanical or push-on joints are used shall conform to the requirements of ANSI/AWWA C111/A21.11, Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings. Unless otherwise specified or indicated on the Drawings, all joints shall be mechanical joints.

2.4 Lining Interior lining for ductile-iron pipe and fittings shall conform to the requirements of ANSI/AWWA C104/A21.4, Cement Mortar Lining for Ductile-Iron Pipe and Fittings for Water. Unless otherwise specified, special fittings and appurtenances shall be the same material as the pipe.

2.5 Check Valve The check valve for the pond level control pipe extension shall be an 18-inch diameter Valmatic Model 518 Swing-Flex or equal full body flanged type with a domed access cover and only one moving part, the valve disc. The valve body shall have full flow equal to the nominal pipe diameter at any point through the valve. The seating surface shall be on a 45-degree angle to minimize disc travel. The top access port shall be full size, allowing removal of the disc without removing the valve from the pipeline. The access cover shall be domed in shape. The disc shall be of one piece construction, precision molded with an integral Oh-ring type sealing surface and contain steel and nylon reinforcements in both the Memory-Flex and central disc areas. The flex portion of the disc shall be warranted for twenty-five years. Non-slam closing characteristics shall be provided through a short 35-degree disc stroke and a Memory-Flex return action. The valve body and cover shall be ASTM A126, Class B cast iron. The disc shall be Buna-N (NBR), ASTM D2000-BG. The interior and exterior of the valve shall be coated with a fusion bonded epoxy. The valve shall be cycle tested 1,000,000 times with no sign of wear or distortion of the valve disc or seat and shall remain drop tight at both high and low pressures. The test results shall be independently certified. Bolts and nuts for the flanges shall be Type 316 stainless steel.

3.0 LAYING AND BEDDING THE PIPE

3.1 Pipe shall be installed to the lines and grades shown on the Drawings with bell socket ends aligned upstream unless otherwise specified. The pipe shall be installed in accordance with the manufacturer's recommendations, unless otherwise specified. Two copies of the pipe manufacturer's installation instructions shall be provided to the Engineer before any pipe placement.

3.2 The pipe shall be firmly and uniformly bedded within the trench throughout the entire length of the pipe section to the depth and in the manner specified. Bell holes for flanged, push-on, or mechanical joint pipe shall be provided as necessary to allow space for joint assembly and to permit the pipe barrel to be uniformly supported on the bedding.

3.3 Joints and Connections: Pipe joints shall be mechanical joints and shall be sound and watertight at a pressure of 20 psi. Non-shrink grout shall be used to seal the annulus where the pipe penetrates concrete manholes. The openings in the manholes shall be between 3 and 4 inches larger than the outside diameter of the ductile iron pipe. Install underground piping with restrained joints at horizontal and vertical changes in direction.

3.4 Thrust Restraint - Plugs, caps, tees, wyes and bends deflecting 11.25 degrees or more, either vertically or horizontally shall be provided with thrust restraints. Valves shall be securely anchored or shall be provided with thrust restraints to prevent movement. Thrust restraints shall be restrained joints.

3.4.1 Restrained Joints - For ductile-iron pipe, restrained joints shall be designed by the Contractor or the pipe manufacturer in accordance with DIPRA-Restraint Design.

4.0 HANDLING THE PIPE

The contractor shall furnish all equipment and facilities needed to handle, store, and place the pipe without damaging the pipe, lining, or coating. Pipe coating or lining that is damaged shall be repaired using methods recommended by the manufacturer unless otherwise specified in 9.0 Items of Work and Construction Details.

5.0 PRESSURE TESTING

Pressure testing of the conduit shall be conducted as follows:

5.1 Placement of backfill before pressure testing shall be as specified in 6.0 Backfill.

5.2 Before pressure testing, the pipeline shall be flushed and free of all foreign material.

5.3 The pipeline shall not be pressure tested until concrete for anchor and thrust blocks has attained the minimum specified compressive strength unless other specified methods of thrust restraint are provided.

5.4 The total conduit or continuous section of conduit to be tested shall be filled with clean water at a rate not to exceed the maximum specified and tested at 20 psi.

5.5 The section of conduit being tested shall be allowed to stand full of water for a minimum of 24 hours before the start of pressure and leakage tests. Test pressures shall be held constant for 2 hours. When the amount of water loss exceeds the maximum allowable loss specified in 9.0 Items of Work and Construction Details, the leak(s) shall be repaired or otherwise corrected and the conduit shall be re-tested. The testing procedure shall be repeated until the requirements of the Specifications are met.

5.6 Except for joint material setting or where concrete thrust blocks necessitate a 5-day delay, pipelines jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Cement-mortar lined pipe may be filled with water as recommended by the manufacturer before being subjected to the pressure test and subsequent leakage test.

6.0 BACKFILL

6.1 Initial backfill in accordance with 9.0 Items of Work and Construction Details shall be accomplished only in sufficient amount to hold the conduit in place during testing, with the following exceptions:

6.1.1 Compacted backfill shall be placed to its final depth as shown on the Drawings at vertical and horizontal deflection points, road crossings, and thrust blocks. Backfill shall be placed so that conduit and joint displacement does not occur.

6.1.2 All joints and connections shall be completely exposed for visual observation during testing, except at locations described in the exception above.

7.0 CORRECTION OF LEAKS

The contractor shall be fully responsible for any and all work required to correct any leakage when the leakage test results in water loss that exceeds the amount specified in 9.0 Items of Work and Construction Details.

8.0 MEASUREMENT AND PAYMENT

8.1 For items of work for which specific unit prices are established in the contract, the quantity of each size, and thickness class of pipe is determined to the nearest foot by measurement of the installed length of pipe along the crown centerline of the conduit. Payment for each size and thickness class of pipe is made at the contract unit price for that size and thickness class of pipe. Such payment constitutes full compensation for furnishing, transporting, handling, and installing the pipe, concrete cradle, and necessary fittings and appurtenances complete in place.

8.2 Compensation for any item of work described in the contract, but not listed, is included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in 9.0 Items of Work and Construction Details.

9.0 ITEMS OF WORK AND CONSTRUCTION DETAILS

9.1 Initial backfill material shall be placed and compacted with approved tampers to a height of at least one-foot above the pipe. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

9.2 All ductile iron pipe shall be Special Thickness Class 55 or heavier. All ductile iron pipe fittings shall be mechanical joint or flanged fittings, pressure class 350 or heavier.

9.3 Connection to the existing 18-inch diameter pipe shall be made with appropriate mechanical joint ductile iron coupling or fitting meeting the requirements of this Specification.

9.4 Leakage test shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the water line shall be subjected to not less than 20 psi pressure. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved or approved section, necessary to maintain pressure within 1 psi of the specified leakage test pressure after the pipe has been filled with water and the air expelled. Piping installation will not be accepted if leakage exceeds the allowable leakage which is determined by the following formula:

$$L = 0.0001351(N)(D)P^{0.5}$$

L = Allowable leakage in gallons per hour

N = Number of joints in the length of pipeline tested

D = Nominal diameter of the pipe in inches

P = Average test pressure during the leakage test, in psi gauge

Should any test of pipe disclose leakage greater than that calculated by the above formula, the defective joints shall be located and repaired until the leakage is within the specified allowance, without additional cost to the Company.

9.5 No separate payment shall be made for ductile iron pipe and fittings. This work shall be considered incidental to Bid Item 17, 16 inch Flow Meter, and to Bid Item 21, 18 inch Pond Level Control Pipe Extension/Intake Structure. Compensation for the 18-inch by 18-inch by 8-inch ductile iron wye, the ductile iron pipe fittings required to connect to the new 8-inch diameter PVC suction line from the pump, and the new 18-inch diameter swing check valve shall be included in the lump sum amount for Bid Item 21, 18 inch Pond Level Control Pipe Extension/Intake Structure.

SECTION 14: PVC PLASTIC PIPE

1.0 SCOPE

The work consists of furnishing and installing plastic and the necessary fittings and appurtenances as shown on the Drawings or as specified herein.

2.0 MATERIAL

2.1 Pipe, fittings, and gaskets shall conform to the requirements of below and as specified in section 14 of this Specification or as shown on the Drawings.

2.2. Scope: This Specification covers the quality of Poly Vinyl Chloride (PVC) plastic pipe, fittings, 8-inch cast iron gate valve, valve box, and joint materials.

2.3. Material:

2.3.1 Pipe - The pipe shall be as uniform as commercially practicable in color, opaqueness, density, and other specified physical properties. It shall be free from visible cracks, holes, foreign inclusions, or other defects. The dimensions of the pipe shall be measured as prescribed in ASTM D 2122. The pipe shall be rated for 200 psi in accordance with ASTM D 2241.

2.3.2 Unless otherwise specified, the pipe shall conform to the requirements listed in this Specification and the requirements shown on the Drawings.

2.3.3 Fittings and joints - Fittings and joints shall be of a schedule, SDR or DR, pressure class, external load carrying capacity, or pipe stiffness that equals or exceeds that of the plastic pipe. The dimensions of fittings and joints shall be compatible with the pipe and measured in accordance with ASTM D 2122. Joint and fitting material shall be compatible with the pipe material. The joints and fittings shall be as uniform as commercially practicable in color, opaqueness, density, and other specified physical properties. It shall be free from visible cracks, holes, foreign inclusions, or other defects. Fittings and joints shall conform to the requirements listed in this Specification, the requirements of the applicable specification referenced in the ASTM or AWWA specification for the pipe, the requirements specified herein, and the requirements shown on the Drawings.

2.3.4 Gaskets - Rubber gaskets for pipe joints shall conform to the requirements of ASTM F 477, Elastomeric Seals (Gaskets) for Jointing Plastic Pipe.

2.3.5 Thrust Restraints - Thrust restraints shall be furnished and installed at all valves, elbows and at the connection with the existing pump. PVC bell restraining harnesses equal to EBAA Series 6500 shall be used. Restraining harnesses shall also be furnished and installed on all pipe joints within 25 feet of all elbows exceeding 11.25 degrees. EBAA 2000 PV Series restraints or equal may be used in lieu of Series 6500 restraining harnesses.

2.3.6 Valve - Gate valves shall be designed for a working pressure of not less than 150 psi. Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening. Valves 3 inches and larger shall be iron body, bronze mounted, and shall conform to AWWA C500 and shall be fitted with mechanical joints. Resilient-Seated Gate Valves: For valves 3 to 12 inches in size, resilient-seated gate valves shall conform to AWWA C509.

2.3.7 Valve boxes shall be cast iron or concrete, except that concrete boxes may be installed only in locations not subjected to vehicular traffic. Cast-iron boxes shall be extension type with slide-type adjustment and with flared base. The minimum thickness of metal shall be 3/16 inch. Concrete boxes shall be the standard product of a manufacturer of precast concrete equipment. The word "WATER" shall be cast in the cover. The box length shall adapt, without full extension, to the depth of cover required over the pipe at the valve location.

3.0 HANDLING AND STORAGE

3.1 Pipe shall be delivered to the job site and handled by means that provide adequate support to the pipe and do not subject it to undue stresses or damage. When handling and placing plastic pipe, care shall be taken to prevent impact blows, abrasion damage, and gouging or cutting (by metal edges and/or surface or rocks). The manufacturer's special handling requirements shall be strictly observed. Special care shall be taken to avoid impact when the pipe must be handled at a temperature of 40 degrees Fahrenheit or less.

3.2 Pipe shall be stored on a relatively flat surface so that the barrels are evenly supported.

Unless the pipe is specifically manufactured to withstand exposure to ultraviolet radiation, it shall be covered with an opaque material when stored outdoors for 15 days or longer.

4.0 EXCAVATION

4.1 Excavation shall be in accordance with Section 6, Excavation or as shown on the Drawings.

4.2 The pipe foundation shall be excavated a minimum of 4 inches lower than the pipe grade shown on the Drawings or staked in the field whenever bedrock, boulders, cobbles, or other material that may cause pipe damage is encountered at planned pipe grade.

5.0 LAYING THE PIPE

5.1 Plastic pipe conduits complete with fittings and other related appurtenances shall be installed to the lines and grades shown on the Drawings or specified in Article 14 of this Specification. The pipe shall be installed so that there is no reversal of grade between joints unless otherwise shown on the Drawings. The pipe shall not be dropped or dumped on the bedding or into the pipe trench. The ground surface near the pipe trench shall be free of loose rocks and stones greater than 1 inch in size. This ensures that rock will not be displaced and impact the pipe.

5.2 Just before placement, each pipe section shall be inspected to ensure that all foreign material is removed from inside the pipe. The pipe ends and the couplings shall be free of foreign material when assembled. At the completion of a work shift, all open ends of the pipeline shall be temporarily closed off using a suitable cover or plug.

5.3 Care shall be taken to prevent distortion and damage during hot or cold weather. During unusually hot weather (daytime high temperature of more than 90 °F), the pipe assembled in the trench shall be lightly backfilled or shaded to keep it as near to ground temperature as possible until final backfill is placed. Backfill operations should be performed during daily construction periods when the ground temperature and the temperature of the pipe do not vary more than 40 degrees Fahrenheit.

5.4 During installation, the pipe shall be firmly and uniformly bedded throughout its entire length. Bell holes shall be placed in bedding material under bells, couplings, and other fittings to assure the pipe is uniformly supported throughout its entire length. Blocking or mounding beneath the pipe to bring the pipe to final grade is not permitted.

6.0 PIPE BEDDING

6.1 Earth Bedding - The pipe shall be firmly and uniformly placed on compacted earthfill bedding or an in-place earth material bedding of ample bearing strength to support the pipe without noticeable settlement. The earth material on which the pipe is placed shall be of uniform density to prevent differential settlement.

6.2 Unless otherwise specified, a groove that closely conforms to the outside surface of the pipe shall be formed in the bedding. The depth of the groove shall be equal to or greater than 0.3 of the pipe diameter.

6.3 Earth bedding shall be compacted to a density not less than adjacent undisturbed in-place earth material or be compacted earth backfill. Earthfill material used for compacted earth bedding shall be free of rocks or stones greater than 1 inch in size and earth clods greater than 2 inches in size. The pipe shall be loaded sufficiently during the compaction of bedding under the haunches and around the sides of the pipe to prevent displacement from its final approved placement.

7.0 BACKFILL

7.1 Initial Backfill - Unless otherwise specified, initial backfill to 6 inches above the top of the conduit is required. Earth haunching and initial backfill material shall consist of soil material that is free of rocks, stones, or hard clods more than 1 inch in diameter.

7.2 Initial backfill shall be placed in two stages. In the first stage (haunching), backfill is placed to the pipe spring line (center of pipe). In the second stage, it is placed to 6 inches above the top of the pipe.

7.3 The first stage material shall be worked carefully under the haunches of the pipe to provide continuous support throughout the entire pipe length. The haunching backfill material shall be placed in layers that have a maximum thickness of about 6 inches and compacted as specified in Section 6.0. During compaction operations, care shall be taken to ensure that the tamping or vibratory equipment does not contact the pipe and the pipe is not deformed or displaced.

7.4 When pressure testing is not specified, the pipe shall be covered with a minimum of 6 inches of backfill material as soon as possible following assembling of the pipe in the trench, but not later than within the same day that placement has occurred. When pressure testing is specified, sufficient backfill material shall be placed over the pipe to anchor the conduit against movement during pressure testing activities.

7.5 Final Backfill - Final backfill shall consist of placing the remaining material required to complete the backfill from the top of the initial backfill to the ground surface, including mounding at the top of the trench. Final backfill material within 2 feet of the top of the pipe shall be free of debris or rocks larger than 3 inches nominal diameter. Final backfill compaction requirements shall be as specified in Section 6.0 or as shown on the Drawings.

7.6 Vehicles or construction equipment shall not be allowed to cross the pipe until there is a minimum earth cover of 2 feet over the pipe.

9.0 JOINTS

9.1 Joints shall be either bell-and-spigot type with elastomeric gaskets or coupling type with elastomeric gaskets. When a lubricant is required to facilitate joint assembly, it shall be a type having no deleterious affect on the gasket or pipe material.

9.2 Pipe joints shall be watertight at the pressures specified except where unsealed joints are indicated.

9.3 Pipe shall be installed and joined in accordance with the manufacturer's recommendations. Laying deflections and joint fitting or stab depths shall be within the manufacturer's recommended tolerances.

9.4 Pipe ends shall be cut square and be deburred to provide a uniform, smooth surface for the jointing process. Reference marks shall be placed on the spigot ends to assist in determining when proper seating depth has been achieved within the joint.

10.0 FITTINGS

10.1 Unless otherwise specified, steel fittings, valves, and bolted connections shall be painted or coated as recommended by the manufacturer.

10.2 Fittings for non-pressure pipe shall be of the same or similar material as the pipe and shall provide the same durability, watertightness, and strength as the pipe unless otherwise specified.

11.0 THRUST BLOCKS AND ANCHORS

11.1 When specified, concrete thrust blocks and anchors shall be installed as shown on the Drawings.

11.2 The concrete for the thrust blocks and anchors shall conform to the requirements of Section 7 (Concrete).

11.3 The thrust block cavity shall be excavated undisturbed soil or previously placed compacted backfill. The cavity shall be formed with soil or wood to hold the freshly placed concrete without displacement until an initial set has occurred.

11.4 When excavation beyond the designated trench widths and depths as shown on the Drawings occurs at locations where installation of concrete thrust blocks is required, the contractor shall install an alternative thrust block provision. The concrete thrust block shall have a thickness of one pipe diameter and a contact face area that shall be formed against the pipe as shown on the Drawings. Backfill shall be placed on all sides of the thrust block and to the sides of the excavation. It shall be compacted as specified for initial backfill.

12.0 PRESSURE TESTING

12.1 The conduit shall be tested for leaks in the following manner:

12.1.1 Before pressure testing:

12.1.1.1 Joints of the assembled pipeline shall be allowed to cure as recommended by the manufacturer.

12.1.1.2 Pipeline shall be flushed and cleaned.

12.1.1.3 All concrete anchors and thrust blocks shall be in place and allowed to cure for a minimum of 3 days.

12.1.1.4 Earth backfill shall be sufficient to anchor the conduit against movement during the pressure testing and shall be compacted.

12.1.1.5 The conduit shall be braced, anchored, or both, at each end to restrict all potential pipe movement.

12.1.1.6 The ends of the conduit shall be plugged. The upstream plug shall have a standpipe installed vertically having a minimum diameter of 2 inches and shall be equipped with a shutoff valve. All high points in the line shall be vented to evacuate air pockets. The conduit and the standpipe shall be slowly filled with water such that no air is entrapped during the filling operation. After filling is complete, all vents shall be closed.

12.1.2. During pressure testing, the water level in the standpipe shall be continuously maintained at a minimum of 10 feet above the highest invert elevation of the conduit for no less than 2 hours.

12.1.3 The volume of water leakage in the 2-hour test period shall be recorded. The maximum allowable leakage (L) in gallons per hour shall not exceed 0.02 times the nominal pipe diameter (D) in inches for each 1,000 feet of pipe line, which is about 50 pipe joints (L = 0.02 x D).

12.1.4 When observed leakage exceeds the allowable, leaks shall be sealed by replacement of pipe and fittings as necessary. The conduit shall be retested as described above. This procedure shall be repeated until the conduit leakage does not exceed the allowable specified above.

12.1.5 The contractor shall be fully responsible for all work required to correct leakage exceeding the amount specified.

12.1.6 When observed leakage exceeds the allowable, leaks shall be sealed by replacement of pipe and fittings as necessary. The conduit shall be retested as described in this section. The procedure shall be repeated until the conduit leakage does not exceed the allowable specified above.

12.2 The contractor shall be fully responsible for all work required to correct leakage exceeding the amount specified.

13.0 MEASUREMENT AND PAYMENT

13.1 For items of work for which specific unit prices are established in the contract, the quantity of each kind, size, and class of pipe is determined to the nearest foot by measurement of the laid length along the crown centerline of the conduit. Payment for each kind, size, and class of pipe is made at the contract unit price for that kind, size, and class. Such payment constitutes full compensation for furnishing, transporting, and installing the pipe including excavation, shoring, backfill, bedding, thrust blocks, and all fittings, appurtenances, and other items necessary and incidental to the completion of the work. Payment for appurtenances listed separately in the bid schedule is made at the contract prices for those items. Compensation for any items of work described in the contract, but not listed in the Bid Form, is included in the payment for the item of work to which it is made subsidiary. Such items and items to which they are made subsidiary are identified in Article 14 of this Specification.

14.0 ITEMS OF WORK AND CONSTRUCTION DETAILS

14.1 Compensation for the 8-inch diameter recirculation line shall be paid for at the unit price for Bid Item 20, 8-inch PVC Recirculation Line.

14.2 Compensation for the 8-inch diameter PVC suction line from the pump to the 18-inch pond level control pipe shall be incidental to the lump sum price for Bid Item 18, Pump Suction Modifications, and shall include the 8-inch valve and valve box as well as the 8-inch PVC pipe and fittings between the 18 x 18 x 8 wye and the pump.

SECTION 15: HIGH DENSITY POLYETHYLENE PIPE

1.0 GENERAL

1.1 Section includes:

Furnishing and installing HDPE pipe and fittings.

1.2 Related Sections

Section 5: Submittals.

1.3 References

ASTM D 638: Test Method for Tensile Properties of Plastics.

ASTM D 790: Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

ASTM D 1238: Test Method for Flow Rates of Thermal Plastics Molding and Extrusion Materials.

ASTM D 1505: Test Method for Density of Plastics by the Density Gradient Technique.

ASTM D 1599: Test Method for Short Time Hydraulic Failure Pressure of Plastic Pipe Materials.

ASTM D 1693: Test Method for Environmental Stress Cracking of Ethylene Plastics.

ASTM D 2122: Method for Determining Dimensions of Thermal Plastic Pipe and Fittings.

ASTM D 2837: Method for Obtaining Hydrostatic Design Basis for Thermal Plastic Pipe Materials.

ASTM D 3350-84: Polyethylene Plastics Pipe and Fitting Material.

ASTM F 714-93: Polyethylene (PE) Plastic Pipe Based on Outside Diameter.

ASTM F 1248:	Determination of Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe.
ASTM D 4218:	Test Method for Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
ASTM D1 248:	Specification for Polyethylene Plastics Molding and Extrusion Material.
ASTM D 2240:	Test Method of Rubber Property - Durometer Hardness.
ASTM D 695:	Test Method for Compressive Strength of Rigid Plastics.
ASTM D 256:	Test Method for Impact Resistance of Plastics and Electrical Insulating Material.
ASTM D 696:	Test Method of Coefficient of Linear Thermal Expansion of Plastics.
ASTM C 177:	Test Method for Steady-State Heat Flux Measurement and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
ASTM D 746:	Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
ASTM D 152S:	Test Method for Vicat Softening Temperature of Plastics.

1.4 Submittals

1.4.1 Submit in accordance with Section 5, Submittals.

1.4.2 Submit certifications, manufacturer's data, shop drawings, test results, and records as necessary to show that materials, methods, and workmanship meet or exceed the requirements of these specifications.

1.4.3 Submit the following to the Engineer for review and acceptance prior to shipment of the pipe:

1.4.3.1. A statement in writing from the pipe manufacturer that it is listed with the Plastic Pipe Institute as an extruder for polyethylene resin being used to manufacture the pipe for this project.

1.4.3.2. Catalog information confirming the pipe conforms to the requirements of these specifications.

2.0 PRODUCTS

2.1 HDPE Pipe Materials

2.1.1. Physical Properties for pipes and fittings:

Typical Physical Properties*

Property		Specification	Units	Nominal Values
Material Designation		PPI/ASTM	---	PE3408
Material Classification		ASTM D1248	---	III C 5 P34
Cell Classification		ASTM D3350	---	345434C
Density (3)		ASTM D1505	gm/cm^3	0.955
Melt Flow	(4)	ASTM D1238	gm/10 min	0.11 @ 2.16 kg***
Flex Modulus	(5)	ASTM D790	psi	135,000
Tensile Str.	(4)	ASTM D638	psi	3,200
ESCR (3)		ASTM D1693	F_0, Hrs	F_0>5,000
HDB @ 73^0F	(4)	ASTM D2837	psi	1,600
U-V Stabilizer	(C)	ASTM D1603	% C	2.5
Hardness		ASTM D2240	Shore "D"	65
Compressive Strength (Yield)		ASTM D695	psi	1,600
Tensile Strength @ Yield(Type IV Spec)		ASTM D638(2"/min)	psi	3,200
Elongation @ Yield		ASTM D638	% minimum	8
Tensile Strength @ Break(Type IV Spec)		ASTM D638(2"/min)	psi	5000
Elongation @ Break		ASTM D638	% minimum	750
Modulus of Elasticity		ASTM D638	psi	130,000
ESCR				
(Cond A, B, C: Mold. Slab)		ASTM D1693	F_0, Hrs	F_0>5,000**
Compressed Ring (Pipe)		ASTM F1248	F_{50}, Hrs	F_{50}>3,500**
Slow Crack Growth		Battelle Method	Days to Failure	F_0>64
Impact Strength (IZOD) (.125" THK)		ASTM D256(Method A)	in-lb/in Notch	42
Linear Thermal Expansion Coef.		ASTM D696	in/in/^{0}F	1.2×10^{-4}
Thermal Conductivity		ASTM C177	BTU-in/Ft^2/hrs/^{0}F	2.7
Brittleness Temp.		ASTM D746	^{0}F	<-180
Vicat Soft Temp.		ASTM D1525	^{0}F	+257
Heat Fusion Cond.		---	psi @ ^{0}F	75 @ 400

This list of Typical Physical Properties is intended for basic characterization of the pipe, and does not represent specific determinations or specifications.

**Tests were discontinued because no failures and no indication of stress crack initiation.

***Average Melt Index Value with a standard deviation of 0.01.

2.1.2 Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight, high density ethylene/hexane copolymer PE 3408 polyethylene resin meeting the above physical properties and pipe performance requirements. The material shall be listed by the Plastics Pipe Institute in PPI TR-4 with a 73^{0}F hydrostatic design basis rating of 1600 psi and a 140^{0}F hydrostatic design basis rating of 800 psi. The PPI Listing shall be based on ASTM D2837 and PPI TR-3 testing and validation of samples of the pipe manufacturer's production pipe.

2.2 Pipe

2.2.1. Solid Pipes

2.2.1.1. Pipe shall be produced with nominal physical properties outlined in Paragraph 2.1.1 and to the dimensions and tolerances specified in ASTM F714. Pipe shall be inspected per industry accepted manufacturer standards for:

Diameter

Wall Thickness

Concentricity

Joint Length

Ovality

Toe-In

Overall Workmanship

Inspection on ID & 0D

Print Line

Pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions or other deleterious defects, and shall be identical in color, density, melt index and other physical properties throughout.

2.2.1.2 Pipe shall be in compliance with the physical and performance requirements of Paragraph 2.1.1.

2.2.1.3. Pipe sizes and types:

a. 14-inch outside diameter, SDR 32, Driscopipe, or approved equal.

b. 10-inch nominal diameter (10.75-inch outside diameter), SDR 21, Driscopipe, or approved equal.

2.3 Fittings

2.3.1 Furnish shop fabricated fittings as shown on the Drawings or required by the work. Fittings shall be molded or custom fabricated and shall have the same pressure ratings and wall thicknesses, or greater, than the pipe connected.

3.0 EXECUTION

3.1 Preparation

3.1.1 Inspect pipe and fittings prior to assembly. Mark and remove from the jobsite all materials that are damaged or do not meet the specifications.

3.1.2 Sections of pipe with cuts or gouges in excess of ten percent of the wall thickness of the pipe shall be cut out and removed.

3.1.3 Confirm location of pipe, fittings and connections.

3.2 Pipe Installation - General

3.2.1 Install pipe to the lines indicated on the Drawings.

3.2.2 Handle and install pipe in accordance with the manufacturer's recommendations.

3.2.3 Joining

3.2.3.1 Butt heat fusion weld the joints in strict accordance with the manufacturer's instructions. The butt fusion equipment shall be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements of 400^0F, alignment and 75 psi interfacial fusion pressure.

3.2.3.2 Joint weld strength shall be equal to or greater than the tensile strength of the pipe.

3.2.3.3 Socket fusion shall not be used.

SECTION 16: CORRUGATED STEEL PIPE

1.0 GENERAL

1.1 References

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM A 123/A 123M:	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 742/A 742M:	Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
ASTM A 760/A 760M:	Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A 762/A 762M:	Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A 798/A 798M:	Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications

2.0 MATERIALS

2.1 Pipe for Culvert

Pipe for culvert shall be 36-inch diameter 10 gauge pipe and shall conform to the requirements specified.

2.1.1 Fully Bituminous Coated AASHTO M 190 Type A and ASTM A 760/A 760M zinc or aluminum (Type 2) coated pipe of either:

a. Type I pipe with helical 2-2/3 by 1/2 inch corrugations.

b. Type IR pipe with helical 3/4 by 3/4 by 7-1/2 inch corrugations.

2.2 Flared End Sections

Sections shall be at least 10 gauge of a standard design fabricated from zinc coated steel sheets meeting requirements of ASTM A 929/A 929M.

2.3 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C 877M or ASTM C 877

2.4 Pipe for Skimmer (Pond Level Control Structure)

Pipe for the skimmer shall be 6-foot diameter 8-gauge pipe and shall conform to the requirements specified below:

2.4.1 Fully Bituminous Coated AASHTO M 190 Type A and ASTM A 760/A 760M zinc or aluminum (Type 2) coated pipe of either:

a. Type I pipe with helical 2-2/3 by 1/2 inch corrugations.

b. Type IR pipe with helical 3/4 by 3/4 by 7-1/2 inch corrugations.

3.0 EXECUTION

3.1 Excavation for Pipe Culverts, Storm Drains, and Drainage Structures

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 6 "Earthwork" and the requirements specified below.

3.1.1 Trenching - The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 18 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified. Contractor shall not overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Company.

3.1.2 Removal of Unstable Material - Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Engineer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor in his performance of shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Company.

3.2 Bedding

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

3.2.1 Corrugated Metal Pipe Bedding for corrugated metal pipe shall be in accordance with ASTM A 798/A 798M. It is not required to shape the bedding to the pipe geometry.

3.3 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

3.4 Placing Pipe

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed 5 inches:

3.4.1 Corrugated Steel Pipe Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Any unprotected metal in the joints shall be coated with bituminous material as specified in AASHTO M 190 or AASHTO M 243. Interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs shall be used to facilitate moving pipe without damage to exterior or interior coatings. During transportation and installation, pipe or pipe arch and coupling bands shall be handled with care to preclude damage to the coating. Damaged coatings shall be repaired in accordance with the manufacturer's recommendations prior to placing backfill. Pipe on which coating has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced.

3.4.2 Multiple Culverts - Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 3 feet apart, whichever is less.

3.4.3 Field Joints - Transverse field joints shall be designed so that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. In addition, the joints shall meet the general performance requirements described in ASTM A 798/A 798M. Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. The space between the pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. The type, size, and sheet thickness of the band and the size of angles or lugs and bolts shall be as indicated or where not indicated, shall be as specified in the applicable standards or specifications for the pipe.

3.5 Backfilling

3.5.1 Backfilling Pipe in Trenches - After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 8 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified in Section 6 (Earthwork). Where it is necessary, in the opinion of the Engineer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

3.5.2 Movement of Construction Machinery - When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

4.0 MEASUREMENT AND PAYMENT

4.1 Pipe Culvert - Compensation for the 36-inch corrugated steel pipe culvert extension, including excavating, backfilling, and furnishing and installing pipe, fittings, and the flared end section, will be paid as a lump sum under Bid Item 16, Culvert, 36-inch CSP.

4.2 Skimmer Pipe - Compensation for the 6-foot diameter skimmer pipe, including furnishing and installing the pipe, will be not be paid for separately and will be incidental to the work required under Bid Item 21, 18-inch Pond Level Control Pipe Extension/Intake Structure.

SECTION 17: INSTRUMENTATION

1.0 GENERAL

1.1 Work to be Performed by Contractor

1.1.1. Furnish and install dike movement monuments.

1.1.2 Furnish and install magnetic flow meter.

1.2 Work to be Performed by Others

1.2.1 Surveying the new monuments.

1.3 Related Work Specified Elsewhere

1.3.1 Section 7: Concrete

1.3.2 Section 13: Ductile Iron Pipe and Fittings

1.4 Alternate Location for Flow Meter

1.4.1 Contractor may propose alternate design for location of the flow meter upstream of the existing flume house. Such proposal shall include a description of all details of installing the meter at the changed location and the cost savings, if any. If the proposal is accepted, Contractor shall submit detailed drawings and specifications for the proposed change.

2.0 PRODUCTS AND EXECUTION

2.1 Embankment Movement Monuments

2.1.1 Monuments for movement monitoring shall be reinforced concrete piers 9 inches in diameter, 5 feet deep with 8-5/8-inch diameter Sch 40 PVC pipe sleeve extending from a depth of 4 feet up to the ground surface as shown on the Drawings. Settlement marker on each monument shall be a Berntsen C-style or equal 3-inch domed bronze survey marker for concrete with the monument number stamped on the surface of the marker. Marker shall be detectable by magnetic instruments.

2.1.2 Reinforcing bars shall be standard ASTM A615 billet-steel bars, uncoated finish, Grade 60.

2.1.3 Concrete backfill shall be as specified in Section 7, Concrete.

2.2 Magnetic Flow Meter

2.2.1 Flow meter shall be an electromagnetic flow meter with a capacitance flow level measuring system built into the wall of the measuring tube to provide accurate flow measurements in partially filled pipelines with levels between 10 and 100% of the pipe cross-section. Flow meter shall be a Krohne Tidalflux 16-inch meter or equal 18-inch or 16-inch meter. Other brands and models will be considered. One source for the Krohne flow meter is Gateway Controls at 636.343.9000.

2.2.2 The measuring error shall be less than 1% of the measured value.

2.2.3 Connecting flanges shall be ANSI B16.5 150 lb.

2.2.4 Power for level measuring system: 230/115 V AC, 60HZ

2.2.5 Grounding rings shall be provided.

2.2.6 Protection Category: NEMA 6

2.2.7 Materials

Measuring tube: stainless steel
Liner: Irathane, 0.47” thick
Electrodes: Hastelloy C4
Connecting flanges: steel
Converter housing: sheet steel
Electronics housing: cast aluminum
PG cable entries: nickel-plated brass
Grounding rings: stainless steel AISI 316 Ti/1.4571

2.2.8 Signal converter shall be a Krohne Model IFC 110 PF or equal, 115/230 V AC, 48-63 Hz, with die cast aluminum housing with polyurethane finish, NEMA 4/4X.

2.2.9 The meter shall accurately measure flows at levels down to 10% of the inside tube diameter.

2.2.10 The meter shall operate in ambient temperatures between –13 to +140 degrees Fahrenheit.

2.2.11 Grounding rings shall be provided.

3.0 EXECUTION

3.1 Installing Embankment Movement Monuments

Install movement monuments at the locations shown on the Drawings or as directed by the Engineer. Backfill with concrete fill, and finish the top of the concrete as shown on the Drawings. The movement monuments will be surveyed by others after installation.

3.2 Installing Flow Meter

3.2.1 Sufficient lengths of straight pipe of the appropriate diameter shall be provided upstream and downstream of the meter in accordance with the meter manufacturer's recommendations. This may require removal of portions of the existing pipe and replacement using pipe the same diameter as the meter. Removal of the existing flume insert and partial demolition of the walls of the flume house and the floor of the flume channel will be necessary. The walls and floor shall be replaced with concrete or non-shrink grout of the same or higher strength and finished to match the existing finishes as closely as practicable. Design and submit details of support for the meter and piping inside the flume house and details of connections to existing 18-inch ductile iron pipe.

3.2.2 Test meter and display following installation to assure that they are working properly.

3.2.3 Provide as-built drawings showing details of the meter installation. Provide three copies of operating and maintenance instructions for the meter and signal converter.

4.0 MEASUREMENT AND PAYMENT

4.1 Compensation for all work required for furnishing and installing the settlement monuments will be paid under the unit price for Bid Item 19 (Movement Monuments).

4.2 Compensation for furnishing and installing the flow meter, including demolition, installing the meter, electrical connections, upstream and downstream piping and fittings, and patching the walls and floor of the flume house will be paid as a lump sum under Bid Item 17 (Flow Meter).

Geosyntec consultants

ATTACHMENT C

Chemical Constituent Analysis – CCR (845.230)

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)

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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
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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

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- 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:

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ATTACHMENT D

On-Site Transportation Plan (845.220)

Surrounding Area Transportation Plan

Plant Transportation Plan

Regional Transportation Plan

Legend

- On Site Roads
- Public Roadways
- Illinois Power Company Lake
- Middle Fork Vermilion River
- Prevailing Wind Direction
- Direction of Traffic

Notes:

Basemap provided by ArcGIS Online.
On site roads will be improved for two way traffic where needed.

0 5,000 Feet

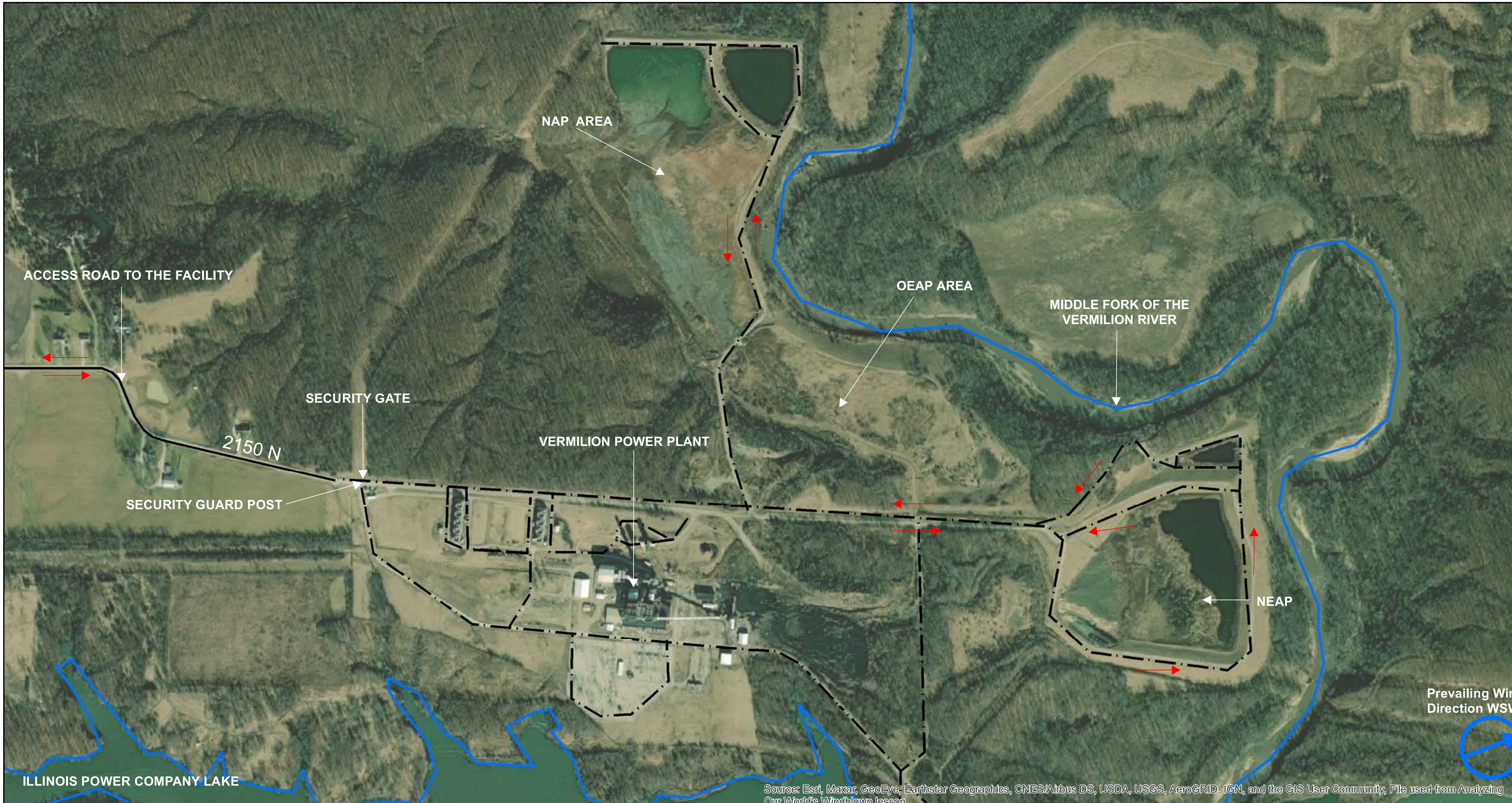
N

Fly Ash Ponds Closure
Surrounding Area Transportation Plan
Vermilion Power Plant
Oakwood, Illinois

Geosyntec consultants

St. Louis | January 2022

Figure D-1



Legend

- On Site Roads
- Public Roadways
- Illinois Power Company Lake
- Middle Fork Vermilion River
- Prevailing Wind Direction
- Direction of Traffic

Notes:

Basemap provided by ArcGIS Online.
On site roads will be improved for two way traffic where needed.

N

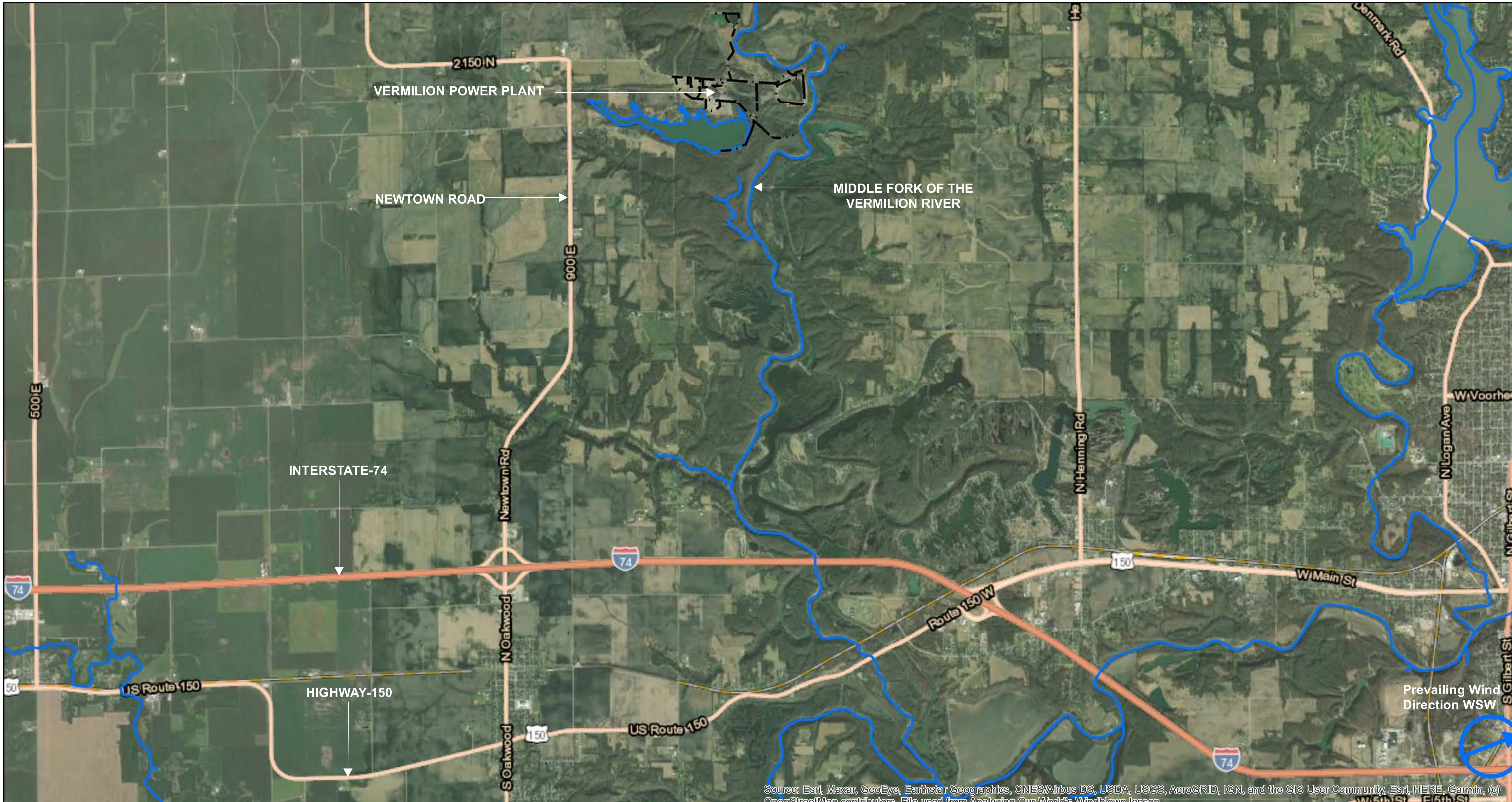
0 1,500 Feet

Fly Ash Ponds Closure
Plant Transportation Plan
Vermilion Power Plant
Oakwood, Illinois

Geosyntec consultants

St. Louis | January 2022

Figure D-2



Legend
- On Site Roads
- Illinois Power Company Lake
- Middle Fork Vermilion River
- Prevailing Wind Direction

Notes:

Basemap provided by ArcGIS Online.

Fly Ash Ponds Closure
Regional Transportation Plan
Vermilion Power Plant
Oakwood, Illinois

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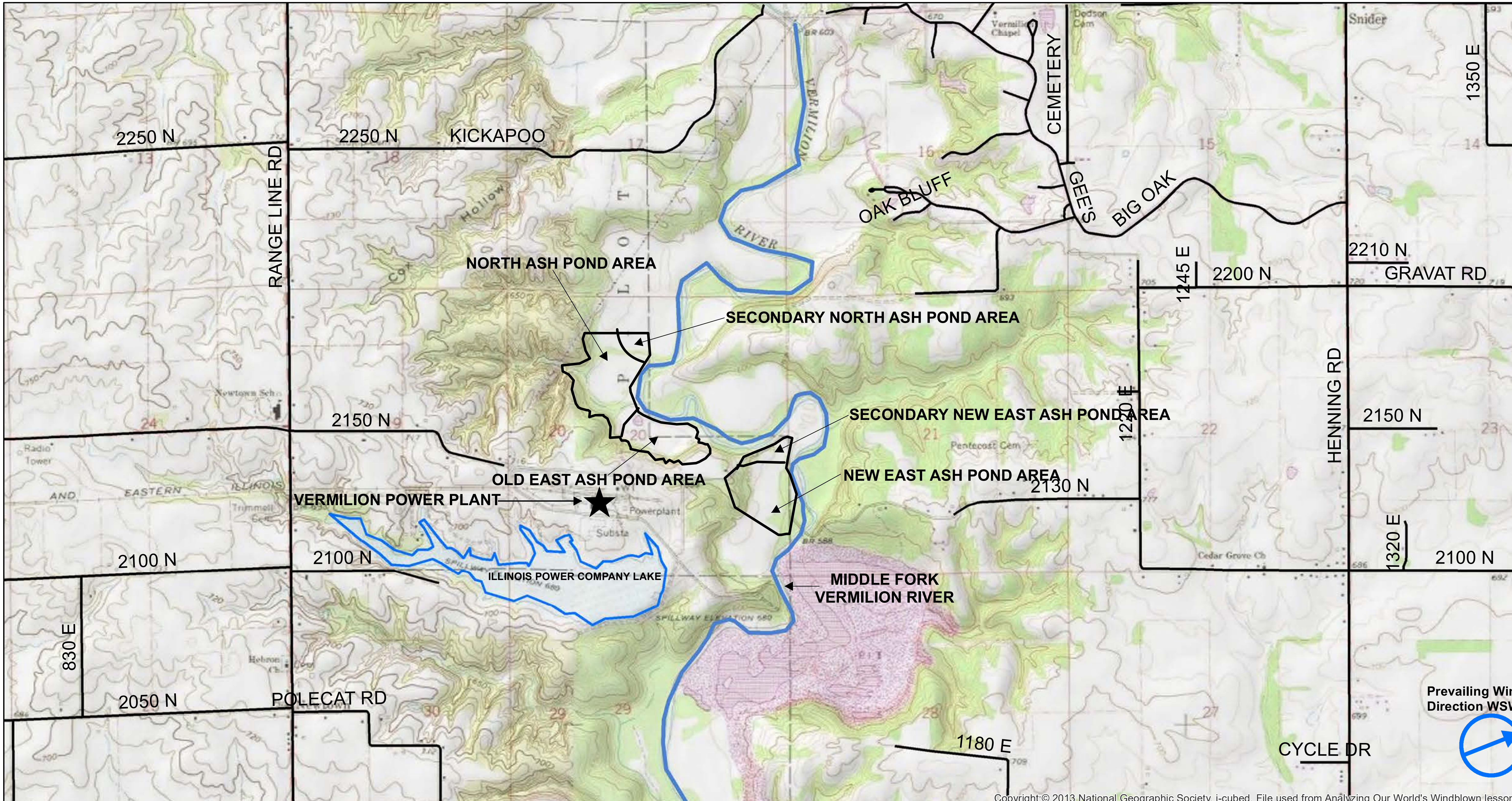
Figure D-3

ATTACHMENT E

Site Location Maps (845.220)

Topographic Vicinity Map

Floodplain Hazard Map



Legend

- On Site Roads
- Public Roadways
- Illinois Power Company Lake
- Middle Fork Vermilion River
- Prevailing Wind Direction

Notes:

Basemap provided by National Geographic Society, i-cubed (2013).
Impoundment boundaries provided by Dynegy Midwest Generation.
Illinois Nature Preserve provided by Natural Resources Awareness Tool (idnr.maps.arcgis.com).

0 5,000 Feet

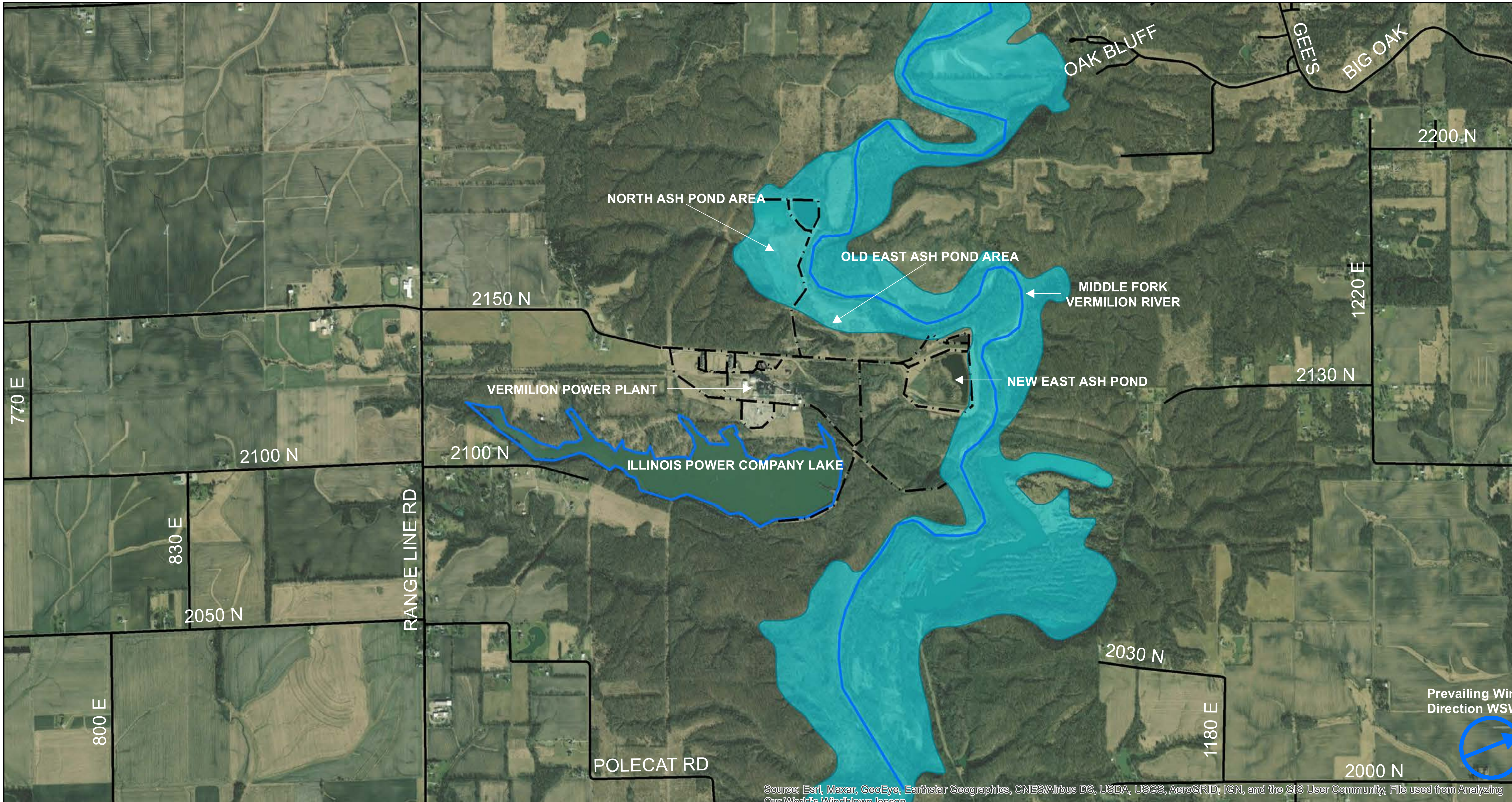
N

Fly Ash Ponds Closure
Topographic Vicinity Map
Vermilion Power Plant
(Oakwood, Illinois)

Geosyntec consultants

St. Louis | January 2022

Figure E-1



Legend

- On Site Roads
- Public Roadways
- 100 Year Floodplain
- Illinois Power Company Lake
- Middle Fork Vermilion River
- Prevailing Wind Direction

Notes:

Basemap provided by ArcGIS Online (2021).
100 Year Floodplain provided by the Illinois Department of Natural Resources.

0 5,000 Feet

N

Fly Ash Ponds Closure
Floodplain Hazard Map
Vermilion Power Plant
Oakwood, Illinois

Geosyntec consultants

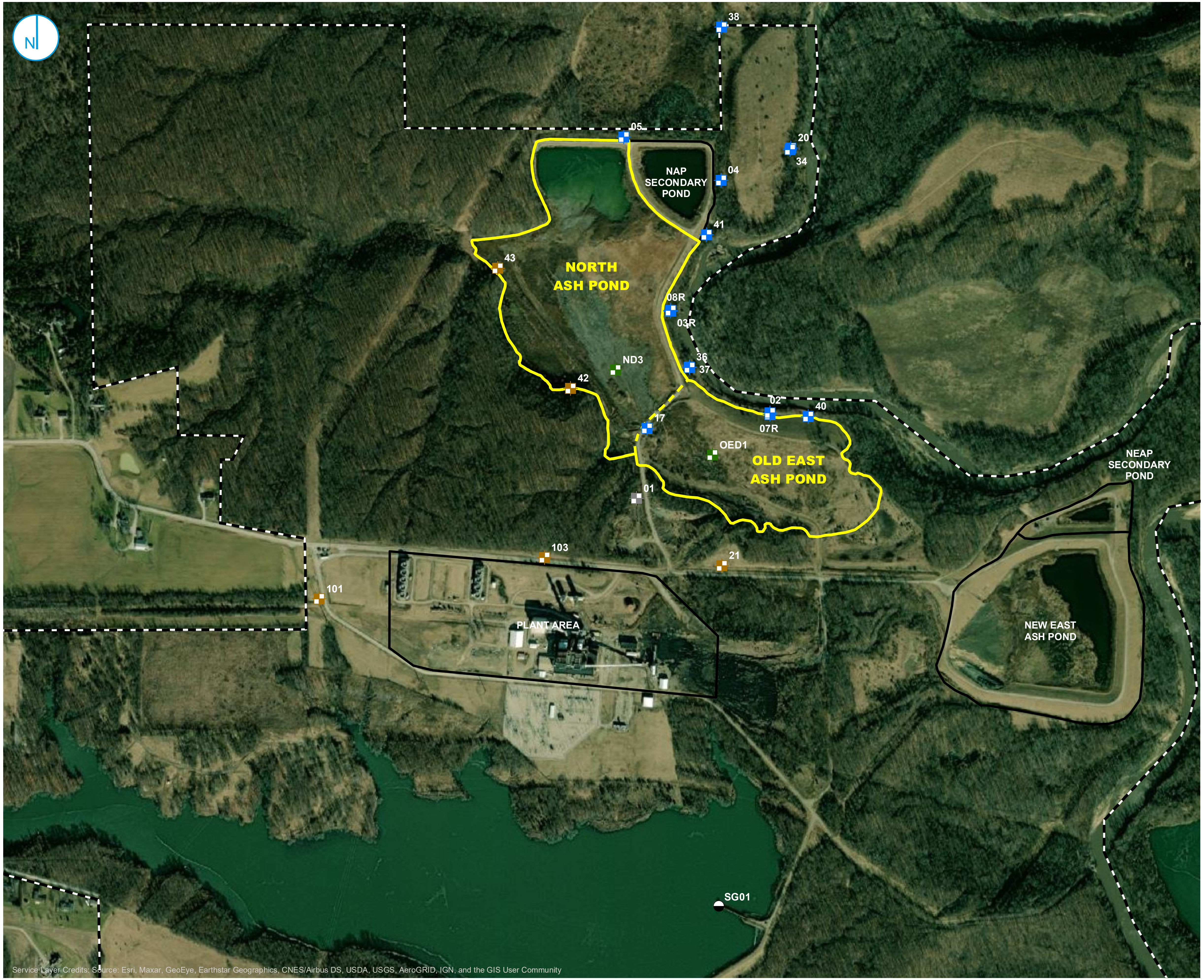
St. Louis | January 2022

Figure
E-2

Geosyntec consultants

ATTACHMENT F

Site Plan Maps (845.220)



Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\GMP\Figure 2-1_Proposed 845 GW Monitoring Well Network.mxd

PROJECT: 169000XXXX | DATED: 10/11/2021 | DESIGNER: STOLZSD

COMPLIANCE WELL
BACKGROUND WELL
SOURCE SAMPLE LOCATION
MONITORING WELL TO BE ABANDONED
STAFF GAUGE
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 300 600 Feet

PROPOSED PART 845 GROUNDWATER MONITORING WELL NETWORK

GROUNDWATER MONITORING PLAN
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 2-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

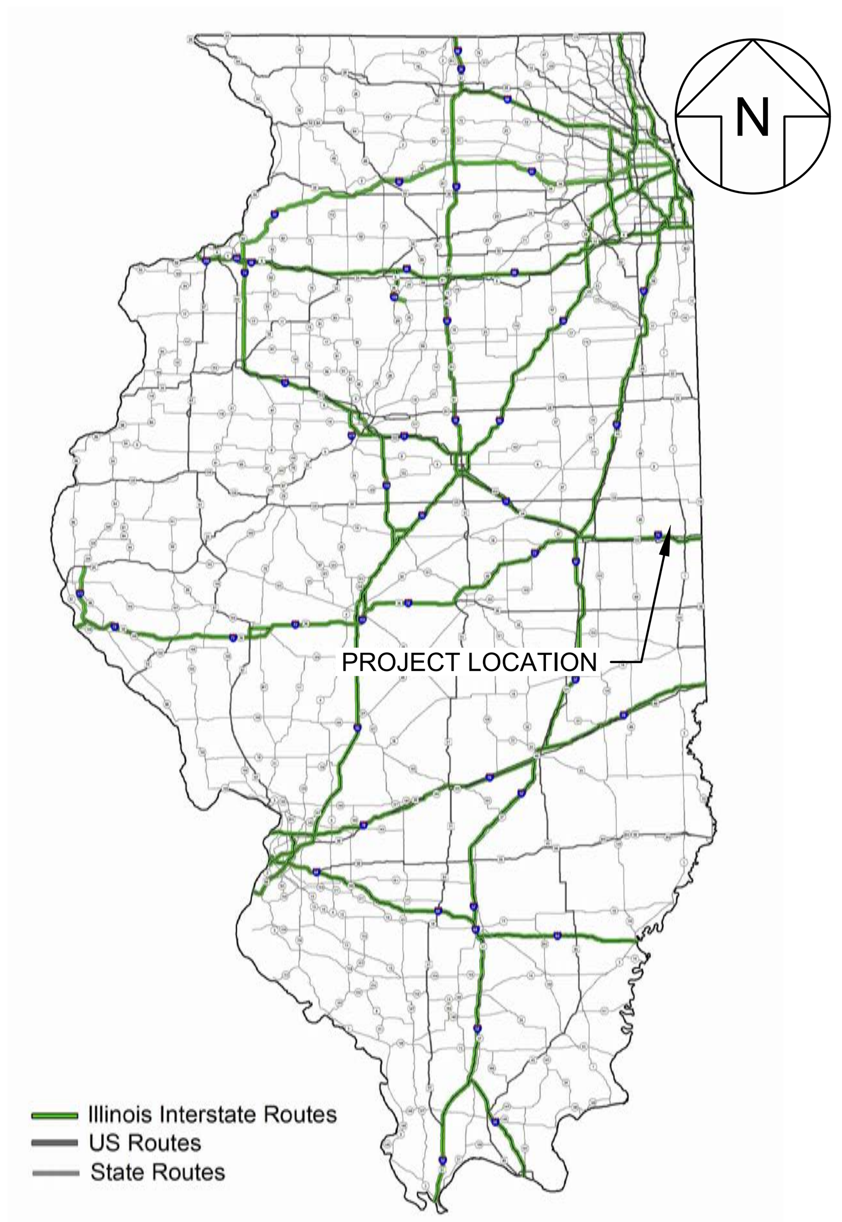
RAMBOLL

Geosyntec consultants

ATTACHMENT G

Plans and Specifications (845.220)

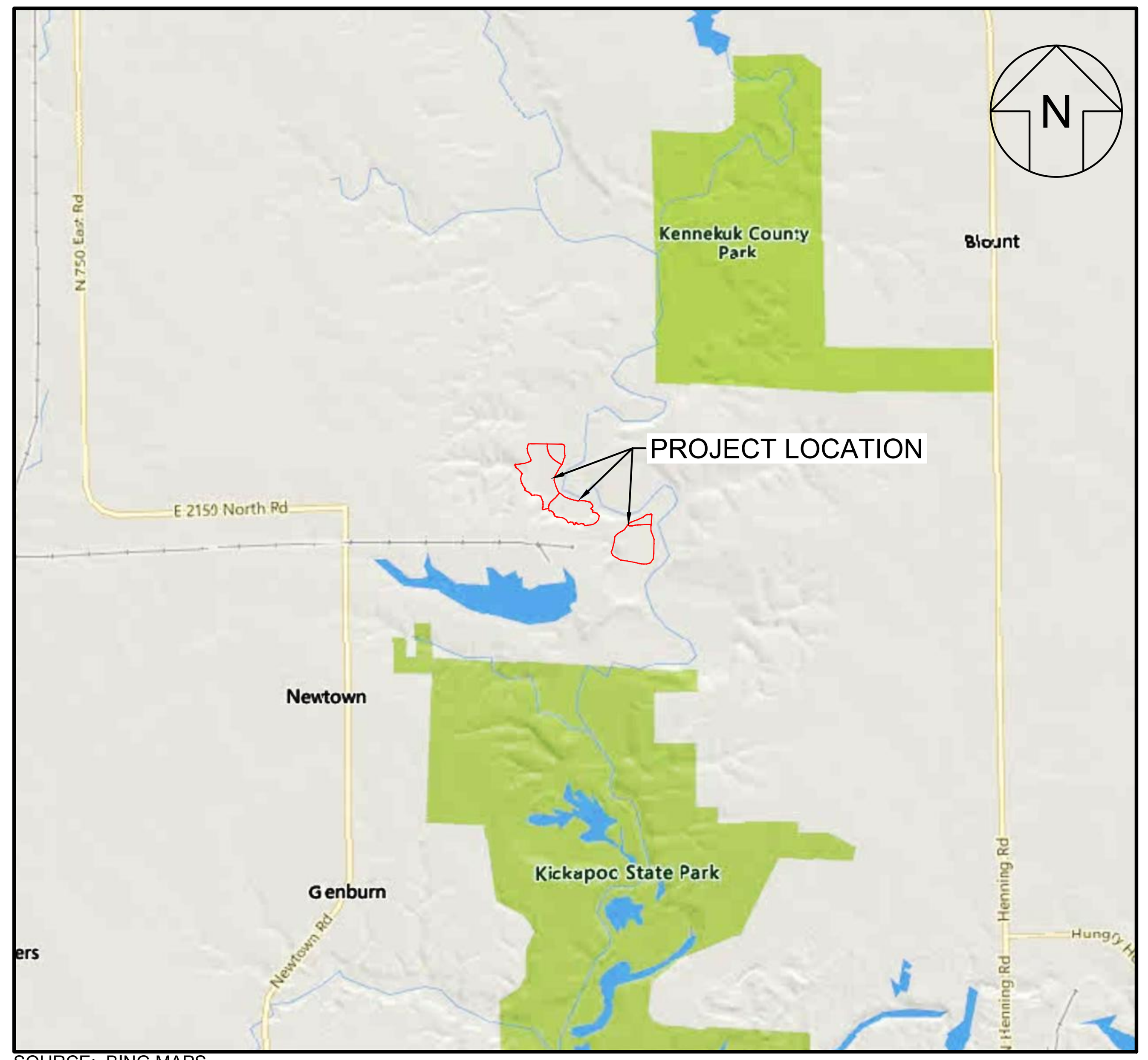
DYNEGY MIDWEST GENERATION - VERMILION POWER PLANT
VERMILION FLY ASH PONDS CLOSURE
VERMILION COUNTY, ILLINOIS
PROJECT NO. CHE8404
JANUARY 2022



SOURCE: IDOT

STATE MAP

NOT TO SCALE

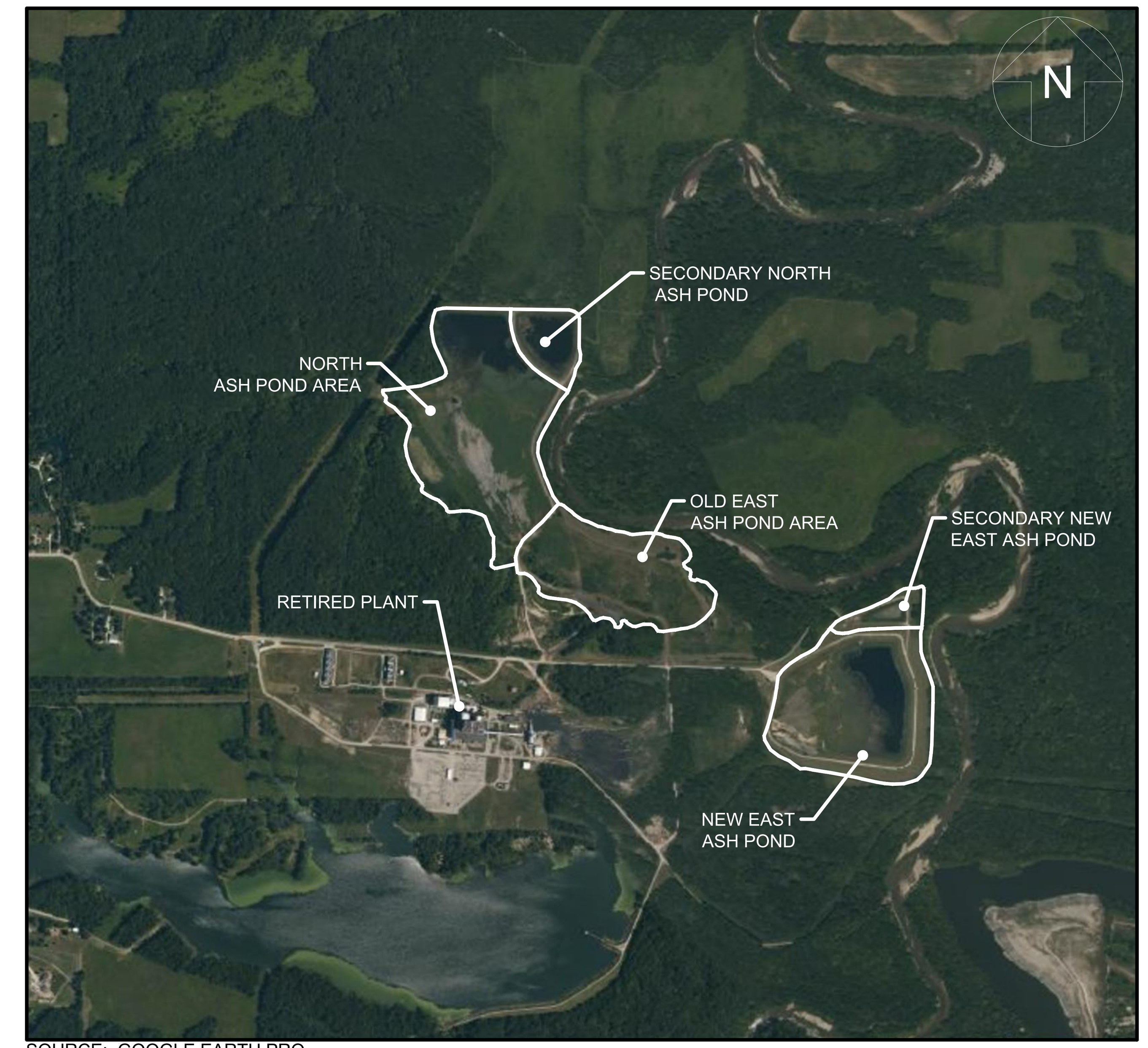


SOURCE: BING MAPS

LOCATION MAP

0 4000 8000

SCALE IN FEET



SOURCE: GOOGLE EARTH PRO

SITE MAP

0 1000 2000

SCALE IN FEET

DRAWINGS LIST	
SHEET NO.	TITLE
G-100	COVER SHEET, LOCATION MAP, & SITE MAP
G-110	OVERALL PROJECT SITE PLAN
G-120	NAP PRE-CONSTRUCTION CONDITIONS
G-130	OEAP PRE-CONSTRUCTION CONDITIONS
G-140	NEAP PRE-CONSTRUCTION CONDITIONS
C-200	NAP BOTTOM OF EXCAVATION
C-210	OEAP BOTTOM OF EXCAVATION
C-220	NEAP BOTTOM OF EXCAVATION
C-300	NAP FINAL GRADING PLAN
C-310	OEAP FINAL GRADING PLAN
C-320	NEAP FINAL GRADING PLAN
C-330	SITE ALIGNMENT PROFILES - NAP, OEAP, & NEAP
C-340	SITE SECTIONS - NAP & OEAP
C-350	SITE SECTIONS - NEAP
C-400	DETAILS
C-500	NAP SWPPP - EXCAVATION
C-510	OEAP SWPPP - EXCAVATION
C-520	NEAP SWPPP - EXCAVATION
C-530	NAP SWPPP - FINAL GRADING
C-540	OEAP SWPPP - FINAL GRADING
C-550	NEAP SWPPP - FINAL GRADING
C-560	SWPPP NOTES

4 / C-400 — DETAIL NUMBER; DRAWING ON WHICH ABOVE DETAIL IS PRESENTED

DETAIL NUMBER — 4 / C-300 — DRAWING ON WHICH ABOVE DETAIL WAS FIRST REFERENCED

DETAIL
TITLE
SCALE:
XREF:

EXAMPLE: DETAIL NUMBER 4 PRESENTED ON DRAWING NO. C-400 WAS REFERENCED FOR THE FIRST TIME ON DRAWING NO. C-300.

ABOVE SYSTEM ALSO APPLIES TO SECTION IDENTIFICATIONS.

DETAIL IDENTIFICATION LEGEND

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: COVER SHEET, LOCATION MAP, & SITE MAP

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	01-CHE8404 G-100
REVIEWED BY:	JPS	DRAWING NO.:	G-100
APPROVED BY:	JPS		

PERMIT APPLICATION
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REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: OVERALL PROJECT SITE PLAN

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	02-CHE8404 G-110
REVIEWED BY:	JPS	DRAWING NO.:	G-110
APPROVED BY:	JPS		

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LEGEND

- EXISTING OVERHEAD ELECTRIC
- EXISTING TREE LINE
- EXISTING FENCE
- EXISTING POWER POLE
- EXISTING GUY WIRE
- EXISTING MANHOLE
- EXISTING 24-INCH HDPE PIPE
- EXISTING MONITORING WELL
- APPROXIMATE LIMITS OF CCR
- EXISTING TOPO (MAJOR CONTOUR)
- EXISTING TOPO (MINOR CONTOUR)
- SITE SECTION ALIGNMENT
- APPROXIMATE EXTENT OF EXISTING GABION BASKETS

DEFINITIONS

NAP - NORTH ASH POND
OEAP - OLD EAST ASH POND
NEAP - NEW EAST ASH POND
(DND) - DO NOT DISTURB
(TBR) - TO BE REMOVED

NOTES:

1. TOPOGRAPHY SHOWN IS A COMBINATION OF A DETAILED TOPOGRAPHIC SURVEY COMPLETED ON MARCH 26, 2018 BY INGENAE AND PUBLICLY AVAILABLE LIDAR, USED TO SUPPLEMENT EXISTING TOPOGRAPHY BEYOND THE LIMITS OF THE DETAILED SURVEY.
2. LIMITS OF ASH ARE APPROXIMATE AND ARE BASED ON LIMIT OF ASH INFORMATION PROVIDED BY OTHERS. ACTUAL LIMITS OF ASH MAY VARY AND WILL BE CONFIRMED DURING CONSTRUCTION.
3. AERIAL IMAGERY WAS OBTAINED BY GEOSYNTEC FROM GOOGLE EARTH PRO IN 2021 AND IS BEST-FIT TO THE PRECONSTRUCTION GROUND CONTOURS AND SURVEYED LOCATION OF SITE FEATURES. ACTUAL LOCATIONS SHOWN IN IMAGERY MAY VARY SLIGHTLY.
4. SITE PREPARATION ACTIVITIES, CLEARING AND GRUBBING ACTIVITIES, AND INSTALLATION OF EROSION AND SEDIMENT CONTROLS, WILL BE PERFORMED PRIOR TO EXCAVATION OR OTHER EARTH-DISTURBING CONSTRUCTION ACTIVITIES. REQUIREMENTS FOR THESE ACTIVITIES WILL BE PROVIDED ON CONSTRUCTION BID DOCUMENTS.
5. LOCATION OF 24-INCH DIA HDPE PIPE THAT MOVES STORMWATER FLOW FROM THE WESTERN VALLEY TO NORTH OF THE NAP IS APPROXIMATE.

0 100 200
SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

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134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: NAP PRE-CONSTRUCTION CONDITIONS

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	03-CHE8404 G-120
REVIEWED BY:	JPS	DRAWING NO.:	G-120
APPROVED BY:	JPS		

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

LEGEND

OHE —— OHE	EXISTING OVERHEAD ELECTRIC
	EXISTING TREE LINE
—x——x—	EXISTING FENCE
	EXISTING POWER POLE
	EXISTING GUY WIRE
	EXISTING MANHOLE
	EXISTING MONITORING WELL
	APPROXIMATE LIMITS OF CCR
600	EXISTING TOPO (MAJOR CONTOUR)
598	EXISTING TOPO (MINOR CONTOUR)
0+00	SITE SECTION ALIGNMENT
	APPROXIMATE EXTENT OF EXISTING GABION BASKETS

NOTES:

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COLLINSVILLE, IL 62234 USA

TITLE: OEAP PRE-CONSTRUCTION CONDITIONS

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	04-CHE8404 G-130
REVIEWED BY:	JPS	DRAWING NO.:	G-130
APPROVED BY:	JPS		

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

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LEGEND

- EXISTING OVERHEAD ELECTRIC
- EXISTING TREE LINE
- EXISTING FENCE
- EXISTING POWER POLE
- EXISTING GUY WIRE
- EXISTING MANHOLE
- EXISTING MONITORING WELL
- APPROXIMATE LIMITS OF CCR
- EXISTING TOPO (MAJOR CONTOUR)
- EXISTING TOPO (MINOR CONTOUR)
- APPROXIMATE EXTENT OF EXISTING GABION BASKETS
- EXISTING CUTOFF WALL
- EXISTING CUTOFF TRENCH

NOTES:

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CHICAGO, ILLINOIS 60602 USA
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1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: NEAP PRE-CONSTRUCTION CONDITIONS

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	05-CHE8404 G-140
REVIEWED BY:	JPS	DRAWING NO.:	G-140
APPROVED BY:	JPS		

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

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LEGEND

- EXISTING OVERHEAD ELECTRIC
- EXISTING TREE LINE
- EXISTING FENCE
- EXISTING POWER POLE
- EXISTING GUY WIRE
- EXISTING MANHOLE
- EXISTING 24-INCH HDPE PIPE
- EXISTING MONITORING WELL
- APPROXIMATE LIMITS OF CCR
- EXISTING TOPO (MAJOR CONTOUR)
- EXISTING TOPO (MINOR CONTOUR)
- PROPOSED GRADING (MAJOR CONTOUR)
- PROPOSED GRADING (MINOR CONTOUR)
- SITE SECTION ALIGNMENT
- APPROXIMATE EXTENT OF EXISTING GABION BASKETS

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5. BOTTOM OF ASH CONTOURS USED TO DEVELOP THE TARGET EXCAVATION GRADES ARE BASED ON THE 1978 PRE-IMPOUNDMENT CONTOUR INFORMATION PROVIDED BY OTHERS.
6. SLOPE STABILITY ENGINEERING ANALYSES WILL BE PERFORMED FOR CONSTRUCTION BID DOCUMENTS TO EVALUATE EXCAVATION CONDITIONS.
7. GROUNDWATER AND PHREATIC SURFACE CONDITION INFORMATION WILL BE PROVIDED WITH CONSTRUCTION BID DOCUMENTS. ACTUAL CONDITIONS MAY VARY BASED ON CLIMACTIC AND SEASONAL FLUCTUATIONS. GROUNDWATER AND PHREATIC SURFACE CONDITIONS WITHIN THE ASH IMPOUNDMENT SHALL BE CONFIRMED PRIOR TO CONSTRUCTION.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONFIRMING GROUNDWATER AND PHREATIC SURFACE CONDITIONS DURING CONSTRUCITON, AND MANAGING DEWATERING EQUIPMENT AS APPROPRIATE TO PREVENT UNAUTHORIZED DISCHARGES OF CONSTRUCTION WATER.
9. DEWATERING ACTIVITIES ARE ANTICIPATED TO CONSIST OF DEWATERING TRENCHES AND SUMPS PUMPED TO TEMPORARY SEDIMENT BASINS PRIOR TO DISCHARGE THROUGH EXISTING NPDES PERMITTED OUTFALLS. DEWATERING DESIGN WILL BE INCLUDED IN CONSTRUCTION BID DOCUMENTS.

0 100 200 SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: NAP BOTTOM OF EXCAVATION

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	06-CHE8404 C-200
REVIEWED BY:	JPS	DRAWING NO.:	
APPROVED BY:	JPS		C-200

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

LEGEND

- EXISTING OVERHEAD ELECTRIC
- EXISTING TREE LINE
- EXISTING FENCE
- EXISTING POWER POLE
- EXISTING GUY WIRE
- EXISTING MANHOLE
- EXISTING MONITORING WELL
- APPROXIMATE LIMITS OF CCR
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8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONFIRMING GROUNDWATER AND PHREATIC SURFACE CONDITIONS DURING CONSTRUCITON, AND MANAGING DEWATERING EQUIPMENT AS APPROPRIATE TO PREVENT UNAUTHORIZED DISCHARGES OF CONSTRUCTION WATER.
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0 100 200
SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

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134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: OEAP BOTTOM OF EXCAVATION

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	07-CHE8404 C-210
REVIEWED BY:	JPS	DRAWING NO.:	C-210
APPROVED BY:	JPS		

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

LEGEND

- EXISTING OVERHEAD ELECTRIC
- EXISTING TREE LINE
- EXISTING FENCE
- EXISTING POWER POLE
- EXISTING GUY WIRE
- EXISTING MANHOLE
- EXISTING MONITORING WELL
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- EXISTING TOPO (MAJOR CONTOUR)
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- PROPOSED GRADING (MAJOR CONTOUR)
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TITLE: NEAP BOTTOM OF EXCAVATION

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	08-CHE8404 C-220
REVIEWED BY:	JPS	DRAWING NO.:	C-220
APPROVED BY:	JPS		

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

LEGEND

OHE — OHE	EXISTING OVERHEAD ELECTRIC
	EXISTING TREE LINE
X — X	EXISTING FENCE
	EXISTING POWER POLE
	EXISTING GUY WIRE
	EXISTING MANHOLE
	EXISTING 24-INCH HDPE PIPE
	EXISTING MONITORING WELL
	APPROXIMATE LIMITS OF CCR
600	EXISTING TOPO (MAJOR CONTOUR)
598	EXISTING TOPO (MINOR CONTOUR)
600	PROPOSED GRADING (MAJOR CONTOUR)
598	PROPOSED GRADING (MINOR CONTOUR)
0+00	SITE SECTION ALIGNMENT
	POST CONSTRUCTION ACCESS ROADS
	RIPRAP PROTECTION
	APPROXIMATE EXTENT OF EXISTING GABION BASKETS
	SURFACE WATER FLOW DIRECTION

NOTES:

1. FOLLOWING ASH REMOVAL, ADDITIONAL EXCAVATION OF THE IMPOUNDMENT BERMS WILL BE PERFORMED WHERE SHOWN. EXCAVATED MATERIALS FROM BERMS WILL BE USED AS BACKFILL TO ACHIEVE FINAL GRADES. ADDITIONAL MATERIALS MAY BE USED AS BACKFILL MATERIAL TO AUGMENT BERM MATERIALS.
2. ENGINEERING ANALYSES WILL BE PERFORMED TO FINALIZE THE SIZE AND DIMENSIONS OF STORMWATER CONVEYANCE FEATURES AND PERMANENT EROSION CONTROL MEASURES. ENGINEERING ANALYSES WILL BE PERFORMED AS PART OF CONSTRUCTION BID DOCUMENTS.
3. THE CONTRACTOR WILL MANAGE DEWATERING OPERATIONS AND EQUIPMENT DURING BACKFILL ACTIVITIES TO ENSURE BACKFILL IS PLACED IN UNSATURATED CONDITIONS AND THE SUBGRADE IS SUITABLE FOR BACKFILL.
4. BACKFILL PLACEMENT AND COMPACTION WILL BE MONITORED AND TESTED AS NECESSARY ACCORDING TO THE CQA PLAN DURING CONSTRUCTION.
5. PERMANENT ACCESS ROADS FOR LIGHT-DUTY VEHICLES WILL BE CONSTRUCTED WITH SLOPES NO GREATER THAN 5H:1V.
6. FINAL GRADING AND FINAL SLOPE TIE-INS TO THE PERIMETER WILL BE COMPLETED WITH CONSTRUCTION BID DOCUMENTS.

0 100 200
SCALE IN FEET

N

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: NAP FINAL GRADING PLAN

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	09-CHE8404 C-300
REVIEWED BY:	JPS	DRAWING NO.:	C-300
APPROVED BY:	JPS		

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

S:\COMPANY\PROJECTS_POST_2014\CHE8404_VPS_CLOSURE_RIA_SPRT\900 - CAD\DRAWINGS\CONCEPTUAL\09-CHE8404 C-300

LEGEND

- EXISTING OVERHEAD ELECTRIC
- EXISTING TREE LINE
- EXISTING FENCE
- EXISTING POWER POLE
- EXISTING GUY WIRE
- EXISTING MANHOLE
- EXISTING 24-INCH HDPE PIPE
- EXISTING MONITORING WELL
- APPROXIMATE LIMITS OF CCR
- EXISTING TOPO (MAJOR CONTOUR)
- EXISTING TOPO (MINOR CONTOUR)
- PROPOSED GRADING (MAJOR CONTOUR)
- PROPOSED GRADING (MINOR CONTOUR)
- SITE SECTION ALIGNMENT
- POST CONSTRUCTION ACCESS ROADS
- APPROXIMATE EXTENT OF EXISTING GABION BASKETS
- SURFACE WATER FLOW DIRECTION

NOTES:

1. FOLLOWING ASH REMOVAL, ADDITIONAL EXCAVATION OF THE IMPOUNDMENT BERMS WILL BE PERFORMED WHERE SHOWN. EXCAVATED MATERIALS FROM BERMS WILL BE USED AS BACKFILL TO ACHIEVE FINAL GRADES. ADDITIONAL MATERIALS MAY BE USED AS BACKFILL MATERIAL TO AUGMENT BERM MATERIALS.
2. ENGINEERING ANALYSES WILL BE PERFORMED TO FINALIZE THE SIZE AND DIMENSIONS OF STORMWATER CONVEYANCE FEATURES AND PERMANENT EROSION CONTROL MEASURES. ENGINEERING ANALYSES WILL BE PERFORMED AS PART OF CONSTRUCTION BID DOCUMENTS.
3. THE CONTRACTOR WILL MANAGE DEWATERING OPERATIONS AND EQUIPMENT DURING BACKFILL ACTIVITIES TO ENSURE BACKFILL IS PLACED IN UNSATURATED CONDITIONS AND THE SUBGRADE IS SUITABLE FOR BACKFILL.
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5. PERMANENT ACCESS ROADS FOR LIGHT-DUTY VEHICLES WILL BE CONSTRUCTED WITH SLOPES NO GREATER THAN 5H:1V.
6. FINAL GRADING AND FINAL SLOPE TIE-INS TO THE PERIMETER WILL BE COMPLETED WITH CONSTRUCTION BID DOCUMENTS.

0 100 200
SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: OEAP FINAL GRADING PLAN

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	10-CHE8404 C-310
REVIEWED BY:	JPS	DRAWING NO.:	C-310
APPROVED BY:	JPS		

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

S:\COMPANY\PROJECTS_POST_2014\CHE8404_VPS_CLOSURE_RIA_SPRT\900 - CAD\DRAWINGS\CONCEPTUAL\10-CHE8404 C-310

LEGEND

- EXISTING OVERHEAD ELECTRIC
- EXISTING TREE LINE
- EXISTING FENCE
- EXISTING POWER POLE
- EXISTING GUY WIRE
- EXISTING MANHOLE
- EXISTING MONITORING WELL
- APPROXIMATE LIMITS OF CCR
- EXISTING TOPO (MAJOR CONTOUR)
- EXISTING TOPO (MINOR CONTOUR)
- PROPOSED GRADING (MAJOR CONTOUR)
- PROPOSED GRADING (MINOR CONTOUR)
- SITE SECTION ALIGNMENT
- POST CONSTRUCTION ACCESS ROADS
- EXISTING CUTOFF WALL
- EXISTING CUTOFF TRENCH
- SURFACE WATER FLOW DIRECTION

NOTES:

1. FOLLOWING ASH REMOVAL, ADDITIONAL EXCAVATION OF THE IMPOUNDMENT BERMS WILL BE PERFORMED WHERE SHOWN. EXCAVATED MATERIALS FROM BERMS WILL BE USED AS BACKFILL TO ACHIEVE FINAL GRADES. ADDITIONAL MATERIALS MAY BE USED AS BACKFILL MATERIAL TO AUGMENT BERM MATERIALS.
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6. FINAL GRADING AND FINAL SLOPE TIE-INS TO THE PERIMETER WILL BE COMPLETED WITH CONSTRUCTION DOCUMENTS.

0 100 200
SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: NEAP FINAL GRADING PLAN

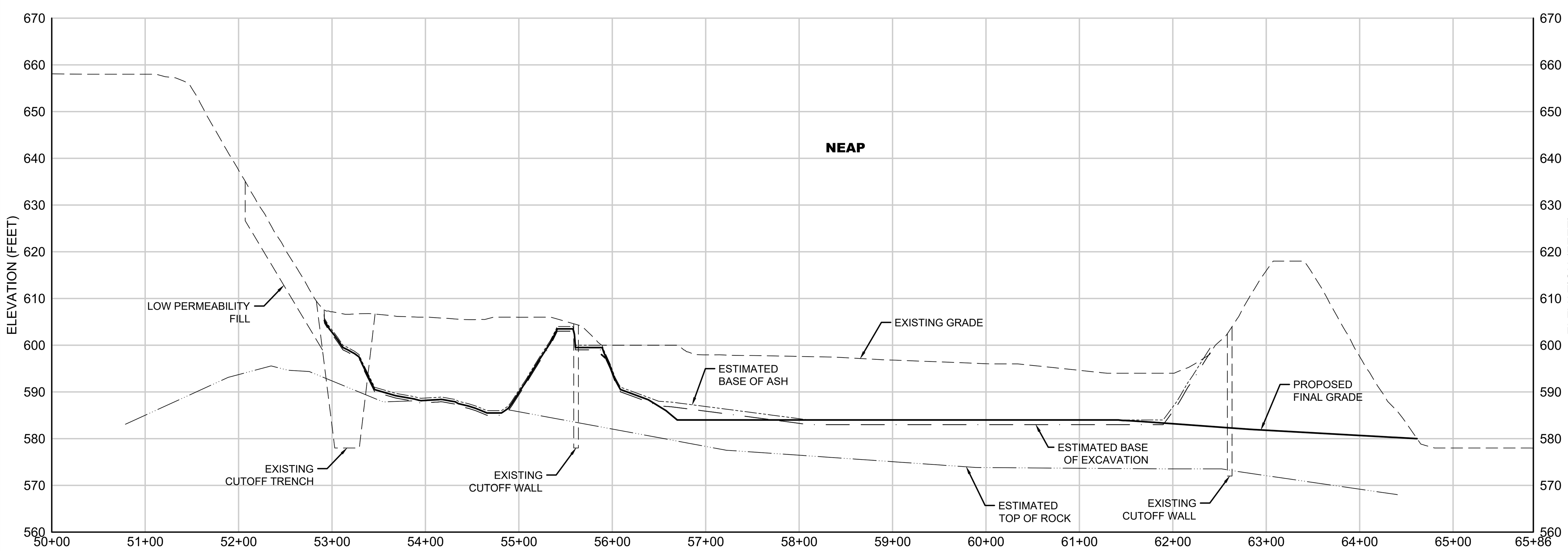
PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	11-CHE8404 C-320
REVIEWED BY:	JPS	DRAWING NO.:	C-320
APPROVED BY:	JPS		

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

1 G-120 SITE ALIGNMENT PROFILE - NAP & OEAP



2 G-140 SITE ALIGNMENT PROFILE - NEAP

NOTES:

1. GROUNDWATER AND PHREATIC SURFACE CONDITIONS SHOWN MAY VARY BASED ON CLIMACTIC AND SEASONAL VARIATIONS. THE CONTRACTOR IS RESPONSIBLE FOR EVALUATING AND CONFIRMING CONDITIONS PRIOR TO AND DURING CONSTRUCTION.
2. EXISTING CUTOFF WALL AND CUTOFF TRENCH LOCATIONS AND ELEVATIONS ARE BASED ON AS-BUILT DRAWINGS.
3. FINAL GRADING AND FINAL SLOPE TIE-INS TO THE PERIMETER WILL BE COMPLETED WITH CONSTRUCTION BID DOCUMENTS.
4. ESTIMATED BASE OF ASH PROVIDED BY OTHERS.

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: SITE ALIGNMENT PROFILES - NAP, OEAP, & NEAP

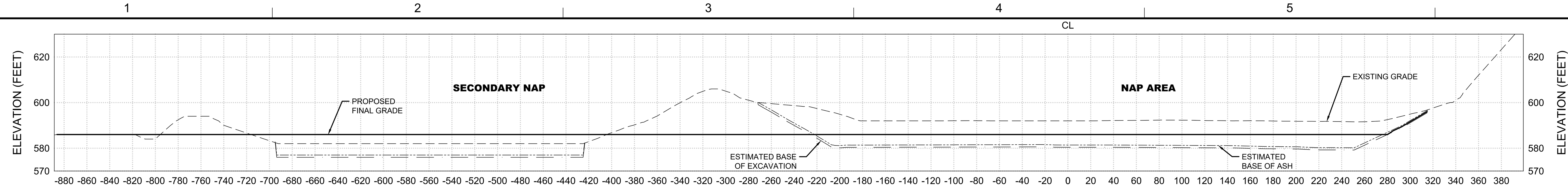
PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

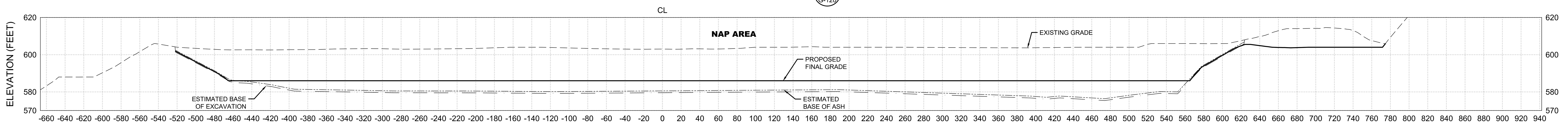
DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	12-CHE8404 C-330
REVIEWED BY:	JPS	DRAWING NO.:	C-330
APPROVED BY:	JPS		

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

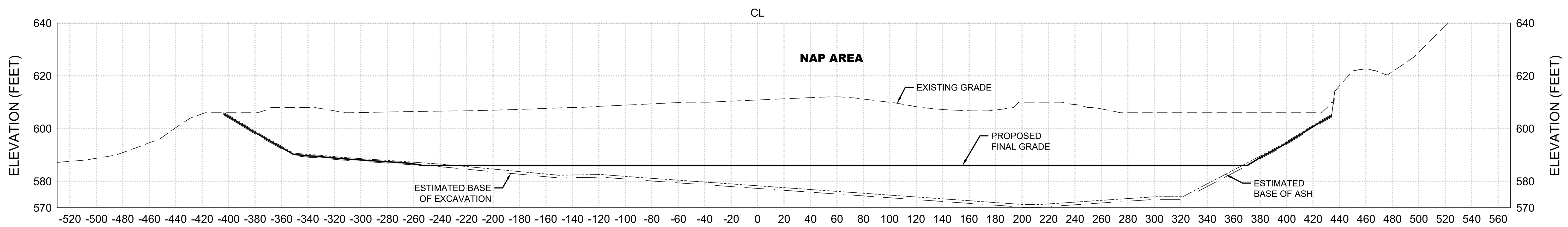
S:\COMPANY\PROJECTS_POST_2014\CHE8404_VPS_CLOSURE_RIA_SPRT\900 - CAD\DRAWINGS\CONCEPTUAL\12-CHE8404 C-330



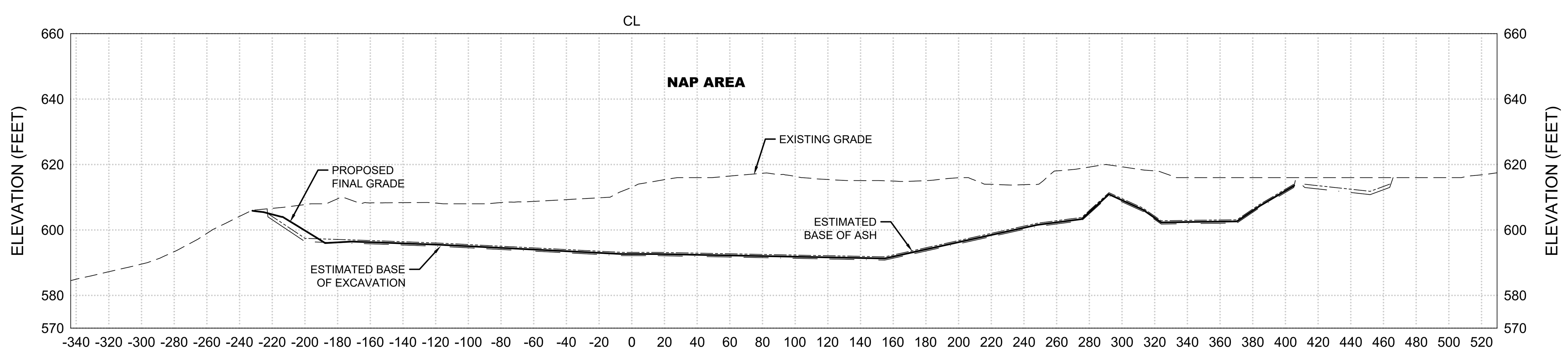
1 STA 3+00 G-120



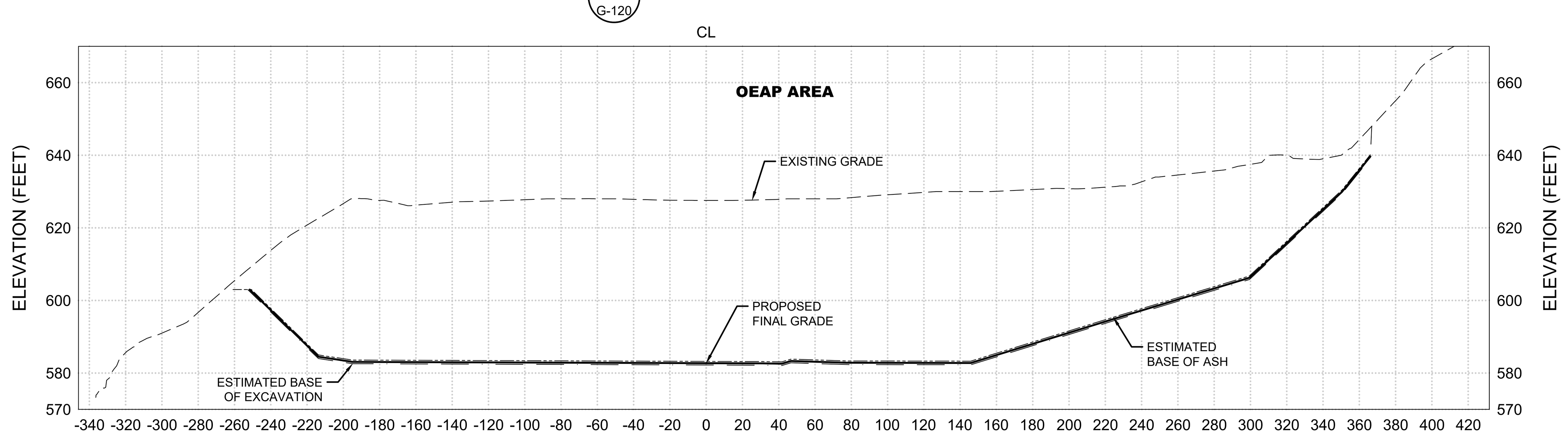
2 STA 8+00 G-120



3 STA 13+00 G-120



4 STA 18+00 G-120



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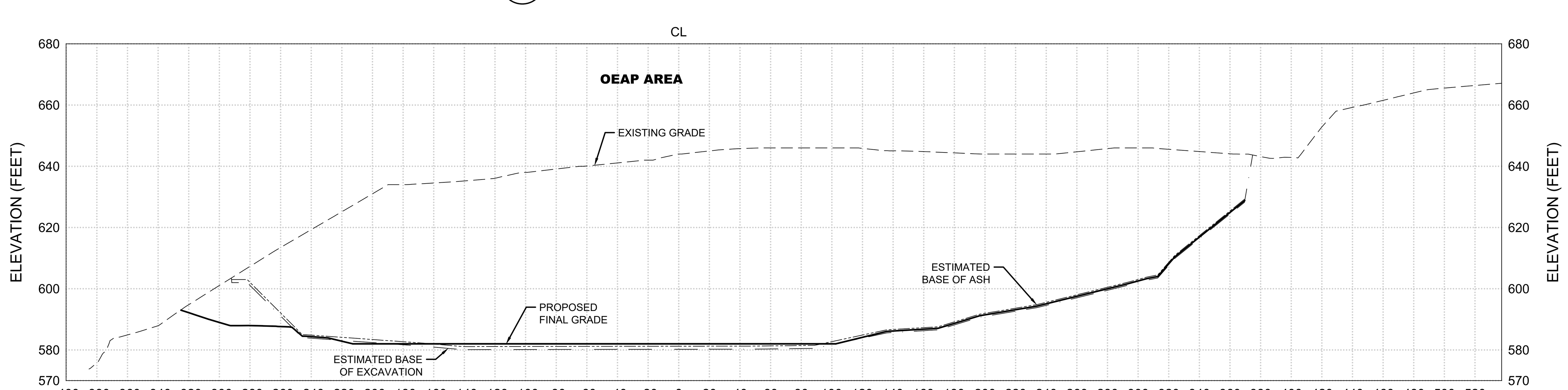


6 STA 29+00 G-130

NOTES:

1. GROUNDWATER AND PHREATIC SURFACE CONDITIONS SHOWN MAY VARY BASED ON CLIMACTIC AND SEASONAL VARIATIONS. THE CONTRACTOR IS RESPONSIBLE FOR EVALUATING AND CONFIRMING CONDITIONS PRIOR TO AND DURING CONSTRUCTION.
2. FINAL GRADING AND FINAL SLOPE TIE-INS TO THE PERIMETER WILL BE COMPLETED WITH CONSTRUCTION BID DOCUMENTS.
3. ESTIMATED BASE OF ASH PROVIDED BY OTHERS.

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

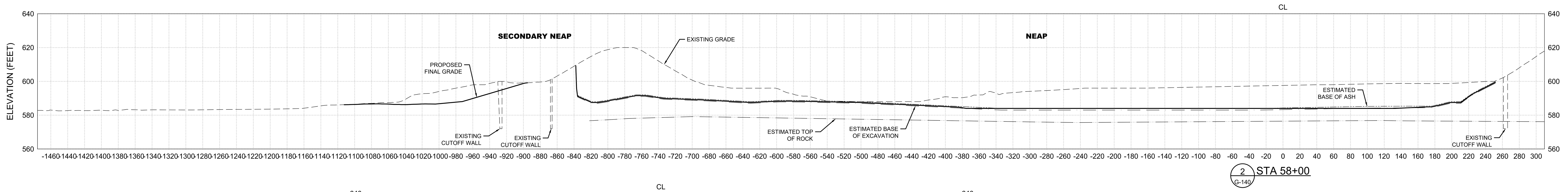
TITLE: SITE SECTIONS - NAP & OEAP

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

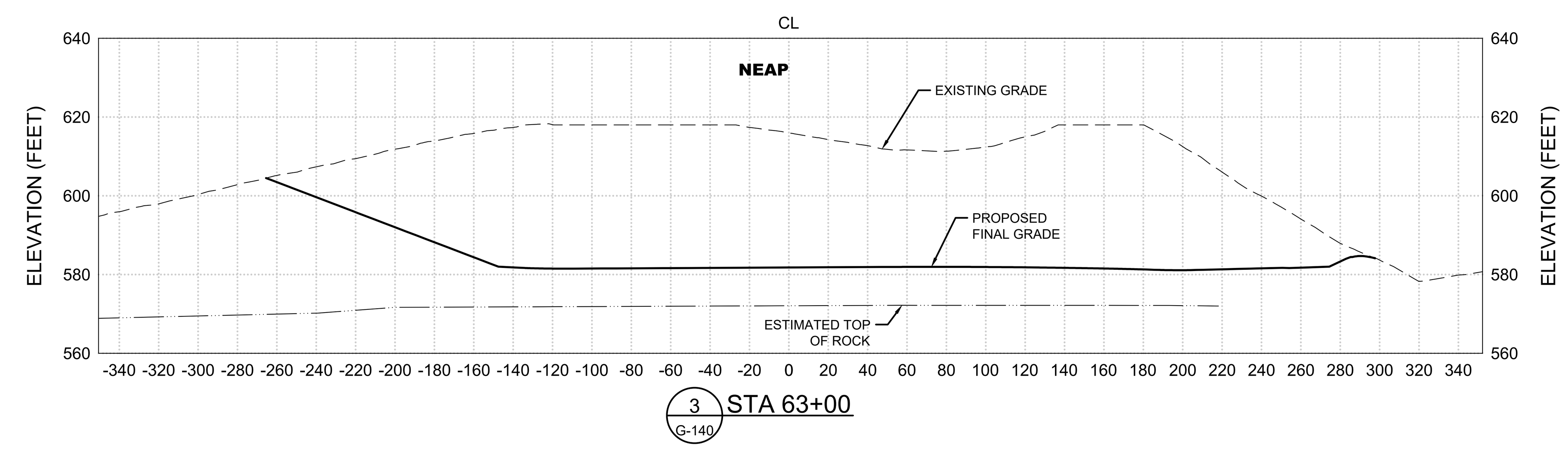
SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	13-CHE8404 C-340
REVIEWED BY:	JPS	DRAWING NO.:	C-340
APPROVED BY:	JPS		

1 STA 54+00
G-140



2 STA 58+00
G-140



3 STA 63+00
G-140

NOTES:

1. GROUNDWATER AND PHREATIC SURFACE CONDITIONS SHOWN MAY VARY BASED ON CLIMACTIC AND SEASONAL VARIATIONS. THE CONTRACTOR IS RESPONSIBLE FOR EVALUATING AND CONFIRMING CONDITIONS PRIOR TO AND DURING CONSTRUCTION.
2. EXISTING CUTOFF WALL AND CUTOFF TRENCH LOCATIONS AND ELEVATIONS ARE BASED ON AS-BUILT DRAWINGS.
3. FINAL GRADING AND FINAL SLOPE TIE-INS TO THE PERIMETER WILL BE COMPLETED WITH CONSTRUCTION BID DOCUMENTS.
4. ESTIMATED BASE OF ASH PROVIDED BY OTHERS.

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

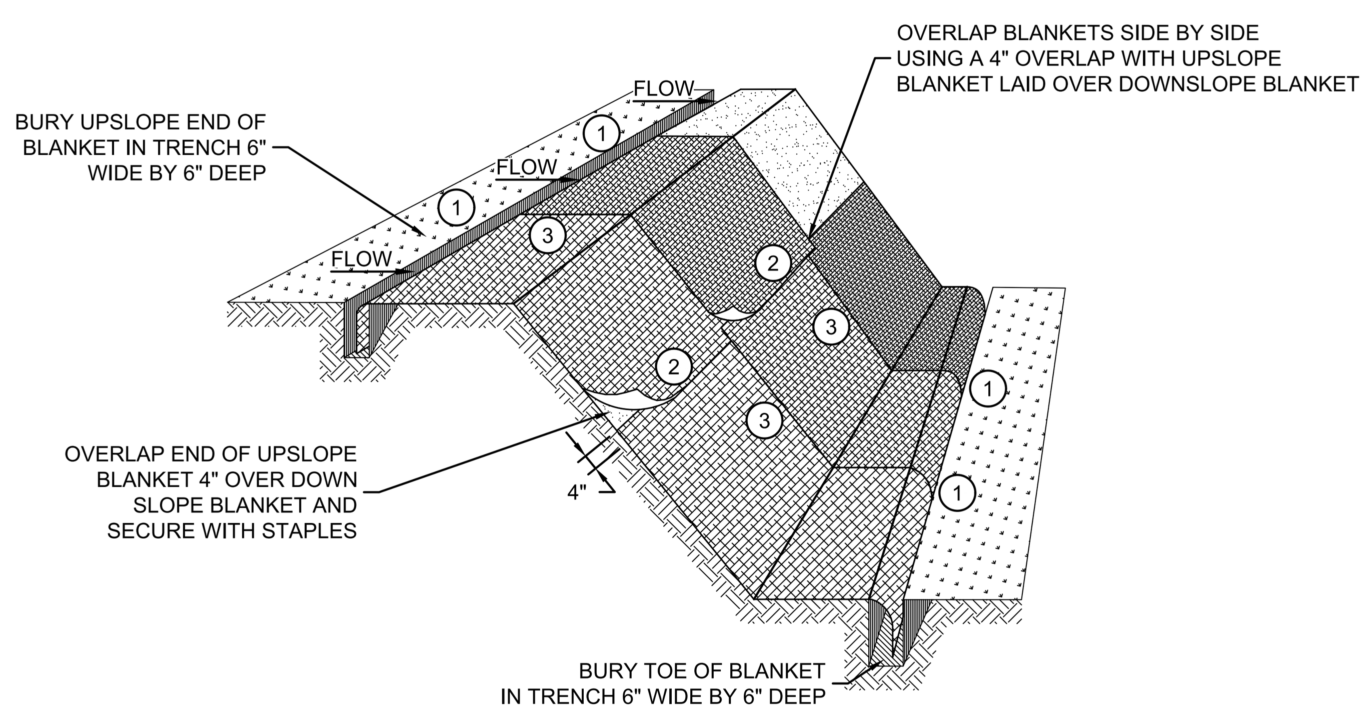
TITLE: SITE SECTIONS - NEAP

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

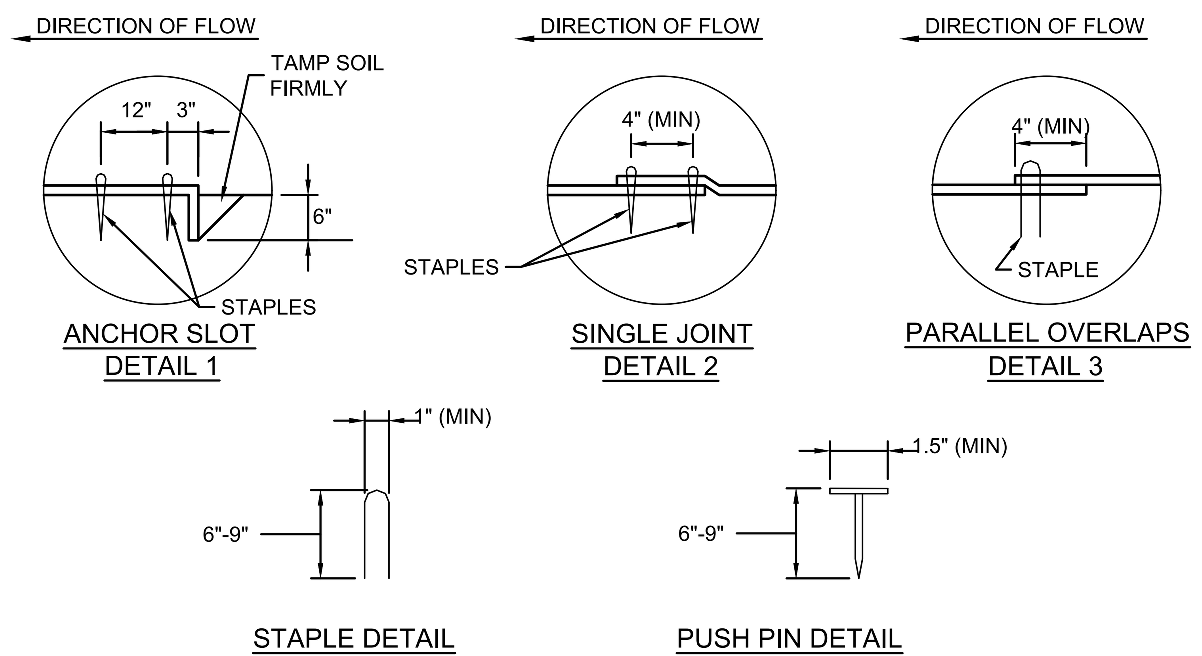
SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	14-CHE8404 C-350
REVIEWED BY:	JPS	DRAWING NO.:	C-350
APPROVED BY:	JPS		

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

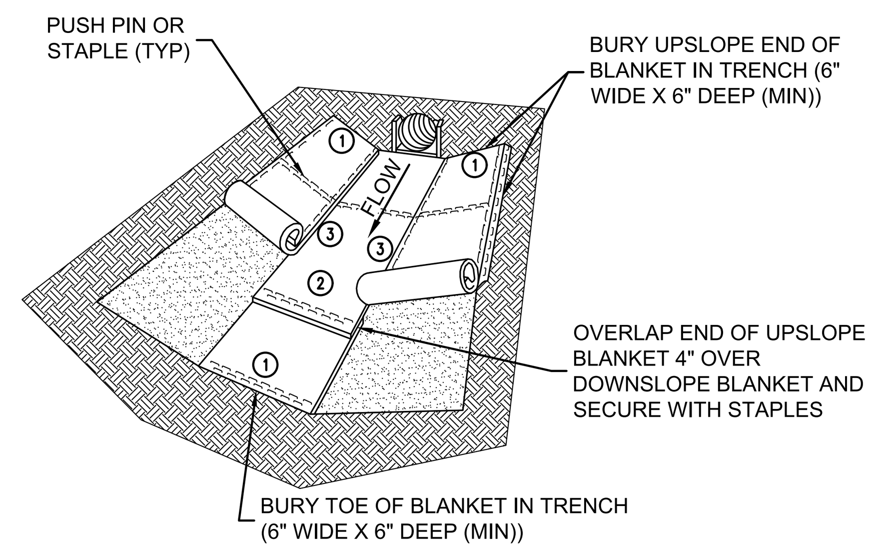


EROSION CONTROL BLANKET INSTALLATION ON SLOPES - GREATER THAN FOUR PERCENT AND STORMWATER CHANNELS



EROSION CONTROL BLANKET ANCHORS AND JOINTS

1 DETAIL
C-500 EROSION CONTROL BLANKET ANCHORS AND JOINTS
SCALE: NTS
XREF: 8404-X001

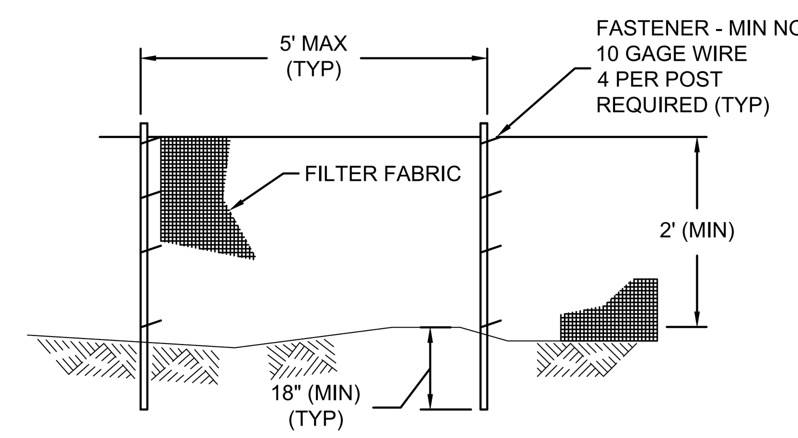


EROSION CONTROL BLANKET DEPLOYMENT

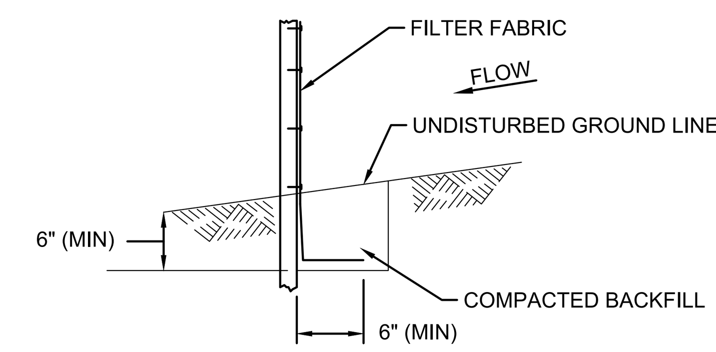
NOTES:

1. STAPLES SHALL BE PLACED IN A DIAMOND PATTERN AT 2 PER S.Y. FOR STICHED BLANKETS. NON-STICHED SHALL USE 4 STAPLES PER S.Y. OF MATERIAL. THIS EQUATES TO 200 STAPLES WITH STICHED BLANKET AND 400 STAPELS WITH NON-STICHED BLANKET PER 100 S.Y. OF MATERIAL.
2. STAPLE OR PUSH PIN LENGTHS SHALL BE SELECTED BASED ON SOIL TYPE AND CONDITIONS. (MINIMUM STAPLE LENGTH IS 6")
3. EROSION CONTROL MATERIAL SHALL BE NORTH AMERICAN GREEN S75BN OR EQUIVALENT FOR OLD WEST ASH POND COVER AND NORTH AMERICAN GREEN SC150BN OR EQUIVALENT FOR EMBANKMENT STABILIZATION AND PLACED IN CONTACT WITH THE SOIL OVER A PREPARED SEEDBED.
4. ALL ANCHOR SLOTS SHALL BE STAPLED AT APPROXIMATELY 12" INTERVALS.

2 DETAIL
C-500 EROSION CONTROL BLANKET
SCALE: NTS
XREF: 8404-X002

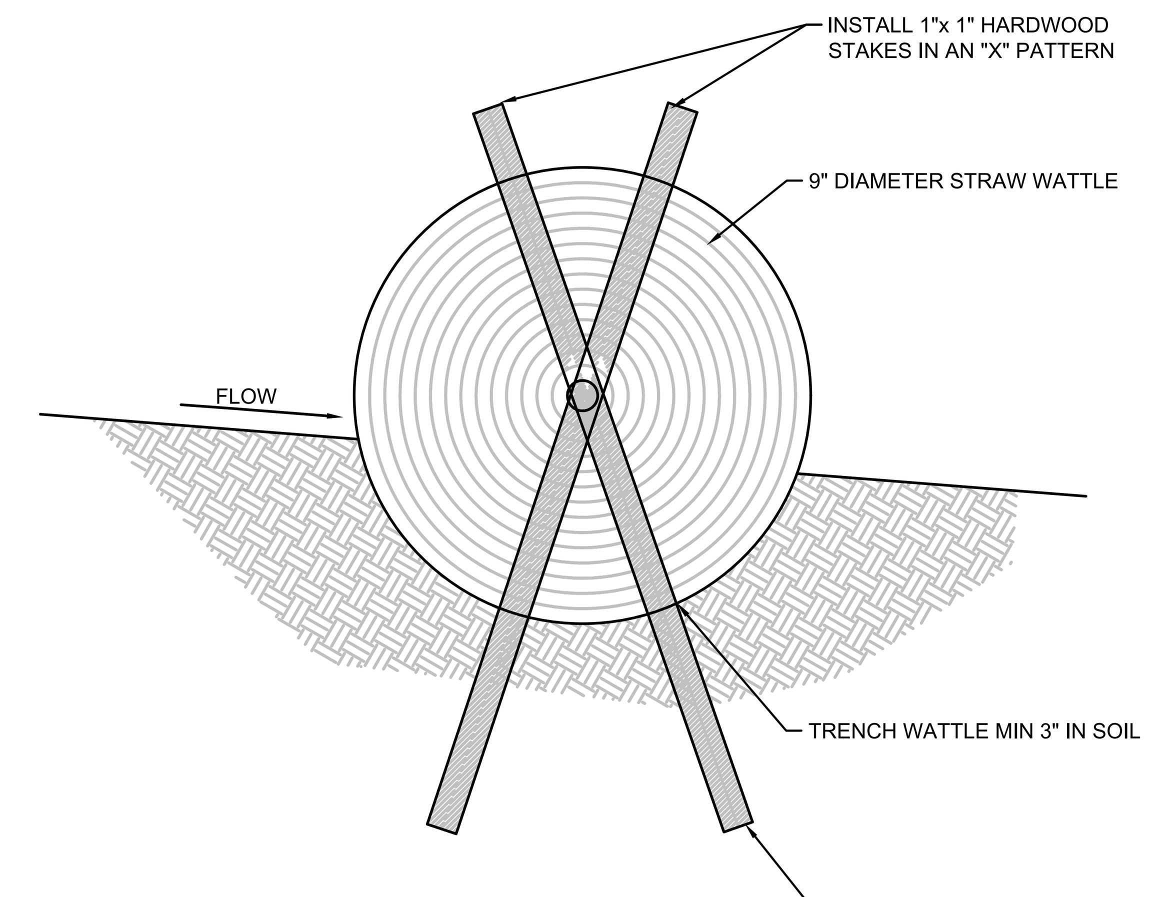


ELEVATION

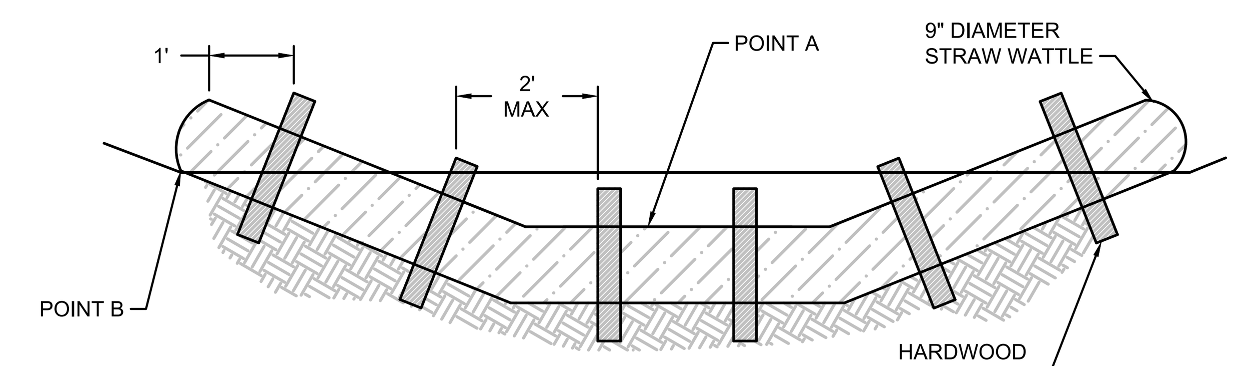


FABRIC ANCHOR DETAIL

3 DETAIL
C-500 SILT FENCE
SCALE: NTS
XREF: 8404-X003



PROFILE

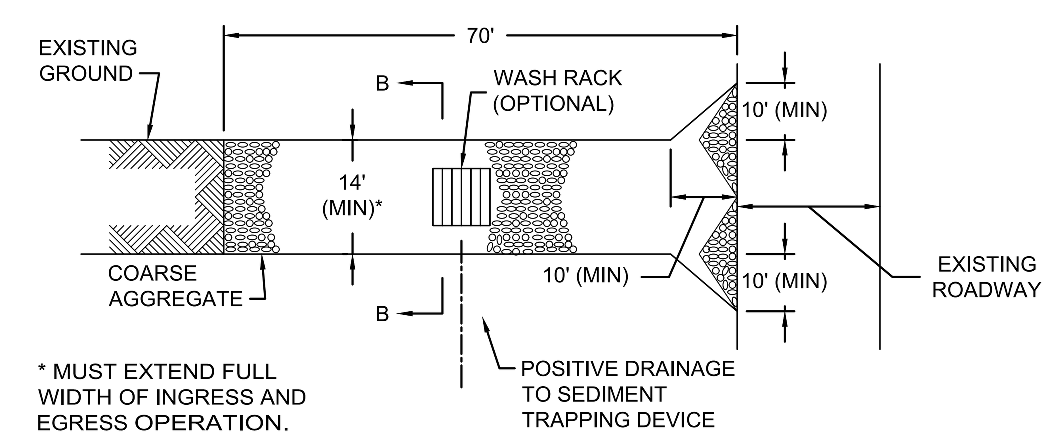


CROSS SECTION

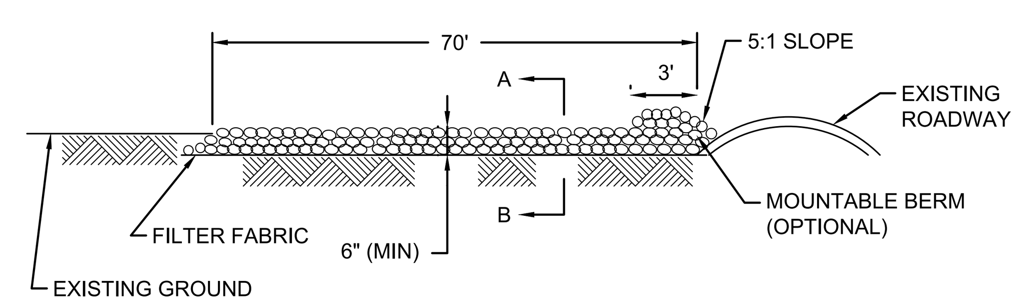
NOTES:

1. CONSTRUCT DITCH CHECK SO THAT "POINT A" IS A MINIMUM OF 3" LOWER THAN "POINT B".
2. PLACE DITCH CHECK PERPENDICULAR TO FLOW LINE OF DITCH.
3. CONSTRUCT DITCH CHECK SO THAT WATER DOES NOT FLOW AROUND THE ENDS OF OR UNDER THE DITCH CHECK.
4. REMOVE ACCUMULATED SEDIMENT WHEN SEDIMENT REACHES ONE-HALF THE HEIGHT OF THE DITCH CHECK.
5. IF ROCKY SOILS PREVENT PROPER INSTALLATION OF WOOD STAKES, CONTRACTOR SHALL PLACE GRAVEL BAGS OVER THE STRAW WATTLE, PERPENDICULAR TO THE STRAW WATTLE, RATHER THAN USING THE WOOD STAKES IN THOSE LOCATIONS. GRAVEL BAGS SHALL BE SPACED MAX 2' ON CENTER.

4 DETAIL
C-500 STRAW WATTLE DITCH CHECK
SCALE: NTS
XREF: 8404-X005



PLAN VIEW

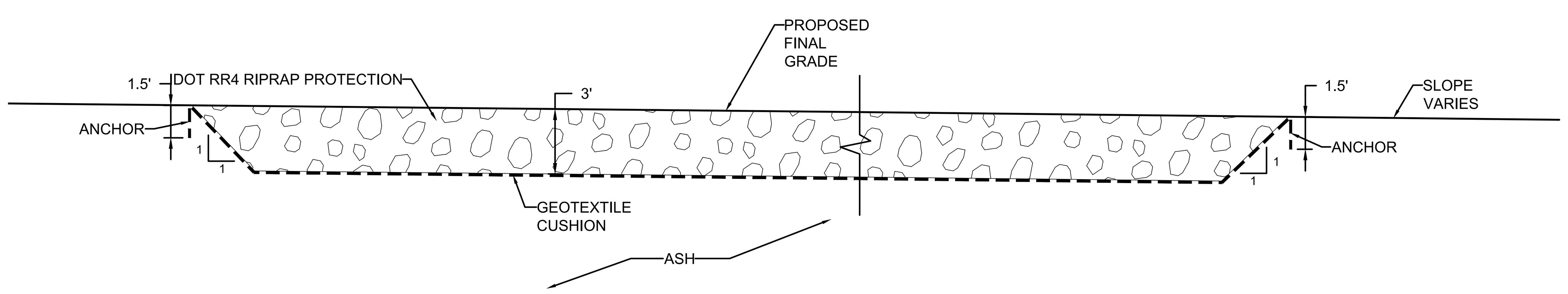


SIDE ELEVATION

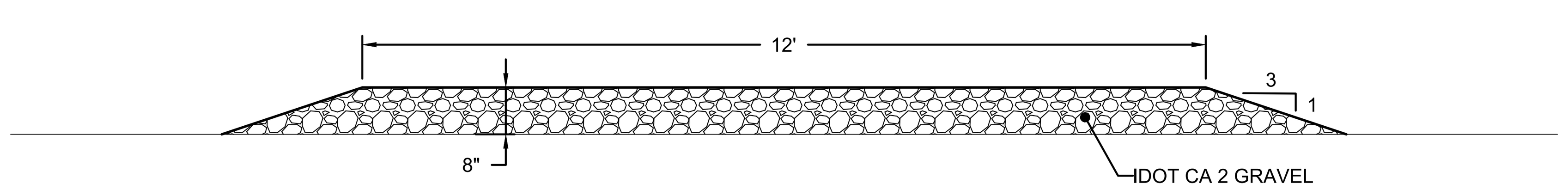
NOTES:

1. FILTER FABRIC SHALL MEET THE REQUIREMENT OF MATERIAL SPECIFICATIONS 592 GEOTEXTILE, TABLE 1 OR 2, CLASS I, II OR IV AND SHALL BE PLACE OVER THE CLEARED AREA PRIOR TO THE PLACING OF ROCK.
2. ROCK OR RECLAIMED CONCRETE SHALL MEET ONE OF THE FOLLOWING IDOT COARSE AGGREGATE GRADATION, CA-1, CA-2, CA-3 OR CA-4 AND BE PLACED ACCORDING TO CONSTRUCTION SPECIFICATION 25 ROCKFILL USING PLACEMENT METHOD 1 AND CLASS III COMPACTION.
3. ANY DRAINAGE FACILITIES REQUIRED BECAUSE OF WASHING SHALL BE CONSTRUCTED ACCORDING TO MANUFACTURER'S SPECIFICATIONS.
4. IF WASH RACKS ARE USED THEY SHALL BE INSTALLED ACCORDING TO THE MANUFACTURER'S SPECIFICATIONS.

6 DETAIL
C-500 STABILIZED CONSTRUCTION ENTRANCE
SCALE: NTS
XREF: 8404-X006



5 DETAIL
C-300 RIPRAP EROSION PROTECTION
SCALE: 1" = 5'



7 DETAIL
C-300 GRAVEL ACCESS ROAD
SCALE: 1" = 5'
XREF: 8404-X004

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: DETAILS

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	JHG	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	15-CHE8404 C-400
REVIEWED BY:	JPS	DRAWING NO.:	
APPROVED BY:	JPS		C-400

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

S:\COMPANY\PROJECTS_POST_2014\CHE8404_VPS_CLOSURE_RA_SPRT\900 - CAD\DRAWINGS\CONCEPTUAL\15-CHE8404 C-400

LEGEND

OHE — OHE	EXISTING OVERHEAD ELECTRIC
	EXISTING TREE LINE
— x — x —	EXISTING FENCE
	EXISTING POWER POLE
	EXISTING GUY WIRE
	EXISTING MANHOLE
	EXISTING 24-INCH HDPE PIPE
	EXISTING MONITORING WELL
	APPROXIMATE LIMITS OF CCR
600	EXISTING TOPO (MAJOR CONTOUR)
598	EXISTING TOPO (MINOR CONTOUR)
600	PROPOSED GRADING (MAJOR CONTOUR)
598	PROPOSED GRADING (MINOR CONTOUR)
SF — SF	SILT FENCE
	POST CONSTRUCTION ACCESS ROADS
	APPROXIMATE EXTENT OF EXISTING GABION BASKETS
	EROSION CONTROL BLANKET
	CONSTRUCTION ENTRANCE
Construction Entrance	SWPPP SIGN
	FLOW DIRECTION

0 100 200
SCALE IN FEET

N

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

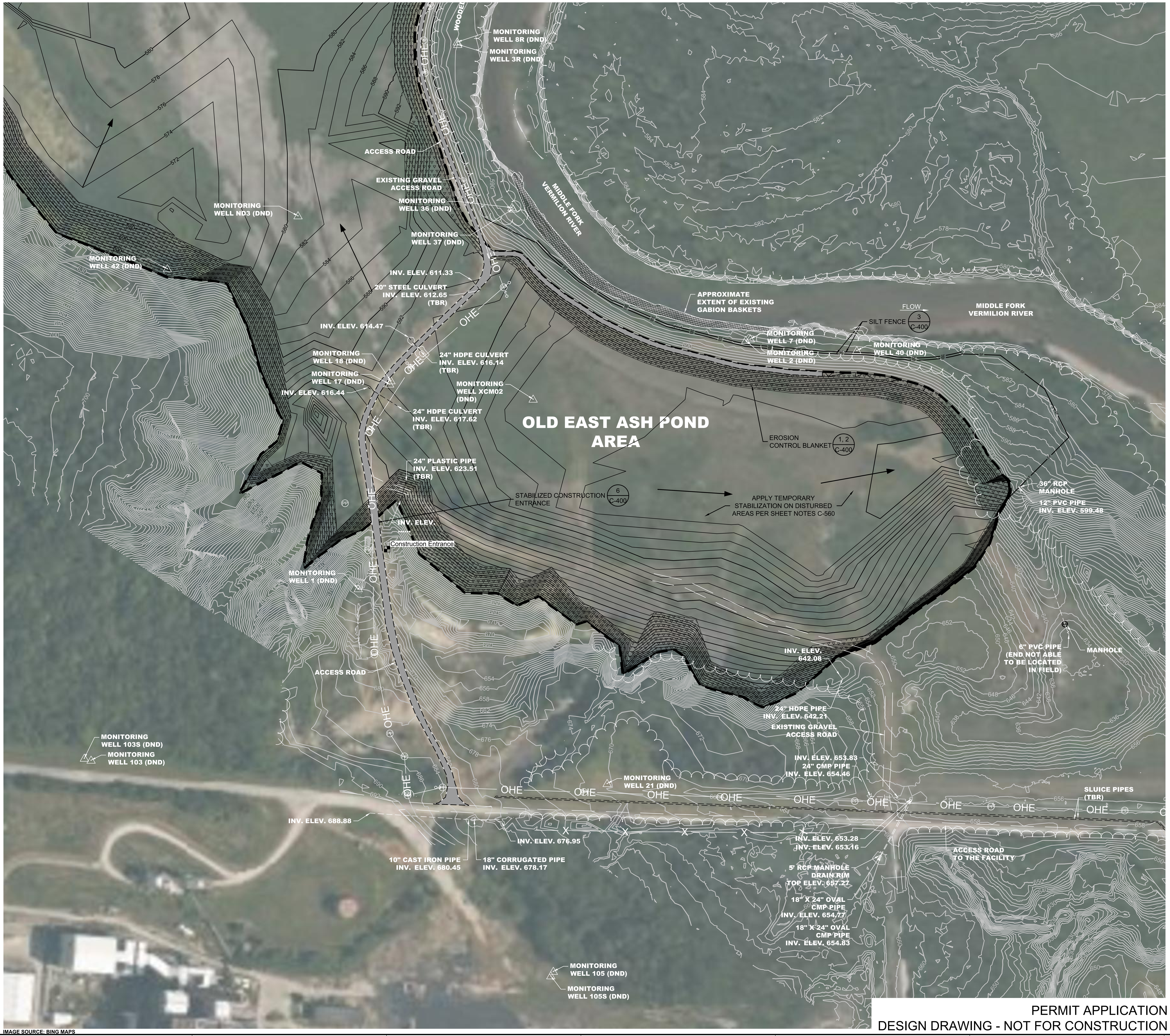
TITLE: NAP SWPPP - EXCAVATION

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	BDH	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	16-CHE8404 C-500
REVIEWED BY:	JPS	DRAWING NO.:	C-500
APPROVED BY:	JPS		

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION



LEGEND

- OHE — EXISTING OVERHEAD ELECTRIC
- EXISTING TREE LINE
- EXISTING FENCE
- EXISTING POWER POLE
- EXISTING GUY WIRE
- EXISTING MANHOLE
- EXISTING 24-INCH HDPE PIPE
- EXISTING MONITORING WELL
- APPROXIMATE LIMITS OF CCR
- 600 — EXISTING TOPO (MAJOR CONTOUR)
- 598 — EXISTING TOPO (MINOR CONTOUR)
- 600 — PROPOSED GRADING (MAJOR CONTOUR)
- 598 — PROPOSED GRADING (MINOR CONTOUR)
- SILT FENCE
- POST CONSTRUCTION ACCESS ROADS
- APPROXIMATE EXTENT OF EXISTING GABION BASKETS
- EROSION CONTROL BLANKET
- CONSTRUCTION ENTRANCE
- SWPPP SIGN
- FLOW DIRECTION

0 100 200
SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: OEAP SWPPP - EXCAVATION

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	BDH	DATE:	JANUARY 2022
DRAWN BY:	BDH	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	16-CHE8404 C-500
REVIEWED BY:	JPS	DRAWING NO.:	C-510
APPROVED BY:	JPS		

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

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LEGEND

- EXISTING OVERHEAD ELECTRIC
- EXISTING TREE LINE
- EXISTING FENCE
- EXISTING POWER POLE
- EXISTING GUY WIRE
- EXISTING MANHOLE
- EXISTING 24-INCH HDPE PIPE
- EXISTING MONITORING WELL
- APPROXIMATE LIMITS OF CCR
- EXISTING TOPO (MAJOR CONTOUR)
- EXISTING TOPO (MINOR CONTOUR)
- PROPOSED GRADING (MAJOR CONTOUR)
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Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: NEAP SWPPP - EXCAVATION

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	BDH	DATE:	JANUARY 2022
DRAWN BY:	TMM	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	16-CHE8404 C-500
REVIEWED BY:	JPS	DRAWING NO.:	C-520
APPROVED BY:	JPS		

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LEGEND

OHE —— OHE	EXISTING OVERHEAD ELECTRIC
	EXISTING TREE LINE
—— X —— X ——	EXISTING FENCE
	EXISTING POWER POLE
	EXISTING GUY WIRE
	EXISTING MANHOLE
	EXISTING 24-INCH HDPE PIPE
△	EXISTING MONITORING WELL
	APPROXIMATE LIMITS OF CCR
600	EXISTING TOPO (MAJOR CONTOUR)
598	EXISTING TOPO (MINOR CONTOUR)
600	PROPOSED GRADING (MAJOR CONTOUR)
598	PROPOSED GRADING (MINOR CONTOUR)
SF —— SF	SILT FENCE
	STRAW WATTLE
	POST CONSTRUCTION ACCESS ROADS
	RIPRAP PROTECTION
	EROSION CONTROL BLANKET
	PERMANENT SEEDING
	CONSTRUCTION ENTRANCE
	SWPPP SIGN
→	FLOW DIRECTION

NOTE:
1. AREAS WITH A SLOPE LESS THAN 1% TO BE VEGETATED WITH WET TO MESIC PLANTS APPROPRIATE TO FINAL HYDROLOGY AND AREAS WITH A SLOPE GREATER THAN 1% TO BE VEGETATED WITH NATIVE BACKGROUND VEGETATIVE COVER.

0 100 200
SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: NAP SWPPP - FINAL GRADING PLAN

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	BDH	DATE:	JANUARY 2022
DRAWN BY:	BDH	PROJECT NO.:	CHE8404
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REVIEWED BY:	JPS	DRAWING NO.:	C-530
APPROVED BY:	JPS		

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LEGEND

- EXISTING OVERHEAD ELECTRIC
- EXISTING TREE LINE
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NOTE:
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Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: OEAP SWPPP - FINAL GRADING

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	BDH	DATE:	JANUARY 2022
DRAWN BY:	BDH	PROJECT NO.:	CHE8404
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REVIEWED BY:	JPS	DRAWING NO.:	C-540
APPROVED BY:	JPS		

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LEGEND

- EXISTING OVERHEAD ELECTRIC
- EXISTING TREE LINE
- EXISTING FENCE
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NOTE:
1. AREAS WITH A SLOPE LESS THAN 1% TO BE VEGETATED WITH WET TO MESIC PLANTS APPROPRIATE TO FINAL HYDROLOGY AND AREAS WITH A SLOPE GREATER THAN 1% TO BE VEGETATED WITH NATIVE BACKGROUND VEGETATIVE COVER.

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Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: NEAP SWPPP - FINAL GRADING

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	BDH	DATE:	JANUARY 2022
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REVIEWED BY:	JPS	DRAWING NO.:	C-550
APPROVED BY:	JPS		

PERMIT APPLICATION
DESIGN DRAWING - NOT FOR CONSTRUCTION

PROJECT NAME AND LOCATION

VERMILION POWER PLANT

VERMILION FLY ASH PONDS CLOSURE

VERMILION COUNTY, ILLINOIS

OWNER NAME AND ADDRESS

DYNEGY MIDWEST GENERATION, LLC

1500 EASTPORT PLAZA DRIVE

COLLINSVILLE, IL 62234

RECEIVING WATERWAY

THE NEAREST RECEIVING WATERWAY IS VERMILION RIVER

DESCRIPTION OF ACTIVITIES

1. THIS SWPPP HAS BEEN PREPARED FOR THE CLOSURE-BY-REMOVAL OF THE NAP, OEAP, AND NEAP, APPROXIMATELY 61 ACRES IN TOTAL.
2. CLOSURE BY REMOVAL WILL CONSIST OF REMOVING BOTH THE IMPOUNDED COAL COMBUSTION RESIDUALS AND THE PERIMETER BERMS AT SELECTION LOCATIONS TO MANAGE NON-CONTACT STORMWATER TO OFFSITE.
3. THE OEAP CONTAINS A COVER OF VEGETATED FILL CONSISTING OF LEAN CLAY, SILTY CLAY, AND SILTY SAND WITH VARYING AMOUNTS OF SAND AND GRAVEL. THE NAP AND NEAP ARE NOT COVERED. THIS COVER SOIL WILL BE EXCAVATED AND STOCKPILED ONSITE FOR FUTURE USE AS BACKFILL FOLLOWING THE REMOVAL OF CCR MATERIALS FROM THE IMPOUNDMENTS.
4. THE EXISTING COAL ASH WILL BE CONSOLIDATED AND REMOVED FROM THE NAP, OEAP, AND NEAP.
5. ALL AREAS AFFECTED BY RELEASES OF CCR FROM THE CCR SURFACE IMPOUNDMENT WILL BE DECONTAMINATED.
6. MOISTURE CONDITIONING MAY BE REQUIRED PRIOR TO HAULING OF CCR MATERIALS. THIS SHALL BE COMPLETED BY WORKING AND DRYING THE CCR MATERIALS TO MEET PLACEMENT AND HAULING REQUIREMENTS.
7. THE VISIBLE CCR WILL BE REMOVED, AS WELL AS ANY PIPES AND DISCHARGE STRUCTURES WITHIN THE SURFACE IMPOUNDMENT. VISUAL OBSERVATIONS WILL BE CONDUCTED TO VERIFY CCR EXCAVATIONS ARE COMPLETED TO THE NATIVE FOUNDATION SOILS OR EMBANKMENT SLOPES.
8. THE COAL ASH WILL BE HAULED TO A LANDFILL THAT MEETS STATE REQUIREMENTS OF IAC PART 811 AND WILL ALSO BE COMPLIANT WITH 40 CFR 257 FOR CCR LANDFILLS.
9. THE EASTERN BERMS THAT DO NOT CONTAIN COAL ASH WILL BE EXCAVATED AT SELECT LOCATIONS TO ALLOW FOR DRAINAGE OF STORMWATER FLOW. THIS MATERIAL WILL BE USED AS LOW PERMEABILITY SOIL OR GENERAL FILL. THE AREA WILL BE GRADED AND/OR BACKFILLED AND VEGETATED WITH NATIVE GRASSES SUITABLE FOR WET SOILS FOLLOWING EXCAVATION OF THE COAL ASH FROM THE NAP AND OEAP. THIS FILL WILL MANAGE NON-CONTACT STORMWATER TO OFFSITE.

GENERAL NOTES

1. A NOTICE OF INTENT SHALL BE SUBMITTED TO THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY (IEPA) BY THE OWNER AND ALL CONSTRUCTION ACTIVITIES SHALL COMPLY WITH THE ILLINOIS GENERAL PERMIT AND THE ILLINOIS URBAN MANUAL.
2. A COPY OF THE STORMWATER POLLUTION PREVENTION PLAN SHALL BE KEPT ON-SITE.
3. A COPY OF THE LETTER OF NOTIFICATION OF COVERAGE ALONG WITH THE GENERAL NPDES PERMIT FOR STORMWATER DISCHARGES FROM CONSTRUCTION SITE ACTIVITIES SHALL BE POSTED IN A PROMINENT PLACE FOR PUBLIC VIEWING.
4. EROSION AND SEDIMENT CONTROL MEASURES ARE TO BE IMPLEMENTED PRIOR TO THE START OF CONSTRUCTION AND MAINTAINED THROUGHOUT CONSTRUCTION.
5. IN ADDITION, CLEARING AND GRUBBING AND GRADING ACTIVITIES ARE TO BE PHASED TO THE EXTENT PRACTICAL TO MINIMIZE THE AMOUNT OF AREA DISTURBED AT ANY GIVEN TIME. THE CONTRACTOR SHALL KEEP A RECORD OF DATES WHEN MAJOR GRADING ACTIVITIES OCCUR, WHEN CONSTRUCTION ACTIVITIES TEMPORARILY OR PERMANENTLY CEASE ON A PORTION OF THE SITE, AND WHEN STABILIZATION MEASURES ARE INITIATED, SHALL BE INCLUDED IN THE PLAN.
6. THE CONTRACTOR SHALL CONDUCT REGULARLY SCHEDULED INSPECTIONS, IN ACCORDANCE WITH THE GENERAL PERMIT, ONCE EVERY SEVEN (7) CALENDAR DAYS AND WITHIN 24 HOURS AFTER ANY STORM EVENT GREATER THAN ½" OF RAIN PER 24-HOUR PERIOD. THE CONTRACTOR SHALL KEEP ALL INSPECTIONS AVAILABLE FOR INSPECTORS IMMEDIATELY UPON REQUEST. AFTER AN INSPECTION, NEW OR MODIFIED CONTROLS MUST BE INSTALLED OR REPAIRED WITHIN SEVEN (7) DAYS OF THE DISCOVERY. THE INSPECTION REPORT IS TO INCLUDE THE FOLLOWING MINIMUM INFORMATION:
   a. INSPECTOR'S NAME, TITLE, AND QUALIFICATIONS (REQUIRED QUALIFICATIONS SPECIFIED IN THE GENERAL PERMIT);
   b. DATE OF INSPECTION;
   c. TOTAL RAINFALL, IF APPLICABLE;
   d. OBSERVATIONS RELATIVE TO THE EFFECTIVENESS OF THE BMPS;
   e. ACTIONS TAKEN AS NECESSARY TO CORRECT THE OBSERVED PROBLEM; AND
   f. LISTING OF AREAS WHERE LAND DISTURBANCES HAVE PERMANENTLY OR TEMPORARILY STOPPED.
7. ALL MATERIAL MANAGEMENT, STORAGE, AND DISPOSAL WILL BE CONDUCTED IN THE MOST PRACTICABLE MANNER TO PREVENT POLLUTION. A SPILL KIT SHOULD BE AVAILABLE ON-SITE WITH APPROPRIATE MEASURES TO CONTROL SPILLS (I.E., OIL ABSORBENT MATERIALS, BROOMS, DUST PAN, ETC.).
8. ALL HAZARDOUS WASTE AND SPILL PREVENTION PROCEDURES AT ALL TIMES SHOULD ADHERE TO APPLICABLE FEDERAL AND STATE REGULATIONS. HAZARDOUS WASTES THAT ARE TRANSPORTED, STORED, OR USED FOR MAINTENANCE, CLEANING, OR REPAIRS SHALL BE MANAGED ACCORDING THE PROVISIONS OF APPLICABLE HAZARDOUS WASTE LAWS AND REGULATIONS. THE CONTRACTOR SHALL CONTACT THE ENGINEER TO DISCUSS PROCEDURES FOR NOTIFICATION OF APPROPRIATE EMERGENCY RESPONSE AGENCIES, AND REGULATORY AGENCIES WHERE A LEAK, SPILL, OR OTHER RELEASE CONTAINING A HAZARDOUS SUBSTANCE OR OIL.
9. EROSION AND SEDIMENT CONTROL MEASURES SHALL BE MAINTAINED AND CLEANED AS NECESSARY TO KEEP THE MEASURES IN EFFECTIVE OPERATING CONDITION, INCLUDING REMOVAL OF EXCESS SEDIMENT AS NECESSARY.

TEMPORARY STABILIZATION

1. FOR ALL DISTURBED AREAS THAT EARTH DISTURBING ACTIVITIES HAVE TEMPORARILY CEASED ON ANY PORTION OF THE SITE AND WILL NOT RESUME FOR A PERIOD EXCEEDING FOURTEEN (14) CALENDAR DAYS, IMPLEMENTATION OF TEMPORARY STABILIZATION MEASURES MUST BE INITIATED WITHIN ONE (1) DAY AND COMPLETED WITHIN FOURTEEN (14) DAYS WITH THE USE OF FAST-GERMINATING ANNUAL GRASS/GRAIN VARIETIES APPROPRIATE FOR SITE SOIL AND CLIMATE CONDITIONS, STRAW/HAY MULCH, WOOD CELLULOSE FIBERS, TACKIFIERS, NETTING AND/OR BLANKETS.
2. PER THE ILLINOIS URBAN MANUAL, SEED SHALL BE EVENLY APPLIED WITH A CYCLONE SEEDER, DRILL, CULTIPACKER SEEDER OR HYDROSEEDER. SMALL GRAINS SHALL BE PLANTED NO MORE THAN ONE INCH DEEP. GRASSES SHALL BE PLANTED NO MORE THAN 1/2 INCH DEEP. RESEED AREAS WHERE SEEDING EMERGENCE IS POOR, OR WHERE EROSION OCCURS, AS SOON AS POSSIBLE.
3. TEMPORARY STABILIZATION IS NOT ACHIEVED SIMPLY THROUGH SEEDING. IN ORDER FOR AN AREA OR CONSOLIDATION AREA TO BE SUFFICIENTLY STABILIZED VIA TEMPORARY STABILIZATION, SEED MUST GERMINATE, GROW AND PROVIDE ADEQUATE VEGETATIVE DENSITY.
4. ALL DISTURBED AREAS ON SLOPES SHALL BE LEFT IN A ROUGHENED CONDITION (I.E., WITH VEHICLE CLEAT MARKS RUNNING PERPENDICULAR TO THE FALL LINE OF THE SLOPE) WHEN TEMPORARY STABILIZATION IS NOT ATTAINABLE TO HELP REDUCE POTENTIAL FOR EROSION.

PERMANENT SEEDING, SOD OR MULCHING

1. FINAL STABILIZATION OF DISTURBED AREAS MUST BE INITIATED WITHIN ONE (1) DAY AND COMPLETED WITHIN FOURTEEN (14) DAYS WHENEVER CLEARING, GRADING, EXCAVATING OR OTHER EARTH DISTURBING ACTIVITIES HAVE PERMANENTLY CEASED ON ANY PORTION OF THE SITE. AT THE COMPLETION OF GROUND-DISTURBING ACTIVITIES THE ENTIRE SITE MUST HAVE PERMANENT VEGETATIVE COVER, MEETING VEGETATIVE DENSITY REQUIREMENTS IN ALL AREAS NOT COVERED BY HARDSCAPE.
2. IN AREAS WHERE FINAL STABILIZATION WILL OCCUR, VEHICLE AND EQUIPMENT ACCESS WILL BE RESTRICTED IN ORDER TO MINIMIZE COMPACTION. IN ADDITION, THE SOIL MAY NEED TO BE CONDITIONED FOR SEEDING OR PLANTING. SEEDED AREAS SHALL BE PROTECTED WITH STRAW MULCH, HYDRAULIC MULCH OR A ROLLED EROSION CONTROL PRODUCT. MULCHING IS ONLY ALLOWED IN AREAS WHERE GRADE IS LESS THAN FOUR PERCENT AND IS NOT DESIGNED FOR CONCENTRATED FLOW, OTHERWISE, ROLLED EROSION CONTROL PRODUCT IS REQUIRED.
3. FINAL SITE STABILIZATION IS ACHIEVED WHEN ALL SOIL DISTURBING ACTIVITIES AT THE SITE HAVE BEEN COMPLETED, AND EITHER OF THE TWO FOLLOWING CONDITIONS ARE MET: (I) A UNIFORM (E.G., EVENLY DISTRIBUTED, WITHOUT LARGE BARE AREAS) PERENNIAL VEGETATIVE COVER WITH A DENSITY OF 70 PERCENT OF THE NATIVE BACKGROUND VEGETATIVE COVER FOR THE AREA HAS BEEN ESTABLISHED ON ALL UNPAVED AREAS AND AREAS NOT COVERED BY PERMANENT STRUCTURES, OR (II) EQUIVALENT PERMANENT STABILIZATION MEASURES (SUCH AS THE USE OF RIPRAP OR GEOTEXTILES) HAVE BEEN EMPLOYED. THIS AREA IS EXCLUSIVE OF AREAS THAT ARE COVERED WITH ROCK (CRUSHED GRANITE, GRAVEL, ETC.) OR LANDSCAPE MULCH, PAVED OR HAVE A BUILDING OR OTHER PERMANENT STRUCTURE ON THEM.

UNWATERING AND/OR DEWATERING

1. THE PROPOSED CLOSURE PLAN WILL REQUIRE PHYSICAL ALTERATIONS TO THE SURFACE IMPOUNDMENTS, INCLUDING REMOVAL OF WATERS FROM THE SURFACE IMPOUNDMENTS. THE CLOSURE CONSTRUCTION ACTIVITIES INCLUDE REMOVAL OF OPEN WATER FROM THE PONDS, REFERRED TO AS "UNWATERING" AND ALSO INCLUDES PARTIAL REMOVAL OF PORE WATER CONTAINED IN ASH-FILLED PORTIONS OF THE SURFACE IMPOUNDMENTS, REFERRED TO AS "DEWATERING". THE NAP CONTAINS WATER IN ITS NORTHERN SECTIONS AND THE NEAP CONTAINS WATER IN ITS EASTERN SECTIONS; EACH HAS EXPOSED COAL ASH ABOVE THE IMPOUNDED WATER LEVEL AND COAL ASH BELOW THE IMPOUNDED WATER. THE OEAP DOES NOT CONTAIN WATER. WATER FROM THE CCR IMPOUNDMENTS ARE REQUIRED TO BE REMOVED AND THE CCR DEWATERED.
2. DISCHARGE OF UNWATERS WOULD OCCUR FROM REMOVAL OF THE FREE SURFACE WATER IN THE NAP AND NEAP. CHANNELS WILL BE CUT INTO THE PONDED ASH IN THE NAP AND NEAP. THESE CHANNELS WILL FACILITATE THE PASSIVE DRAINAGE OF THE MAJORITY OF THE UNWATERS AND SOME SMALLER AMOUNTS OF THE DEWATERS TO A COLLECTION POINT AND THEN PUMPED AND DISCHARGED TO THE SECONDARY PONDS AND THEN TO THE RIVER THROUGH THE NPDES OUTFALLS. DISCHARGE OF DEWATERS WOULD OCCUR FROM REMOVAL OF THE WATER FROM PORE SPACES IN DEPOSITED ASH IN THE SURFACE IMPOUNDMENTS. AFTER THE FREE SURFACE UNWATERS (I.E., STORM WATER) ARE REMOVED FROM THE SURFACE IMPOUNDMENTS AND TO FACILITATE MORE ACTIVE DRAINAGE OF THE DEWATERS, ADDITIONAL CHANNELS WILL BE EXCAVATED INTO THE VALLEY AREAS OF THE PROPOSED EARTHEN COVER GEOMETRY. DEEPER SUMPS MAY BE INSTALLED ALONG SELECTED AREAS OF THE CHANNELS. THE DEWATERS WILL BE DRAINED TO A COLLECTION POINT AND THEN PUMPED AND DISCHARGED TO THE SECONDARY PONDS AND THEN TO THE RIVER THROUGH THE NPDES OUTFALLS. IN NO CASE IS WATER FROM UNWATERING AND/OR DEWATERING ACTIVITIES TO BE PUMPED OFF-SITE WITHOUT BEING PROPERLY TREATED.
3. INTAKE HOSES USED DURING DEWATERING SHALL BE POSITIONED SUCH THAT PUMPING FROM THE BOTTOM OF BASINS, TRENCHES, ETC. IS PREVENTED. WATER DISCHARGED FROM DEWATERING ACTIVITIES MUST DISCHARGE TO A SECONDARY POND TO REMOVE SUSPENDED SOLIDS BEFORE DISCHARGE. SEDIMENT BAGS, INFILTRATION TRENCHES, VEGETATED SWALES, OR FILTER BERMS MAY ALSO BE USED IN ADDITION TO THE SECONDARY PONDS. IN NO CASE SHALL DISCHARGE FROM DEWATERING ACTIVITIES BE DIRECTED OFF-SITE WITHOUT CONTROLS TO MEET PERMIT REQUIREMENTS. SECONDARY CONTAINMENT SHOULD BE USED TO PREVENT THE POTENTIAL LEAK OF CHEMICALS USED DURING DEWATERING, SUCH AS CHEMICALS FOR FLOCCULATION.

EROSION CONTROL BLANKET

1. EROSION CONTROL BLANKETS SHALL BE INSTALLED ON SLOPES MORE STEEP THAN 3H:1V AND AFTER THE SEED BED PREPARATION, FERTILIZING, OR LIMING AND SEEDING IS COMPLETED. THE BLANKET SHALL BE IN FIRM CONTACT WITH THE SOIL AND ALL ROCKS OR SOIL CLODS 1.5 INCHES OR LARGER MUST BE REMOVED PRIOR TO INSTALLATION. BLANKETS SHALL BE ANCHORED PER THE MANUFACTURER'S RECOMMENDATION WITH THE PROPER NUMBER AND SPACING OF STAPLES. THE STAPLES/PINS SHALL BE THE PROPER WIDTH AND LENGTH TO MEET THE MANUFACTURER'S RECOMMENDATIONS.
2. ON SLOPES AND IN FLOW CHANNELS, THE BLANKET SHALL BE UNROLLED UPSTREAM TO DOWNSTREAM PARALLEL TO THE DIRECTION OF FLOW. THE UPSTREAM END OF EACH BLANKET SHALL BE ANCHORED IN A MINIMUM 6-INCH DEEP ANCHOR TRENCH, BACKFILLED, AND COMPACTED. THESE BLANKETS, WHEN LAID SIDE-BY-SIDE, SHALL OVERLAP A MINIMUM OF 4 INCHES.
3. WHEN INSPECTING EROSION CONTROL BLANKETS, CHECK FOR DAMAGE DUE TO WATER RUNNING UNDER THE BLANKET, TENTING OF THE BLANKET, OR IF THE BLANKETS HAVE BEEN DISPLACED BY WIND. ALSO, INSPECT LOCATIONS IN THE FLOW CHANNELS WHERE THE BLANKET TERMINATES AND TRANSITIONS IN ANOTHER BMP FOR EROSION UNDER THE BLANKET. IN ANY AREAS WHERE WATER SEEPED UNDER THE BLANKET, MORE STAPLES MAY BE NEEDED PER GIVEN AREA OR MORE FREQUENT ANCHORING TRENCHES INSTALLED WITH BETTER COMPACTION. IF SIGNIFICANT EROSION HAS OCCURRED UNDER THE BLANKET, GRADING AND RESEEDING MAY ALSO BE NECESSARY. ANY BLANKETS THAT HAVE BEEN DISPLACED WILL NEED TO BE REINSTALLED AND RE-STAPLED.

STOCKPILE MANAGEMENT

1. MATERIALS RESULTING FROM CLEARING AND GRUBBING EXCAVATION OPERATIONS AND OTHER SUCH SOIL STOCKPILES SHALL BE CONSOLIDATED UP SLOPE FROM ADEQUATE SEDIMENTATION CONTROLS. SILT FENCE OR STRAW WATTLE DITCH CHECKS WILL BE USED IN ORDER TO DIVERT, RETAIN, OR DETAIN FLOWS OR OTHERWISE LIMIT EXPOSURE TO AND DISCHARGE FROM STOCKPILES. INACTIVE STOCKPILES SHALL BE STABILIZED IN ACCORDANCE WITH THE SPECIFICATION INDICATED IN TEMPORARY STABILIZATION.

DITCH CHECK

1. MANUFACTURED DITCH CHECKS MUST BE TRENCHED IN 3 INCHES AND STAKED THROUGH THE OUTER MESH MATERIAL AT A 45 DEGREE ANGLE IN THE DIRECTION OF FLOW. IF ROLLED EROSION CONTROL PRODUCTS ARE SPLICED, A MINIMUM OVERLAP EQUAL TO THE DIAMETER OF THE PRODUCT SHALL BE USED.
2. THE CONTROL STRUCTURES MUST BE PLACED PERPENDICULAR TO THE DIRECTION OF WATER FLOW. THERE MUST BE FIRM CONTACT BETWEEN THE BOTTOM OF THE CHECK AND SOIL OR BASE MATERIAL, SUCH AS AN EROSION CONTROL BLANKET. ALL MANUFACTURED DITCH CHECKS MUST BE INSTALLED TO ENSURE THE CENTER OF THE STRUCTURE IS AT LEAST 6 INCHES LOWER THAN OUTSIDE EDGES OF CHECK TO ALLOW WATER TO FLOW OVER THE MIDDLE OF THE DITCH CHECK AND NOT AROUND THE EDGES. EACH MANUFACTURED DITCH CHECK SHALL HAVE A CENTRAL SECTION/PORTION FORMING A HORIZONTAL WEIR AND INCLINED PORTIONS WHICH EXTEND FROM THE WEIR UP THE EMBANKMENT AND THE BACKSLOPE.
3. SEDIMENT SHALL BE REMOVED FROM THE UPSTREAM SIDE OF THE DITCH CHECK WHEN SEDIMENT HAS REACHED ONE-HALF THE HEIGHT OF THE DITCH CHECK. INSPECT ANY FABRIC FOR TEARS, DISLODGING, OR COMPRESSED STRAW AFTER SEDIMENT IS REMOVED AND REPAIR OR REPLACE IMMEDIATELY.

SILT FENCE

1. PER THE ILLINOIS URBAN MANUAL, FENCE POSTS SHALL BE A MINIMUM OF 48 INCHES LONG. WOOD POSTS SHALL BE OF SOUND QUALITY WOOD WITH A NOMINAL CROSS SECTIONAL AREA OF 1.5 X 1.5 INCHES. STEEL POSTS SHALL BE STANDARD T AND U SECTIONS WEIGHING NOT LESS THAN 1.33 POUNDS PER LINEAR FOOT OR OTHER STEEL POSTS HAVING EQUIVALENT STRENGTH AND BENDING RESISTANCE. THE MAXIMUM SPACING SHALL BE 5 FEET. WHEN WIRE OR OTHER FORMS OF APPROVED BACKING ARE USED, THE MAXIMUM SPACING MAY BE INCREASED TO 10 FEET. THE POSTS SHALL BE DRIVEN A MINIMUM OF 18 INCHES INTO THE GROUND OR AS APPROVED BY THE ENGINEER. SPACING MAY NEED TO BE ADJUSTED SO THE POSTS ARE LOCATED IN LOW AREAS WHERE WATER MAY POND. ADDITIONAL POSTS MAY BE REQUIRED A LOW AREAS. THE POSTS SHALL BE INSTALLED, TRENCH BACKFILLED, AND THE SOIL COMPACTED OVER THE FABRIC TO 95%. THE WIRE MESH DOES NOT GET BURIED AND COMPACTED IN THE ANCHOR TRENCH; IT STOPS AT GROUND LEVEL.
2. WIRE FENCE SHALL BE A MINIMUM 14 GAUGE WIRE WITH A MAXIMUM 6-INCH MESH OPENING. THE GEOTEXTILE FABRIC SHALL BE FURNISHED IN A CONTINUOUS ROLL CUT TO THE LENGTH OF THE WIRE FENCE NEEDED TO AVOID SPLICES. WHEN SPLICES ARE NECESSARY, THE FABRIC SHALL BE SPLICED AT A SUPPORT POST AND POSTS TWISTED TOGETHER PER DRAWING SO SILT-LADEN WATER CANNOT ESCAPE AROUND OR BENEATH THE FENCE.
3. THE HEIGHT OF A SILT FENCE SHALL BE A MINIMUM OF 24 INCHES ABOVE THE ORIGINAL GROUND SURFACE. THE SILT FENCE SHALL BE ENTRENCHED TO A MINIMUM DEPTH OF 6 INCHES, WITH AN ADDITIONAL 6 INCHES EXTENDING ALONG THE BOTTOM OF THE TRENCH IN THE UPSLOPE DIRECTION. THE 6 INCH EXTENSION OF FABRIC ALONG THE BOTTOM MAY NEED TO BE CUT WHERE TWO FENCES ARE SPLICED PER THE ABOVE MENTIONED METHOD.
4. THE FILTER FABRIC AND WIRE SUPPORT, IF USED, MUST BE SECURELY FASTENED TO THE UPSLOPE SIDE OF THE POSTS USING HEAVY DUTY WIRE STAPLES AT LEAST ONE INCH LONG OR IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS. THE FABRIC SHALL BE ATTACHED TO THE WIRE SUPPORT TO PREVENT SAGGING OF THE FABRIC.

ROCK PROTECTION

1. RIPRAP PROTECTION SHALL BE LOCATED SO THAT THERE ARE NO BENDS IN THE HORIZONTAL. STONE FOR RIPRAP SHALL CONSIST OF FIELD STONE OR ROUGH UNHEWN QUARRY STONE. THE STONE SHALL BE HARD AND ANGULAR AND OF A QUALITY THAT WILL NOT DISINTEGRATE ON EXPOSURE TO WATER OR WEATHERING.
2. RIPRAP SHALL BE INSPECTED AFTER HEAVY RAIN EVENTS GREATER THAN 0.5 INCHES, TO SEE IF ANY EROSION AROUND OR BELOW THE RIPRAP HAS TAKEN PLACE OR IF STONES HAVE BEEN DISLODGED. MAKE ALL NEEDED REPAIRS IMMEDIATELY TO PREVENT FURTHER EROSION OR SEDIMENT DISCHARGE.

STABILIZED CONSTRUCTION ENTRANCE

1. THE STABILIZED CONSTRUCTION ENTRANCE SHALL HAVE A THICKNESS OF 6 INCHES OR MORE AND BE MADE OF IDOT COARSE AGGREGATE GRADATIONS CA-1. THE CONSTRUCTION ENTRANCE WIDTH SHALL BE A MINIMUM 14 FEET BUT NOT LESS THAN THE FULL WIDTH OF INGRESS OR EGRESS POINTS AND THE LENGTH SHALL NOT BE LESS THAN 70 FEET.
2. FILTER FABRIC SHALL BE USED UNDER THE AGGREGATE TO MINIMIZE THE MIGRATION OF STONE INTO UNDERLYING SOIL BY HEAVY VEHICLE LOADS. PER THE ILLINOIS URBAN MANUAL, THE FILTER FABRIC SHALL MEET THE REQUIREMENTS OF MATERIALS SPECIFICATION 592 GEOTEXTILE TABLE 2 CLASS I.
3. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OF SEDIMENT ONTO PUBLIC RIGHT-OR-WAYS OR STREETS AND MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL AGGREGATE OR OVER TURNING THE EXISTING AGGREGATE WHEN THE VOIDS BETWEEN THE STONES BECOME CLOGGED WITH SEDIMENT. ALL SEDIMENT SPILLED, DROPPED OR WASHED ONTO PUBLIC RIGHT-OF-WAYS MUST BE REMOVED IMMEDIATELY.
4. PER THE ILLINOIS URBAN MANUAL, IF CONDITIONS ON THE SITE ARE SUCH THAT THE VEHICLES TRAVELING OVER THE GRAVEL DO NOT REMOVE THE MAJORITY OF THE MUD, THEN THE TIRES OF the VEHICLES MUST BE WASHED BEFORE ENTERING A PUBLIC ROAD. WASH WATER MUST BE CARRIED AWAY FROM THE ENTRANCE TO A SEDIMENT TRAPPING FACILITY. A WASH RACK MAY BE USED TO MAKE WASHING MORE CONVENIENT AND EFFECTIVE.

PERMIT APPLICATION

DESIGN DRAWING - NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO, ILLINOIS 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: STORMWATER POLLUTION PREVENTION PLAN NOTES

PROJECT: VERMILION POWER PLANT
VERMILION FLY ASH POND CLOSURE

SITE: VERMILION COUNTY, ILLINOIS

DESIGN BY:	BDH	DATE:	JANUARY 2022
DRAWN BY:	BDH	PROJECT NO.:	CHE8404
CHECKED BY:	TWW	FILE:	22-CHE8404 C-560
REVIEWED BY:	JPS	DRAWING NO.:	C-560
APPROVED BY:	JPS		

ATTACHMENT H

Hydrogeologic Site Characterization (845.620)

Intended for
Dynegy Midwest Generation, LLC

Date
October 25, 2021

Project No.
1940100722

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT

NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT VERMILION POWER PLANT NORTH ASH POND AND OLD EAST ASH POND

Project Name	**Vermilion Power Plant North Ash Pond and Old East Ash Pond**
Project No.	**1940100722**
Recipient	**Dynegy Midwest Generation, LLC**
Document Type	**Hydrogeologic Site Characterization Report**
Revision	**FINAL**
Date	**October 25, 2021**

Ramboll
234 W. Florida Street
Fifth Floor
Milwaukee, WI 53204
USA

T 414-837-3607
F 414-837-3608
https://ramboll.com

Nicole M. Pagano
Senior Managing Engineer

Brian G. Hennings, PG
Senior Managing Hydrogeologist

Jake J. Walczak, PG
Senior Hydrogeologist

Eric D. Plante
Geologist

CONTENTS

Executive Summary		**6**
1.	**Introduction**	**12**
1.1	Overview	12
1.2	Part 845 Description	12
1.3	Previous Investigations and Reports	12
1.4	Site Location and Background	13
1.5	Site History and CCR Units	14
2.	**Regional and Site Geology**	**15**
2.1	Topography	15
2.2	Regional Geomorphology	15
2.3	Soils	15
2.4	Regional Geology	16
2.4.1	Regional Unlithified Geology	16
2.4.2	Regional Bedrock Geology	17
2.4.3	Structure	17
2.4.4	Seismic Setting	17
2.4.5	Mining Activities	18
2.5	Site Geology	18
2.5.1	Site Specific Unlithified Geology	18
2.5.2	Fill and CCR	19
2.5.3	Mixed Deposits of the Cahokia Alluvium	20
2.5.4	Alluvial Sand and Gravel with Some Silt	21
2.5.5	Upper Till Unit	22
2.5.6	Glacial Outwash and Re-Worked Glacial Deposits	23
2.5.7	Lower Till Unit	24
2.5.8	Site Specific Bedrock Geology	24
3.	**Regional and Local Hydrogeology**	**26**
3.1	Regional Hydrogeology	26
3.1.1	Unlithified Deposits Hydrogeology	26
3.1.2	Bedrock Hydrogeology	26
3.2	Site Hydrogeology	27
3.2.1	Hydrostratigraphic Units	27
3.2.2	Uppermost Aquifer	29
3.2.3	Potential Migration Pathways	29
3.2.4	Water Table Elevation and Groundwater Flow Direction	29
3.2.4.1	Vertical Hydraulic Gradient	30
3.2.4.2	Impact of Existing Ponds	30
3.2.4.3	Ash Saturation	30
3.2.4.4	Impact of River Stage on Groundwater Flow	31
3.2.5	Hydraulic Conductivity	31
3.2.5.1	Field Hydraulic Conductivity	31
3.2.5.2	Laboratory Hydraulic Conductivity	31
3.2.6	Horizontal Groundwater Gradients and Flow Velocity	32
3.2.6.1	Groundwater Velocity	33
3.2.7	Groundwater Classification	34

3.3	Surface Water Hydrology	34
3.3.1	Climate	34
3.3.2	Surface Waters	34
4.	**Groundwater Quality**	**37**
4.1	Summary of Groundwater Monitoring Activities	37
4.1.1	Groundwater Quality Investigations (1982-2018)	37
4.1.2	Part 845 Well Installation and Groundwater Monitoring	37
4.2	Groundwater Monitoring Results and Analysis	38
4.2.1	Arsenic	39
4.2.2	Beryllium	39
4.2.3	Boron	39
4.2.4	Chromium	40
4.2.5	Cobalt	40
4.2.6	Lead	40
4.2.7	Lithium	40
4.2.8	Molybdenum	41
4.2.9	pH	41
4.2.10	Sulfate	41
4.2.11	Thallium	41
4.2.12	Total Dissolved Solids	42
4.2.13	Radium 226 and 228 Combined	42
5.	**Evaluation of Potential Receptors**	**43**
5.1	Water Well Survey	43
5.2	Surface Water	43
5.3	Nature Preserves, Historic Sites, Endangered/Threatened Species	44
6.	**Conclusions**	**45**
7.	**References**	**47**

TABLES (IN TEXT)

Table A	History of Construction and Operation
Table B	Average Monthly Temperature Extremes and Precipitation for Danville, IL
Table C	2017-2018 Groundwater Monitoring Parameters
Table D	Part 845 Groundwater Monitoring Program Parameters

TABLES (ATTACHED)

Table ES-1	Part 845 Requirements Checklist
Table 2-1	Geotechnical Results
Table 2-2	Ash Analytical Results
Table 2-3	Porewater Analytical Results
Table 2-4	Soil Analytical Results
Table 3-1	Monitoring Well Locations and Construction Details
Table 3-2	Vertical Hydraulic Gradients
Table 3-3	Field Hydraulic Conductivities
Table 3-4	Horizontal Hydraulic Gradients and Groundwater Flow Velocities
Table 4-1	Groundwater Analytical Results
Table 4-2	Groundwater Field Parameters

FIGURES (IN TEXT)

Figure A	Daily Gage Height (feet) January 1, 2017 to July 1, 2021 for USGS Gaging Station 03336645 at the Middle Fork Vermilion River above Oakwood, Illinois.

FIGURES (ATTACHED)

Figure 1-1	Site Location Map
Figure 1-2	Site Map
Figure 2-1	Site Topographic Map
Figure 2-2	Site Topographic Map 1948 Pre-Construction
Figure 2-3	Soil Survey Map
Figure 2-4	Surficial Geologic Deposits
Figure 2-5	Generalized Stratigraphic Column for the Vermilion Area
Figure 2-6	Major Structural Features of Illinois
Figure 2-7	Field Investigation Locations
Figure 2-8	Bottom of Ash Map
Figure 2-9	Geologic Cross Sections A-A’ and A’-A’’
Figure 2-10	Geologic Cross Sections B-B’ and B’-B’’
Figure 2-11	Geologic Cross Sections C-C’ and D-D’
Figure 2-12	Geologic Cross Sections E-E’
Figure 3-1	Monitoring Well Location Map
Figure 3-2	Uppermost Aquifer Groundwater Elevation Contours, March 29, 2021
Figure 3-3	Uppermost Aquifer Groundwater Elevation Contours, April 12, 2021
Figure 3-4	Potential Migration Pathway Groundwater Elevation Contours, March 29, 2021
Figure 3-5	Potential Migration Pathway Groundwater Elevation Contours, April 12, 2021

APPENDICES

Appendix A	Information Pertinent to 35 I.A.C. § 845.220(a)(3)
Appendix B	Boring Logs and Well Construction Logs
Appendix C	Geotechnical Laboratory Reports
Appendix D	Groundwater Elevations and Contour Maps (2017 – 2018)
Appendix E	Field Hydraulic Conductivity Test Data
Appendix F	FEMA Flood Hazard Map

ACRONYMS AND ABBREVIATIONS

§	Section
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
CAP	Corrective Action Plan
CCR	coal combustion residuals
cm/s	centimeters per second
Company Lake	Illinois Power Company Lake
CSM	conceptual site model
DMG	Dynegy Midwest Generation, LLC
ESRI	Environmental Systems Research Institute
ft/day	feet/day
ft/ft	feet per foot
GIS	Geographic Information System
GMP	Groundwater Monitoring Plan
GWPS	Groundwater Protection Standard
HCR	Hydrogeologic Site Characterization Report
HUC	Hydrologic Unit Code
ID	identification
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
ISAS	Illinois State Archaeological Survey
ISGS	Illinois State Geological Survey
ISWS	Illinois State Water Survey
Kelron	Kelron Environmental, Inc.
LGU	Lower Groundwater Unit
Mathes	John Mathes & Associates, Inc.
mg/L	milligrams per liter
MGU	Middle Groundwater Unit
Middle Fork	Middle Fork of the Vermilion River
NAP	North Ash Pond
NAVD88	North American Vertical Datum of 1988
NEAP	New East Ash Pond
NGVD29	National Geodetic Vertical Datum of 1929
NID	National Inventory of Dams
No.	number
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRT	Natural Resource Technology, Inc.
OEAP	Old East Ash Pond
Part 845	Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
pCi/L	picocuries per liter

PMP	potential migration pathway
Ramboll	Ramboll Americas Engineering Solutions, Inc.
SI	surface impoundment
Site	combined area including NAP and OEAP
SSURGO	Soil Survey Geographic
TDS	total dissolved solids
USDI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VPP	Former Vermilion Power Plant

EXECUTIVE SUMMARY

This Hydrogeologic Site Characterization Report (HCR) for the North Ash Pond (NAP) and Old East Ash Pond (OEAP) expands upon the hydrogeology, groundwater quality data, and conceptual site model (CSM) in previous hydrogeologic investigation reports prepared for the NAP and OEAP (Kelron Environmental, Inc. [Kelron], 2012a; Kelron, 2012b). This report has been assembled to satisfy the information and analysis requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) Section (§) 845.620 as summarized in **Table ES-1**. The CSM includes hydrogeologic and groundwater quality data specific to the NAP/OEAP, which has been collected between 1983 and 2021. The NAP/OEAP are part of the Former Vermilion Power Plant (VPP) which is located four miles northeast of the Village of Oakwood in Vermilion County (**Figure 1-1**).

The VPP property is situated in a predominantly agricultural area. The VPP is bound by fallow fields owned by the Illinois Department of Natural Resources (IDNR) to the north, the Middle Fork of the Vermilion River (Middle Fork) to the east, the Kickapoo State Recreation Area to the south, and steep bluffs that include the Orchid Hill National Heritage Landmark to the west. The Orchid Hill National Heritage Landmark is partially within the VPP's property boundary but is administered by IDNR. Three coal combustion residuals (CCR) Units are present on the VPP property including the NAP (Vistra identification [ID] number [No.] 910, Illinois Environmental Protection Agency [IEPA] ID No. W1838000002-01), OEAP (Vistra ID No. 911, IEPA ID No. W1838000002-03), and New East Ash Pond (NEAP; Vistra ID No. 912, IEPA ID No. W1838000002-04, and National Inventory of Dams (NID) No. IL50291). The three units are inactive with plans for closure by removal at the NAP/OEAP.

In addition to the CCR present in the NAP and OEAP, there are five layers of unlithified material present above the bedrock, which were categorized into hydrostratigraphic units in this report. Underlying the constructed CCR unit, the six (including bedrock) hydrostratigraphic units in descending order are:

- **Upper Unit:** clayey sands to sandy clays of the Cahokia Alluvium which are the uppermost unit in the Middle Fork bottomlands.
- **Middle Groundwater Unit (MGU):** alluvial deposits of coarser grained material encountered at the base of the Cahokia Alluvium. This unit is laterally continuous below the NAP and OEAP and is designated as the uppermost aquifer.
- **Upper Confining Unit:** a low permeability till composed of clay with isolated sand lenses. This unit is present both below the NAP and OEAP, and in the uplands, and limits vertical migration of groundwater.
- **Lower Groundwater Unit (LGU):** glacial outwash and re-worked glacial deposits of the Henry Formation is the lowermost, laterally extensive coarse grained unlithified deposit identified beneath the Site and in the uplands. Based on permeability and continuous lateral extent, this unit is identified as a potential migration pathway (PMP).
- **Lower Confining Unit:** composed of silty or sandy clay with isolated sand lenses and is the lowermost unlithified deposit. Low permeability unit limits vertical migration of groundwater.
- **Bedrock Confining Unit:** lowermost unit identified at the site and underlies all unlithified deposits. This unit occurs within Pennsylvanian shale which is the uppermost lithified unit at the Site.

Groundwater flow direction and gradients have not changed significantly since the first hydrogeologic study of the NAP/OEAP was completed in 1983, and recent data supports the existing CSM which has been refined to incorporate additional data as follows:

- The NAP/OEAP overlies the Upper Unit in most areas of the Site, with the exception of the northern portion and western boundary of the NAP, where the Upper Unit is absent.
- Groundwater migrates within high permeability sands and gravels of the MGU and LGU that flow to the east under normal river conditions. There is the potential for short duration and temporary flow direction reversal during periods of high river stage.
- Groundwater flows into the Middle Fork through the MGU and LGU, which are the primary pathways that contaminant migration could occur. Upward gradients measured in the underlying shale bedrock indicate that the Middle Fork is a regional discharge area.
- Vertical gradients measured between the bedrock, LGU, and MGU are generally upward near the Middle Fork, indicating that it is a regional discharge area.

Part 845 parameters were monitored in the MGU (*i.e.,* uppermost aquifer) and LGU (*i.e.,* PMP) monitoring wells at the NAP and OEAP as part of the groundwater quality investigations performed between 1988 and 2018. The totals analytical data collected from 2017 to 2018 was supplemented with installation and sampling of additional wells in 2021. The results indicate that the following parameters were greater than the applicable 35 I.A.C. § 845.600 groundwater protection standards (GWPSs):

- Arsenic – at downgradient wells 02, 03R, 07R, 08R, 34, 37, 38, and 40; intermediate well 18; and upgradient wells 21, 42, 43, 44, 101, 102, 103, 104, and 105.
- Beryllium - at upgradient well 105.
- Boron - at downgradient wells 03R, 04, 05, 07R, 08R, 36, 40, and 41; at intermediate wells 17 and 18; and at upgradient wells 01, 101, and 104.
- Chromium- at downgradient well 07R; at upgradient well 105.
- Cobalt- at downgradient well 07R; at upgradient well 105.
- Lead- at downgradient well 07R; at upgradient well 105
- Lithium - at downgradient wells 04, 05, 07R, 08R, 36, and 40; at intermediate well 18; and at upgradient wells 01 and 105.
- Molybdenum - at downgradient wells 03R, 07R, 08R, and 36.
- pH – at downgradient well 40.
- Sulfate - at downgradient wells 03R, 07R, 08R, 36 and 40; at intermediate wells 17 and 18; and at upgradient wells 01 and 104.
- Thallium – at downgradient well 40.
- Total Dissolved Solids (TDS) - at downgradient wells 02, 03R, 07R, 08R, 36, and 40; at intermediate wells 17 and 18; and at upgradient well 01.
- Radium 226 and 228 combined- at downgradient well 07R; and at upgradient well 105.

Concentration results for the above parameters were compared directly to 35 I.A.C. § 845.600 GWPSs to determine potential exceedances. Potential exceedances include results reported during the background groundwater monitoring or prior period that are greater than the GWPS. The results are considered potential exceedances because the results were compared directly to the standard and did not include an evaluation of background groundwater quality or utilize the statistical methodologies proposed in the groundwater monitoring plan (GMP) provided in the Operating Permit application. Exceedances will be determined following IEPA approval of the GMP and issuance of an operating permit.

TABLE ES-1. PART 845 REQUIREMENTS CHECKLIST

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT

VERMILION POWER PLANT

NORTH ASH POND AND OLD EAST ASH POND

OAKWOOD, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in HCR
845.620(b)	**The hydrogeologic site characterization shall include but not be limited to the following:**	
845.620(b)(1)	Geologic well logs/boring logs;	Table 3-1 Figure 3-1 Appendix B
845.620(b)(2)	Climatic aspects of the site, including seasonal and temporal fluctuations in groundwater flow;	Sections 3.2.2 & 3.3.1 Figures 3-2 to 3-5
845.620(b)(3)	Identification of nearby surface water bodies and drinking water intakes;	Sections 3.3.2 & 5.2 Appendix A
845.620(b)(4)	Identification of nearby pumping wells and associated uses of the groundwater;	Section 5.1 Appendix A
845.620(b)(5)	Identification of nearby dedicated nature preserves;	Section 5.3 Appendix A
845.620(b)(6)	Geologic setting;	Section 2 Figures 2-1 to 2-5
845.620(b)(7)	Structural characteristics;	Section 2.4.3 Figure 2-6
845.620(b)(8)	Geologic cross-sections;	Figures 2-9 through 2-12
845.620(b)(9)	Soil characteristics;	Section 2.3 Figure 2-3
845.620(b)(10)	Identification of confining layers;	Section 3.2.1

TABLE ES-1. PART 845 REQUIREMENTS CHECKLIST
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in HCR
845.620(b)(11)	Identification of potential migration pathways;	Section 3.2.1.2
845.620(b)(12)	Groundwater quality data;	Section 4.2 Table 4-1
845.620(b)(13)	Vertical and horizontal extent of the geologic layers to a minimum depth of 100 feet below land surface, including lithology and stratigraphy;	Section 2.5 Figures 2-9 to 2-15
845.620(b)(14)	A map displaying any known underground mines beneath a CCR surface impoundment;	Section 2.4.5 Appendix A
845.620(b)(15)	Chemical and physical properties of the geologic layers to a minimum depth of 100 feet below land surface;	Section 2.5 Tables 2-1, 2-2, & 2-4 Appendices A & C
845.620(b)(15)(A)	Hydraulic characteristics of the geologic layers identified as migration pathways and geologic layers that limit migration, including:	Sections 3.2.1, 3.2.1.1 & 3.2.1.2 Tables 3-2 to 3-4 Appendices C & F
845.620(b)(15)(B)	water table depth;	Section 3.2.2 Figures 3-3 to 3-5
845.620(b)(15)(C)	hydraulic conductivities;	Section 3.2.6 Table 3-3 Appendix F
845.620(b)(15)(D)	effective and total porosities;	Sections 2.5 & 3.1 Table 2-1
845.620(b)(15)(E)	direction and velocity of groundwater flow; and	Sections 3.2.2, 3.2.3 & 3.2.4 Tables 3-2 & 3-4 Figures 3-3 to 3-5

TABLE ES-1. PART 845 REQUIREMENTS CHECKLIST
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in HCR
845.620(b)(16)	map of the potentiometric surface;	Figures 3-2 to 3-5
845.620(b)(17)	Groundwater classification pursuant to 35 I.A.C. § 620; and	Section 3.2.7

[O: EDP 07/15/21; U: LDC 09/21/21; C: EDP 10/06/21]

Notes:
35 I.A.C. § 620 = Title 35 of the Illinois Administrative Code, Part 620
HCR = Hydrogeologic Characterization Report
-- = reference to main regulation

1. INTRODUCTION

1.1 Overview

In accordance with requirements of the Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: 35 I.A.C. § 845 (Part 845) (IEPA, April 15, 2021), Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this HCR on behalf of the VPP (**Figure 1-1**), operated by Dynegy Midwest Generation, LLC (DMG). This report will apply specifically to the CCR Units referred to as the NAP and OEAP. However, information gathered to evaluate other CCR units at the VPP regarding geology, hydrogeology, and groundwater quality is included, where appropriate. The 41-acre NAP is an expansion of the 21.3-acre OEAP. The southern end of the NAP overlies the northern end of the OEAP. Both are inactive, unlined CCR surface impoundments (SIs) that were used to manage CCR and non-CCR waste streams and to clarify process water prior to discharge in accordance with the plants National Pollutant Discharge Elimination System (NPDES) permit (IL0004057) at the VPP. This HCR includes Part 845 content requirements specific to 35 I.A.C. § 845.620(b) (Hydrogeologic Site Characterization) for the NAP and OEAP at the VPP.

1.2 Part 845 Description

Part 845 contains comprehensive rules for the design, construction, operation, corrective action, closure, and post closure care of SIs containing CCR. CCR is commonly referred to as coal ash, and CCR SIs are commonly referred to as coal ash ponds. This rule includes GWPSs applicable to each CCR SI at the waste boundary and requires each owner or operator to monitor groundwater. IEPA's rule includes a permitting program as well as all federal standards for CCR SIs promulgated by the United States Environmental Protection Agency (USEPA). In addition, the rules include procedures for public participation, closure alternatives analyses, and closure prioritization, and provides access to records via public website. The rules also include financial assurance requirements for CCR SIs.

A checklist which identifies the specific requirements of 35 I.A.C. § 845.620 is included in **Table ES-1**. The table provides references to sections, tables, and figures included in this document to locate the information that meets specific requirements of 35 I.A.C. § 845.620.

1.3 Previous Investigations and Reports

Numerous hydrogeologic investigations have been performed concerning the CCR Units located at the VPP. The information presented in this HCR includes data collected in support of the monitoring well network established for development of the GMP and supplements comprehensive data collection and evaluations from prior hydrogeologic investigation reports (recent to oldest), including, but not limited to, the following:

- ***Kelron, March 15, 2012. Hydrogeology and Groundwater Quality of the North Ash Pond System, Dynegy Midwest Generation, Inc., Vermilion Power Station, Oakwood, Illinois.***
  A hydrogeologic investigation report prepared to provide background information needed to develop a Corrective Action Plan (CAP) for the NAP and OEAP at the VPP. The primary objective of the report was to present the result of the investigation of the hydrogeology and groundwater quality in the vicinity of the NAP and OEAP.

- ***Kelron, March 15, 2012. Hydrogeology and Groundwater Quality of the Old East Ash Pond, Dynegy Midwest Generation, Inc., Vermilion Power Station, Oakwood, Illinois***
  A hydrogeologic investigation report prepared to provide background information needed to develop a CAP for the NAP and OEAP at the VPP. The primary objective of the report was to present the result of the investigation of the hydrogeology and groundwater quality in the vicinity of the NAP and OEAP.
- ***Natural Resource Technology, Inc. (NRT) and Kelron, June 15, 2009. Water Well Survey, Dynegy Midwest Generation, Inc., Vermilion Power Station, Oakwood, Illinois.***
  A water well survey was performed in accordance with the “Right to Know” Potable Water Well Survey procedures of 35 I.A.C. § 1600.210(b)(1) and 35 I.A.C. § 1600.210(b)(2). The purpose of the survey was to identify water wells located within 2,500 feet of DMG’s VPP property boundary.
- ***Kelron, November 30, 2003. Regional and Local Hydrogeology and Geochemistry, Vermilion Power Plant, Illinois. Volumes 1 and 2.***
  A comprehensive regional and local hydrogeologic and geochemical report to characterize the site, specifically in the vicinity of the NEAP, and support a planned expansion of the primary cell of the NEAP.
- ***Atlantic Environmental Services, Inc., March 1994. Ash Impoundment Closure Study, Results of Field Studies at Two Illinois Power Company Ash Impoundments.***
  A closure study report to evaluate the relative effectiveness of different closure designs for the Havana Power Plant and VPP ash impoundments.
- ***John Mathes & Associates, Inc. (Mathes), July 13, 1987., Hydrogeologic Investigation of Existing Ash Disposal Ponds, Vermilion Power Plant, Illinois Power Company, Oakwood, Illinois.***
  A hydrogeological report to obtain information concerning subsurface conditions at the site to make recommendations concerning location and construction of the new ash pond system for the VPP (Kelron, 2003).
- ***Mathes, April 19, 1983. Preliminary Hydrogeologic Study, Proposed Ash Pond Site, Vermilion Power Station, Illinois Power Company, Oakwood, Illinois.***
  A preliminary hydrogeologic study to obtaining general hydrogeologic conditions at the VPP concerning location and construction of the new ash ponds considering the IEPA draft regulations for Class III Landfill sites.
- ***Mathes, April 11, 1983. Hydrogeologic Study, Existing Ash Ponds, Vermilion Power Station, Illinois Power Company, Oakwood, Illinois.***
  A preliminary hydrogeologic study to obtaining general hydrogeologic conditions at the VPP concerning location and construction of the new ash ponds considering the IEPA draft regulations for Class III Landfill sites.

A GMP is being prepared for the NAP and OEAP in conjunction with this report.

1.4 Site Location and Background

The VPP is located in east central Illinois in Vermilion County, approximately five miles northeast of the Village of Oakwood, located within Section 20, Township 20 North, Range 12 West (**Figure 1-1**). The VPP is an approximately 982-acre property consisting of 19 parcels, including a retired coal-fired power plant and SIs. The VPP ceased operations in 2011 when the power plant was retired.

The NAP and OEAP, which are the subject of this HCR, are located adjacent to each other in the northern portion of the VPP. The NAP is bordered to the north by fallow fields owned by IDNR, to the east by the Middle Fork, to the south by the OEAP, and to the west by steep bluffs that include the Illinois Department of Conservation designated Orchid Hill Natural Heritage Landmark, which is partially within the VPP property boundary but is administered by IDNR. The OEAP is bordered to the north and northeast by the Middle Fork; to the southeast, south, and west by steep bluffs; and to the northwest by the NAP. The NAP and OEAP are both located on terraces adjacent to the Middle Fork, which is bordered to the east and west by steep bluffs.

Figure 1-2 depicts the location of the inactive NAP and OEAP. The combined area including the NAP and OEAP will hereinafter be referred to as the Site.

1.5 Site History and CCR Units

All ash ponds at the VPP are out of service. Until the coal pile was substantially removed in March 2011, the NAP received inflows from coal-pile runoff. The NPDES-permitted outfalls to the Middle Fork are still in effect; however, the only flows from the NAP and OEAP are during significant periods of precipitation and controlled releases via Outfall 001, usually occurring once or twice a year.

The 41-acre NAP is an expansion of the 21.3-acre OEAP. The southern end of the NAP overlies the northern end of the OEAP. The OEAP was built as part of the original plant construction and put into service in the mid-1950's. The OEAP continued in operation until the NAP was constructed and put on-line in the mid-1970's. The NAP was utilized for sluiced coal ash disposal from the mid-1970's to 1989-1990, at which time all ash disposal was diverted to the NEAP. The NEAP was expanded in 2002.

The NAP was originally designed and operated for coal ash sedimentation and control. The pond received plant process wastewater, sluiced coal ash, and stormwater runoff from the pond embankments. Treated process wastewater was discharged through an overflow outlet structure.

The approximate dates of construction of VPP CCR Units, are summarized in **Table A** below.

Table A. History of Construction and Operation

Date	Event
mid-1950's	Construction of OEAP
mid-1970's	Construction of NAP; CCR disposal to OEAP ceased
1989-1990	Construction of original East Ash Pond (1989 pond footprint), CCR disposal at NAP ceased
2002	Embankment raised to expand the capacity of the East Ash Pond (1989 pond footprint) in 2002, forming the footprint of the present-day NEAP.
2011	CCR disposal to NEAP ceased

2. REGIONAL AND SITE GEOLOGY

Historic NAP and OEAP hydrogeologic and groundwater quality data was presented in the 2012 hydrogeologic investigation reports (Kelron, 2012a; Kelron, 2012b) and used to establish a CSM. Significant portions of the results of the 2012 hydrogeologic investigation reports are included in this HCR, along with supplemental information (including information sourced from previous investigations and reports identified in **Section 1.3** of this HCR) and updated as needed to satisfy the content requirements specific to 35 I.A.C. § 845.620(b).

2.1 Topography

Topography in the vicinity of the Site (**Figure 2-1**) ranges from approximately 580 feet North American Vertical Datum 1988 (NAVD88) along the Middle Fork east of the Site to approximately 720 feet NAVD88 in the upland areas to the west. The uplands are fairly uniform in elevation. They generally occur between the elevations of 650 and 720 feet NAVD88 in the vicinity of the VPP. For the purposes of this report, slopes (elevations 600 to 650 feet National Geodetic Vertical Datum of 1929 [NGVD29]) between the uplands and lowlands are also considered upland areas. The lowland areas along the Middle Fork lie between elevations of 580 and 600 feet NGVD29.

Prior to the construction of the ponds, the existing surface topography within the lowlands was relatively flat with elevations ranging from 560 to 570 feet NAVD88 at the NAP and 580 to 590 feet NAVD88 at the OEAP (**Figure 2-2**) with drainage toward the Middle Fork (Kelron, 2012a; Kelron, 2012b).

2.2 Regional Geomorphology

The VPP is located within Vermilion County, which has an area of about 577,030 acres or 901 square miles (Natural Resources Conservation Service [NRCS], 2009). The physiographic division in the region of the Site is 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 (NRT, 2017).

2.3 Soils

Surficial soils at the Site are shown on **Figure 2-3** and based on Vermilion County soil survey data available in the Soil Survey Geographic (SSURGO) by the United States Department of Agriculture's NRCS provided by Environmental Systems Research Institute (ESRI) web hosted layer. Soils underlying the Site are primarily Orthents (loamy, undulating) and to a lesser extent Ozaukee silt loam (30 to 70 percent slopes) underlying the areas southeast of the OEAP and west of the NAP and OEAP along the boundary between the lowlands and upland bluffs. Other surficial soils in the vicinity of the Site west of the Middle Fork include Blount silt loam, Shaffton loam, Ozaukee silt loam, Orthents loam, and Landes fine sandy loam.

2.4 Regional Geology

2.4.1 Regional Unlithified Geology

The unlithified deposits covering the bedrock in the region surrounding the Site are derived from recent river deposition (alluvial sediments) in the river valleys and glacial drift deposits occurring below the alluvial sediments and in the upland areas. The glacial and interglacial geologic events that shaped the topography seen today occurred during the Pleistocene Epoch, about 2 million to 12,000 years ago. Thickness of these deposits in the region range from zero thickness along portions of the Middle Fork where bedrock is exposed to over 200 feet in the upland areas (Piskin and Bergstrom, 1975).

At least three major glaciations (pre-Illinoisan, Illinoisan, and Wisconsin) are known to have entered the east-central Illinois region (Selkregg and Kempton, 1958). Each glaciation was followed by an interglacial period in which the climate warmed and the ice front moved back. The surficial features seen in the upland areas are part of the Gifford Moraine, which was formed during the Woodfordian Substage of the Wisconsinan Stage of glaciation (Willman and Frye, 1970).

Based on stack-unit maps of geologic materials to a depth of 15 meters (49.3 feet) prepared by Berg and Kempton (1988), the lowlands adjacent to the Middle Fork are characterized by the following downward sequence of unlithified deposits:

- Less than 6 meters (19.7 feet) of Cahokia Alluvium (*i.e.,* alluvial sediments deposited by streams and rivers).
- Less than 6 meters of Henry Formation deposits of Wisconsinan age, which consist of glacial outwash dominated by sand and gravel.
- Less than 6 meters of Glasford Formation deposits of Illinoisan age, which consist of silty and clayey diamictons.

Diamicton is unsorted, non-stratified sediment with a wide range of particle sizes (*i.e.,* clay, silt, sand, gravel, cobbles, and boulders). When diamicton is due to glacial deposition it is known as till. The diamictons in the vicinity of the Site are till deposits characterized by a clay matrix containing variable percentages of silt, sand, gravel, cobbles, and boulders.

The unlithified deposits of the upland areas bordering the Middle Fork are characterized by the following downward sequence:

- Greater than 6 meters (19.7 feet) of Wedron Formation deposits of Wisconsinan age, which consist of silty and clayey diamictons; and
- Less than 6 meters of Glasford Formation silty and clayey diamictons (Berg and Kempton, 1988).

Unlithified deposits greater than 15 meters (49.3 feet) below ground surface (bgs) are not identified in the stack-unit maps but based on published literature the Glasford Formation deposits either extend to the top of bedrock or are underlain by the Banner Formation of pre-Illinoisan age (*i.e.,* greater than 500,000 years of age). The Banner Formation, which consists of till and intercalcated outwash where present, is draped over the bedrock surface and is generally deepest where the bedrock is deepest.

The surficial geologic deposits in the vicinity of the Site are shown on **Figure 2-4** and a generalized stratigraphic column is shown on **Figure 2-5**.

2.4.2 Regional Bedrock Geology

The VPP and vicinity are located on the northeast flank of the Illinois Basin. The bedrock strata are of Pennsylvanian age and dip gently southwestward toward the center of the Basin. The Site lies approximately 3 miles west of the central axis of the Danville Bedrock Valley, which is oriented northwest to southeast and midway between the Middle Fork and North Fork of the Vermilion River (Selkregg and Kempton, 1958). Regionally, the Pennsylvanian bedrock consists of mainly shale with thin limestone, sandstone, and coal beds (Selkregg and Kempton, 1958). The bedrock surface elevation in the vicinity of the Site is between 500 and 600 feet NGVD29 (Willman et al., 1967). The rocks were originally deposited as unlithified sediments in coastal marshes or in shallow seas that repeatedly formed in the area. The shale was originally deposited as clay, while coal was formed from plants buried in the coastal swamps. Sandstone was deposited as sand and the limestone was formed by precipitation of carbonates and by accumulation of seashells on the sea floor (Selkregg and Kempton, 1958).

After the Pennsylvanian sediments were deposited, the seas retreated, and the upper part of the bedrock was deeply eroded. During the Pleistocene epoch, continental glaciers advanced from the north and overrode the eroded bedrock surface (Selkregg and Kempton, 1958), leaving the glacial deposits that mantle the area today.

The principal formations within the Pennsylvanian bedrock in the region are, from upper to lower, the Bond, Shelburn, and Carbondale Formations. In the vicinity of the VPP, the principal formation is the Shelburn, which contains a major coal seam mined in the region, the Danville (No. 7) Coal. Based on the Kelron (2003) investigation of the hydrogeology in the vicinity of the New East Ash Pond at the VPP, the upper zone of the shale is moderately weathered at the surface at most of locations. Otherwise, the shale is massive with very few horizontal joints or partings. Some near vertical joints were observed near the surface but were typically irregular and closed.

2.4.3 Structure

The major geologic structural features around Illinois are shown on **Figure 2-6.** The VPP is located within a relatively stable region of the continent on the east flank of the Illinois Basin. Rock units to the west of the Site form the La Salle Anticlinorium where folds are expressed in synclines, anticlines, arches, and monoclines present in the area (Nelson, 1993; Nelson, 1995) and can change local dip and strike of bedrock units (Nelson, 1995). Rock units to the south of the Site form the Marshal-Sidell Syncline a north-trending depression between the La Salle Anticlinorium and the east flank of the Illinois Basin (Nelson, 1995). The syncline is expressed by relatively steep irregular dips west of the syncline and gentle dips to the east of the syncline (Nelson, 1995).

2.4.4 Seismic Setting

Seismic impact zone is defined by the Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257.53 as an area having a 2 percent or greater probability that the maximum expected horizontal acceleration (g), expressed as a percentage of the earth's gravitational pull, will exceed 0.10 g in 50 years. The 2014 United States Geological Survey (USGS) Hazard Map for the CCR Unit indicates that the maximum expected horizontal acceleration for 2 percent probability of exceedance in 50 years is between 0.06g and 0.1g. In addition, the 2018 USGS National

Seismic Hazard Map also describes the project's region as an area with the "low risk level" of seismic hazard (Geosyntec, 2021).

2.4.5 Mining Activities

A survey to identify historic mining activities was conducted for a 1,000-meter radius of the NAP and OEAP as shown and tabulated in **Appendix A**. Based on the directory of coal mines for Vermilion County (Illinois State Geological Survey [ISGS], 2021), the nearest coal mines in the vicinity of the NAP and OEAP are immediately adjacent to the east and southeast of the OEAP (**Figure A-1**). All identified coal mines in the vicinity of the NAP and OEAP mined Danville (No. 7) Coal. The Danville (No. 7) Coal has been mined extensively in the region both as surface (strip) mines and underground mines. With the exception to the Harmattan Mine (Mine ID 0673), an abandoned surface mine owned by Ayrshire Coal Company, Inc., a Division of AMAX and located approximately 0.5 miles southeast of the OEAP, all mines within a 1,000-meter radius of the NAP and OEAP were identified as underground (subsurface) mines. The Harmattan Mine operated between 1949 and 1970 at depths between 70 to 102 feet bgs to mine a coal seam thickness ranging from approximately 5 to 7 feet. The following abandoned subsurface mines were identified in the survey: Crawford Mine (Mine ID 3889, 300 feet east of the OEAP), Middle Fork Coal Company Mines ([Mine ID 3888, located approximately 0.3 miles southeast of the OEAP, and Mine ID 3891, located approximately 0.6 miles southeast of the OEAP]), Calvert Mine (Mine ID 3893, located approximately 0.4 miles south of the OEAP), Pilot Mine (Mine ID 3890, located approximately 0.5 miles southeast of the OEAP), and Homer Fletcher Mine (Mine ID 6534, located approximately 0.5 miles south of the OEAP).

The Crawford Mine (Mine ID 3889) and Middle Fork Company Mine (Mine ID 3888) are located beneath the NEAP and vicinity (Kelron, 2003) (**Figure A-2**). The former entrance to the Crawford Mine (Mine ID 3889), owned by W.F. Crawford & Sons, was located in the field (Kelron, 2003). Crawford Mine (Mine ID 3889) is a slope mine with the main coal seam (the Danville, or No. 7 Coal) located between the depths of 80 and 92 feet bgs. The average thickness of the main coal seam is approximately 5.5 feet (Kelron, 2003). The Middle Fork Coal Company Mine (Mine ID 3888) operated from 1939 to 1948 using a room-pillar method whereby the coal is removed in 'rooms' with 'pillars' of coal left in place to support the roof (Kelron, 2003), removing approximately 7,633 tons of coal during operation (**Appendix A**). To varying degrees, these mining activities have altered the natural topography, hydrology, surface water chemistry, and groundwater chemistry that existed in the area before mining began (Kelron, 2003).

An oil and gas well survey was also conducted for a 1,000-meter radius around the Site. Based on records obtained from ISGS, there are no oil or gas wells located within a 1,000-meter radius of the VPP property.

2.5 Site Geology

A field investigation was performed in 2021 to collect additional data for the discussion of vertical and horizontal lithology, stratigraphy, chemical properties, and physical properties of geologic layers to a minimum of 100 feet bgs as specified in 35 I.A.C. § 845.620(b). Field investigation locations are shown on **Figure 2-7**.

2.5.1 Site Specific Unlithified Geology

The six principal types of unlithified materials overlying bedrock present at the VPP consist of the following in descending order:

- **Fill and CCR:** (identified as Layer 1 [Kelron, 2012a; Kelron, 2012b]) CCR 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 compositions of CCR and re-worked native silt and clay.
- **Mixed deposits of the Cahokia Alluvium:** including silt deposits (identified as Layer 2a [Kelron, 2012a; Kelron, 2012b]) sand and gravel deposits with some intermittent silt (identified as Layer 2b [Kelron, 2012a; Kelron, 2012b]) clay and silty clay (identified as Layer 3 [Kelron, 2012a; Kelron, 2012b]).
- **Alluvial sand and gravel with some silt:** (identified as Layer 4 [Kelron, 2012a; Kelron, 2012b]).
- **Upper Till Unit:** Wedron Formation till, including diamicton, consisting of clay and silty clay with occasional sand lenses (identified as Layer 5 and Layer 7, respectively [Kelron, 2012a; Kelron, 2012b]).
- **Glacial outwash and re-worked glacial deposits:** with sand, silty sand, and clayey sand predominating (identified as Layer 6 [Kelron, 2012a; Kelron, 2012b]).
- **Lower Till Unit:** Glasford Formation till, consisting of primarily clay, silty clay, and sandy clay with occasional sand lenses (identified as Layer 8 [Kelron, 2012a; Kelron, 2012b]).

2.5.2 Fill and CCR

The CCR contained within the NAP and OEAP consist predominantly of fly ash with lesser amounts of bottom ash and slag. Based on the 2012 hydrogeologic investigations borings into the NAP, only fly ash deposits were intercepted, whereas some intervals of bottom ash and slag were intercepted in the OEAP, although the CCR in the OEAP were still predominantly fly ash. Average and median thickness of CCR measured within the combined areas of the NAP and OEAP are 27 and 24 feet, respectively, based on comparisons between the topographic surface (**Figure 2-1**) within the NAP and OEAP and an approximate base of ash surface provided by Geosyntec (**Figure 2-8**) developed using all available boring log data through the 2021 field investigation (**Appendix B**). The maximum thickness of CCR encountered was approximately 39 feet in the NAP along the south and west portion of the NAP along the bluff area, and approximately 65 feet in the southeastern portion of the OEAP based on comparisons between the topographic (**Figure 2-1**) and approximate base of ash surfaces (**Figure 2-8**).

The elevation at the top of the fill layer estimated from the topographic surface (**Figure 2-1**) within the limits of the NAP and OEAP (**Figure 2-8**) is highest towards the southeast end of the OEAP at 651 feet. The fill layer elevation declines towards the north and northwest to its lowest measured elevation of 594 feet; elevation is visually observed to slope down from that point to the north. The average slope of the fill within the NAP and OEAP is towards the northwest at approximately 0.02 feet per foot (ft/ft).

The elevation at the base of the fill layer, which corresponds to the elevation at the top of the uppermost alluvial deposits, ranges from 571 to 642 feet based on the approximate base of ash surface (**Figure 2-8**). These elevations correlate with land surface elevations presented on USGS topographic maps prepared in 1948 prior to ash management (**Figure 2-2**).

The lateral extent of CCR within the NAP and OEAP provided in the base of ash surface (**Figure 2-8**) indicate the CCR material approximates the CCR unit boundaries as shown in **Figure 1-2**, where CCR are bound by the NAP and OEAP berms to the north and east, and the bluffs to the southeast and west.

Five samples of fly ash from the fill were collected for geotechnical analysis as part of the 2011 hydrogeologic investigations. Results of the geotechnical analysis from the 2011 hydrogeologic investigations are included in a summary table and laboratory report available in **Appendix C** of this HCR. The fly ash found in the 2011 NAP and OEAP samples is generally classified as silt-size with variable amounts of fine sand-size particles. It is consistently dark gray in color and has moisture contents ranging from 29 to 42 percent. Total porosity calculated from the measured geotechnical data ranges from 49 to 55 percent. Average total porosity is 52 percent, average water filled porosity is 42 percent, and average air-filled porosity is 10 percent. For more detailed information, the summary table (Table 6 found in **Appendix C**) categorizes the geotechnical data into samples collected in 2011 from the NAP versus samples collected in 2011 from the OEAP.

Additionally, one boring XCM02 was drilled within the OEAP unit to characterize the CCR materials during the 2021 field investigation. Results were consistent with historical samples, with the OEAP samples classified as silt-sized with variable amounts of sand-size particles. The total porosity calculated from the measured geotechnical data ranges from 47 to 63 percent. Average total porosity is 55 percent which is similar to 2012 data (**Table 2-1**).

Ash and leachate samples were collected from the NAP/OEAP and submitted for laboratory geochemical analysis. **Table 2-2** presents a summary of ash geochemical analytical data. Leachate well ND3 was sampled in 2021. The results of leachate samples collected from within the NAP/OEAP are summarized in **Table 2-3**.

2.5.3 Mixed Deposits of the Cahokia Alluvium

This layer consists of three sublayers, including alluvial silt deposits, alluvial sand and gravel deposits with some intermittent silt, and alluvial clay and silty clay. Based on the 2012 hydrogeologic investigations, where present, the alluvial silt sublayer of the Cahokia Alluvium ranges in thickness from one to five feet with both average and median thicknesses of 2.3 feet. The alluvial silt occurs between the elevations of 587 and 595 feet NGVD29 and was observed at five boring locations during the 2012 hydrogeologic investigations. This silt sub layer was not observed in some borings at the Site for one or more of the following reasons:

- Removal of silt sublayer during construction of the ash ponds (*e.g.,* borings VP-1 through VP-5) (**Appendix B**)
- Deposited during flood events of the Middle Fork but subsequently eroded away; or,
- Not deposited or laterally transitioning into a silty clay or clay (*e.g.,* boring JMA-6) (**Appendix B**)

Based on the 2012 hydrogeologic investigations, where present, the alluvial sand and gravel with some intermittent silt sublayer of the Cahokia Alluvium ranges in thickness from 7 to 12 feet, with average and median thicknesses of 8.8 and 8.0 feet, respectively. The alluvial sand and gravel occurs between the elevations of 574 and 589 feet NGVD29 and was observed at three boring locations during the 2012 hydrogeologic investigations, all to the east and north of the NAP (borings MW-34, 101, and JMA-6 [**Appendix B**]) and adjacent to a north-south stretch of the Middle Fork. During the 2012 hydrogeologic investigations, this sublayer was not observed in borings immediately adjacent to or beneath the NAP and OEAP and appears to represent coarser point-bar deposits lain down as the Middle Fork progressed eastward along this northern stretch of the river. Along the western bluffs of the Middle Fork valley, the layer's alluvial deposits rest unconformably against the Upper Till Unit.

Based on the 2012 hydrogeologic investigations, the alluvial clay and silty clay sublayer of the Cahokia Alluvium was identified in borings throughout the Site, with the exception of VP-1 under the NAP where it was missing either due to non-deposition, erosion, or removal during construction of the NAP. An approximately half-foot thick silty clay layer containing fly ash lenses was also identified at boring VP-2, which appears to represent a transitional zone from the northern half of the NAP with no apparent underlying clay layer beneath the fill, to the southern half of the NAP with several feet of clay beneath the fill. With the exception of a transitional occurrence of mixed silty clay and CCR at boring VP-2, this clay and silty clay sublayer ranges in thickness from 1.5 to 15 feet across the Site with average and median thicknesses of 6.3 and 5.0 feet, respectively. Based on the 2012 hydrogeologic investigations, the alluvial clay and silty clay sublayer of the Cahokia Alluvium occurs between the elevations of 571 and 593 feet NGVD29.

Cross-sections developed as part of this HCR are provided in **Figure 2-9** through **Figure 2-12** and include data collected between 2012 and 2021 to further define the vertical and horizontal lithology, and stratigraphy in the vicinity of the NAP and OEAP. The lateral and vertical extent of the mixed deposits of the Cahokia Alluvium as presented in **Figure 2-9** through **Figure 2-12** are consistent with observations from the 2012 hydrogeologic investigations described above.

Geotechnical samples were collected as part of the 2021 investigation to characterize the mixed deposits of the Cahokia Alluvium. Portions of the Cahokia Alluvium in the NAP and OEAP were classified as clay, with sand content ranging from 40 to 44 percent. In other areas (MW-38 [5-7]), the Cahokia Alluvium was classified as silty sand with approximately 44 percent fines. The Cahokia Alluvium is consistently dark brown to dark gray in color and has a moisture content ranging from 11 to 20 percent. Total porosity calculated from the measured geotechnical data ranges from 24 to 37 percent with an average total porosity of 30 percent. Detailed information on moisture content is provided in **Table 2-1**.

Soil samples were collected from the mixed deposits of the Cahokia Alluvium and submitted for laboratory geochemical analysis. **Table 2-4** presents a summary of soil geochemical analytical data.

2.5.4 Alluvial Sand and Gravel with Some Silt

The alluvial sand and gravel with some silt layer at the base of the mixed deposits of the Cahokia Alluvium is the most prevalent coarse alluvial deposit identified within borings throughout the bottomlands of the river valley. This sand and gravel layer, which has a highly variable lithology, contains varying amounts of silt and intermittent inter-layers and lenses of clay.

The alluvial sand and gravel layer has been identified beneath both the NAP and OEAP and extends to the Middle Fork. Based on the 2012 hydrogeologic investigations, the alluvial sand and gravel layer ranges in thickness from 5 to 26 feet with average and median thicknesses of 10.1 and 9.8 feet, respectively. During the 2012 hydrogeologic investigations, the uppermost observed elevation is 586 feet NGVD29 at boring VAMW-17 and the lowermost observed elevation is 559 feet NGVD29, also at VAMW-17 (**Appendix B**). Along the western bluffs of the Middle Fork valley the alluvial deposits rest unconformably against the Upper Till Unit.

Cross-sections developed as part of this HCR are provided in **Figure 2-9** through **Figure 2-12** and include data collected between 2012 and 2021 to further define the vertical and horizontal lithology, and stratigraphy in the vicinity of the NAP and OEAP. The lateral and vertical extent of the alluvial sand and gravel with some silt layer as presented in **Figure 2-9** through **Figure 2-12** are consistent with observations from the 2012 hydrogeologic investigations described above.

Geotechnical samples were collected as part of the 2021 investigation to characterize the alluvial sand and gravel with some silt layer. In the NAP and OEAP this layer is classified as clayey sand with 41 percent fines and poorly graded sand with up to 9 percent fines. The alluvial sand and gravel with some silt is consistently dark brown to dark gray in color, and has a moisture content ranging from 3 to 16 percent. Total porosity calculated from the measured geotechnical data ranges from 26 to 45 percent, with an average total porosity of 38 percent (**Table 2-1**).

Soil samples were collected from the Alluvial Sand and Gravel with Some Silt and submitted for laboratory geochemical analysis. **Table 2-4** presents a summary of soil geochemical analytical data.

2.5.5 Upper Till Unit

This till layer consists predominantly of silty and clayey diamictons of the Wedron Formation (Snider Till) (**Figure 2-4**) with intermittent sand layers and lenses. Based on the 2012 hydrogeologic investigation boring logs, the Upper Till Unit has been identified as a brown to gray clay to silty clay with variable amounts of sand with sporadic lenses of silt and sand. The top of this layer represents the top of the glacial till across the Site, and is the most prevalent and laterally continuous fine-grained unlithified deposit within both the uplands and the lowlands at the Site. In the upland areas the top of till is near ground surface (covered by topsoil). The river valley was carved out of the Upper Till Unit over time and the top of till was covered by alluvial deposits of the Cahokia Formation within the river valley. This is one contiguous unit that is visible as the upland bluff area that bounds the river valley and is present beneath the alluvial sand and gravel in the bottomlands of the river valley. The alluvial deposits of the Cahokia Formation within the bottomlands of the river valley rest unconformably against the upland bluff portion of the Upper Till Unit to the west of the NAP and OEAP. The unit is thickest in the uplands and thinnest within the river valley.

Based on the 2012 hydrogeologic investigations, the Upper Till Unit within the lowland areas (river valley) ranges in thickness from 4 to greater than 25 feet, with average and median thicknesses exceeding 12 and 10 feet, respectively. The uppermost elevation of this layer is 578 feet NGVD29 and the lowermost elevation is below 552 feet NGVD29. Based on the 2012 hydrogeologic investigations, this fine-grained layer is very thin, where present, under portions of the NAP. The 2012 hydrogeologic investigation observed thickness of the Upper Till Unit beneath the southern portion of the NAP at borings VAMW-17 and VP-3 is 5 feet (**Appendix B**). Towards the center of the NAP at boring VP-2, this layer is only 0.5 feet thick and is mixed with fly ash. Towards the northern portion of the NAP (*e.g.,* boring VP-1) the Upper Till Unit is no longer present due to either non-deposition or excavation. Just north of the NAP at boring JMA-5, this clay layer is approximately 8 feet thick. Based on the 2012 hydrogeologic investigations, the Upper Till Unit deposits range in thickness from 5 to 5.5 feet beneath the northwestern and central portions of the OEAP (borings VAMW-17 and VP-4). Along the northeastern edge paralleling the Middle Fork, the silty clay and clay ranges in thickness from 2 to 8 feet (borings B-1 through B-5).

Cross-sections developed as part of this HCR are provided in **Figure 2-9** through **Figure 2-12** and include data collected between 2012 and 2021 to further define the vertical and horizontal lithology, and stratigraphy in the vicinity of the NAP and OEAP. The lateral and vertical extent of the Upper Till Unit as presented in **Figure 2-9** through **Figure 2-12** are consistent with observations from the 2012 hydrogeologic investigations described above.

Geotechnical samples were collected as part of the 2021 investigation to characterize the Upper Till Unit. The Upper Till Unit in the NAP and OEAP is classified as mostly clay with variable sand-sized particles, but also as clayey sand, silty sand to sand classifications in four locations. The Upper Till Unit is consistently dark gray in color, and has a moisture content ranging from 9 to 25 percent. Total porosity calculated from the measured geotechnical data ranges from 21 to 43 percent, with an average total porosity of 31 percent (**Table 2-1**).

Soil samples were collected from the Upper Till Unit and submitted for laboratory geochemical analysis. **Table 2-4** presents a summary of soil geochemical analytical data.

2.5.6 Glacial Outwash and Re-Worked Glacial Deposits

This layer consists of glacial outwash and re-worked glacial deposits with sand, silty sand, and clayey sand predominating and is identified as Henry Formation deposits of Wisconsinan Age. The glacial outwash and re-worked glacial deposits layer is the lowermost, laterally extensive coarse grained unlithified deposit identified beneath the Site. Soil borings and monitoring wells completed at locations 101, 102, 103, 104, and 105 in 2021 confirmed the presence of a laterally continuous sand unit between the elevations of 553 and 560 feet NAVD88 in the upland that is in hydraulic connection with the glacial outwash and re-worked glacial deposits layer in the river valley. The 2012 hydrogeologic investigations also identified a sand layer between 552 and 565 feet NGVD29 at borings JMA-1 and VAMW-21 (**Appendix B**) in the upland that is in hydraulic connection with the glacial outwash and re-worked glacial deposits layer in the river valley. The deposits may rest unconformably against the geologically older Lower Till Unit of the Glasford Formation and Pennsylvanian Bedrock.

Based on the 2012 hydrogeologic investigation, the glacial outwash and re-worked glacial deposits layer ranges in thickness from 2 to 18 feet in the bottomlands. Based only on the 2012 hydrogeologic investigation borings where it was intercepted, the average and median thicknesses are 9.8 and 9.5 feet, respectively. The thickest glacial outwash and re-worked glacial deposits (16 to 18 feet) observed during the 2012 hydrogeologic investigations were intercepted to the east of the NAP and towards the center of the valley, at borings JMA-3 and MW-34 (**Appendix B**). Based on the 2012 hydrogeologic investigations the uppermost observed elevation of this layer within the bottomlands is 562.5 feet NGVD29 (boring JMA-2) and the lowermost elevation is 536 feet NGVD29 (boring MW-34).

Cross-sections developed as part of this HCR are provided in **Figure 2-9** through **Figure 2-12** and include data collected between 2012 and 2021 to further define the vertical and horizontal lithology, and stratigraphy in the vicinity of the NAP and OEAP. The lateral and vertical extent of the glacial outwash and re-worked glacial deposits layer as presented in **Figure 2-9** through **Figure 2-12** are consistent with observations from the 2012 hydrogeologic investigations described above.

Geotechnical samples were collected as part of the 2021 investigation to characterize the glacial outwash and re-worked glacial deposits layer. The glacial outwash and re-worked glacial deposits in the NAP and OEAP is classified as sand, clayey sand, and silty sand. Glacial outwash and re-worked glacial deposits are consistently gray to dark gray in color, and have a moisture content ranging from 14 to 18 percent. Total porosity calculated from the measured geotechnical data ranges from 34 to 42 percent, with an average total porosity of 38 percent (**Table 2-1**).

Soil samples were collected from the glacial outwash and re-worked glacial deposits and submitted for laboratory geochemical analysis. **Table 2-4** presents a summary of soil geochemical analytical data.

2.5.7 Lower Till Unit

The Lower Till Unit comprises the lowermost and oldest unlithified deposits identified in borings at the Site and occurs in both upland and bottomland areas. This layer consists predominantly of silty to sandy clay diamictons with occasional sand lenses. Based on the 2012 hydrogeologic investigations, in the Middle Fork valley this unit can either be overlain by the alluvial sand and gravel layer, Upper Till Unit, or the glacial outwash and re-worked glacial deposits layer, or is absent due to non-deposition or erosion.

In upland areas bordering the Middle Fork valley, the Lower Till Unit underlies the glacial outwash and re-worked glacial deposits layer based on upland soil borings and monitoring wells completed at locations 101, 102, 103, 104, and 105 (completed in 2021), and historic borings JMA-1 and VAMW-21 (**Appendix B**).

Based on the 2012 hydrogeologic investigations, within the Middle Fork valley, the uppermost and lowermost observed elevations of the Lower Till Unit are 562 and 520 feet, respectively. Although the lower surface of the till unit's interface with bedrock was not intercepted at any borings, the thickness observed during the 2012 hydrogeologic investigations within the valley ranges from 0 to greater than 16 feet (boring MW-34) (**Appendix B**).

Cross-sections developed as part of this HCR are provided in **Figure 2-9** through **Figure 2-12** and include data collected between 2012 and 2021 to further define the vertical and horizontal lithology, and stratigraphy in the vicinity of the NAP and OEAP. The lateral and vertical extent of the Lower Till Unit as presented in **Figure 2-9** through **Figure 2-12** are consistent with observations from the 2012 hydrogeologic investigations described above.

Geotechnical samples were collected as part of the 2021 investigation to characterize the Lower Till Unit. The Lower Till Unit in the NAP and OEAP is classified as lean clay with greater than 90 percent fines. The Lower Till Unit is consistently gray to dark gray in color, and has a moisture content ranging from 22 to 24 percent. Total porosity calculated from the measured geotechnical data ranges from 37 to 40 percent, with an average total porosity of 39 percent (**Table 2-1**).

Soil samples were collected from the Lower Till Unit and submitted for laboratory geochemical analysis. **Table 2-4** presents a summary of soil geochemical analytical data.

2.5.8 Site Specific Bedrock Geology

The lowermost layer, and only lithified geologic layer identified in borings at the Site, is the Pennsylvanian shale bedrock. The bedrock layer was intercepted by borings in both the uplands and bottomlands of the Middle Fork valley. Based on the 2012 hydrogeologic investigations, the highest elevation at which the bedrock was intercepted at the Site was 585 feet NGVD29 in the upland borings MW-10/MW-22 and B103 (2001), and the lowest elevation was 495.7 feet NAVD88 at bottomlands boring S-32 (2017). In the vicinity of the VPP, the principal formation is the Shelburn, which contains a major coal seam mined in the region, Danville (No. 7) Coal.

Cross-sections developed as part of this HCR are provided in **Figure 2-9** through **Figure 2-12** and include data between 2012 and 2021 to further define the vertical and horizontal lithology, and stratigraphy in the vicinity of the NAP and OEAP. The lateral and vertical extent of the bedrock layer as presented in **Figure 2-9** through **Figure 2-12** are consistent with observations from the 2012 hydrogeologic investigations described above.

3. REGIONAL AND LOCAL HYDROGEOLOGY

3.1 Regional Hydrogeology

3.1.1 Unlithified Deposits Hydrogeology

Alluvial deposits along the Middle Fork valley contain a wide variety of sediments ranging from clay to sand, gravel, and cobbles. The effective porosities for the types of sediments found in the vicinity of the Site range from 20 to 35 percent for poorly sorted sand and gravel alluvial deposits to 10 to 20 percent for the diamictons found in the upland areas and in the deeper deposits within the Middle Fork valley (Fetter, 1980). Effective porosity, which is a measure of the pore space through which saturated flow can occur, typically ranges from 10 to 30 percent for poorly sorted sand and gravel deposits to 5 to 20 percent for diamictons (Walton, 1988).

Horizontal hydraulic conductivity for the alluvial deposits as measured by field tests can vary greatly depending on the percentage of fine-grained materials within those deposits. Deposits with materials ranging from sand to gravel typically have horizontal hydraulic conductivity ranging from 10^{-1} to 10^{-4} centimeters per second (cm/s). Silt, clay, and mixtures of sand, silt, and clay typically have values ranging from 10^{-4} to 10^{-7} cm/s (United States Department of the Interior [USDI], 1981; Fetter, 1980).

3.1.2 Bedrock Hydrogeology

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 field hydraulic conductivity for shale typically ranges from 5×10^{-6} to 5×10^{-10} cm/s. Representative aquitard field permeability ranges for shale, which is defined as the rate of vertical flow of water through a unit horizontal cross-sectional area of the aquitard, are 5×10^{-8} to 5×10^{-12} cm/s. In contrast to the low permeability of shale, coal deposits have horizontal permeability ranging from 5×10^{-2} to 5×10^{-5} cm/s (Walton, 1988).

The Pennsylvanian rocks in the region yield small amounts of water to wells from interconnected pores, cracks, fractures, crevices, joints, and bedding planes. Water-bearing openings are variable from place to place and are best developed near the surface in thin limestones and sandstones, when present, within the predominantly shale formation. Shallow sandstone and creviced limestone may yield small supplies in some areas, but water quality becomes poorer with increasing depth. The Pennsylvanian bedrock is not a reliable source of groundwater and the quality varies considerably. Small domestic supplies have been obtained from creviced limestone, permeable sandstone, or cracked shale and coal in the upper part of the bedrock (Selkregg and Kempton, 1958).

Water in the Pennsylvanian rocks becomes highly mineralized with increasing depth. 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. Water occurs in these rocks mainly under artesian and leaky-artesian conditions (Csallany, 1966).

The detailed hydrogeologic data for the shallow bedrock discussed in the following paragraphs has been incorporated from data collected from previous studies completed by Mathes (1987) and Kelron (2003) in the vicinity of the NEAP. For additional information about the hydrogeology of the shallow bedrock in the immediate vicinity of the VPP, and specifically for the vicinity of the NEAP, refer to Kelron (2003).

Groundwater elevations in the shale are highest in the topographically highest areas to the west and east of the Middle Fork. The lowest groundwater elevations occur at wells located adjacent to the Middle Fork. Flow lines derived from potentiometric surface maps indicate that the Middle Fork in this area is a zone of discharge for the shale. The occurrence of the Middle Fork in this area as a regional discharge zone for the shallow bedrock is supported by the upward vertical hydraulic gradients measured within the shale. The shale outcrops along the banks of the Middle Fork and groundwater moving upward through the shale discharges into both the alluvium and directly into the Middle Fork.

The horizontal hydraulic conductivity of the shale was determined by Mathes (1987) from field permeability tests. Seven wells screened in the shale were tested, and the computed hydraulic conductivity ranged from 4×10^{-10} to 1×10^{-8} cm/s. The geometric mean hydraulic conductivity of the shale based on the seven wells tested was 4.3×10^{-9} cm/s. The vertical hydraulic conductivity calculated from tests performed in the laboratory on one shale core ranged from 1×10^{-8} to 5×10^{-8} cm/s. The field and laboratory values for hydraulic conductivity of the shale all fall within the range of 5×10^{-6} to 5×10^{-10} cm/s reported by Walton (1988).

Field hydraulic conductivity tests conducted by Kelron (2003) on seven monitoring wells screened within the Pennsylvanian Shale in the vicinity of the NEAP resulted in a higher estimate of permeability than Mathes (1987). The geometric mean hydraulic conductivity for all seven shale wells was 3×10^{-6} cm/s and the range was 1.04×10^{-4} to 1.45×10^{-7} cm/s. The higher values calculated by Kelron (2003) relative to the lower values calculated by Mathes (1987) could be either from actual permeability differences of the bedrock deposits or systematic differences associated with analysis methods.

3.2 Site Hydrogeology

Prior to 2021, there were 11 monitoring wells around the NAP and seven monitoring wells around the OEAP for monitoring groundwater. Nine additional monitoring wells (36 through 44, and 07R) were installed in 2021 around the perimeter of the NAP and OEAP to meet the requirements of Part 845 and 10 monitoring wells (101 through 105, and 101S through 105S) were completed in the upland areas south and west of the NAP and OEAP to characterize upland hydrogeologic conditions. Construction details for monitoring wells and piezometers are provided in **Table 3-1** and depicted in **Figure 3-1**. Boring logs, monitoring well and piezometer construction forms are provided in **Appendix B**.

3.2.1 Hydrostratigraphic Units

Seven distinct water-bearing units have been identified in the vicinity of the NAP and OEAP based on stratigraphic relationships and common hydrogeologic characteristics. The units are described as follows:

- **Fill Unit** (identified as Unit 0 [Kelron, 2012a; Kelron, 2012b]): comprised predominantly of CCR primarily fly ash, bottom ash, and boiler slag within the fill and CCR material described in **Section 2.5.1**. This hydrostratigraphic unit is present within the NAP and OEAP and occurs within saturated materials. Fill materials are present at elevations ranging from 651 to 571 feet NAVD88. The base of this unit is the base of ash within the NAP and OEAP (**Figure 2-8**). Water levels (the phreatic surface) measured in piezometer ND3 within the Fill Unit indicate the phreatic surface is greater than the elevation of the water levels in the underlying MGU (**Figures 3-2 to 3-5; Table 3-1**).

- **Upper Unit** (identified as Unit 1 [Kelron, 2012a; Kelron, 2012b]): includes mixed alluvial deposits of clay, silt, sand, and minor gravel of the Cahokia Alluvium described in **Section 2.5.1**. This unit is composed of primarily fine grained unlithified natural geologic materials of the Cahokia Alluvium that occur at elevations ranging from 595 to 571 feet NGVD29. The Upper Unit is the uppermost native material present in the bottomlands within the river valley. This unit may be covered by the fill material of the NAP and OEAP and may be very thin or absent beneath portions of the NAP (Kelron, 2012a; Kelron, 2012b). There is only one monitoring well installed within the Upper Unit (MW-06R) located north of the NAP.
- **MGU** (identified as Unit 2 [Kelron, 2012a; Kelron, 2012b]): composed of alluvial sand and gravel that corresponds to the lower portion of the Cahokia Formation in the bottomlands of the river valley described in **Section 2.5.4**. This unit is not present outside of the river valley. These alluvial deposits lie unconformably on top of the underlying glacial till and terminate laterally along the western bluffs of the river valley where the deposits rest unconformably against the till that comprises the uplands. This moderate permeability layer has a thickness ranging from 5 to 26 feet, with a median thickness of 9.8 feet, is the uppermost coarse-grained deposit beneath the NAP and OEAP, and is considered the uppermost aquifer.
- **Upper Confining Unit** (identified as Upland Confining Unit [Unit 5a] and Middle Confining Unit [Unit 3] [Kelron, 2012a; Kelron, 2012b]): comprised of clay, silt, and minor amounts of sand lenses within the Upper Till Unit described in **Section 2.5.5**. The low permeability deposits of the Upper Confining Unit lie directly above the LGU, inhibiting the vertical movement of groundwater between the MGU and the LGU (Kelron, 2012a; Kelron, 2012b). Wells 101S, 102S, 103S, 104S, and 105S are screened within discontinuous sand lenses observed in the upland area west of the NAP and OEAP. These sand lenses are present at elevations above the pre-construction ground surface in the NAP and OEAP. These wells went dry during development and 103S did not contain enough water to sample indicating that the lateral continuity and extent of these sand lenses is limited. Well 44 located west of the NAP along the bluff is also screened within a discontinuous sand lens of the UCU below the preconstructed ground surface for the NAP and OEAP above the LGU.
- **LGU** (identified as Units 4 and 5b [Kelron, 2012a; Kelron, 2012b]): composed of sand, gravel, silt, and some clay described as glacial outwash and re-worked glacial deposits in **Section 2.5.6**. Soil borings and monitoring wells 101 through 105, completed in 2021, confirmed the presence of a laterally continuous sand unit between the elevations of 553 and 560 feet NAVD88 in the upland that is in connection with the LGU in the river valley. Although overlain and underlain by confining units, the LGU is in lateral connection across the Site at upgradient locations (01, 21, 42, 43, 101, 102, 103, 104, and 105) along the southwest side of the Middle Fork Valley and in downgradient wells (02, 03R, 34, and 37). The thickness of the LGU ranges from 2 to 18 feet in the bottomlands, with average and median thicknesses of approximately 10 feet. The uppermost elevation of the top of this unit is 565 feet NGVD29 (observed in the upland areas) and the lowermost base elevation is 536 feet NGVD29 (observed in the bottomlands). Thirteen monitoring wells are screened within the LGU (**Table 3-1**).
- **Lower Confining Unit** (identified as Unit 6 [Kelron, 2012a; Kelron, 2012b]): composed of clay, silt, and some sand, is the lowermost unlithified confining unit at the Site described as

the Lower Till Unit in **Section 2.5.7**. It extends across the upland and bottomland areas, except at locations where it is missing due to non-deposition or erosion. At locations where this unit is missing, the lower confining unit is the shale bedrock. It ranges in thickness from zero (not present) to greater than 16 feet and has average and median thicknesses of greater than 8 and greater than 5 feet, respectively, since most borings stopped short of its base. The highest elevation at which this unit was intercepted by borings at the Site was 562 feet NGVD29 and the lowest elevation was 520 feet NGVD29. The base of this unit is the top of bedrock.

- **Bedrock Confining Unit** (identified as Unit 7 [Kelron, 2012a; Kelron, 2012b]): the lowermost unit identified at the Site, and underlies all unlithified deposits. This unit occurs within Pennsylvanian shale bedrock described in **Section 2.5.8**, which is the uppermost lithified unit at the Site. As presented by Kelron (2003), groundwater in the shale flows into the overlying alluvium and enters directly into the Middle Fork in some locations. Groundwater within the bedrock is at the end of its flow path as indicated by upward hydraulic gradients, high dissolved mineral content, and isotopic analysis indicating water is significantly older by 13,000 to 35,000 radiocarbon years before present than recent groundwater in the overlying unlithified deposits.

3.2.2 Uppermost Aquifer

The MGU has been identified as the uppermost aquifer for the NAP and OEAP. The MGU is the uppermost laterally continuous coarse-grained deposit beneath the NAP and OEAP. Twelve monitoring wells are screened in the MGU (04, 05, 07R, 08R, 17, 18, 19, 20, 36, 38, 40, and 41). This unit is not present outside of the river valley. These alluvial deposits lie unconformably on top of the underlying glacial till and terminate laterally along the western bluffs of the river valley where the deposits rest unconformably against the till that comprises the uplands. This layer has a thickness ranging from 5 to 26 feet, with a median thickness of 9.8 feet. The MGU is interpreted to be an unconfined aquifer. The MGU is overlain by the Upper Unit, which is not laterally continuous beneath the NAP and OEAP. Groundwater elevations collected from well 06R (screened in the Upper Unit) are very similar to groundwater elevations collected from well 38 (screened in the MGU), indicating no significant head differences between the units. The base of the MGU is the top of the Upper Confining Unit.

3.2.3 Potential Migration Pathways

The LGU has been identified as a PMP. This unit is a laterally continuous coarse-grained deposit located below the MGU and is separated from the MGU by the Upper Confining Unit. Thirteen monitoring wells are screened in the LGU.

3.2.4 Water Table Elevation and Groundwater Flow Direction

Groundwater elevations at the NAP and OEAP have been collected intermittently since 1992. Prior to groundwater elevation measurements collected during the 2021 field investigations, the most recent groundwater elevation data was collected at the NAP and OEAP in July 2017 and continued for six rounds ending in May 2018. Groundwater flow is represented using groundwater elevation contour maps for 2021 sampling events (**Figures 3-2 through 3-5**). Groundwater contour maps are also provided for September 2017 and March 2018 sampling events in **Appendix D.** The groundwater elevation in wells surrounding the NAP and OEAP averaged 585.1 feet NAVD88 in the MGU, and averaged 582.5 feet NAVD88 in the LGU from March to May 2021.

3.2.4.1 Vertical Hydraulic Gradient

Vertical hydraulic gradients were calculated using available groundwater elevation data in March, April, and May 2021 at nested well locations within the Upper Unit, MGU, and LGU. Vertical hydraulic gradients for the NAP and OEAP are presented in **Table 3-2**. The results of the vertical hydraulic gradient calculations for these hydrostratigraphic units are summarized below:

- Upper Unit to MGU:
  - Vertical gradients in well nest 06R/38 north of the NAP were consistently slightly upward in 2021 with an average vertical gradient of -0.011 ft/ft.
- MGU to MGU (within):
  - Vertical gradients in well nest 17/18 located on the berm road between the NAP and OEAP were consistently downward with an average vertical gradient of -0.737 ft/ft.
- MGU to LGU:
  - Vertical gradients in downgradient well nest 36/37 in the central area of the Site near the boundary between the NAP and the OEAP, and downgradient well nest 08R/03R in the central area of the NAP, were consistently upward (08R/03R) in 2021 with average vertical gradients of -0.170 ft/ft and -0.221 ft/ft, respectively.
  - Vertical gradients in downgradient well nest 20/34 in the north area of the NAP were downward in March, April, and July 7, 2021 events, and upward during all other events in 2021. Overall vertical gradients averaged slightly upward at approximately -0.001 ft/ft.
- UCU to LGU

  Vertical gradients in upgradient well nest 44/43 in the central area of the NAP were upward in March 2021, and downward April through August 2021. Vertical gradients averaged slightly downward at approximately 0.062 ft/ft.

Vertical gradients as calculated for data collected in 2021 at well nests 08R/03R and 20/34 were consistent with those reported by Kelron (2012a; 2012b) for data collected in 2011. Upward vertical gradients were also reported for 2011 data collected between wells screened in the Upper Unit and MGU at well nest 06R/09, which is consistent with 2021 vertical gradients calculated at Upper Unit and MGU at well nest 06R/38. Vertical gradients reported at well nest 17/18 were strongly downward in 2011 (Kelron 2012a; Kelron, 2012b) and consistent with vertical gradients calculated at well nest 17/18 in the MGU during 2021.

3.2.4.2 Impact of Existing Ponds

Water level elevations collected from ND3 indicate the phreatic surface is above the water levels observed in the uppermost aquifer; however, the groundwater elevation contours of the uppermost aquifer (**Figures 3-2 through 3-5**) illustrate flow toward the Middle Fork with no observable radial component of flow outward along the perimeter of the NAP and OEAP. The absence of a radial component of flow indicates the NAP and OEAP do not significantly impact groundwater flow direction.

3.2.4.3 Ash Saturation

Saturated ash has been observed within the NAP and OEAP. As reported by Kelron (2012a; 2012b), the amount of saturated ash within the ash ponds was variable both laterally and temporally. The maximum thickness of saturated ash was measured within the southern portion of the NAP at VPZ-3, with 21.4 feet of saturated ash in June 2011 and decreasing to 14.1 feet of saturated ash in October 2011. The minimum thickness of saturated ash was measured within the northwest portion of the OEAP, varying from 11.5 feet in June 2011 and decreasing to 6.2 feet or less in September through November. Water level measurements collected from ND3 and OED1 in 2021 were compared to the base of ash elevations in the vicinity of these borings, indicating approximately 25 feet of saturated ash in the NAP and less than two feet thickness of saturated ash in the OEAP.

3.2.4.4 Impact of River Stage on Groundwater Flow

Although a gaining stream through most of the year, there are periods of high precipitation during which surface water runoff (*i.e.,* overland flow) directly into the Middle Fork results in higher river elevations and the Middle Fork may temporarily become a losing stream, with surface water moving outward from the river into the adjacent groundwater units (Kelron, 2012a; Kelron, 2012b). Groundwater elevations and contour maps from spring months, when reversals would be expected to occur, do not indicate flow inland from the river (**Figures 3-2 through 3-7**, and **Appendix D)**. Additional discussion of river elevations are presented in **Section 3.3.2** of this HCR.

3.2.5 Hydraulic Conductivity

3.2.5.1 Field Hydraulic Conductivity

Field hydraulic conductivity tests performed on the MGU materials and LGU materials at the Site were completed as part of the 2021 field investigation. Hydraulic conductivity test analyses and results are summarized in **Table 3-3** and provided in **Appendix E**. Field hydraulic conductivity tests indicated that the horizontal hydraulic conductivity for the MGU ranged from 8.4×10^{-6} to 2.7×10^{-1} cm/s with a geometric mean of 2.5×10^{-3} cm/s. Based on field hydraulic conductivity testing, the horizontal hydraulic conductivity for the LGU ranged from 1.1×10^{-5} to 7.4×10^{-2} cm/s with a geometric mean of 7.3×10^{-4} cm/s, which is approximately three times lower than the geometric mean hydraulic conductivity tests for the MGU.

Fill Unit field hydraulic conductivity testing completed in 2021 from wells ND2 and ND3 result in estimated horizontal hydraulic conductivity values of 4.8×10^{-5} and 1.3×10^{-4} cm/s, respectively.

The horizontal hydraulic conductivity of the shale was determined by Mathes (1987) from field permeability tests, where the results ranged from 4×10^{-10} to 1×10^{-8} cm/s, with a geometric mean hydraulic conductivity of 4.3×10^{-9} cm/s. Field hydraulic conductivity tests conducted by Kelron (2003) on shale in the vicinity of the NEAP resulted in a range of 1.0×10^{-4} to 1.5×10^{-7} cm/s, with a geometric mean of 3×10^{-6} cm/s.

3.2.5.2 Laboratory Hydraulic Conductivity

Twenty-five samples were collected for laboratory vertical hydraulic conductivity analysis (ASTM D 5084) during the 2021 field investigations from the hydrostratigraphic units described in **Section 3.2.1** of this HCR. The results of the 2021 analyses are tabulated in **Table 2-1** and laboratory reports are provided in **Appendix C**. The results of the 2021 vertical hydraulic conductivity analysis, as well as data available from the 2012 hydrogeologic investigations, for these hydrostratigraphic units are summarized below:

- Fill Unit
  - Five samples of fly ash from the Fill Unit were collected at four locations for vertical hydraulic conductivity analysis as part of the 2011 hydrogeologic investigations. Results of the vertical hydraulic conductivity analysis from the 2011 hydrogeologic investigations are included in a summary table and laboratory report available in **Appendix C** of this HCR. The fly ash found in the 2011 NAP and OEAP samples has laboratory vertical hydraulic conductivities ranging from 1.3 x 10^{-5} to 1.7 x 10^{-4} cm/s. For more detailed information, the summary table (Table 6 found in **Appendix C**) identifies the geotechnical data and samples collected from the NAP versus the OEAP.
  - Two samples were collected from the Fill Unit at one location within the OEAP as part of the 2021 field investigation and resulting vertical hydraulic conductivities for the samples were 8.86 x 10^{-6} cm/s and 3.30 x 10^{-5} cm/s. The 2021 results of the vertical hydraulic conductivity analysis of Fill Unit samples collected within the OEAP is consistent with 2012 hydrogeologic investigation results for Fill Unit samples collected within the OEAP (average vertical hydraulic conductivity of 3.4 x 10^{-5} cm/s).
- Upper Unit
  - Four samples were collected from the Upper Unit at four locations as part of the 2021 field investigation and the resulting vertical hydraulic conductivities for the samples ranged from 2.17 x 10^{-8} to 4.79 x 10^{-6} cm/s with a geometric mean of approximately 2.98 x 10^{-7} cm/s.
- MGU
  - Three samples were collected from the MGU at three locations as part of the 2021 field investigation and resulting vertical hydraulic conductivities for the samples ranged from 5.07 x 10^{-6} to 2.37 x 10^{-3} cm/s with a geometric mean of approximately 1.24 x 10^{-4} cm/s.
- Upper Confining Unit
  - Twelve samples were collected from the Upper Confining Unit at seven locations as part of the 2021 field investigation and resulting vertical hydraulic conductivities for the samples ranged from 1.6 x 10^{-8} to 2.13 x 10^{-4} cm/s with a geometric mean of approximately 1.17 x 10^{-6} cm/s.
- LGU
  - Two samples were collected from the LGU at two locations as part of the 2021 field investigations and resulting vertical hydraulic conductivities were 8.16 x 10^{-4} cm/s and 4.31 x 10^{-6} cm/s.
- Lower Confining Unit
  - Two samples were collected from the Lower Confining Unit at two locations as part of the 2021 field investigations and resulting vertical hydraulic conductivities were 5.44 x 10^{-8} cm/s and 4.17 x 10^{-7} cm/s.

3.2.6 Horizontal Groundwater Gradients and Flow Velocity

The Middle Fork is the regional receiving body for both the uppermost aquifer (MGU) and underlying PMP (LGU). Under normal conditions in the vicinity of the NAP and OEAP, groundwater generally flows from the west to east toward the Middle Fork (**Figures 3-2 through 3-5**) in both the uppermost aquifer and PMP. West of the NAP and OEAP in the LGU, groundwater flow diverges south in the vicinity of Well 104. Seasonal variation of groundwater levels and flow direction near the NAP and OEAP are depicted in the series of 2017 and 2018 contour maps (**Appendix D**), along with 2021 contour maps (**Figures 3-2 through 3-5**). There is little seasonal variation in groundwater flow direction in the unlithified materials as illustrated in **Figures 3-2 through 3-5** and **Appendix D**.

Average horizontal hydraulic gradients calculated for the MGU between March and August 2021 range from 0.0070 to 0.0182 ft/ft (**Table 3-4**), and groundwater generally flows from west to east across the Site toward the Middle Fork. The average horizontal hydraulic gradient for the MGU is slightly steeper as groundwater flows toward the Middle Fork south of the NAP, 0.0182 ft/ft (between Wells 17 and 36), in comparison to average horizontal hydraulic gradient to the north of the NAP, 0.0070 ft/ft, between Wells 05 and 04 (**Table 3-4**). Based on data provided in **Table 3-4** and previous studies, there is little seasonal variation of horizontal hydraulic gradients in the MGU.

Average horizontal hydraulic gradients in the LGU between March 2021 and August 2021 range from 0.0043 to 0.0087 ft/ft, (**Table 3-4**) as groundwater generally flows from west to east across the Site toward the Middle Fork. Based on data provided in **Table 3-4** and previous studies, there is little seasonal variation of horizontal hydraulic gradients in the LGU.

Groundwater in the shale bedrock is expected to flow toward the Middle Fork (Kelron, 2003). Evidence for this flow includes upward vertical gradients within the shale that were observed during various periods at multiple locations between the shale and the alluvium. In areas the shale outcrops along the banks of the Middle Fork and groundwater moving upward through the shale flows into the alluvium and enters the river.

3.2.6.1 Groundwater Velocity

Groundwater flow in the MGU and LGU under normal flow conditions is generally from west to east across the Site (**Figure 3-2** through **3-5**) towards the Middle Fork. The average hydraulic conductivities between wells (**Table 3-3**) and an average total porosity were used in each hydrostratigraphic unit to calculate groundwater velocities.

Average groundwater flow velocities in the Middle Groundwater Unit between March 2021 and August 2021 ranged from 0.18 feet per day (ft/day) to 0.47 ft/day (**Table 3-4**) as groundwater flows from west to east across the Site toward the Middle Fork with higher velocity occurring near the Middle Fork and southern portion of the NAP. Based on data provided in **Table 3-4**, there is little seasonal variation to groundwater flow velocity in the MGU. These groundwater flow velocity values are attributed to the high permeability sands and gravels associated with the MGU that are present continuously through bottomlands of the river valley.

Average groundwater flow velocities in the LGU between March and August 2021 range from 0.05 to 0.10 ft/day (**Table 3-4**) as groundwater flows from west to east across the Site toward the Middle Fork. Based on data provided in **Table 3-4** there is little seasonal variation in groundwater flow velocity in the LGU. On average, groundwater flow velocity within the LGU ranges from 3.4 to 6.7 times lower than within the MGU based on March through August 2021 groundwater elevations.

3.2.7 Groundwater Classification

The classification of groundwater at NAP and OEAP has been evaluated and based on the detailed geologic information provided in the 2012 hydrogeologic investigations (Kelron, 2012a; Kelron, 2012b) for the MGU (*i.e.,* uppermost aquifer), the NAP and OEAP can be classified as Class I - Potable Resource Groundwater. The MGU is comprised of predominantly sand and gravel with some silt and is the primary groundwater transport pathway. Based on the 2012 hydrogeologic investigations, the thickness of the MGU ranges from 5 to 26 feet, with an average thickness of 10.1 feet. (Kelron, 2012a; Kelron, 2012b). Field hydraulic conductivity tests performed on the MGU indicate a geometric mean hydraulic conductivity of 2.1 x 10^{-3} centimeters per second (cm/s) (Kelron, 2012a; Kelron, 2012b). Sands and gravels with thicknesses greater than 5 feet or with a hydraulic conductivity of greater than 1 x 10^{-4} cm/s meets the provisions of Section Class I - Potable Resource Groundwater (35 I.A.C. § 620.210).

3.3 Surface Water Hydrology

3.3.1 Climate

The climate at the VPP is characterized by four distinct seasons (summer, fall, winter, and spring) without prolonged periods of extreme cold, extreme heat, or high humidity. Precipitation is usually adequate though summer although drought periods are not uncommon. Because of its latitude, the area can experience very abrupt temperature changes during all but the mid-summer season. Average monthly climatic data was obtained from the Illinois State Water Survey (ISWS). The data was recorded between 1981 and 2010 from Danville, Illinois, which is located approximately eight miles southeast of the VPP. The data includes monthly maximum and minimum temperatures (degrees Fahrenheit [°F]) and average rainfall for each month calculated from daily values collected over the 29-year period, and is summarized below in **Table B** below.

Table B: Average Monthly Temperature Extremes and Precipitation for Danville, IL

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Maximum Temperature (°F)	35.1	40.0	51.9	64.8	74.7	83.3	85.4	83.8	78.3	66.1	52.2	38.3	62.9
Minimum Temperature (°F)	19.2	22.9	32.0	42.1	51.5	60.9	64.7	63.1	55.1	43.8	34.5	23.3	42.8
Precipitation (inches)	2.21	2.21	3.02	3.98	4.74	4.55	4.67	3.48	2.93	3.57	3.83	2.83	42.02

https://www.isws.illinois.edu/statecli/newnormals/normals.USC00112140.txt

3.3.2 Surface Waters

The predominant surface water body in the region is the Middle Fork. The Middle Fork is located directly adjacent to and downgradient from the NAP and OEAP. A USGS stream gage (03336645) for the Middle Fork Vermilion River above Oakwood, Illinois is located 3 miles south (downstream) of the VPP. The gage datum elevation is 544.42 feet NGVD29. Daily gage heights for the periods of January 1, 2017 to July 1, 2021 are shown in **Figure A** below (USGS, 2021).

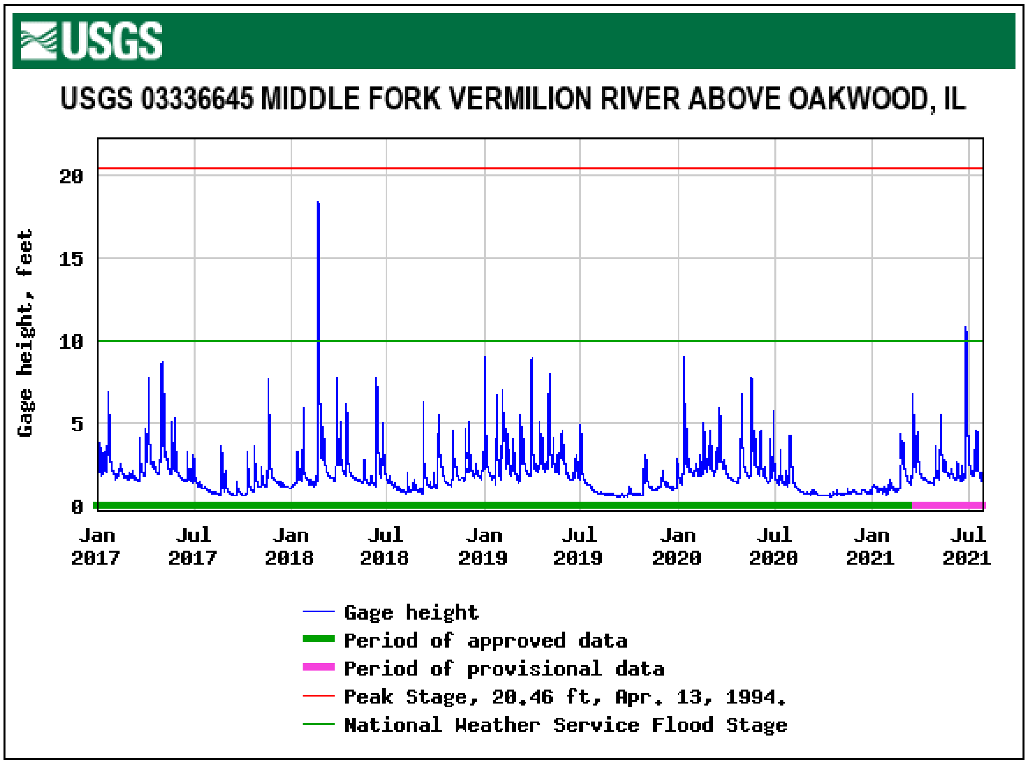

Figure A. Daily Gage Height (feet) January 1, 2017 to July 1, 2021 for USGS Gaging Station 03336645 at the Middle Fork Vermilion River above Oakwood, Illinois.

Elevations of the river bordering the east perimeter of the NAP and OEAP are lower than groundwater elevations and little seasonal variation in groundwater flow has been observed; so, for most of the year the Middle Fork is a gaining stream. Although the majority of groundwater baseflow into the river is from unlithified deposits within the river valley, the Middle Fork is also a regional receiving water body for the shallow bedrock (Kelron, 2012a; Kelron, 2012b).

The Illinois Power Company Lake (Company Lake) is another large surface water body located to the south of the VPP. Company Lake is located within the VPP property and was created to provide process water for the VPP. A former stream valley was dammed, and the reservoir was filled with water pumped from the Middle Fork (the river-intake pump house for VPP is located east of the lake on the Middle Fork to the east of the Site) and supplemented by natural precipitation. Company Lake is located south of the VPP which sits on top of the bluff between the lake and the NAP and OEAP. The base of the lake is interpreted to be the Upper Confining Unit. Boring logs completed during construction of Company Lake indicate it is above and not in direct connection to the LGU. Groundwater flow in the LGU beneath the bluff and Company Lake appears to reflect the topography, flowing from the VPP toward the NAP and OEAP to the north, and toward Company Lake to the south (**Figures 3-4 and 3-5**). Company Lake is not downgradient of the NAP and OEAP.

A map of wetlands and surface waters in the vicinity of the NAP and OEAP is presented in **Figure A-4** in **Appendix A.** A FEMA Flood Insurance Rate Map (Map number 17183C0275D date effective 5/15/2012) is attached in **Appendix F** and can also be viewed online at: https://www.illinoisfloodmaps.org/dfirm.aspx. The NAP and OEAP occur within the floodplain of the Vermilion River identified on the 2012 FEMA map. The flood hazard areas shown on the map are defined as those areas subject to inundation by the 1 percent annual chance flood (*i.e.,* 100-year flood), also known as the base flood, that has a 1 percent chance of being equaled or exceeded in any given year. No base flood elevation has been established for this area.

4. GROUNDWATER QUALITY

4.1 Summary of Groundwater Monitoring Activities

Groundwater quality investigations were completed intermittently at the NAP and OEAP from 1983 to 2018. Groundwater quality data collected from 1992 to 2011 was compared to 35 I.A.C §620.410 (Groundwater Quality Standards for Class I - Potable Resource Groundwater) in the Hydrogeology and Groundwater Quality of the North Ash Pond System, and Hydrogeology and Groundwater Quality of the Old East Ash Pond (Kelron, 2012a; Kelron, 2012b). In 2021, additional wells were installed to comply with Part 845 requirements, specifically to reduce the lateral spacing between monitoring points and to further characterize the upland bluff and PMPs. These wells were sampled for the parameters listed in 35 I.A.C. § 845.600. A review and summary of data collected from 2015 through 2021 for parameters with GWPSs listed in 35 I.A.C. § 845.600 is included in **Section 4.2**.

4.1.1 Groundwater Quality Investigations (1982-2018)

Currently, there are no IEPA-required groundwater monitoring programs for the NAP and OEAP. Although groundwater monitoring was not required at the NAP and OEAP, a network of monitoring wells was voluntarily installed between 1982 and 2010 as part of previous investigations. Groundwater monitoring at certain wells was conducted as early as 1988 and monitoring generally continued through 2007, at which time the voluntary monitoring was discontinued. Four quarterly rounds of groundwater monitoring were also completed at the NAP and OEAP during 2011 as part of the 2012 hydrogeologic investigations (Kelron, 2012a; Kelron, 2012b). Groundwater monitoring was re-established at the NAP/OEAP in July 2017 and continued for six rounds ending in May 2018. Thirteen NAP and OEAP monitoring wells (01, 02, 03R, 04, 05, 06R, 08R, 10, 17, 18, 20, 21, and 34) were sampled for water quality and field parameters listed in **Table C** below. The boring logs, well construction forms, and other related monitoring well forms for the well network are included in **Appendix B** of the HCR. The well locations are shown on **Figure 3-1**.

Table C. 2017-2018 Groundwater Monitoring Parameters

Field Parameters			
pH	Temperature	Turbidity	Groundwater Elevation
Dissolved Oxygen	Specific Conductivity	Oxidation/Reduction Potential	
Metals (Dissolved)			
Arsenic	Barium	Boron	
Iron	Manganese	Selenium	
Inorganics			
Fluoride (dissolved)	Sulfate (total)	Chloride (total)	
TDS	Nitrate-N (total)		

4.1.2 Part 845 Well Installation and Groundwater Monitoring

In 2021, seven additional monitoring wells (36, 37, 38, 41, 42, 43, and 44) were installed along the perimeter of the NAP, two wells (40 and 07R) were added at the OEAP, and ten monitoring wells (101/101S, 102/102S, 103/103S, 104/104S, and 105/105S) were completed in the bluff upgradient of the NAP and OEAP to assess the vertical and horizontal lithology, stratigraphy, chemical properties, and physical properties of geologic layers to a minimum of 100 feet bgs as specified in 35 I.A.C. § 845.620(b). The boring logs, well construction forms, and other related monitoring well forms for the wells are included in **Appendix B** of the HCR.

As discussed in Section 3.2.1, wells 101S, 102S, 103S, 104S, and 105S are screened within discontinuous sand lenses observed in the upland area west of the NAP and OEAP. These sand lenses are present at elevations above the pre-construction ground surface in the NAP and OEAP. These wells went dry during development and 103S did not contain enough water to sample indicating that the lateral continuity and extent of these sand lenses is limited; therefore, the limited amount of groundwater quality data obtained from these wells was not presented for discussion for the NAP and OEAP. The well locations with water quality data for discussion are shown on **Figure 3-1**.

Prospective Part 845 monitoring wells were sampled for eight rounds between March and August 2021 and the results were assessed for selection of the NAP and OEAP Part 845 monitoring well network presented in the GMP.

Groundwater samples were analyzed for 35 I.A.C. § 845.600 parameters summarized in **Table D** below. Part 845 groundwater monitoring results are included below in **Section 4.2**. A summary of groundwater analytical data collected between 2015 and 2021 is presented in **Table 4-1**.

Table D. Part 845 Groundwater Monitoring Program Parameters

Field Parameters[1]			
Groundwater elevation	pH	Turbidity	
Metals (Total)			
Antimony	Boron	Cobalt	Molybdenum
Arsenic	Cadmium	Lead	Selenium
Barium	Calcium	Lithium	Thallium
Beryllium	Chromium	Mercury	
Inorganics (Total)			
Fluoride	Sulfate	Chloride	TDS
Other (Total)			
Radium 226 and 228 combined			

[1]Dissolved oxygen, temperature, specific conductance, and oxidation/reduction potential were recorded during sample collection.

4.2 Groundwater Monitoring Results and Analysis

The groundwater analytical results are summarized in **Table 4-1** and discussed in the subsections below. Results indicate that the parameters discussed in the following sections were greater than the applicable 35 I.A.C. § 845.600 GWPSs and are considered potential exceedances[1].

[1] Potential exceedances include results reported during the eight rounds of baseline groundwater monitoring that are greater than the applicable 35 I.A.C. § 845.600(a)(1) standards. The results are considered

4.2.1 Arsenic

Arsenic was detected at concentrations greater than the GWPS (0.01 milligrams per liter [mg/L]) in five MGU wells (07R, 08R, 18, 38, and 40). Arsenic concentrations in wells 07R, 08R, 18, 38, and 40 ranged from 0.0011 to 0.193 mg/L, with a median arsenic concentration greater than the GWPS of 0.0113 mg/L.

Arsenic was detected at concentrations greater than the GWPS in twelve LGU wells (02, 03R, 21, 34, 37, 42, 43, 101, 102, 103, 104, and 105). Arsenic concentrations in wells 02, 03R, 21, 34, 37, 42, 101, 103, 104, and 105 ranged from 0.0041 to 0.0668 mg/L, with a median arsenic concentration greater than the GWPS of 0.0214 mg/L.

Arsenic was detected at concentrations greater than the GWPS in Upper Confining Unit well 44. Arsenic concentrations in wells 44 ranged from 0.0122 to 0.0379 mg/L, with median arsenic concentration greater than the GWPS of 0.0289 mg/L.

Arsenic was detected at concentrations greater than the GWPS in downgradient wells screened in the MGU and the LGU and in upgradient wells screened in the MGU, LGU, and Upper Confining Unit Wells.

4.2.2 Beryllium

Beryllium was not detected at concentrations greater than the GWPS (0.004 mg/L) in MGU wells during groundwater monitoring events.

Beryllium was detected at concentrations greater than the GWPS in upgradient LGU well 105 during one event in 2021. Beryllium concentrations in well 105 ranged from less than 0.001 to 0.0047 mg/L, with a median beryllium concentration less than the GWPS of 0.001 mg/L.

4.2.3 Boron

Boron is a primary indicator parameter for CCR leachate impacts on groundwater quality. Boron was detected at concentrations greater than the GWPS (2 mg/L) in nine MGU wells (04, 05, 07R, 08R, 17, 18, 36, 40, and 41). Boron concentrations in these MGU wells ranged from 1.41 to 48.2 mg/L, with a median boron concentration greater than the GWPS of approximately 13.7 mg/L. The most elevated concentrations in the MGU are reported in 05, 07R, 08R, and 40. These wells are located between the Middle Fork and the NAP and OEAP, with the exception of 05 which is located north of the NAP.

Boron was detected at concentrations greater than the GWPS in four LGU wells (01, 03R, 101, and 104). Boron concentrations in wells 01, 03R, 101 and 104 ranged from 0.479 to 19.9 mg/L, with a median boron concentration greater than the GWPS of 3.60 mg/L. The highest boron concentrations in the LGU are detected in 03R (18.4 to 19.9 mg/L), which is located downgradient of the NAP. Boron concentrations in LGU wells with potential exceedances and located upgradient of the Site range from 2.02 to 4.8 mg/L.

potential exceedances because the results were compared directly to the standard and did not include an evaluation of background groundwater quality or apply the statistical methodologies proposed in the Groundwater Monitoring Plan (GMP). For simplicity, “GWPS” will be used hereafter in discussing potential exceedances. Exceedances will be determined following IEPA approval of the GMP.

Boron was detected at concentrations greater than the GWPS in downgradient wells screened in the MGU and the LGU and in upgradient wells screened in the LGU.

4.2.4 Chromium

Chromium was detected at concentrations greater than the GWPS (0.1 mg/L) in downgradient MGU well 07R during two sampling events in June 2021. Chromium concentrations in well 07R ranged from less than 0.001 to 0.339 mg/L, with a median chromium concentration less than the GWPS of 0.0015 mg/L.

Chromium was detected at concentrations greater than the GWPS in upgradient LGU well 105 during one sample event in April 2021. Chromium concentrations in well 105 ranged from less than 0.001 to 0.214 mg/L, with a median chromium concentration less than the GWPS of 0.0016 mg/L.

Chromium was detected at concentrations greater than the GWPS in one downgradient well screened in the MGU and in an upgradient well screened in the LGU.

4.2.5 Cobalt

Cobalt was detected at concentrations greater than the GWPS (0.006 mg/L) in downgradient MGU well 07R during two sampling events in June 2021 and well 40 in one event in July and one event in August 2021. Cobalt concentrations in well 07R ranged from less than 0.001 to 0.0658 mg/L, with a median cobalt concentration less than the GWPS of 0.001 mg/L. Cobalt concentrations in well 40 ranged from 0.0051 to 0.007 mg/L with a median cobalt concentration less than the GWPS of 0.0057 mg/L.

Cobalt was detected at concentrations greater than the GWPS in upgradient LGU well 105 during one sample event in April 2021. Cobalt concentrations in well 105 ranged from less than 0.001 to 0.0569 mg/L, with a median cobalt concentration less than the GWPS of 0.001 mg/L.

Cobalt was detected at concentrations greater than the GWPS in downgradient wells screened in the MGU and in an upgradient well screened in the LGU.

4.2.6 Lead

Lead was detected at concentrations greater than the GWPS (0.075 mg/L) in downgradient MGU well 07R during two sampling events in June 2021. Lead concentrations in well 07R ranged from less than 0.001 to 0.24 mg/L, with a median lead concentration less than the GWPS of 0.001 mg/L.

Lead was detected at concentrations greater than the GWPS in upgradient LGU well 105 during one sample event in April 2021. Lead concentrations in well 105 ranged from less than 0.001 to 0.115 mg/L, with a median lead concentration greater than the GWPS of 0.001 mg/L.

Lead was detected at concentrations greater than the GWPS in downgradient wells screened in the MGU and in an upgradient well screened in the LGU.

4.2.7 Lithium

Lithium was detected at concentrations greater than the GWPS (0.04 mg/L) in seven MGU wells (04, 05, 07R, 08R, 18, 36, and 40). Lithium concentrations in wells 04, 05, 07R, 08R, 18, 36, and 40 ranged from 0.0457 to 1.22 mg/L, with a median lithium concentration greater than the GWPS of 0.143 mg/L. Consistent with boron concentration distribution, the most elevated concentrations of lithium occur in wells 07R, 08R, and 40 located between the NAP and OEAP and the Middle Fork.

Lithium was detected at concentrations greater than the GWPS in two LGU wells (01 and 105). Lithium concentrations in wells 01 and 105 ranged from less than 0.003 to 0.116 mg/L, with a median lithium concentration greater than the GWPS of 0.0419 mg/L.

Lithium was detected at concentrations greater than the GWPS in downgradient wells screened in the MGU and in an upgradient well screened in the LGU.

4.2.8 Molybdenum

Molybdenum was detected at concentrations greater than GWPS (0.1 mg/L) in three MGU wells (07R, 08R, and 36) during at least one sample event in 2021. Molybdenum concentrations in wells 07R, 08R, and 36 ranged from 0.0575 to 0.786 mg/L, with a median molybdenum concentration greater than the GWPS of 0.273 mg/L.

Molybdenum was detected at concentrations greater than the GWPS in LGU well 03R. Molybdenum concentrations in well 03R ranged from 0.151 to 0.225 mg/L, with a median molybdenum concentration greater than the GWPS of 0.194 mg/L.

Molybdenum was detected at concentrations greater than the GWPS in downgradient wells screened in the MGU and LGU.

4.2.9 pH

Measurements of pH were detected at less than the lower limit GWPS for pH (6.5 standard units [SU]) at downgradient MGU well 40 during June and July 2021. The upper limit standard for pH is 9.0 SU. Measurements of pH at MGU well 40 ranged from 6.3 to 6.6 SU, with a median measurement of 6.54.

Measurements of pH were not detected at concentrations less than, or greater than the GWPS in LGU or UCU wells during groundwater monitoring events.

4.2.10 Sulfate

Sulfate is also a primary indicator of CCR leachate impacts on groundwater quality. Sulfate was detected at concentrations greater than the GWPS (400 mg/L) at six MGU wells (07R, 08R, 17, 18, 36, and 40). Sulfate concentrations at wells 07R, 08R, 17, 18, 36, and 40 ranged from 206 to 3,300 mg/L, with a median sulfate concentration greater than the GWPS of 1,000 mg/L. The highest concentrations were reported in wells 07R, 17, and 40.

Sulfate concentrations were detected at concentrations greater than the GWPS in three LGU wells (01, 03R, and 104). Sulfate concentrations at wells 01, 03R, and 104 ranged from 371 to 1,220 mg/L with a median sulfate concentration greater than the GWPS of 490 mg/L.

Sulfate was detected at concentrations greater than the GWPS in downgradient wells screened in the MGU and LGU and in an upgradient well screened in the LGU.

4.2.11 Thallium

Thallium was detected at concentrations greater than the GWPS (0.002 mg/L) in downgradient MGU well 40 during June and August 2021 sampling events. Thallium concentrations at well 40 ranged from 0.0023 to 0.0025, with a median thallium concentration equal to the GWPS of 0.002 mg/L.

Thallium was not detected at concentrations greater than the GWPS in LGU or UCU wells during groundwater monitoring events.

4.2.12 Total Dissolved Solids

TDS was detected at concentrations greater than the GWPS (1,200 mg/L) in six MGU wells (07R, 08R, 17, 18, 36, and 40). TDS concentrations in wells 07R, 08R, 17, 18, 36 and 40 ranged from 766 to 4,860 mg/L, with a median TDS concentration at concentrations greater than the GWPS of 1815 mg/L. Between July 2017 and May 2018, TDS concentrations in wells 08R, 17, and 18 ranged from 1100 to 2,090 mg/L, with a median TDS concentration below the GWPS of 1,705 mg/L.

TDS was detected at concentrations greater than the GWPS in two LGU wells (01 and 03R). TDS concentrations in wells 01 and 03R ranged from 1,050 to 2,420 mg/L, with a median TDS concentration less than the GWPS of approximately 1,145 mg/L. Between July 2017 and May 2018, TDS concentrations in well 01 ranged from 542 to 2,240 mg/L, with a median TDS concentration greater than the GWPS of approximately 2075 mg/L.

TDS was detected at concentrations greater than the GWPS in downgradient wells screened in the MGU and LGU.

4.2.13 Radium 226 and 228 Combined

Radium 226 and 228 combined detected at concentrations greater than the GWPS (5.0 picocuries per liter [pCi/L]) in MGU well 07R during one groundwater monitoring event in June 2021. Radium 226 and 228 combined concentrations in well 07R ranged from 0.0962 to 15.6 pCi/L, with a median radium 226 and 228 combined concentration less the GWPS of 1.34 pCi/L.

Radium 226 and 228 combined was detected at concentrations greater than the GWPS at upgradient LGU well 105 during one sample event in April 2021. Radium 226 and 228 combined concentrations in well 105 ranged from 0.0997 to 8.59 pCi/L, with a median radium 226 and 228 combined concentration less than the GWPS of 0.328 pCi/L.

Radium 226 and 228 combined was detected at concentrations greater than the GWPS in one downgradient well screened in the MGU and one upgradient well screened in the LGU.

5. EVALUATION OF POTENTIAL RECEPTORS

5.1 Water Well Survey

A water well inventory was completed in 2021 utilizing federal and state databases to assess nearby pumping wells, drinking water receptors, and other uses of water in the vicinity of the NAP and OEAP. Based on records obtained from IEPA, ISGS, and ISWS, there are 42 wells located within 1000-meters of either the NAP or OEAP (**Figure A-3**). These included two coal test wells, fifteen farm/domestic private water wells, one test hole, one municipal water supply, one semi-private/farm domestic well, and 22 monitoring wells for Illinois Power and DMG. The identified wells within a 1,000-meter radius around the Site are shown and tabulated in **Appendix A** along with available well construction information from well forms, also provided in **Appendix A**. Groundwater flow in the unlithified materials in the vicinity of the NAP and OEAP is generally to the east. Based on west to east groundwater flow immediately toward the receiving surface water body (Middle Fork) and no wells between the NAP and OEAP and surface water body, none of the 42 identified wells are downgradient of the NAP and OEAP or in the prevailing direction of groundwater flow, and are not likely to be impacted by groundwater from the NAP and OEAP. One private water well (121830035200) is located immediately upgradient of the OEAP (not in the prevailing direction of groundwater flow). One private water well (121832569600) is plugged as shown in **Appendix A**. All the monitoring wells described above are identified in well forms (**Appendix A**) as being installed/owned by either Illinois Power Plant or DMG.

5.2 Surface Water

A survey to identify surface water features was conducted for a 1,000-meter radius around the NAP and OEAP as shown in **Appendix A.** Based on an ESRI Geographic Information System (GIS) database layer which presents the detailed water bodies (*e.g.,* lakes, reservoirs, large rivers, and swamps) in the United States provided by the United States Fish and Wildlife Service (USFWS), the National Hydrography Database, and National Wetland Inventory, there are approximately 35 surface water features within a 1,000-meter radius around the NAP and OEAP, where 18 of the features are located hydraulically downgradient of the NAP, and 11 of the features are located hydraulically downgradient of the OEAP. The identified surface water features within a 1,000-meter radius around the NAP and OEAP are tabulated along with their distance from the unit, physical orientation to the unit, and approximate hydraulic orientation to the unit in **Appendix A** and shown in **Figure A-4**

As discussed in **Section 3.2.6** of this HCR, lateral groundwater flow in the unlithified materials is generally west to east across the NAP and OEAP toward the Middle Fork and there is little seasonal variation in groundwater flow direction. The predominant receiving surface water body in the region is the Middle Fork (borders the VPP to the east) (**Figure 1-2**). Seasonal changes in river elevations over time, and the influence on groundwater flow, are described in **Section 3.2.6** of this HCR. The USGS National Map places the NAP and OEAP within the Middle Fork Vermilion River Watershed (Hydrologic Unit Code [HUC] 051201090509). The HUC watershed location is presented in **Figure A-4**

Company Lake is another large surface water body located to the south of the VPP. As discussed in **Section 3.3.2**, Company Lake is not downgradient of the NAP and OEAP, and is not considered a potential receptor of impacts from the NAP and OEAP.

Based on the survey to identify surface water features for a 1,000-meter radius around the NAP and OEAP, several freshwater forested/shrub emergent wetlands are located to the northeast, east, and southeast of the NAP and OEAP. A map of wetlands and surface waters in the vicinity of the Site is presented in **Figure A-4** Other surface waters in the vicinity include various freshwater ponds and lakes ranging from 0.14 acres to approximately 70 acres, and 19 riverines, streams, or rivers, six of which are categorized as intermittent.

5.3 Nature Preserves, Historic Sites, Endangered/Threatened Species

A survey to identify nature preserves and historic sites was conducted for a 1,000-meter radius of the NAP and OEAP as shown and tabulated in **Appendix A**. Based on an ESRI GIS database layers which present the national register of historic places, national forests, state parks, national parks, and national heritage areas (as designated by the National Park Service) in the United States, no national forests or national parks were identified within a 1,000-meter radius of the NAP and OEAP. However, based on data available from IDNR Illinois Nature Preserves Commission (IDNR, April 2021), there are 10 nature preserves within Vermilion County. Based on data available from the IDNR's Illinois Natural Heritage Database there are 27 natural areas in Vermilion County (IDNR, December 2020b) and the IDNR Illinois Nature Preserves Commission identified 20 protected areas in Vermilion County (IDNR, October 2019) as tabulated in **Appendix A**. As shown in **Figure A-5** Kennekuk Cove County Park Local Recreation Area, Middle Fork State Conservation Area, Orchid Hill Natural Heritage Landmark, and Kickapoo State Resource Management Area were also identified in the survey within 1,000 meters of the NAP and OEAP. The Middle Fork State Conservation Area was designated a State and National Scenic river in 1990. The Middle Fork area extends through Kennekuk Cove County Park, along the eastern portion of the VPP, and ends at the south boundary of Kickapoo State Resource Management Area adjacent to the Middle Fork (IDNR, April 2021). The Illinois Department of Conservation designated Orchid Hill Natural Heritage Landmark is partially within the VPP property boundary but is administered by IDNR.

A survey to identify endangered/threatened species was conducted for Vermilion County and tabulated **Appendix A**. Based on data available from the IDNR Illinois Natural Heritage Database (IDNR, December 2020a), as of December 2020 there are 46 endangered or threatened species reported in Vermilion County. Twenty-eight species are listed as endangered and 18 are listed as threatened.

Additionally, a search of the IDNR Historic Preservation Division database for historic sites in the vicinity of the Site yielded no results within 1,000 meters of the NAP and OEAP. The Illinois State Archaeological Survey (ISAS) databases that do not require credentials to access were also searched and yielded no results within 1,000 meters of the NAP and OEAP.

6. CONCLUSIONS

Hydrogeologic characterization of the VPP was originally developed as part of the *Hydrogeologic Study, Existing Ash Ponds, Vermilion Power Station, Illinois Power Company, Oakwood, Illinois* (Mathes, 1983) and most recently updated for the *Hydrogeology and Groundwater Quality of the North Ash Pond System Report* (Kelron, 2012a; Kelron, 2012b), *Hydrogeology and Groundwater Quality of the Old East Ash Pond Report* (Kelron, 2012a; Kelron, 2012b). Results of these hydrogeologic studies were reintroduced in this HCR and updated to include geologic, hydrogeologic, and groundwater quality data collected with a focus on the NAP and OEAP (Part 845 regulated) CCR Units and subject of this HCR.

The data were summarized and evaluated for changes in groundwater conditions since the previous investigations; available groundwater quality data for the EAP was compared to the GWPS.

The results of the hydrogeologic and groundwater quality evaluation are:

- There are six principal types of unlithified materials above bedrock in the vicinity of the VPP, these include the following in descending order: Fill (predominantly CCR), Mixed deposits of Cahokia Alluvium, Alluvial sand and gravel with some silt, Upper Till Unit clays with occasional sand lenses, Glacial outwash and re-worked glacial deposits with sand, and Lower Till Unit clays.
- In the vicinity of the VPP, the principal bedrock formation is the Shelburn, which contains a major coal seam mined in the region, the Danville (No. 7) Coal. Groundwater in the shale flows into the overlying alluvium and eventually enters into the Middle Fork. Groundwater within the bedrock is at the end of its flow path as indicated by upward hydraulic gradients, high dissolved mineral content, and isotopic analysis indicating water is significantly older by 13,000 to 35,000 radiocarbon years before present than recent groundwater in the overlying unlithified deposits.
- Seven distinct water bearing layers have been identified at the Site based on stratigraphic relationships and common hydrogeologic characteristics, these include the following in descending order: Fill Unit (predominantly CCR), Upper Unit (mixed deposits of Cahokia Alluvium), MGU (alluvial deposits), Upper Confining Unit (clay till), LGU (glacial outwash), Lower Confining Unit (clay till), and the Bedrock Confining Unit.
- The MGU has been identified as the uppermost aquifer for the NAP and OEAP. The MGU is the uppermost laterally continuous coarse-grained deposit beneath the NAP and OEAP. This unit is not present outside of the river valley. These alluvial deposits lie unconformably on top of the underlying glacial till and terminate laterally along the western bluffs of the river valley where the deposits rest unconformably against the till that comprises the uplands.
- The LGU has been identified as a PMP. This unit is a laterally continuous coarse-grained deposit located below the MGU and separated from the MGU by the Upper Confining Unit.
- The predominant surface water body in the region is the Middle Fork. The Middle Fork is located directly adjacent to and downgradient of the NAP and OEAP.
- The NAP and OEAP overlie the recharge area for the underlying transmissive geologic media (*i.e.,* MGU and LGU) which are composed of sands and gravels.

- As indicated by groundwater potentiometric surfaces, groundwater flows from beneath the Site toward the Middle Fork through the MGU as the primary pathway that contaminant migration could occur. Groundwater in the LGU generally flows from west to east toward the Middle Fork and follows topography as it approaches the river which results in localized groundwater divides, as evidenced by the flow divide present beneath the former power plant on top of the bluff.
- Vertical migration within the bedrock and unlithified units near the river are consistently upwards throughout the hydrostratigraphic units. Vertical migration within unlithified units near the bluff west of the NAP and OEAP are consistently downwards.
- As determined by the detailed geologic information provided, and the hydrogeologic and groundwater quality data, groundwater within the uppermost aquifer at the NAP and OEAP is classified as Class I – Potable Resource Groundwater.
- Arsenic, beryllium, boron, chromium, cobalt, lead, lithium, molybdenum, pH, sulfate, thallium, TDS and radium 226 and 228 combined were detected above the GWPS in downgradient wells screened in the MGU and/or LGU. Results for these parameters were compared directly to GWPS, without an evaluation of background concentrations or application of statistical methods. Evaluation of background groundwater quality will be completed as part of the GMP, and compliance with Part 845 will be determined following the first round of groundwater sampling. The first round of groundwater sampling for compliance will be completed following issuance of the Operating Permit and in accordance with the GMP.

This HCR satisfies Part 845 content requirements specific to 35 I.A.C. § 845.620(b) (Hydrogeologic Site Characterization) for the NAP and OEAP at the VPP.

7. REFERENCES

Atlantic Environmental Services, Inc., 1994. Ash Impoundment Closure Study, Results of Field Studies at Two Illinois Power Company Ash Impoundments. March.

Berg, R.C. and J.P. Kempton, 1988. Stack-Unit Mapping of Geologic Materials in Illinois to a Depth of 15 Meters. Illinois State Geological Survey Circular 542. Champaign, Illinois.

Csallany, Sandor, 1966. Yields of Wells in Pennsylvanian and Mississippian Rocks in Illinois. Illinois State Water Survey Report of Investigation 55. Champaign, Illinois.

Fetter, C.W., 1980, 1988. Applied Hydrogeology, Merrill Publishing Company, Columbus, Ohio.

Geosyntec, 2021. Memorandum IEPA Part 845- Seismic Impact Zone Certification for New East Ash Pond at Vermilion Power Plant.

Illinois Department of Natural Resources (IDNR), 2019. Protected Areas in Illinois by County, Illinois Nature Preserves Commission. October. Accessed from URL: https://www2.illinois.gov/dnr/conservation/NaturalHeritage/Documents/Database/inpccountylist.pdf

Illinois Department of Natural Resources (IDNR), 2021. Protected Areas in Illinois by County, Illinois Nature Preserves Commission. April. Accessed from URL: https://www2.illinois.gov/dnr/conservation/NaturalHeritage/Documents/Database/inpccountylist.pdf

Illinois Department of Natural Resources (IDNR), 2020a. Illinois Threatened and Endangered Species by County, Illinois Natural Heritage Database as of December 2020. Accessed from URL: https://www2.illinois.gov/dnr/ESPB/Documents/ET%20List%20Review%20and%20Revision/Illinois%20Threatened%20and%20Endangered%20Species%20by%20County.pdf

Illinois Department of Natural Resources (IDNR), 2020b. Illinois Natural Area Inventory (INAI) Sites by County, Illinois Natural Heritage Database. December 2020. Accessed from URL: https://www2.illinois.gov/dnr/conservation/NaturalHeritage/Documents/Database/inaicountylist.pdf

Illinois Environmental Protection Agency (IEPA), 2021. Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845; Final Rule. April 15, 2021.

John Mathes & Associates, Inc. (Mathes), 1983. Preliminary Hydrogeologic Study, Proposed Ash Pond Site, Vermilion Power Station, Illinois Power Company, Oakwood, Illinois. April 19, 1983.

John Mathes & Associates, Inc. (Mathes), 1983. Hydrogeologic Study, Existing Ash Ponds, Vermilion Power Station, Illinois Power Company, Oakwood, Illinois. April 11, 1983.

John Mathes & Associates, Inc. (Mathes), 1987. Hydrogeologic Investigation of Existing Ash Disposal Ponds, Vermilion Power Plant, Illinois Power Company, Oakwood, Illinois. July 13, 1987.

Kelron Environmental, Inc. (Kelron), 2003. Regional and Local Hydrogeology and Geochemistry, Vermilion Power Plant, Illinois, Dynegy Midwest Generation, Inc., November 30, 2003.

Kelron Environmental, Inc. (Kelron), 2012a. Hydrogeology and Groundwater Quality of the North Ash Pond System, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC, March 15, 2012.

Kelron Environmental, Inc. (Kelron), 2012b. Hydrogeology and Groundwater Quality of the Old East Ash Pond, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC, March 15, 2012.

Natural Resources Conservation Service (NRCS), 2009. Soil Survey of Vermilion County, Illinois.

Natural Resource Technology (NRT), 2017. Hydrogeologic Monitoring Plan, Hennepin East Ash Pond System, Hennepin Power Station, Hennepin, Illinois. October 17, 2017.

Natural Resource Technology, Inc. (NRT) and Kelron, 2009. Water Well Survey, Dynegy Midwest Generation, Inc., Vermilion Power Station, Oakwood, Illinois. June 15, 2009.

Nelson, W.J., 1993. Structural Features in Illinois, Plates 1 and 2. Illinois State Geological Survey, Bulletin 100. Champaign, Illinois.

Nelson, W.J., 1995. Structural Features in Illinois. Illinois State Geological Survey, Bulletin 100. Champaign, Illinois.

Piskin, K. and R.E. Bergstrom. 1975. Glacial Drift in Illinois: Thickness and Character. Illinois State Geological Survey Circular 490. Champaign, Illinois.

Selkregg, L.F. and J.P. Kempton, 1958. Groundwater Geology in East-Central Illinois: A Preliminary Geologic Report. Illinois State Geological Survey Circular 248. Champaign, Illinois.

URS, 2013. Geotechnical Report, North ash Pond and Old East Ash Pond, Vermilion Site, Embankment Evaluations, Oakwood, Illinois, Dynegy Midwest Generation, LLC, November 18, 2013.

United States Department of the Interior (USDI), 1981. Groundwater Manual. U.S. Government Printing Office, Denver, Colorado.

United States Geological Survey (USGS), 2021. National Water Information System data available on the World Wide Web (Peak Streamflow for Illinois, USGS 03336645, Middle Fork Vermilion River above Oakwood, IL). Accessed July 1, 2021 at URL: https://waterdata.usgs.gov/il/nwis/uv/?site_no=0336645&agency_cd=USGS

Walton, W.C., 1988. Practical Aspects of Groundwater Modeling. National Water Well Association, Worthington, Ohio.

Willman, H.B. and J.C. Frye. 1970. Pleistocene Stratigraphy of Illinois. Illinois State Geological Survey Bulletin 94. Champaign, Illinois.

Willman, H.B. and others, 1967. Geologic Map of Illinois. Illinois State Geological Survey. Champaign, Illinois.

Willman, H.B. and J.C. Frye, 1970. Pleistocene Stratigraphy of Illinois. Illinois State Geological Survey Bulletin 94. Champaign, Illinois.

TABLES

TABLE 2-1. GEOTECHNICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample ID	Field Location ID	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Moisture Content (%)	Dry Density (pcf)	Specific Gravity	Total Porosity[1]	Vertical Hydraulic Conductivity (cm/s)	LL	PL	PI	Laboratory USCS	Gravel (%)	Sand (%)	Fines (%)
Fill and CCR															
XCM02 (15.5-16)	XCM02	15.5	16	30.7	88.1	2.67	47%	8.86E-06	26	28	NP	ML	0.0	5.1	94.9
XCM02 (36-36.5)	XCM02	36	36.5	64.2	61.2	2.66	63%	3.30E-05	53	57	NP	MH	0.3	17.8	81.9
VP-1 (10-12)	VP-1	10	12	41.0	73.3	2.55	54%	1.70E-04	--	--	--	ML	--	--	--
VP-2 (5-7)	VP-2	5	7	31.0	79.8	2.68	52%	9.60E-05	--	--	--	ML	--	--	--
VP-4 (8-10)	VP-4	8	10	42.4	70.2	2.30	51%	6.20E-05	--	--	--	ML	--	--	--
VP-4 (18-20)	VP-4	18	20	31.1	81.8	2.58	49%	1.30E-05	--	--	--	ML	--	--	--
VP-5 (13-15)	VP-5	13	15	29.2	71.1	2.53	55%	4.80E-05	--	--	--	ML	--	--	--
Mixed Deposits of the Cahokia Alluvium															
MW-37 (5-7)	37	5	7	19.3	105.8	2.70	37%	4.79E-06	27	17	10	CL	0.0	39.5	60.5
MW-38 (5-7)	38	5	7	17.1	108.3	2.65	34%	2.20E-06	17	14	3	SM	0.0	55.6	44.4
MW-41 (8-10)	41	8	10	12.8	127.7	2.72	25%	3.46E-08	23	11	12	CL	0.7	43.9	55.4
MW-43 (35-37)	43	35	37	11.8	128.7	2.70	24%	2.17E-08	21	11	10	CL	0.0	43.5	56.5
MW-70SA (16.5-17)	70S	16.5	17	20.8	99.6	2.66	40%	5.15E-04	12	12	NP	SM	0.1	60.0	39.9
MW-71S (10-10.5)	71S	10	10.5	20.8	93.2	2.65	44%	1.26E-03	17	10	7	SP	0.0	95.3	4.7
Alluvial Sand and Gravel with Some Silt															
MW-37 (18.5-19)	37	18.5	19	3.1	122.7	2.66	26%	5.07E-06	19	11	8	SC	8.2	50.6	41.2
MW-38 (21.5-22)	38	21.5	22	12.6	97.2	2.71	42%	1.67E-04	11	7	4	SP-SC	4.7	86.1	9.2
MW-41 (25-25.5)	41	25	25.5	16.0	90.5	2.65	45%	2.37E-03	13	4	9	SP	0.00	95.6	4.4
Upper Till Unit															
MW-37 (25-27)	37	25	27	17.7	98.5	2.68	41%	2.13E-04	9	11	NP	SP-SM	1.4	87.3	11.3
MW-37 (35.5-36)	37	35.5	36	9.9	130.5	2.66	21%	3.35E-05	17	11	6	SC-SM	4.2	47.6	48.2
MW-38 (35-37)	38	35	37	12.6	125.6	2.70	25%	3.11E-08	21	12	9	CL	3.9	35.1	61.0
MW-41 (35-37)	41	35	37	12.3	122.9	2.71	27%	5.74E-07	20	14	6	CL-ML	0.7	42.9	56.4
MW-43 (50-52)	43	50	52	16.3	117.1	2.69	30%	1.39E-07	28	16	12	CL	0.0	23.2	76.8
MW-101 (10-12)	101	10	12	15.6	--	--	--	--	22	15	7	CL-ML	1.4	16.4	82.2
MW-101 (30-32)	101	30	32	13.3	--	--	--	--	--	--	--	--	--	--	--
MW-101 (32-33)	101	32	33	15.3	--	--	--	--	28	15	13	CL	0.0	14.5	85.5
MW-101 (60-62)	101	60	62	12.0	127.4	--	--	1.00E-07	--	--	--	--	--	--	--
MW-101 (62-63)	101	62	63	11.9	--	--	--	--	24	13	11	CL	2.9	21.4	75.7
MW-101 (92-93)	101	92	93	11.4	--	--	--	--	25	13	12	CL	2.4	26.3	71.3
MW-101 (132-133)	101	132	133	11.3	--	--	--	--	20	12	8	CL	3.5	42.5	54.0
MW-102 (10-12)	102	10	12	16.2	--	--	--	--	28	16	12	CL	0.2	15.9	83.9
MW-102 (28-30)	102	28	30	14.9	--	--	--	--	24	14	10	CL	1.3	17.0	81.7
MW-102 (30-32)	102	30	32	15.0	120.6	--	--	1.60E-08	--	--	--	--	--	--	--
MW-102 (60-62)	102	60	62	12.5	--	--	--	--	--	--	--	--	--	--	--
MW-102 (62-64)	102	62	64	12.4	--	--	--	--	24	14	10	CL	1.7	24.9	73.4
MW-102 (94-96)	102	94	96	9.2	--	--	--	--	27	14	13	CL	3.1	26.2	70.7
MW-102 (130-132)	102	130	132	10.2	--	--	--	--	20	12	8	CL	2.3	43.7	54.0
MW-103 (10-12)	103	10	12	15.0	--	--	--	--	28	16	12	CL	1.0	14.4	84.6
MW-103 (15-17)	103	15	17	16.6	116.8	2.70	31%	3.61E-08	30	15	15	CL	0.0	14.7	85.3

RAMBOLL

TABLE 2-1. GEOTECHNICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample ID	Field Location ID	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Moisture Content (%)	Dry Density (pcf)	Specific Gravity	Total Porosity[1]	Vertical Hydraulic Conductivity (cm/s)	LL	PL	PI	Laboratory USCS	Gravel (%)	Sand (%)	Fines (%)
MW-103 (28-30)	103	28	30	13.5	--	--	--	--	21	13	8	CL	3.8	26.4	69.8
MW-103 (30-32)	103	30	32	13.2	125.2	--	--	--	--	--	--	--	--	--	--
MW-103 (60-62)	103	60	62	15.8	--	--	--	--	--	--	--	--	--	--	--
MW-103 (88-90)	103	88	90	15.9	--	--	--	--	28	15	13	CL	0.9	14.2	84.9
MW-103 (90-92)	103	90	92	18.1	--	2.68	--	--							100
MW-103 (95.5-96)	103	95.5	96	13.9	128.4	2.71	24%	9.35E-06	17	10	7	CL-ML	0.0	48.2	51.8
MW-103 (102-104)	103	102	104	10.2	--	--	--	--	--	--	--	--	--	--	--
MW-103 (130.5-131)	103	130.5	131	8.9	98.8	2.69	41%	2.19E-05	16	11	5	SC-SM	37.1	50.3	12.6
MW-103 (132.5-133)	103	132	133	15.3	95.2	2.68	43%	8.17E-05	14	7	7	SP-SC	0.0	94.3	5.7
MW-103 (138-140)	103	138	140	10.5	--	--	--	--	21	11	10	CL	1.7	41.8	56.5
MW-103 (140.5-141)	103	140.5	141	10.8	127.5	2.70	24%	3.82E-07	23	11	12	CL	0.0	42.6	57.4
MW-104 (10-12)	104	10	12	14.5	--	--	--	--	26	15	11	CL	1.3	16.8	81.9
MW-104 (30-32)	104	30	32	15.2	--	2.73	--	--	--	--	--	--	--	--	--
MW-104 (60.5-61)	104	60.5	61	12.4	--	--	--	--	20	13	7	CL-ML	4.5	24.7	70.8
MW-104 (92-94)	104	92	94	9.5	--	--	--	--	25	13	12	CL	1.5	22.8	75.7
MW-104 (130-132)	104	130	132	12.1	--	--	--	--	20	12	8	CL	4.3	40.7	55.0
MW-105 (10-12)	105	10	12	25.2	--	2.74	--	--	44	19	25	CL	0.6	1.9	97.5
MW-105 (17-19)	105	17	19	24.8	--	--	--	--	--	--	--	--	--	--	--
MW-105 (28-30)	105	28	30	17.8	--	--	--	--	39	17	22	CL	0.0	3.1	96.9
MW-105 (58-60)	105	58	60	12.9	--	--	--	--	22	13	9	CL	0.9	26.1	73
MW-105 (88-90)	105	88	90	10.5	--	--	--	--	25	12	13	CL	0.3	33.8	65.9
MW-105 (130-132)	105	130	132	10.2	--	--	--	--	20	12	8	CL	7.1	42.5	50.4
Glacial Outwash and Re-worked Glacial Deposits															
MW-37 (50.5-51)	37	50.5	51	17.7	96.2	2.645	42%	8.16E-04	13	7	6	SP-SC	0.0	93.1	6.9
MW-103 (163-163.5)	103	163	163.5	13.8	109.5	2.68	34%	4.31E-06	17	11	6	SC-SM	0.0	64.8	35.2
Lower Till Unit															
MW-37 (55-57)	37	55	57	23.8	101.4	2.69	40%	5.44E-08	31	18	13	CL	0.0	1.9	98.1
MW-43 (61-61.5)	43	61	61.5	22.4	105.2	2.68	37%	4.17E-07	33	21	12	CL	0.0	0.8	99.2

[O:EDP 7/13/21 C: EGP 7/27/21, U:EDP 9/30/2021, C: KLT 10/5/21]

Notes:
[1] Porosity calculated as relationship of bulk density (p_b) to particle density (p_d) ($n = 100[1- (p_b/p_d)]$)
-- = Not Analyzed
% = Percent
bgs = below ground surface
CCR = coal combustion residuals
ft = foot/feet
LL = Liquid Limit
NP = Non Plastic
pcf = pounds per cubic foot
PI = Plasticity Index
PL = Plastic Limit
USCS = Unified Soil Classification System

USCS
CL = Lean Clay
CL-ML = Silty Clay
MH = Plastic Silt
ML = Silt
SC = Clayey Sand
SC-SM = Silty Clayey Sand
SM = Silty Sand
SP = Poorly Graded Sand
SP-SC= Poorly Graded Sand with Clay
SP-SM = Poorly Graded Sand with Silt

TABLE 2-2. ASH ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Depth (ft BGS)	Sample Date	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Boron (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Cobalt (mg/kg)	Lead (mg/kg)	Lithium (mg/kg)	Mercury (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Thallium (mg/kg)
XCM02	18-20	03/04/2021	5.3	274	168	4.29	227	3	46.6	13.9	138	60.7	0.024	6.39	1.8	3.84
XCM02	38-40	03/04/2021	2.99	75.8	90.5	4.54	1190	1.07	58.2	9.59	37	16.2	0.021	5.45	<0.96	3.06

Notes:
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method.
BGS = below ground surface
ft = feet
mg/kg = milligrams per kilogram
generated 10/05/2021, 4:11:50 PM CDT

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TABLE 2-3. POREWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, Total (mg/L)	Chloride, total in water (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)
ND3	03/31/2021	0.0116	0.21	0.0595	0.0012	32	<0.001	291	10	0.0073	0.0026	0.2	0.0297	0.573	<0.0002	0.199	8.7	0.855	0.0191	953	0.0024
ND3	04/21/2021	0.012	0.199	0.0591	0.0016	30.3	<0.001	310	9	0.0075	0.0025	0.16	0.0264	0.659	<0.0002	0.208	8.4	1.8	0.0152	984	0.0031
ND3	05/11/2021	0.0124	0.172	0.0382	<0.001	31	<0.001	332	8	0.00301	0.00102	0.15	0.0113	0.82	<0.0002	0.252	8.3	0.173	0.0105	970	0.00348
ND3	06/03/2021	0.0092	0.14	0.0265	<0.001	28.5	<0.001	333	7	<0.0015	<0.001	0.15	0.0033	0.855	<0.0002	0.213	7.9	--	0.019	1040	0.0034
ND3	07/28/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.9	0.181	--	--	--
ND3	08/17/2021	0.009	0.211	0.0643	0.0015	29.4	0.001	344	6	0.0082	0.0029	0.17	0.0303	0.759	<0.0002	0.215	7.9	0.145	0.01	1050	0.0041
OED1	06/03/2021	0.0015	0.0382	0.0392	<0.001	45.5	<0.001	886	5	0.0037	<0.001	<0.1	0.009	0.553	<0.0002	0.291	10.0	0.0631	0.0025	1890	<0.002
OED1	06/16/2021	0.0012	0.031	0.0343	<0.001	46.7	<0.001	838	4	0.0018	<0.001	<0.1	0.0042	0.6	<0.0002	0.266	10.2	0.743	0.0021	1930	<0.002
OED1	07/08/2021	<0.0011	0.0294	0.0312	<0.0011	46.7	<0.0011	810	3	<0.0017	<0.0011	<0.1	0.003	0.519	<0.0002	0.257	10.3	1.41	0.0021	1960	<0.0022
OED1	07/27/2021	<0.001	0.0269	0.0258	<0.001	35	<0.001	886	3	<0.0015	<0.001	<0.1	<0.001	0.463	<0.0002	0.248	10.3	0.167	0.0023	1950	<0.002
OED1	08/17/2021	0.0014	0.0434	0.039	<0.001	39.5	<0.001	828	2	0.0035	<0.001	<0.1	0.0091	0.388	<0.0002	0.219	10.1	0.575	0.0033	1910	<0.002

Notes:
Field readings are reported with as many significant figures as provided by analytical laboratory.
-- = data not available
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method.
mg/L = milligrams per liter
pCi/L = picocuries per liter
SU = standard units

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RAMBOLL

TABLE 2-4. SOIL ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Geologic Unit	Sample Depth (ft BGS)	Sample Date	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Boron (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Cobalt (mg/kg)	Lead (mg/kg)	Lithium (mg/kg)	Mercury (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Thallium (mg/kg)
36	Alluvial Sand and Gravel	17-19	03/03/2021	<0.39	4.03	21.2	<0.27	10.9	<0.18	5.52	3.02	4.35	4.83	<0.011	3.52	<0.91	<0.18
36	Upper Till Unit	20-22	03/03/2021	<0.38	3.54	38.6	0.44	12.6	<0.19	14.8	5.18	7.24	12.2	<0.011	0.31	<0.96	<0.19
37	Mixed deposits of the Cahokia alluvium	3-5	03/03/2021	<0.36	5.4	45.6	0.41	10.1	0.2	13	5.73	11	9.35	0.013	0.52	<0.94	<0.19
37	Alluvial Sand and Gravel	30.5-32.5	03/03/2021	<0.36	16.7	10.6	<0.28	5.15	<0.19	5.7	7.79	4.01	6.22	<0.01	3.63	<0.93	<0.19
37	Glacial Outwash and Re-Worked Glacial Deposits	48-50	03/03/2021	<0.38	2.11	8.92	<0.28	<4.72	<0.19	3.72	1.79	3.46	2.34	<0.012	0.23	<0.94	<0.19
37	Lower Till Unit	60-62	03/03/2021	<0.39	1.43	88.3	0.81	<4.9	<0.2	21.7	8.86	10.2	17.8	0.017	<0.2	<0.98	<0.2
38	Mixed deposits of the Cahokia alluvium	6-8	03/02/2021	<0.38	5.1	21	<0.29	5	<0.2	11	3.27	7.82	6.52	<0.012	0.83	<0.98	<0.2
38	Alluvial Sand and Gravel	18-20	03/02/2021	<0.4	5.99	11.5	<0.29	8.24	<0.2	8.01	3.82	102	5.14	<0.011	0.38	<0.98	<0.2
38	Upper Till Unit	33-35	03/02/2021	<0.39	4.79	37.4	0.38	8.58	<0.19	13.4	6.02	7.46	10.9	0.011	0.77	<0.94	<0.19
41	Mixed deposits of the Cahokia alluvium	6.7-8	03/04/2021	<0.38	3.81	29.7	0.41	13.1	<0.18	12.8	5.48	7.51	16	<0.011	0.3	<0.91	<0.18
41	Alluvial Sand and Gravel	24-25	03/04/2021	<0.38	2.23	8.32	<0.27	<4.55	<0.18	3.72	1.85	2.85	3.33	<0.012	<0.18	<0.91	<0.18
41	Upper Till Unit	32-34	03/04/2021	<0.38	5.11	35.2	0.37	7.64	<0.19	11.3	6.71	8.36	9.68	<0.01	0.59	<0.94	<0.19
42	Mixed deposits of the Cahokia alluvium	2-4	03/07/2021	6.23	307	120	7.8	231	3.66	40.1	25	161	51.3	0.203	4.59	14.7	<4.63
43	Upper Till Unit	33-35	03/07/2021	<0.38	3.48	32.7	0.35	11.1	<0.19	13.4	5.13	6.63	14.2	0.012	0.29	<0.96	<4.81
43	Upper Till Unit	43-43.7	03/07/2021	<0.37	2.52	15.9	0.14	4.77	<0.19	6.96	2.59	3.84	5.3	<0.011	0.22	<0.94	<4.72
43	Upper Till Unit	52-54	03/07/2021	<0.39	5.06	53.4	0.35	8.23	<0.19	17	6.4	9.75	12.3	0.013	0.59	<0.96	<4.81
43	Glacial Outwash and Re-Worked Glacial Deposits	59-60	03/07/2021	<0.38	2.74	37.2	0.12	5.1	<0.2	8.98	4.11	6.06	4.75	<0.012	0.37	<0.98	<4.9
43	Lower Till Unit	62-64	03/07/2021	<0.37	4.91	137	0.36	9.58	<0.18	20.4	7.94	11.9	15.9	0.017	0.6	<0.91	<4.55

TABLE 2-4. SOIL ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Geologic Unit	Sample Depth (ft BGS)	Sample Date	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Boron (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Cobalt (mg/kg)	Lead (mg/kg)	Lithium (mg/kg)	Mercury (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Thallium (mg/kg)
103	Upper Till Unit	13-15	03/07/2021	<0.38	5.61	40.1	0.63	16.5	<0.2	23.4	8.14	14.2	26.3	0.012	1.84	<0.98	<4.9
103	Upper Till Unit	92-94	03/08/2021	1.71	26.3	7.99	0.06	3.38	<0.19	7.18	9.77	38	3.9	<0.011	1.41	<0.93	<4.63
103	Lower Till Unit	173-175	03/09/2021	<0.38	3.87	46.7	0.33	8.24	<0.2	14.9	5.82	9.02	12	<0.011	0.86	<0.98	<4.9

Notes:
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method.
BGS = below ground surface
ft = foot or feet
mg/kg = milligrams per kilogram

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TABLE 3-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Well Number	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)
01	LGU	10/29/1982	661.69	661.69	Top of PVC	660.09	99.60	104.40	560.60	555.80	119.00	541.20	4.8	2	40.18086	-87.746898
02	LGU	11/03/1982	593.87	593.87	Top of PVC	590.39	30.10	39.70	560.30	550.70	39.70	549.40	9.6	2	40.182334	-87.743855
03R	LGU	12/07/1993	589.86	589.86	Top of PVC	587.83	29.00	34.00	558.80	553.80	35.30	551.30	5	2	40.184122	-87.746092
04	UA	11/04/1982	590.89	590.89	Top of PVC	587.38	8.70	13.50	578.70	573.90	13.50	573.90	4.8	2	40.186394	-87.74493
05	UA	11/04/1982	595.65	595.65	Top of PVC	592.28	9.10	13.90	583.10	578.30	13.90	578.30	4.8	2	40.187159	-87.747129
06R	UU	11/23/1999	592.43	592.43	Top of PVC	589.69	8.40	13.50	581.20	576.10	13.50	575.60	5.1	2	40.189082	-87.74491
07R	UA	04/27/2021	594.50	594.50	Top of PVC	591.83	11.00	21.00	580.83	570.83	21.00	551.83	20	2	40.182309	-87.743853
08R	UA	12/06/1993	589.86	589.86	Top of PVC	587.92	9.50	14.50	578.50	573.50	18.00	570.00	5	2	40.184136	-87.746095
17	UA	12/06/1993	623.19	623.19	Top of PVC	619.62	54.00	59.00	565.60	560.60	60.00	547.60	5	2	40.182087	-87.746641
18	UA	12/08/1993	622.79	622.79	Top of PVC	619.55	38.50	43.50	580.70	575.70	44.50	574.20	5	2	40.182106	-87.746631
20	UA	12/08/1993	592.27	592.27	Top of PVC	590.18	12.50	17.50	577.70	572.70	18.50	571.20	5	2	40.186949	-87.743335
21	LGU	12/08/1993	672.71	672.71	Top of PVC	670.69	104.00	109.00	566.40	561.40	110.00	558.40	5	2	40.179682	-87.744962
34	LGU	10/21/2010	592.45	592.45	Top of PVC	590.11	49.10	54.10	540.90	535.88	54.30	535.70	5	2	40.186921	-87.743359
36	UA	03/03/2021	589.96	589.96	Top of PVC	587.82	16.00	21.00	571.82	566.82	21.00	565.80	5	2	40.183141	-87.745676
37	LGU	03/03/2021	589.71	589.71	Top of PVC	587.84	48.00	53.00	539.84	534.84	53.00	525.80	5	2	40.183133	-87.745668
38	UA	03/02/2021	591.69	591.69	Top of PVC	589.14	21.00	31.00	568.14	558.14	31.00	552.10	10	2	40.189062	-87.744898
40	UA	10/03/2018	592.27	592.27	Top of PVC	589.57	12.50	17.50	577.07	572.07	17.50	--	5	2	40.182269	-87.742987
41	UA	03/04/2021	587.17	587.17	Top of PVC	585.07	21.00	31.00	564.07	554.07	31.00	548.10	10	2	40.185445	-87.745262
42	LGU	03/07/2021	608.40	608.40	Top of PVC	605.41	50.00	60.00	555.41	545.41	60.00	545.40	10	2	40.182788	-87.748374
43	LGU	03/07/2021	607.84	607.84	Top of PVC	605.30	55.00	65.00	550.30	540.30	65.00	530.30	10	2	40.184888	-87.750015
44	UCU	03/08/2021	607.89	607.89	Top of PVC	605.37	40.00	45.00	565.37	560.37	45.00	560.40	5	2	40.184879	-87.750003
101	LGU	03/05/2021	706.67	706.67	Top of PVC	704.09	141.00	151.00	563.09	553.09	151.00	544.10	10	2	40.179149	-87.754113
102	LGU	03/06/2021	589.86	589.86	Top of PVC	702.98	148.00	158.00	554.98	544.98	158.00	543.00	10	2	40.177887	-87.750283

RAMBOLL

TABLE 3-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Well Number	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)
103	LGU	03/09/2021	720.38	720.38	Top of PVC	717.38	155.00	165.00	562.38	552.38	165.00	540.40	10	2	40.179842	-87.748995
104	LGU	03/08/2021	705.88	705.88	Top of PVC	703.24	152.00	162.00	551.24	541.24	162.00	533.20	10	2	40.177681	-87.748843
105	LGU	03/05/2021	705.88	705.88	Top of PVC	698.46	129.00	139.00	569.46	559.46	139.00	538.50	10	2	40.178557	-87.745392
ND3	CCR	02/05/2019	614.55	614.55	Top of PVC	610.78	8.65	23.31	602.13	587.48	23.87	586.91	14.66	2	40.1831	-87.747349
OED1	CCR	02/06/2019	630.41	630.41	Top of PVC	627.29	23.68	43.34	603.61	583.95	43.83	583.46	19.66	2	40.181608	-87.745161
SG01	SW	04/01/2021	689.32	689.32	Top of PVC	689.32	--	--	--	--	689.30	--	0	2	40.173756	-87.745091

Notes:
All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
-- = data not available
BGS = below ground surface
CCR = Coal Combustion Residual
ft = foot or feet
HSU = Hydrostratigraphic Unit
LGU = lower groundwater unit
PVC = polyvinyl chloride
SW = surface water
UA = uppermost aquifer
UCU = upper confining unit
UU = upper unit

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TABLE 3-2. HORIZONTAL HYDRAULIC GRADIENTS AND GROUNDWATER FLOW VELOCITIES

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

$V = K i \ / \ n_e$

V = Groundwater Velocity
K = Hydraulic Conductivity [1]
n_e = Effective Porosity [2]

Central NAP Middle Groundwater Unit (44 to 08R): Uppermost Aquifer

Distance between Wells (ft): 1123
Hydraulic Conductivity (ft/day): 7.1
Effective Porosity (%): 27 Assumes: sand and gravel

Date	44 Groundwater Elevation (ft NAVD88)	08R Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity [3] (ft/day)
3/29/2021	591.97	579.30	12.67	0.0113	0.29
4/12/2021	593.85	577.23	16.62	0.0148	0.39
5/10/2021	593.85	580.35	13.50	0.0120	0.31
6/2/2021	593.86	577.32	16.54	0.0147	0.38
6/16/2021	593.59	576.96	16.63	0.0148	0.39
7/7/2021	594.09	577.89	16.20	0.0144	0.38
7/26/2021	594.06	577.67	16.39	0.0146	0.38
8/16/2021	593.61	577.90	15.71	0.0140	0.37
			Average	0.0138	0.36

Southern NAP Middle Groundwater Unit (17 to 36): Uppermost Aquifer

Distance between Wells (ft): 467
Hydraulic Conductivity (ft/day): 7.1
Effective Porosity (%): 27 Assumes: sand and gravel

Date	17 Groundwater Elevation (ft NAVD88)	36 Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity (ft/day)
3/29/2021	586.83	578.56	8.27	0.0177	0.46
4/12/2021	584.37	575.98	8.39	0.0180	0.47
5/10/2021	587.12	579.19	7.93	0.0170	0.44
6/2/2021	584.31	576.25	8.06	0.0173	0.45
6/16/2021	584.49	575.96	8.53	0.0183	0.48
7/7/2021	585.79	576.76	9.03	0.0193	0.51
7/26/2021	585.70	576.47	9.23	0.0198	0.52
8/16/2021	585.41	576.97	8.44	0.0181	0.47
			Average	0.0182	0.47

TABLE 3-2. HORIZONTAL HYDRAULIC GRADIENTS AND GROUNDWATER FLOW VELOCITIES

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT

VERMILION POWER PLANT

NORTH ASH POND AND OLD EAST ASH POND

OAKWOOD, ILLINOIS

Northern NAP Middle Groundwater Unit (05 to 04): Uppermost Aquifer

Distance between Wells (ft): 675

Hydraulic Conductivity (ft/day): 7.1

Effective Porosity (%): 27 Assumes: sand and gravel

Date	05 Groundwater Elevation (ft NAVD88)	04 Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity (ft/day)
3/29/2021	589.05	584.61	4.44	0.0066	0.17
4/12/2021	588.83	584.20	4.63	0.0069	0.18
5/10/2021	589.27	584.65	4.62	0.0068	0.18
6/2/2021	588.60	583.71	4.89	0.0072	0.19
6/16/2021	588.24	583.33	4.91	0.0073	0.19
7/7/2021	588.66	584.18	4.48	0.0066	0.17
7/26/2021	588.60	583.75	4.85	0.0072	0.19
8/16/2021	588.07	582.87	5.20	0.0077	0.20
			Average	0.0070	0.18

Central NAP Lower Groundwater Unit (43 to 03R): Potential Migration Pathway

Distance between Wells (ft): 1126

Hydraulic Conductivity (ft/day): 2.1

Effective Porosity (%): 18 Assumes: sand and clay

Date	43 Groundwater Elevation (ft NAVD88)	03R Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity (ft/day)
3/29/2021	593.41	582.64	10.77	0.0096	0.11
4/12/2021	592.29	582.44	9.85	0.0087	0.10
5/10/2021	592.18	582.84	9.34	0.0083	0.10
6/2/2021	592.42	582.58	9.84	0.0087	0.10
6/16/2021	592.19	582.26	9.93	0.0088	0.10
7/7/2021	592.54	583.23	9.31	0.0083	0.10
7/26/2021	592.69	583.01	9.68	0.0086	0.10
8/16/2021	592.44	582.69	9.75	0.0087	0.10
			Average	0.0087	0.10

TABLE 3-2. HORIZONTAL HYDRAULIC GRADIENTS AND GROUNDWATER FLOW VELOCITIES
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Northern NAP Lower Groundwater Unit (43 to 34): Potential Migration Pathway

Distance between Wells (ft): 2011
Hydraulic Conductivity (ft/day): 2.1
Effective Porosity (%): 18 Assumes: sand and clay

Date	43 Groundwater Elevation (ft NAVD88)	34 Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity (ft/day)
3/29/2021	593.41	579.94	13.47	0.0067	0.08
4/12/2021	592.29	578.63	13.66	0.0068	0.08
5/10/2021	592.18	579.35	12.83	0.0064	0.08
6/2/2021	592.42	579.00	13.42	0.0067	0.08
6/16/2021	592.19	578.54	13.65	0.0068	0.08
7/7/2021	592.54	579.86	12.68	0.0063	0.07
7/26/2021	592.69	579.03	13.66	0.0068	0.08
8/16/2021	592.44	579.15	13.29	0.0066	0.08
			Average	0.0066	0.08

Western OEAP Lower Groundwater Unit (103 to 02): Potential Migration Pathway

Distance between Wells (ft): 1699
Hydraulic Conductivity (ft/day): 2.1
Effective Porosity (%): 18 Assumes: sand and clay

Date	103 Groundwater Elevation (ft NAVD88)	02 Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity (ft/day)
3/29/2021	583.18	577.05	6.13	0.0036	0.04
4/12/2021	583.21	575.13	8.08	0.0048	0.06
5/10/2021	583.27	577.31	5.96	0.0035	0.04
6/17/21-6/18/21	583.07	574.67	8.40	0.0049	0.06
7/5/21-7/8/21	583.63	575.97	7.66	0.0045	0.05
7/26/21-7/27/21	583.63	575.77	7.86	0.0046	0.05
8/16/2021	583.30	576.16	7.14	0.0042	0.05
			Average	0.0043	0.05

[O:EDP 07/16/21; U:EDP 10/5/21; C:KLT 10/5/21]

Notes:

[1] Hydraulic conductivity values used above are the geometric mean of hydrostratigraphic unit hydraulic conductivity values calculated from slug tests completed in April 2021 by Ramboll.

[2] Effective porosity used in these calculations was derived from an average between estimated values of 0.20 for silt material, 0.267 for gravel, 0.07 for clay, and 0.28 for sand from Morris, D.A and A.I. Johnson, 1967. Summary of hydrologic and physical properties of rock and soil materials as analyzed by the Hydrologic Laboratory of the U.S. GeologicalSurvey. U.S. Geological Survey Water-Supply Paper 1839-D, 42p. and Heath, R.C., 1983. Basicground-water hydrology, U.S. Geological Survey Water-Supply Paper 2220, 86p. Effective porosity may be as high as maximum total porosity (45%) calculated in Table 2-1.

[3] A negative groundwater velocity indicates a reversal of groundwater flow from normal conditions.

% = percent
ft/day = feet per day
ft/ft = feet per foot
ft= foot/feet
NAP = North Ash Pond
NAVD88 = North American Vertical Datum of 1988
OEAP = Old East Ash Pond

TABLE 3-3. FIELD HYDRAULIC CONDUCTIVITIES
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
VERMILION NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Well ID	Gradient Position	Bottom of Screen Elevation (ft NAVD88)	Screen Length [1] (ft)	Field Identified Screened Material (USCS)	Slug Type	Analysis Method	Number of Field Tests	Test Analyzed[2]	Hydraulic Conductivity (cm/s)	Minimum Hydraulic Conductivity (cm/s)	Maximum Hydraulic Conductivity (cm/s)	Hydraulic Conductivity Geometric Mean (cm/s)
Middle Groundwater Unit; Upper Aquifer												
04	D	573.90	4.8	SC, GP-GM	Solid	Kansas Geological Survey	4	RH-1	4.94E-03	8.38E-06	2.66E-01	2.52E-03
05	S	578.30	4.8	SM/SP	Solid	Kansas Geological Survey	4	RH-2	2.26E-03			
08R	D	573.50	5.0	SM/SP	Solid	Bouwer-Rice	3	RH-1	9.26E-04			
17	VAR	560.60	5.0	SM/SP	Solid	Bouwer-Rice	1	FH-1	8.38E-06			
18	VAR	575.70	5.0	SP-SM	Solid	Bouwer-Rice	1	RH-1	1.03E-01			
20	SG	572.70	5.0	CL/CH, SP, GW	Solid	Bouwer-Rice	4	FH-1	3.60E-03			
36	D	566.82	5.0	SM, SP, (SW)g, CL/ML	Solid	Bouwer-Rice	6	RH-2	3.26E-03			
38	SG	558.14	10.0	SP, CL	Solid	Kansas Geological Survey	6	RH-1	1.13E-02			
40	D	572.07	5.0	SP-SM, CL	Solid	Kansas Geological Survey	5	FH-2	2.66E-01			
41	D	554.07	10.0	CL, SP, SC, (GW)s	Solid	Bouwer-Rice	6	RH-1	4.20E-03			
44	U	560.37	5.0	CL, SP	Solid	Bouwer-Rice	1	FH-1	1.95E-05			
Lower Groundwater Unit; Potential Migration Pathway												
02	D	550.70	9.6	CL, SP, (CL)s	Solid	Kansas Geological Survey	2	FH-1	1.65E-04	1.13E-05	7.44E-02	7.32E-04
03R	D	553.80	5	(SP)g, CL	Solid	Kansas Geological Survey	4	RH-2	6.35E-03			
21	U	561.40	5	CL, SC	Solid	Bouwer-Rice	2	FH-1	3.14E-05			
34	D	572.65	5	SW, SW-SC, SP-SM	Solid	Kansas Geological Survey	4	RH-2	2.80E-03			
37	D	534.84	5	SP-SM, SW-SC, CL/ML	Solid	Kansas Geological Survey	4	FH-2	6.33E-03			
42	U	545.41	10	CL/ML, (GP)s	Solid	Kansas Geological Survey	4	RH-1	7.44E-02			
43	U	540.30	10	CL/ML, SP, ML, CL	Solid	Kansas Geological Survey	4	RH-2	2.37E-04			
101	U	553.09	10	CL/ML, SP-SM	Solid	Cooper-Bredehoeft-Papadopulos	1	FH-1	2.61E-05			
102	U	544.98	10	CL, SP, (SW)g	Solid	Kansas Geological Survey	2	RH-1	1.30E-03			
103	U	552.38	10	CL/ML, SP, SM, SP-SM, CL	Solid	Bouwer-Rice	1	FH-1	1.13E-05			
104	U	541.24	10	CL, SP, SP-SM	Solid	Kansas Geological Survey	4	FH-2	2.19E-02			
105	U	559.46	10	CL, (SP)g, SP-SM	Solid	Kansas Geological Survey	1	FH-1	2.73E-04			
CCR												
ND2	NA	580.44	14.7	CCR	Solid	Kansas Geological Survey	4	RH-2	4.84E-05	4.84E-05	1.25E-04	7.78E-05
ND3	NA	587.48	14.7	CCR	Solid	Bouwer-Rice	4	RH-1	1.25E-04			

Notes:

[U:EDP:7/28/21C: EGP 7/27/21; U: EDP 10/4/21, C: KLT 10/5/21]

[1] All wells are constructed from 2 inch polyvinyl chloride (PVC) with 0.01 inch slotted screens.
[2] Test response data (elapsed time and corresponding changes in water levels) were plotted as normalized displacement to evaluate similarity among repeat test data within each well. A single test was selected for analysis at each well based on the quality of the test data (i.e., smooth recovery curve) and coincidence of repeat test data.

cm/s = centimeters per second
CCR = coal combustion residuals
D = downgradient
FH-1 = Falling Head 1 Test
FH-2 = Falling Head 2 Test
ft = foot/feet
NA = Not Applicable
NAVD88 = North American Vertical Datum of 1988
RH-1 = Rising Head 1 Test
RH-2 = Rising Head 2 Test
SG = sidegradient
U= upgradient
VAR = variable

USCS = Unified Soil Classification System

CH = Fat Clay
CL = Lean Clay
(CL)s = Lean Clay with Sand
CL/ML = Silty Clay
(GP)s = Poorly Graded Gravel with Sand
GP-GM = Gravel with Silt
GW = Well Graded Gravel
(GW)s = Well Graded Gravel with Sand
ML = Silt
SC = Clayey Sand
SM = Silty Sand
SP = Poorly Graded Sand
(SP)g = Poorly Graded Sand with Gravel
SP-SM = Poorly Graded Sand with Silt
SP-SM = Sand with Silt
SW = Well Graded Sand
(SW)g = Well Graded Sand with Gravel
SW-SC = Well Graded Sand with Clay

TABLE 3-4. VERTICAL HYDRAULIC GRADIENTS

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
VERMILION NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Date	36 Groundwater Elevation (ft NAVD88)	37 Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	MGU	LGU				
3/29/2021	578.56	582.59	-4.03	31.98	-0.126	up
4/12/2021	575.98	582.33	-6.35	31.98	-0.199	up
5/10/2021	579.19	582.68	-3.49	31.98	-0.109	up
6/2/2021	576.25	582.48	-6.23	31.98	-0.195	up
6/16/2021	575.96	582.12	-6.16	31.98	-0.193	up
7/7/2021	576.76	583.02	-6.26	31.98	-0.196	up
7/26/2021	576.47	581.83	-5.36	31.98	-0.168	up
8/16/2021	576.97	582.51	-5.54	31.98	-0.173	up
			Middle of screen elevation 36			569.3
			Middle of screen elevation 37			537.3

Date	08R Groundwater Elevation (ft NAVD88)	03R Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	MGU	LGU				
3/29/2021	579.30	582.64	-3.34	19.70	-0.170	up
4/12/2021	577.23	582.44	-5.21	20.93	-0.249	up
5/10/2021	580.35	582.84	-2.49	19.70	-0.126	up
6/2/2021	577.32	582.58	-5.26	21.02	-0.250	up
6/16/2021	576.96	582.26	-5.30	20.66	-0.257	up
7/7/2021	577.89	583.23	-5.34	21.59	-0.247	up
7/26/2021	577.67	583.01	-5.34	21.37	-0.250	up
8/16/2021	577.90	582.69	-4.79	21.60	-0.222	up
			Middle of screen elevation 08R			576.0
			Middle of screen elevation 03R			556.3

RAMBOLL

TABLE 3-4. VERTICAL HYDRAULIC GRADIENTS

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
VERMILION NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Date	06R Groundwater Elevation (ft NAVD88)	38 Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	UU	MGU				
3/29/2021	588.49	588.59	-0.10	15.60	-0.006	up
4/12/2021	588.28	588.38	-0.10	15.60	-0.006	up
5/10/2021	588.45	588.64	-0.19	15.60	-0.012	up
7/7/2021	588.72	588.06	0.66	15.60	0.042	down
7/26/2021	585.78	586.94	-1.16	15.60	-0.074	up
8/16/2021	584.87	585.00	-0.13	15.60	-0.008	up
			Middle of screen elevation 06R			578.7
			Middle of screen elevation 38			563.1

Date	20 Groundwater Elevation (ft NAVD88)	34 Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	MGU	LGU				
3/29/2021	580.29	579.94	0.35	36.66	0.010	down
4/12/2021	579.00	578.63	0.37	36.66	0.010	down
5/10/2021	579.19	579.35	-0.16	36.66	-0.004	up
6/2/2021	578.56	579.00	-0.44	36.66	-0.012	up
6/16/2021	578.21	578.54	-0.33	36.66	-0.009	up
7/7/2021	580.62	579.86	0.76	36.66	0.021	down
7/26/2021	578.92	579.03	-0.11	36.66	-0.003	up
8/16/2021	578.54	579.15	-0.61	36.66	-0.017	up
			Middle of screen elevation 20			575.2
			Middle of screen elevation 34			538.5

Date	18 Groundwater Elevation (ft NAVD88)	17 Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	MGU	MGU				
3/29/2021	598.24	586.83	11.41	15.43	0.739	down
4/12/2021	598.39	584.37	14.02	15.43	0.908	down
5/10/2021	598.49	587.12	11.37	15.43	0.737	down
6/2/2021	598.67	584.31	14.36	15.43	0.930	down
6/16/2021	597.99	584.49	13.50	15.43	0.875	down
7/7/2021	600.59	585.79	14.80	15.43	0.959	down
7/26/2021	599.82	585.70	14.12	15.43	0.915	down
8/16/2021	598.81	585.41	13.40	15.43	0.868	down
			Middle of screen elevation 18			578.6
			Middle of screen elevation 17			563.1

TABLE 3-4. VERTICAL HYDRAULIC GRADIENTS

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT

VERMILION POWER PLANT

VERMILION NORTH ASH POND AND OLD EAST ASH POND

OAKWOOD, ILLINOIS

Date	44 Groundwater Elevation (ft NAVD88)	43 Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	UCU	LGU				
3/29/2021	593.46	591.92	1.54	17.57	0.088	down
4/12/2021	593.85	592.29	1.56	17.57	0.089	down
5/10/2021	593.85	592.18	1.67	17.57	0.095	down
6/2/2021	593.86	592.42	1.44	17.57	0.082	down
6/16/2021	593.59	592.19	1.40	17.57	0.080	down
7/7/2021	594.09	592.54	1.55	17.57	0.088	down
7/26/2021	594.06	592.69	1.37	17.57	0.078	down
8/16/2021	593.61	592.44	1.17	17.57	0.067	down
			Middle of screen elevation 44			562.9
			Middle of screen elevation 43			545.3

[O:EDP 6/29/21, C: EGP 7/27/21; U:EDP 7/28/21, C: KLT 8/13/21, U:EDP 9/20/21, C: KLT 10/5/21]

Notes:

1. Distance change was calculated using the midpoint of the piezometer screen and water table surface. If the water table
2. Vertical gradients between ±0.0015 are considered flat, and typically have less than 0.02 foot difference in groundwater elevation between wells.

-- = data not available
dh = head change
dl = distance change
ft = foot/feet
LGU = lower groundwater unit
MGU = middle groundwater unit
NAVD88 = North American Vertical Datum of 1988
UCU = upper confining unit
UU = upper unit

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, Total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
01	07/13/2017	--	--	--	--	--	--	--	22	--	--	--	--	--	--	--	7.2	--	--	1070	--	2060
01	09/13/2017	--	--	--	--	--	--	--	22	--	--	--	--	--	--	--	7.2	--	--	995	--	2040
01	11/08/2017	--	--	--	--	--	--	--	20	--	--	--	--	--	--	--	7.0	--	--	1000	--	2070
01	01/24/2018	--	--	--	--	--	--	--	21	--	--	--	--	--	--	--	6.9	--	--	1040	--	2080
01	03/22/2018	--	--	--	--	--	--	--	22	--	--	--	--	--	--	--	6.9	--	--	1280	--	2240
01	05/09/2018	--	--	--	--	--	--	--	14	--	--	--	--	--	--	--	6.6	--	--	1070	--	2090
01	03/31/2021	<0.001	<0.001	0.0156	<0.001	2.53	<0.001	393	16	<0.0015	<0.001	0.12	0.0026	0.0528	<0.0002	<0.0015	7.0	0.819	<0.001	1050	<0.002	2200
01	04/19/2021	<0.001	<0.001	0.0195	<0.001	4.8	<0.001	448	22	<0.0015	<0.001	0.12	0.0012	0.0459	<0.0002	<0.0015	6.9	0.352	<0.001	1220	<0.002	2420
01	05/11/2021	<0.002	<0.001	0.022	<0.001	4.17	<0.001	457	21	<0.001	<0.001	0.12	0.00153	0.0419	<0.0002	0.00113	6.9	0.104	<0.001	1180	<0.001	2410
01	06/04/2021	<0.001	<0.001	0.0123	<0.001	1.22	<0.001	380	17	<0.0015	<0.001	0.13	<0.001	0.0478	<0.0002	<0.0015	6.8	0.0179	<0.001	967	<0.002	1870
02	07/13/2017	--	--	--	--	--	--	--	49	--	--	--	--	--	--	--	7.8	--	--	13	--	514
02	09/14/2017	--	--	--	--	--	--	--	49	--	--	--	--	--	--	--	7.7	--	--	20	--	530
02	11/08/2017	--	--	--	--	--	--	--	47	--	--	--	--	--	--	--	7.7	--	--	14	--	506
02	01/24/2018	--	--	--	--	--	--	--	45	--	--	--	--	--	--	--	7.4	--	--	19	--	432
02	03/22/2018	--	--	--	--	--	--	--	33	--	--	--	--	--	--	--	7.6	--	--	85	--	506
02	05/09/2018	--	--	--	--	--	--	--	37	--	--	--	--	--	--	--	7.4	--	--	46	--	502
02	03/31/2021	<0.001	0.0065	0.198	<0.001	0.321	<0.001	90.4	27	<0.0015	<0.001	0.43	<0.001	0.008	<0.0002	<0.0015	7.6	0.582	<0.001	129	<0.002	554
02	04/21/2021	<0.001	0.0082	0.236	<0.001	0.343	<0.001	97.4	35	<0.0015	<0.001	0.48	<0.001	0.0041	<0.0002	<0.0015	7.5	0.256	<0.001	110	<0.002	602
02	05/12/2021	<0.002	0.00994	0.222	<0.001	0.311	<0.001	101	41	<0.001	<0.001	0.52	<0.001	<0.005	<0.0002	<0.001	7.5	0.834	<0.001	110	<0.001	578
02	06/03/2021	<0.001	0.0071	0.236	<0.001	0.357	<0.001	107	39	<0.0015	<0.001	0.53	<0.001	<0.003	<0.0002	<0.0015	7.5	1.15	<0.001	120	<0.002	624
02	06/17/2021	<0.001	0.0062	0.233	<0.001	0.315	<0.001	106	43	<0.0015	<0.001	0.56	<0.001	<0.003	<0.0002	<0.0015	7.1	1.32	<0.001	123	<0.002	630
02	07/08/2021	<0.001	0.0111	0.264	<0.001	0.386	<0.001	99.2	45	<0.0015	<0.001	0.5	<0.001	0.0062	<0.0002	<0.0015	7.2	1.52	<0.001	89	<0.002	592

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, Total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
02	07/27/2021	<0.001	0.0057	0.203	<0.001	0.324	<0.001	102	47	<0.0015	<0.001	0.55	<0.001	0.0062	<0.0002	<0.0015	7.6	0.236	<0.001	88	<0.002	558
02	08/17/2021	<0.001	0.0041	0.194	<0.001	0.333	<0.001	93.6	49	<0.0015	<0.001	0.55	<0.001	0.0034	<0.0002	<0.0015	7.6	0.752	<0.001	74	<0.002	584
03R	07/13/2017	--	--	--	--	--	--	--	27	--	--	--	--	--	--	--	7.6	--	--	179	--	742
03R	09/14/2017	--	--	--	--	--	--	--	27	--	--	--	--	--	--	--	7.2	--	--	144	--	698
03R	11/08/2017	--	--	--	--	--	--	--	25	--	--	--	--	--	--	--	7.4	--	--	70	--	606
03R	01/24/2018	--	--	--	--	--	--	--	26	--	--	--	--	--	--	--	7.0	--	--	55	--	542
03R	03/22/2018	--	--	--	--	--	--	--	25	--	--	--	--	--	--	--	7.3	--	--	101	--	606
03R	05/09/2018	--	--	--	--	--	--	--	24	--	--	--	--	--	--	--	7.2	--	--	167	--	678
03R	03/30/2021	<0.001	0.0107	0.297	<0.001	18.4	0.0012	157	29	0.002	<0.001	0.48	0.0024	<0.003	<0.0002	0.151	7.2	--	<0.001	538	<0.002	1090
03R	04/21/2021	<0.001	0.0091	0.325	<0.001	19.1	<0.001	163	27	<0.0015	<0.001	0.44	0.001	<0.003	<0.0002	0.202	7.3	1.81	<0.001	489	<0.002	1170
03R	05/11/2021	<0.002	0.00804	0.325	<0.001	19.9	<0.001	179	27	0.00123	<0.001	0.46	<0.001	<0.005	<0.0002	0.225	7.4	1.63	<0.001	501	<0.001	1210
03R	06/02/2021	<0.001	0.0049	0.289	<0.001	19.6	<0.001	169	33	<0.0015	<0.001	0.46	<0.001	<0.003	<0.0002	0.195	7.3	1.15	<0.001	484	<0.002	1110
03R	06/16/2021	<0.001	0.005	0.293	<0.001	19.2	<0.001	167	31	<0.0015	<0.001	0.49	<0.001	<0.003	<0.0002	0.216	7.2	1.72	<0.001	491	<0.002	1100
03R	07/07/2021	<0.001	0.0059	0.278	<0.001	19.7	<0.001	163	32	<0.0015	<0.001	0.44	<0.001	<0.003	<0.0002	0.187	7.2	1.82	<0.001	485	<0.002	1120
03R	07/26/2021	<0.001	0.0047	0.289	<0.001	19.5	<0.001	167	29	<0.0015	<0.001	0.47	<0.001	<0.003	<0.0002	0.193	7.2	0.52	<0.001	510	<0.002	1100
03R	08/16/2021	<0.001	0.0045	0.277	<0.001	19.2	<0.001	158	28	<0.0015	<0.001	0.47	<0.001	<0.003	<0.0002	0.188	7.3	0.658	<0.001	506	<0.002	1050
04	07/13/2017	--	--	--	--	--	--	--	12	--	--	--	--	--	--	--	7.7	--	--	95	--	452
04	09/13/2017	--	--	--	--	--	--	--	11	--	--	--	--	--	--	--	7.5	--	--	69	--	428
04	11/08/2017	--	--	--	--	--	--	--	9	--	--	--	--	--	--	--	7.5	--	--	44	--	330
04	01/24/2018	--	--	--	--	--	--	--	10	--	--	--	--	--	--	--	6.9	--	--	32	--	338
04	03/22/2018	--	--	--	--	--	--	--	9	--	--	--	--	--	--	--	7.5	--	--	47	--	370
04	05/09/2018	--	--	--	--	--	--	--	11	--	--	--	--	--	--	--	7.2	--	--	99	--	430

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, Total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
04	03/30/2021	<0.001	0.0068	0.254	<0.001	9.24	<0.001	77.3	12	<0.0015	<0.001	0.3	<0.001	0.0584	<0.0002	0.0301	7.3	--	<0.001	63	<0.002	388
04	04/19/2021	<0.001	0.0053	0.232	<0.001	8.13	<0.001	70.4	12	<0.0015	<0.001	0.3	<0.001	0.0522	<0.0002	0.0293	7.7	1.04	<0.001	67	<0.002	400
04	05/10/2021	<0.002	0.00526	0.247	<0.001	7.49	<0.001	73.8	12	<0.001	<0.001	0.31	<0.001	0.0457	<0.0002	0.0306	7.4	0.763	<0.001	81	<0.001	414
04	06/02/2021	<0.001	0.0055	0.248	<0.001	8.92	<0.001	76.4	12	<0.0015	<0.001	0.31	<0.001	0.0499	<0.0002	0.031	7.4	0.701	<0.001	87	<0.002	418
04	06/16/2021	<0.001	0.0062	0.251	<0.001	9.05	<0.001	76.6	13	<0.0015	0.001	0.33	<0.001	0.0491	<0.0002	0.032	7.4	0.485	<0.001	95	<0.002	420
04	07/07/2021	<0.001	0.0067	0.237	<0.001	10.1	<0.001	72.6	13	<0.0015	<0.001	0.31	<0.001	0.0504	<0.0002	0.0334	7.3	1.15	<0.001	89	<0.002	396
04	07/26/2021	<0.001	0.0062	0.24	<0.001	9.75	<0.001	74.6	13	<0.0015	<0.001	0.33	<0.001	0.0501	<0.0002	0.0352	7.2	0.859	<0.001	70	<0.002	388
04	08/16/2021	<0.001	0.0066	0.253	<0.001	10.9	<0.001	75.1	15	<0.0015	<0.001	0.32	<0.001	0.0533	<0.0002	0.0353	7.4	1.38	<0.001	46	<0.002	406
05	07/13/2017	--	--	--	--	--	--	--	11	--	--	--	--	--	--	--	7.6	--	--	268	--	618
05	09/14/2017	--	--	--	--	--	--	--	12	--	--	--	--	--	--	--	7.3	--	--	262	--	634
05	11/08/2017	--	--	--	--	--	--	--	12	--	--	--	--	--	--	--	7.3	--	--	291	--	362
05	01/24/2018	--	--	--	--	--	--	--	11	--	--	--	--	--	--	--	7.0	--	--	261	--	588
05	03/22/2018	--	--	--	--	--	--	--	11	--	--	--	--	--	--	--	7.4	--	--	281	--	624
05	05/09/2018	--	--	--	--	--	--	--	9	--	--	--	--	--	--	--	7.2	--	--	283	--	674
05	03/30/2021	<0.001	<0.001	0.0279	<0.001	22	<0.001	117	10	<0.0015	<0.001	0.52	<0.001	0.108	<0.0002	0.0194	7.1	--	<0.001	285	<0.002	560
05	04/21/2021	<0.001	<0.001	0.0251	<0.001	18.5	<0.001	104	9	<0.0015	<0.001	0.52	<0.001	0.0953	<0.0002	0.0216	7.3	0.124	<0.001	254	<0.002	574
05	05/11/2021	<0.002	<0.001	0.0245	<0.001	19.2	<0.001	110	10	<0.001	<0.001	0.54	<0.001	0.0839	<0.0002	0.0228	7.4	0.0443	<0.001	239	<0.001	596
05	06/02/2021	<0.001	<0.001	0.0221	<0.001	19	<0.001	103	10	<0.0015	<0.001	0.54	<0.001	0.0901	<0.0002	0.0217	7.3	1.62	<0.001	245	<0.002	556
05	06/16/2021	<0.001	<0.001	0.0223	<0.001	18.4	<0.001	103	10	<0.0015	<0.001	0.57	<0.001	0.0895	<0.0002	0.0229	7.2	0.39	<0.001	244	<0.002	526
05	07/07/2021	<0.001	<0.001	0.0211	<0.001	18.5	<0.001	94.8	10	<0.0015	<0.001	0.54	<0.001	0.0886	<0.0002	0.0242	7.1	0.412	<0.001	228	<0.002	508
05	07/26/2021	<0.001	<0.001	0.0219	<0.001	18	<0.001	101	10	<0.0015	<0.001	0.57	<0.001	0.0893	<0.0002	0.0249	7.2	0.083	<0.001	224	<0.002	552
05	08/16/2021	<0.001	<0.001	0.0226	<0.001	19.8	<0.001	99	11	<0.0015	<0.001	0.58	<0.001	0.0904	<0.0002	0.0255	7.2	0.0661	<0.001	231	<0.002	536

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, Total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
06R	07/13/2017	--	--	--	--	--	--	--	7	--	--	--	--	--	--	--	7.2	--	--	87	--	524
06R	09/13/2017	--	--	--	--	--	--	--	12	--	--	--	--	--	--	--	6.9	--	--	68	--	546
06R	11/08/2017	--	--	--	--	--	--	--	7	--	--	--	--	--	--	--	7.0	--	--	160	--	606
06R	01/24/2018	--	--	--	--	--	--	--	7	--	--	--	--	--	--	--	6.8	--	--	103	--	578
06R	03/22/2018	--	--	--	--	--	--	--	6	--	--	--	--	--	--	--	7.1	--	--	135	--	590
06R	05/09/2018	--	--	--	--	--	--	--	<5	--	--	--	--	--	--	--	6.8	--	--	166	--	568
07R	05/12/2021	<0.002	0.00109	0.0206	<0.001	25.2	<0.001	1080	6	<0.001	<0.001	0.11	<0.001	0.534	<0.0002	0.394	7.3	0.87	0.00349	1930	<0.001	2970
07R	06/03/2021	0.0013	0.108	0.682	0.0019	40.4	0.0019	947	6	0.244	0.0482	0.12	0.146	0.592	<0.0002	0.494	7.4	15.6	0.0075	1890	<0.002	2940
07R	06/17/2021	0.0017	0.193	1.24	0.0023	37.3	0.0027	1070	7	0.339	0.0658	0.13	0.24	0.598	<0.0002	0.786	7.3	3.87	0.011	2030	<0.002	2890
07R	07/08/2021	<0.001	0.0017	0.0176	<0.001	42.4	<0.001	621	6	<0.0015	<0.001	0.13	<0.001	0.572	<0.0002	0.445	7.3	1.19	0.0057	1930	<0.002	2920
07R	07/27/2021	<0.001	0.002	0.0183	<0.001	42.4	<0.001	710	6	<0.0015	<0.001	0.14	<0.001	0.534	<0.0002	0.578	7.7	1.49	<0.001	1800	<0.002	2880
07R	08/17/2021	<0.001	0.0022	0.018	<0.001	48.2	<0.001	721	6	<0.0015	<0.001	0.15	<0.001	0.54	<0.0002	0.656	7.8	0.0962	<0.001	1820	<0.002	2860
08R	07/13/2017	--	--	--	--	--	--	--	16	--	--	--	--	--	--	--	8.8	--	--	1140	--	2040
08R	09/14/2017	--	--	--	--	--	--	--	18	--	--	--	--	--	--	--	8.4	--	--	1210	--	2080
08R	11/08/2017	--	--	--	--	--	--	--	17	--	--	--	--	--	--	--	8.6	--	--	1140	--	2040
08R	01/24/2018	--	--	--	--	--	--	--	7	--	--	--	--	--	--	--	6.9	--	--	378	--	1110
08R	03/22/2018	--	--	--	--	--	--	--	15	--	--	--	--	--	--	--	7.7	--	--	1010	--	1700
08R	05/09/2018	--	--	--	--	--	--	--	9	--	--	--	--	--	--	--	7.2	--	--	754	--	1400
08R	03/30/2021	<0.001	0.0072	0.112	<0.001	14.4	<0.001	178	4	<0.0015	<0.001	0.12	<0.001	0.13	<0.0002	0.0899	6.5	--	<0.001	299	<0.002	834
08R	04/21/2021	<0.001	0.0162	0.0966	<0.001	37	<0.001	274	7	<0.0015	<0.001	<0.1	<0.001	0.376	<0.0002	0.452	7.6	1.32	<0.001	645	<0.002	1330
08R	05/11/2021	<0.002	0.0105	0.0976	<0.001	8.59	<0.001	174	3	<0.001	<0.001	0.13	<0.001	0.0725	<0.0002	0.0575	6.7	1.22	<0.001	206	<0.001	766
08R	06/02/2021	<0.001	0.0141	0.0611	<0.001	36.9	<0.001	274	7	<0.0015	<0.001	<0.1	<0.001	0.353	<0.0002	0.349	7.8	1.95	<0.001	676	<0.002	1280

RAMBOLL

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, Total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
08R	06/16/2021	<0.001	0.0192	0.0479	<0.001	36.6	<0.001	286	7	<0.0015	<0.001	<0.1	<0.001	0.348	<0.0002	0.356	8.0	0.265	<0.001	742	<0.002	1260
08R	07/07/2021	<0.001	0.0112	0.132	<0.001	29.8	<0.001	220	6	<0.0015	<0.001	0.13	<0.001	0.288	<0.0002	0.191	6.7	0.378	<0.001	551	<0.002	1110
08R	07/26/2021	<0.001	0.0168	0.0772	<0.001	35.7	<0.001	289	7	<0.0015	<0.001	<0.1	<0.001	0.336	<0.0002	0.335	7.6	0.689	<0.001	758	<0.002	1320
08R	08/16/2021	<0.001	0.0185	0.0585	<0.001	41.6	<0.001	284	7	<0.0015	<0.001	<0.1	<0.001	0.346	<0.0002	0.317	8.0	0.373	<0.001	805	<0.002	1380
17	07/12/2017	--	--	--	--	--	--	--	31	--	--	--	--	--	--	--	6.9	--	--	1100	--	2030
17	09/13/2017	--	--	--	--	--	--	--	35	--	--	--	--	--	--	--	7.0	--	--	1020	--	1970
17	11/08/2017	--	--	--	--	--	--	--	6	--	--	--	--	--	--	--	6.8	--	--	1200	--	2020
17	01/24/2018	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	6.6	--	--	976	--	1630
17	03/22/2018	--	--	--	--	--	--	--	26	--	--	--	--	--	--	--	6.9	--	--	1270	--	2090
17	05/09/2018	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	6.7	--	--	1150	--	1980
17	03/31/2021	<0.001	0.0034	0.0307	<0.001	1.41	<0.001	457	6	<0.0015	0.0041	0.13	0.0017	0.0386	<0.0002	<0.0015	6.7	1.63	0.001	1260	<0.002	2230
17	04/20/2021	<0.001	0.005	0.0231	<0.001	6.55	<0.001	322	29	<0.0015	0.0027	0.18	<0.001	0.0218	<0.0002	0.0058	7.0	0.0134	<0.001	945	<0.002	1910
17	05/11/2021	<0.002	0.00494	0.0296	<0.001	3.3	<0.001	384	13	<0.001	0.00261	0.16	<0.001	0.0266	<0.0002	0.00303	6.8	0.306	<0.001	1020	<0.001	1820
17	06/02/2021	<0.001	0.0055	0.0299	<0.001	4.86	<0.001	383	28	<0.0015	0.0032	0.18	0.0014	0.0339	<0.0002	0.005	6.8	0.969	<0.001	990	<0.002	1930
17	08/16/2021	<0.001	0.0045	0.0277	<0.001	6.56	<0.001	322	31	<0.0015	0.0057	0.2	<0.001	0.0231	<0.0002	0.0074	6.7	1.01	<0.001	1010	<0.002	1890
18	07/12/2017	--	--	--	--	--	--	--	27	--	--	--	--	--	--	--	6.8	--	--	754	--	1600
18	09/13/2017	--	--	--	--	--	--	--	23	--	--	--	--	--	--	--	6.9	--	--	784	--	1650
18	11/08/2017	--	--	--	--	--	--	--	21	--	--	--	--	--	--	--	6.8	--	--	835	--	1710
18	01/24/2018	--	--	--	--	--	--	--	25	--	--	--	--	--	--	--	6.6	--	--	749	--	1590
18	03/22/2018	--	--	--	--	--	--	--	24	--	--	--	--	--	--	--	6.9	--	--	795	--	1540
18	05/09/2018	--	--	--	--	--	--	--	17	--	--	--	--	--	--	--	6.7	--	--	700	--	1420
18	03/29/2021	<0.001	0.0105	0.0207	<0.001	15.7	<0.001	292	16	<0.0015	<0.001	0.14	<0.001	0.0753	<0.0002	0.0125	7.0	--	<0.001	722	<0.002	1300

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, Total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
18	04/20/2021	<0.001	0.004	0.0163	<0.001	12.4	<0.001	233	16	<0.0015	<0.001	0.13	<0.001	0.0707	<0.0002	0.0111	7.0	0.00733	<0.001	652	<0.002	1340
18	05/11/2021	<0.002	0.0017	0.0181	<0.001	11	<0.001	255	17	<0.001	<0.001	0.13	<0.001	0.0644	<0.0002	0.0123	6.8	0.201	<0.001	677	<0.001	1320
18	06/02/2021	<0.001	0.0078	0.0176	<0.001	11.2	<0.001	259	18	<0.0015	<0.001	0.13	<0.001	0.0774	<0.0002	0.0116	6.9	0.224	<0.001	685	<0.002	1370
18	08/16/2021	<0.001	0.0113	0.017	<0.001	10	<0.001	248	17	<0.0015	<0.001	0.13	<0.001	0.0795	<0.0002	0.0116	6.8	0	<0.001	688	<0.002	1320
20	07/13/2017	--	--	--	--	--	--	--	<5	--	--	--	--	--	--	--	7.2	--	--	61	--	368
20	09/13/2017	--	--	--	--	--	--	--	<5	--	--	--	--	--	--	--	7.1	--	--	60	--	392
20	11/08/2017	--	--	--	--	--	--	--	<5	--	--	--	--	--	--	--	7.2	--	--	58	--	372
20	01/24/2018	--	--	--	--	--	--	--	4	--	--	--	--	--	--	--	6.7	--	--	73	--	366
20	03/22/2018	--	--	--	--	--	--	--	<5	--	--	--	--	--	--	--	7.2	--	--	46	--	312
20	05/09/2018	--	--	--	--	--	--	--	<5	--	--	--	--	--	--	--	7.0	--	--	53	--	352
20	03/30/2021	<0.001	0.0013	0.0307	<0.001	1.11	<0.001	130	5	<0.0015	<0.001	<0.1	<0.001	0.0393	<0.0002	<0.0015	7.1	--	<0.001	150	<0.002	522
20	04/19/2021	<0.001	<0.001	0.0186	<0.001	0.741	<0.001	99	4	<0.0015	<0.001	<0.1	<0.001	0.0222	<0.0002	<0.0015	7.1	1.03	<0.001	110	<0.002	462
20	05/10/2021	<0.002	<0.001	0.0239	<0.001	0.946	<0.001	110	5	<0.001	0.00104	<0.1	<0.001	0.0284	<0.0002	0.00173	6.9	0.212	<0.001	136	<0.001	528
20	06/02/2021	<0.001	<0.001	0.018	<0.001	0.607	<0.001	95.4	4	<0.0015	<0.001	<0.1	<0.001	0.0203	<0.0002	<0.0015	7.0	0.844	<0.001	83	<0.002	426
20	06/16/2021	<0.001	<0.001	0.0186	<0.001	0.673	<0.001	100	4	<0.0015	<0.001	<0.1	<0.001	0.0219	<0.0002	<0.0015	7.0	1.1	<0.001	93	<0.002	406
20	07/07/2021	<0.001	<0.001	0.0189	<0.001	0.587	<0.001	89.2	4	<0.0015	<0.001	<0.1	<0.001	0.0208	<0.0002	<0.0015	6.9	0.826	<0.001	76	<0.002	386
20	07/26/2021	<0.001	<0.001	0.0159	<0.001	0.48	<0.001	87.5	4	<0.0015	<0.001	<0.1	<0.001	0.0182	<0.0002	<0.0015	6.8	0.969	<0.001	64	<0.002	372
20	08/16/2021	<0.001	0.0012	0.0171	<0.001	0.583	<0.001	86	4	<0.0015	<0.001	<0.1	<0.001	0.0221	<0.0002	<0.0015	7.0	0	<0.001	80	<0.002	394
21	07/13/2017	--	--	--	--	--	--	--	<5	--	--	--	--	--	--	--	7.6	--	--	44	--	440
21	09/13/2017	--	--	--	--	--	--	--	<5	--	--	--	--	--	--	--	7.3	--	--	18	--	400
21	11/08/2017	--	--	--	--	--	--	--	<5	--	--	--	--	--	--	--	7.4	--	--	10	--	382
21	01/24/2018	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	7.3	--	--	12	--	346

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, Total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
21	03/22/2018	--	--	--	--	--	--	--	<5	--	--	--	--	--	--	--	7.4	--	--	22	--	390
21	05/09/2018	--	--	--	--	--	--	--	<5	--	--	--	--	--	--	--	7.0	--	--	25	--	394
21	03/31/2021	<0.001	0.0429	0.109	<0.001	1.02	<0.001	61.2	2	<0.0015	<0.001	1.11	<0.001	0.0035	<0.0002	0.0021	7.6	0.332	<0.001	29	<0.002	416
21	04/20/2021	<0.001	0.0449	0.106	<0.001	0.851	<0.001	61.6	3	<0.0015	<0.001	1.1	<0.001	<0.003	<0.0002	0.0035	7.6	0.178	<0.001	<10	<0.002	394
21	05/11/2021	<0.002	0.0472	0.109	<0.001	1	<0.001	63.7	2	<0.001	<0.001	1.1	<0.001	<0.005	<0.0002	0.00382	7.5	0.111	<0.001	11	<0.001	342
21	06/03/2021	<0.001	0.0499	0.109	<0.001	0.837	<0.001	64.1	3	<0.0015	<0.001	1.05	<0.001	<0.003	<0.0002	0.003	7.3	1.36	<0.001	20	<0.002	392
21	06/16/2021	<0.001	0.0476	0.109	<0.001	0.859	<0.001	62.1	3	<0.0015	<0.001	1.14	<0.001	<0.003	<0.0002	0.0032	7.2	0.51	<0.001	14	<0.002	364
21	07/08/2021	<0.001	0.0555	0.113	<0.001	0.883	<0.001	61.7	3	<0.0015	<0.001	1.04	<0.001	<0.003	<0.0002	0.0028	7.3	0.679	<0.001	15	<0.002	398
21	07/27/2021	<0.001	0.0426	0.11	<0.001	0.784	<0.001	64.4	3	<0.0015	<0.001	1.12	<0.001	<0.003	<0.0002	0.003	7.3	0.341	<0.001	14	<0.002	432
21	08/17/2021	<0.001	0.0417	0.103	<0.001	0.788	<0.001	60.4	3	<0.0015	<0.001	1.12	<0.001	<0.003	<0.0002	0.0026	7.3	0.367	<0.001	14	<0.002	396
34	07/13/2017	--	--	--	--	--	--	--	33	--	--	--	--	--	--	--	7.3	--	--	<10	--	510
34	09/13/2017	--	--	--	--	--	--	--	33	--	--	--	--	--	--	--	7.0	--	--	<10	--	494
34	11/08/2017	--	--	--	--	--	--	--	33	--	--	--	--	--	--	--	6.9	--	--	<10	--	488
34	01/24/2018	--	--	--	--	--	--	--	33	--	--	--	--	--	--	--	6.6	--	--	<10	--	456
34	03/22/2018	--	--	--	--	--	--	--	34	--	--	--	--	--	--	--	7.2	--	--	<10	--	484
34	05/09/2018	--	--	--	--	--	--	--	32	--	--	--	--	--	--	--	6.9	--	--	<10	--	472
34	03/30/2021	<0.001	0.0319	0.207	<0.001	0.651	<0.001	87.6	33	0.0033	0.0011	0.68	0.0022	0.0064	<0.0002	0.0019	7.2	--	<0.001	<10	<0.002	464
34	04/19/2021	<0.001	0.025	0.159	<0.001	0.53	<0.001	70.4	36	0.0028	<0.001	0.65	0.002	0.0033	<0.0002	<0.0015	7.2	0.321	<0.001	<10	<0.002	568
34	05/10/2021	<0.002	0.026	0.16	<0.001	0.554	<0.001	73.8	33	0.00116	<0.001	0.66	0.00105	<0.005	<0.0002	<0.001	7.0	0.276	<0.001	<10	<0.001	486
34	06/02/2021	<0.001	0.0259	0.175	<0.001	0.486	<0.001	73.8	34	0.007	0.0018	0.64	0.0035	0.006	<0.0002	<0.0015	7.1	2.02	<0.001	<10	<0.002	492
34	06/16/2021	<0.001	0.0247	0.16	<0.001	0.519	<0.001	74	37	0.0038	0.0011	0.67	0.002	0.0035	<0.0002	<0.0015	6.9	0.643	<0.001	11	<0.002	480
34	07/07/2021	<0.001	0.031	0.163	<0.001	0.503	<0.001	73.3	34	0.0043	0.0013	0.65	0.0026	0.004	<0.0002	<0.0015	6.9	1.07	<0.001	<10	<0.002	490

RAMBOLL

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, Total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
34	07/26/2021	<0.001	0.0274	0.168	<0.001	0.458	<0.001	74.9	36	0.005	0.0016	0.68	0.0034	0.0044	<0.0002	<0.0015	6.9	0.753	<0.001	<10	<0.002	480
34	08/16/2021	<0.001	0.0239	0.151	<0.001	0.479	<0.001	70.3	36	<0.0015	<0.001	0.66	0.0011	<0.003	<0.0002	<0.0015	7.0	0.849	<0.001	<10	<0.002	498
36	03/31/2021	<0.001	0.0015	0.0692	<0.001	18.8	<0.001	409	18	<0.0015	<0.001	0.25	<0.001	0.346	<0.0002	0.229	7.4	1.78	<0.001	1140	<0.002	1980
36	04/20/2021	<0.001	0.002	0.145	<0.001	13.1	<0.001	346	22	<0.0015	<0.001	0.25	<0.001	0.194	<0.0002	0.144	7.3	0.768	<0.001	957	<0.002	1810
36	05/11/2021	<0.002	0.00242	0.167	<0.001	13.7	<0.001	327	26	<0.001	<0.001	0.26	<0.001	0.15	<0.0002	0.127	7.1	1.07	<0.001	931	<0.001	1700
36	06/02/2021	<0.001	0.0028	0.154	<0.001	13.1	<0.001	340	28	<0.0015	<0.001	0.26	<0.001	0.17	<0.0002	0.137	7.1	2.08	<0.001	946	<0.002	1710
36	06/16/2021	<0.001	0.0029	0.161	<0.001	10.9	<0.001	326	30	<0.0015	<0.001	0.27	<0.001	0.114	<0.0002	0.0953	7.0	1.34	<0.001	981	<0.002	1630
36	07/07/2021	<0.001	0.0026	0.121	<0.001	13.7	<0.001	353	22	<0.0015	<0.001	0.26	<0.001	0.193	<0.0002	0.13	6.9	1.57	<0.001	1060	<0.002	1780
36	07/26/2021	<0.001	0.0027	0.143	<0.001	11.7	<0.001	338	26	<0.0015	<0.001	0.28	<0.001	0.143	<0.0002	0.105	6.9	1.83	<0.001	1100	<0.002	1730
36	08/16/2021	<0.001	0.0032	0.151	<0.001	11	<0.001	303	29	<0.0015	<0.001	0.26	<0.001	0.111	<0.0002	0.0946	7.1	1.94	<0.001	955	<0.002	1640
37	03/31/2021	<0.001	0.0084	0.239	<0.001	1.14	<0.001	78.5	44	<0.0015	<0.001	0.64	<0.001	0.0041	<0.0002	0.0027	7.3	1.6	<0.001	140	<0.002	624
37	04/21/2021	<0.001	0.0257	0.298	<0.001	1.22	<0.001	98.4	45	<0.0015	<0.001	0.58	0.0012	<0.003	<0.0002	<0.0015	6.9	1.89	<0.001	185	<0.002	700
37	05/11/2021	<0.002	0.0347	0.314	<0.001	1.37	<0.001	109	45	0.00155	<0.001	0.62	0.00113	<0.005	<0.0002	<0.001	7.0	0.865	<0.001	179	<0.001	744
37	06/02/2021	<0.001	0.0375	0.304	<0.001	1.54	<0.001	109	43	<0.0015	<0.001	0.61	<0.001	<0.003	<0.0002	<0.0015	7.0	1.38	<0.001	223	<0.002	726
37	06/16/2021	<0.001	0.0359	0.29	<0.001	1.33	<0.001	110	45	<0.0015	<0.001	0.63	<0.001	<0.003	<0.0002	<0.0015	6.9	0.808	<0.001	223	<0.002	758
37	07/07/2021	<0.001	0.0382	0.283	<0.001	1.34	<0.001	108	47	<0.0015	<0.001	0.61	<0.001	<0.003	<0.0002	<0.0015	6.8	1.12	<0.001	229	<0.002	760
37	07/26/2021	<0.001	0.0367	0.289	<0.001	1.13	<0.001	109	51	<0.0015	<0.001	0.64	<0.001	<0.003	<0.0002	<0.0015	6.8	0.379	<0.001	247	<0.002	800
37	08/16/2021	<0.001	0.0385	0.322	<0.001	1.35	<0.001	114	46	<0.0015	<0.001	0.62	<0.001	<0.003	<0.0002	<0.0015	6.9	0.886	<0.001	248	<0.002	804
38	03/30/2021	<0.001	0.0075	0.279	<0.001	0.582	<0.001	94.9	23	<0.0015	<0.001	0.44	<0.001	0.0204	<0.0002	0.01	7.2	--	<0.001	<10	<0.002	486
38	04/19/2021	<0.001	0.0063	0.236	<0.001	0.46	<0.001	80.9	19	<0.0015	<0.001	0.41	<0.001	0.012	<0.0002	0.0087	7.2	0.644	<0.001	<10	<0.002	550
38	05/11/2021	<0.002	0.0061	0.221	<0.001	0.409	<0.001	76.7	19	<0.001	<0.001	0.38	<0.001	0.00661	<0.0002	0.00608	7.2	0.931	<0.001	<10	<0.001	496
38	06/02/2021	<0.001	0.0086	0.22	<0.001	0.407	<0.001	77.8	19	<0.0015	<0.001	0.35	<0.001	0.0047	<0.0002	0.0049	7.1	1.85	<0.001	<10	<0.002	522

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, Total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
38	06/16/2021	<0.001	0.0097	0.219	<0.001	0.453	<0.001	75.7	18	<0.0015	<0.001	0.36	<0.001	0.004	<0.0002	0.0032	7.0	0.921	<0.001	<10	<0.002	548
38	07/07/2021	<0.001	0.0088	0.218	<0.001	0.48	<0.001	75	19	<0.0015	<0.001	0.35	<0.001	0.0033	<0.0002	0.0028	6.8	1.63	<0.001	<10	<0.002	532
38	07/26/2021	<0.001	0.0128	0.218	<0.001	0.405	<0.001	75.3	23	<0.0015	<0.001	0.35	<0.001	<0.003	<0.0002	0.0022	6.8	1.01	<0.001	<10	<0.002	534
38	08/16/2021	<0.001	0.0153	0.205	<0.001	0.455	<0.001	74	20	<0.0015	<0.001	0.34	<0.001	<0.003	<0.0002	0.0021	6.9	1.2	<0.001	<10	<0.002	554
40	03/31/2021	<0.001	0.0188	0.0312	<0.001	20.4	<0.001	612	14	<0.0015	0.0059	<0.1	<0.001	0.804	<0.0002	0.0552	6.6	0.765	<0.001	2960	<0.002	4630
40	04/21/2021	<0.001	0.0186	0.0334	<0.001	20.6	<0.001	661	16	<0.0015	0.0058	<0.1	<0.001	0.906	<0.0002	0.075	6.6	1.03	<0.001	2650	<0.002	4500
40	05/12/2021	<0.002	0.0161	0.0321	<0.001	23.9	<0.001	978	17	<0.001	0.00542	<0.1	<0.001	1.22	<0.0002	0.0663	6.6	0.681	<0.001	2800	<0.001	4340
40	06/03/2021	<0.001	0.0175	0.0315	<0.001	22	<0.001	663	17	<0.0015	0.0051	<0.1	<0.001	0.882	<0.0002	0.0707	6.5	0.305	<0.001	2790	<0.002	4460
40	06/17/2021	<0.001	0.0201	0.033	<0.001	18.6	<0.001	675	16	<0.0015	0.0051	<0.1	<0.001	0.84	<0.0002	0.0667	6.4	0.821	<0.001	3070	0.0023	4480
40	07/08/2021	<0.001	0.0193	0.0313	<0.001	20.4	<0.001	653	14	<0.0015	0.0056	0.1	<0.001	0.74	<0.0002	0.0786	6.3	1.46	<0.001	2840	<0.002	4260
40	07/27/2021	<0.001	0.0175	0.0324	<0.001	17	<0.001	672	15	<0.0015	0.007	<0.1	<0.001	0.77	<0.0002	0.0802	6.6	1.37	<0.001	3300	<0.002	4860
40	08/17/2021	<0.001	0.02	0.0334	<0.001	21.2	<0.001	693	13	<0.0015	0.0065	<0.1	<0.001	0.768	<0.0002	0.071	6.5	1.68	<0.001	3140	0.0025	4400
41	03/30/2021	<0.001	0.0019	0.258	<0.001	2.33	<0.001	81	60	0.0161	<0.001	0.41	<0.001	<0.003	<0.0002	<0.0015	7.0	--	<0.001	<10	<0.002	570
41	04/20/2021	<0.001	0.0027	0.25	<0.001	2.48	<0.001	80.2	60	<0.0015	<0.001	0.41	<0.001	<0.003	<0.0002	<0.0015	7.1	1.49	<0.001	<10	<0.002	646
41	05/10/2021	<0.002	0.00448	0.237	<0.001	2.86	<0.001	83.8	56	<0.001	<0.001	0.42	<0.001	<0.005	<0.0002	<0.001	7.0	1.34	<0.001	<10	<0.001	594
41	06/02/2021	<0.001	0.0048	0.241	<0.001	3.28	<0.001	81.1	56	<0.0015	<0.001	0.41	<0.001	<0.003	<0.0002	<0.0015	7.1	1.42	<0.001	<10	<0.002	608
41	06/16/2021	<0.001	0.006	0.238	<0.001	2.89	<0.001	85.6	58	<0.0015	<0.001	0.43	<0.001	<0.003	<0.0002	<0.0015	7.0	1.13	<0.001	<10	<0.002	634
41	07/07/2021	<0.001	0.0065	0.234	<0.001	2.96	<0.001	83.2	59	<0.0015	<0.001	0.42	<0.001	<0.003	<0.0002	<0.0015	6.8	1.92	<0.001	<10	<0.002	618
41	07/26/2021	<0.001	0.0078	0.223	<0.001	2.64	<0.001	89.5	60	<0.0015	<0.001	0.43	<0.001	<0.003	<0.0002	<0.0015	7.0	1.17	<0.001	13	<0.002	644
41	08/16/2021	<0.001	0.0096	0.249	<0.001	2.99	<0.001	86.2	58	<0.0015	<0.001	0.41	<0.001	<0.003	<0.0002	<0.0015	7.1	1.92	<0.001	12	<0.002	608
42	03/31/2021	<0.001	0.0348	0.133	<0.001	0.811	<0.001	115	7	<0.0015	<0.001	0.51	<0.001	0.0106	<0.0002	0.0089	7.5	0.481	<0.001	215	<0.002	714
42	04/19/2021	<0.001	0.05	0.113	<0.001	0.882	<0.001	128	9	<0.0015	<0.001	0.44	<0.001	0.0121	<0.0002	0.0062	7.4	0.289	<0.001	227	<0.002	746

RAMBOLL

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, Total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
42	05/11/2021	<0.002	0.0419	0.102	<0.001	0.84	<0.001	134	7	<0.001	<0.001	0.43	<0.001	0.00972	<0.0002	0.00459	7.2	0.453	<0.001	204	<0.001	726
42	06/03/2021	<0.001	0.0391	0.105	<0.001	0.919	<0.001	133	7	<0.0015	<0.001	0.41	<0.001	0.0115	<0.0002	0.0042	6.8	0.145	<0.001	196	<0.002	702
42	06/16/2021	<0.001	0.0406	0.109	<0.001	0.973	<0.001	141	8	<0.0015	<0.001	0.42	<0.001	0.0105	<0.0002	0.0047	7.1	0.21	<0.001	191	<0.002	726
42	07/07/2021	<0.0011	0.039	0.0955	<0.0011	0.981	<0.0011	132	5	<0.0017	<0.0011	0.39	<0.0011	0.0101	<0.0002	0.0048	6.8	1.67	<0.0011	185	<0.0022	714
42	07/26/2021	<0.001	0.0386	0.0926	<0.001	0.945	<0.001	151	6	<0.0015	<0.001	0.39	<0.001	0.0104	<0.0002	0.0044	7.0	0.0986	<0.001	188	<0.002	736
42	08/17/2021	<0.001	0.04	0.0998	<0.001	0.99	<0.001	144	6	<0.0015	<0.001	0.36	<0.001	0.0118	<0.0002	0.0041	7.0	0.825	<0.001	187	<0.002	736
43	03/31/2021	<0.001	0.0066	0.483	<0.001	1.09	<0.001	63.4	81	<0.0015	<0.001	0.52	<0.001	0.0124	<0.0002	0.005	7.4	0.606	<0.001	<10	<0.002	604
43	04/20/2021	0.0011	0.0064	0.5	<0.001	1.19	<0.001	75.7	82	0.0022	<0.001	0.52	0.0018	0.0127	<0.0002	0.0046	7.4	1.24	<0.001	<10	<0.002	652
43	05/11/2021	<0.002	0.00659	0.473	<0.001	1.14	<0.001	73	81	<0.001	<0.001	0.54	<0.001	0.00903	<0.0002	0.00436	7.5	0.377	<0.001	<10	<0.001	596
43	06/02/2021	<0.001	0.0057	0.475	<0.001	1.21	<0.001	68.6	75	<0.0015	<0.001	0.51	<0.001	0.011	<0.0002	0.0068	7.2	1.91	<0.001	<10	<0.002	574
43	06/16/2021	<0.001	0.0058	0.481	<0.001	1.17	<0.001	69.8	77	<0.0015	<0.001	0.53	<0.001	0.0098	<0.0002	0.0054	7.1	1.64	<0.001	<10	<0.002	584
43	07/07/2021	<0.0011	0.0058	0.449	<0.0011	1.21	<0.0011	69.3	75	<0.0017	<0.0011	0.5	<0.0011	0.0088	<0.0002	0.0044	6.9	1.1	<0.0011	<10	<0.0022	590
43	07/26/2021	<0.001	0.0384	0.092	<0.001	0.942	<0.001	149	77	<0.0015	<0.001	0.54	<0.001	0.0102	<0.0002	0.0042	7.0	0.973	<0.001	<10	<0.002	618
43	08/17/2021	<0.001	0.0064	0.524	<0.001	1.09	<0.001	72.2	77	<0.0015	<0.001	0.52	<0.001	0.0091	<0.0002	0.004	7.0	1.27	<0.001	<10	<0.002	600
44	03/31/2021	<0.001	0.0304	0.177	<0.001	1.18	<0.001	58.2	50	<0.0015	<0.001	0.9	<0.001	0.0058	<0.0002	0.0092	7.5	0.687	<0.001	29	<0.002	568
44	04/20/2021	0.0016	0.0122	0.179	<0.001	1.3	<0.001	64.5	46	0.0067	0.0022	0.88	0.0027	0.0122	<0.0002	0.0105	7.5	0.404	<0.001	23	<0.002	692
44	05/11/2021	<0.002	0.0132	0.172	<0.001	1.4	<0.001	70.7	46	0.00397	0.00186	0.9	0.0023	0.008	<0.0002	0.0102	7.5	0.237	<0.001	15	<0.001	564
44	06/02/2021	<0.001	0.0128	0.151	<0.001	1.38	<0.001	60.5	47	<0.0015	<0.001	0.88	<0.001	0.0049	<0.0002	0.0094	7.4	0.118	<0.001	<10	<0.002	584
44	06/16/2021	<0.001	0.0379	0.186	<0.001	1.35	<0.001	66	49	0.0039	0.0015	0.91	0.0017	0.0066	<0.0002	0.0094	7.3	0.0617	<0.001	<10	<0.002	594
44	07/07/2021	<0.0011	0.0315	0.17	<0.0011	1.42	<0.0011	62	49	0.0029	<0.0011	0.87	<0.0011	0.005	<0.0002	0.0096	7.2	0.296	<0.0011	<10	<0.0022	590
44	07/26/2021	<0.001	0.0295	0.158	<0.001	1.28	<0.001	66.5	49	0.0026	<0.001	0.92	<0.001	0.0048	<0.0002	0.0094	7.2	0.0708	<0.001	<10	<0.002	598
44	08/17/2021	<0.001	0.0283	0.175	<0.001	1.18	<0.001	64.4	48	0.003	0.001	0.89	0.0016	0.0053	<0.0002	0.009	7.3	0.183	<0.001	<10	<0.002	594

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, Total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
101	04/01/2021	<0.001	0.0142	0.142	<0.001	2.02	<0.001	68.9	15	0.0207	0.0043	0.88	0.006	0.0122	<0.0002	0.0095	7.2	0.964	<0.001	10	<0.002	436
101	04/20/2021	<0.001	0.0187	0.121	<0.001	2.19	<0.001	57.1	12	0.0046	<0.001	0.87	0.0012	0.0044	<0.0002	0.0042	7.6	0.172	<0.001	<10	<0.002	540
101	05/12/2021	<0.002	0.0121	0.0644	<0.001	0.479	<0.001	135	11	0.00152	0.00127	0.9	0.00141	0.0315	<0.0002	0.016	7.6	1.04	<0.001	10	<0.001	444
101	06/04/2021	<0.001	0.0147	0.116	<0.001	2.39	<0.001	55.4	13	<0.0015	<0.001	0.86	<0.001	0.0033	<0.0002	0.0047	7.5	--	<0.001	<10	<0.002	456
101	06/18/2021	<0.001	0.0165	0.113	<0.001	2.06	<0.001	55.4	13	<0.0015	<0.001	0.89	<0.001	<0.003	<0.0002	0.004	7.4	1.26	<0.001	<10	<0.002	468
101	07/08/2021	<0.0011	0.0203	0.111	<0.0011	2.45	<0.0011	54.5	13	<0.0017	<0.0011	0.88	<0.0011	<0.0033	<0.0002	0.0036	7.3	1.01	<0.0011	<10	<0.0022	436
101	07/27/2021	<0.001	0.0231	0.113	<0.001	2.14	<0.001	60.1	13	<0.0015	<0.001	0.9	<0.001	<0.003	<0.0002	0.0025	7.4	0.596	<0.001	<10	<0.002	508
101	07/28/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.5	0.89	--	--	--	--
101	08/18/2021	<0.001	0.0336	0.125	<0.001	2.21	<0.001	56.9	12	<0.0015	<0.001	0.87	<0.001	<0.003	<0.0002	<0.0015	7.4	0.121	<0.001	<10	<0.002	462
102	04/01/2021	<0.001	0.0043	0.244	<0.001	0.637	<0.001	116	54	0.0075	0.0028	0.5	0.004	0.0199	<0.0002	0.0052	6.7	1.11	<0.001	35	<0.002	596
102	04/20/2021	<0.001	0.0045	0.195	<0.001	1.3	<0.001	92.9	21	<0.0015	<0.001	0.59	<0.001	0.0066	<0.0002	0.0017	7.6	0.123	<0.001	30	<0.002	538
102	05/12/2021	<0.002	0.00792	0.192	<0.001	1.58	<0.001	91	14	<0.001	<0.001	0.65	<0.001	<0.005	<0.0002	0.0012	7.4	1.74	<0.001	40	<0.001	490
102	06/04/2021	<0.001	0.0101	0.18	<0.001	1.66	<0.001	84.3	12	<0.0015	<0.001	0.65	<0.001	0.0033	<0.0002	<0.0015	7.4	0.86	<0.001	45	<0.002	510
102	08/18/2021	<0.001	0.0199	0.192	<0.001	1.62	<0.001	82.6	8	<0.0015	<0.001	0.67	<0.001	<0.003	<0.0002	<0.0015	7.5	1.56	<0.001	49	<0.002	494
103	04/02/2021	<0.001	0.0227	0.124	<0.001	1.5	<0.001	55.3	24	0.0065	0.0024	0.96	0.0039	0.019	<0.0002	0.0219	7.0	1.68	<0.001	30	<0.002	394
103	04/20/2021	<0.001	0.0198	0.107	<0.001	1.73	<0.001	51.1	19	<0.0015	<0.001	0.97	<0.001	0.0111	<0.0002	0.0195	7.7	0.284	<0.001	22	<0.002	424
103	05/12/2021	<0.002	0.0214	0.11	<0.001	1.83	<0.001	55.4	19	<0.001	<0.001	1.02	<0.001	0.00925	<0.0002	0.0188	7.6	0.89	<0.001	20	<0.001	376
103	06/04/2021	<0.001	0.0187	0.132	<0.001	1.91	<0.001	63.6	20	0.0097	0.003	1.02	0.0043	0.0143	<0.0002	0.0216	7.3	1.19	<0.001	15	<0.002	412
103	08/18/2021	<0.001	0.0176	0.109	<0.001	1.86	<0.001	54.1	14	<0.0015	<0.001	1	<0.001	0.0056	<0.0002	0.0191	7.6	0.375	<0.001	<10	<0.002	422
104	04/01/2021	<0.001	0.0103	0.384	<0.001	3.35	<0.001	167	28	0.0072	0.0011	0.55	0.0014	0.0064	<0.0002	0.0045	6.9	2.47	<0.001	437	<0.002	1050
104	04/20/2021	<0.001	0.009	0.339	<0.001	3.4	<0.001	149	30	<0.0015	<0.001	0.56	<0.001	0.0046	<0.0002	0.005	7.5	0.407	<0.001	371	<0.002	1030
104	05/12/2021	<0.002	0.0182	0.376	<0.001	3.82	<0.001	171	28	<0.001	<0.001	0.55	<0.001	<0.005	<0.0002	0.00179	7.5	1.48	<0.001	479	<0.001	1070

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, Total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
104	06/04/2021	<0.001	0.0183	0.377	<0.001	3.98	<0.001	169	27	<0.0015	<0.001	0.53	<0.001	<0.003	<0.0002	0.0016	7.3	0.962	<0.001	482	<0.002	1080
104	06/17/2021	<0.001	0.0182	0.364	<0.001	3.48	<0.001	167	26	<0.0015	<0.001	0.55	<0.001	<0.003	<0.0002	0.0017	7.3	1.27	<0.001	490	<0.002	1080
104	07/08/2021	<0.0011	0.0194	0.364	<0.0011	4.09	<0.0011	170	27	<0.0017	<0.0011	0.51	<0.0011	<0.0033	<0.0002	<0.0017	7.2	0.362	<0.0011	467	<0.0022	1050
104	07/27/2021	<0.001	0.0199	0.363	<0.001	3.55	<0.001	186	26	<0.0015	<0.001	0.55	<0.001	<0.003	<0.0002	0.0016	7.3	1.79	<0.001	470	<0.002	1100
104	08/18/2021	<0.001	0.0201	0.365	<0.001	3.64	<0.001	172	25	<0.0015	<0.001	0.54	<0.001	<0.003	<0.0002	<0.0015	7.4	2.03	<0.001	472	<0.002	1030
105	04/02/2021	<0.001	0.0668	0.771	0.0047	1.25	<0.001	309	21	0.214	0.0569	0.92	0.115	0.116	0.00038	0.0249	7.5	8.59	<0.001	33	<0.002	388
105	04/20/2021	<0.001	0.03	0.13	<0.001	1.82	<0.001	63.6	10	0.0016	<0.001	1.1	<0.001	0.0049	<0.0002	0.0112	7.5	0.0997	<0.001	17	<0.002	462
105	05/11/2021	<0.002	0.0317	0.138	<0.001	1.96	<0.001	64.3	8	<0.001	<0.001	1.1	<0.001	<0.005	<0.0002	0.0106	7.6	0.215	<0.001	19	<0.001	410
105	06/04/2021	<0.001	0.0454	0.136	<0.001	1.95	<0.001	59.4	7	<0.0015	<0.001	1.1	<0.001	0.0031	<0.0002	0.0087	7.4	0.376	<0.001	20	<0.002	446
105	08/18/2021	<0.001	0.0389	0.13	<0.001	1.61	<0.001	62.5	10	<0.0015	<0.001	1.1	<0.001	<0.003	<0.0002	0.0082	7.4	0.328	<0.001	17	<0.002	424

Notes:
Detected at concentration greater than the GWPS
-- = data not available
GWPS = Groundwater Protection Standard
mg/L = milligrams per liter
pCi/L = picocuries per liter
SU = standard units
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method. Estimated concentrations below the reporting limit and associated qualifiers are not provided since they are not utilized in statistics to determine exceedances above Part 845 standards.
35 I.A.C. 845.600 = Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845

TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
01	07/13/2017	7.40	83	7.2	2000	19.3	<1
01	09/13/2017	5.97	105	7.2	1910	18.6	<1
01	11/08/2017	6.89	139	7.0	2210	13.0	<1
01	01/24/2018	<1	64	6.9	3450	11.8	<1
01	03/22/2018	1.02	77	6.9	2820	--	3.3
01	05/09/2018	4.99	96	6.6	2500	14.3	<1
01	03/31/2021	10.23	112	7.0	2.288	12.2	10.3
01	04/19/2021	1.76	38.4	6.9	2719	13.6	3.41
01	05/11/2021	1.28	20.9	6.9	3073	12.9	15.1
01	06/04/2021	3.57	104	6.8	2700	13.6	3.3
02	07/13/2017	1.86	-141	7.8	623	16.3	1
02	09/14/2017	<1	-110	7.7	699	14.7	<1
02	11/08/2017	<1	-139	7.7	796	13.7	<1
02	01/24/2018	3.33	-88	7.4	1090	12.7	<1
02	03/22/2018	<1	-144	7.6	862	--	<1
02	05/09/2018	<1	-124	7.4	821	14.4	<1
02	03/31/2021	2.14	-93.5	7.6	891.8	13.7	0
02	04/21/2021	0.49	-108	7.5	1034	13.3	0
02	05/12/2021	0.12	-145	7.5	23.9	13.5	0
02	06/03/2021	0.36	-173	7.5	1140	12.8	<1
02	06/17/2021	0.68	-125	7.1	1040	12.7	<1
02	07/08/2021	0.66	-107	7.2	1060	13.0	1
02	07/27/2021	0.51	-132	7.6	1070	13.8	1
02	08/17/2021	0.57	-125	7.6	977	13.9	<1
03R	07/13/2017	<1	-142	7.6	803	14.6	5.5
03R	09/14/2017	<1	-108	7.2	806	16.6	<1
03R	11/08/2017	<1	-137	7.4	816	14.9	5.2
03R	01/24/2018	<1	-58	7.0	1180	12.0	<1
03R	03/22/2018	<1	-128	7.3	1070	--	1.5
03R	05/09/2018	<1	-106	7.2	1060	14.0	<1
03R	03/30/2021	0.09	-108	7.2	1560	12.4	46.5
03R	04/21/2021	0.09	-125	7.3	1560	12.7	37.2
03R	05/11/2021	0.11	-127	7.4	1853	12.6	44
03R	06/02/2021	0.32	-169	7.3	1660	12.4	<1
03R	06/16/2021	0.31	-178	7.2	1500	12.6	1.8
03R	07/07/2021	0.46	-121	7.2	1630	13.0	6.6
03R	07/26/2021	0.46	-140	7.2	1560	15.8	22
03R	08/16/2021	0.47	-112	7.3	1440	13.1	9.8
04	07/13/2017	1.15	-116	7.7	448	19.5	1.3
04	09/13/2017	<1	-115	7.5	507	15.5	<1
04	11/08/2017	<1	-93	7.5	535	15.0	<1
04	01/24/2018	<1	2	6.9	736	10.1	<1
04	03/22/2018	<1	-126	7.5	643	--	<1
04	05/09/2018	<1	-94	7.2	648	12.2	<1

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
04	03/30/2021	0.03	-101	7.3	651.3	9.5	11.5
04	04/19/2021	0.07	-123	7.7	661.3	10.1	0
04	05/10/2021	0.11	-109	7.4	965.6	10.9	1.12
04	06/02/2021	0.27	-155	7.4	709	11.3	<1
04	06/16/2021	0.47	-180	7.4	647	13.1	<1
04	07/07/2021	0.42	-130	7.3	719	13.8	<1
04	07/26/2021	0.36	-139	7.2	666	14.3	1
04	08/16/2021	0.47	-155	7.4	642	14.9	1
05	07/13/2017	1.09	-49	7.6	600	16.3	<1
05	09/14/2017	<1	68	7.3	696	15.2	<1
05	11/08/2017	<1	17	7.3	815	14.7	<1
05	01/24/2018	<1	-35	7.0	1050	10.0	<1
05	03/22/2018	<1	-16	7.4	888	--	<1
05	05/09/2018	<1	-27	7.2	923	11.8	<1
05	03/30/2021	0.03	101	7.1	847.1	10.2	4.8
05	04/21/2021	0.07	106	7.3	853.5	10.1	0
05	05/11/2021	0.09	-2.5	7.4	967.8	10.8	0
05	06/02/2021	0.31	-17	7.3	855	11.2	<1
05	06/16/2021	0.33	-43	7.2	766	11.7	<1
05	07/07/2021	0.41	-64	7.1	840	12.6	<1
05	07/26/2021	0.38	-101	7.2	794	13.2	<1
05	08/16/2021	0.47	-112	7.2	755	14.3	<1
06R	07/13/2017	<1	-74	7.2	558	16.5	2.3
06R	09/13/2017	<1	-44	6.9	698	15.2	<1
06R	11/08/2017	<1	-101	7.0	845	14.7	<1
06R	01/24/2018	<1	-69	6.8	1200	10.6	<1
06R	03/22/2018	<1	-121	7.1	1040	--	1.5
06R	05/09/2018	<1	-66	6.8	868	11.6	<1
07R	05/12/2021	1.52	-75.3	7.3	2987	13.2	7.97
07R	06/03/2021	4.75	-109	7.4	3110	12.7	1600
07R	06/17/2021	4.88	-116	7.3	2810	13.1	1300
07R	07/08/2021	0.80	-112	7.3	3110	13.3	1.7
07R	07/27/2021	4.11	-71	7.7	3000	13.7	8.8
07R	08/17/2021	1.67	-120	7.8	2740	14.1	5.8
08R	07/13/2017	<1	-231	8.8	1730	15.0	2.7
08R	09/14/2017	4.96	-159	8.4	1980	14.7	<1
08R	11/08/2017	<1	-97	8.6	2020	14.3	<1
08R	01/24/2018	<1	-20	6.9	1610	10.6	<1
08R	03/22/2018	<1	-54	7.7	2200	--	1.6
08R	05/09/2018	<1	-47	7.2	1720	13.3	4
08R	03/30/2021	0.22	79.4	6.5	1157	10.1	0.07
08R	04/21/2021	0.15	-54.6	7.6	1550	11.2	0
08R	05/11/2021	0.23	31.2	6.7	1241	11.6	0
08R	06/02/2021	0.21	-116	7.8	1590	12.0	<1

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
08R	06/16/2021	0.33	-154	8.0	1460	12.4	<1
08R	07/07/2021	0.44	-83	6.7	1400	13.4	<1
08R	07/26/2021	0.33	-121	7.6	1570	13.8	2.2
08R	08/16/2021	0.42	-146	8.0	1510	14.2	5.8
101	04/01/2021	11.02	87.9	7.2	544.7	6.1	4350
101	04/20/2021	0.32	-59.2	7.6	114.9	11.6	144
101	05/12/2021	0.78	-139	7.6	832	13.2	10.1
101	06/04/2021	0.64	-203	7.5	885	14.5	9.9
101	06/18/2021	0.69	-182	7.4	813	14.8	3.6
101	07/08/2021	0.62	-130	7.3	876	14.6	2.6
101	07/27/2021	0.84	-96	7.4	857	15.3	6.4
101	07/28/2021	0.34	-107	7.5	849	14.3	1.4
101	08/18/2021	0.53	-127	7.4	770	15.0	1
102	04/01/2021	0.56	-60.9	6.7	802.2	11.3	17800
102	04/20/2021	11.28	-92.7	7.6	0.1	10.8	0
102	05/12/2021	0.26	-135	7.4	758.3	13.5	79.1
102	06/04/2021	1.98	-166	7.4	967	16.0	<1
102	08/18/2021	1.13	-125	7.5	827	15.1	9.8
103	04/02/2021	0.29	-66.1	7.0	645.7	11.1	0
103	04/20/2021	0.81	-125	7.7	783.6	11.6	35.7
103	05/12/2021	0.57	-87.5	7.6	675.9	13.3	7.27
103	06/04/2021	2.55	-150	7.3	806	15.6	320
103	08/18/2021	1.48	-106	7.6	704	16.2	9.8
104	04/01/2021	1.22	-44.5	6.9	1474	8.6	729
104	04/20/2021	0.92	-92.3	7.5	1383	11.7	401
104	05/12/2021	0.30	-137	7.5	1563	14.4	1.66
104	06/04/2021	0.97	-184	7.3	1650	15.0	<1
104	06/17/2021	1.42	-174	7.3	1490	16.7	4.5
104	07/08/2021	1.07	-117	7.2	1620	16.0	2.7
104	07/27/2021	1.42	-94	7.3	1580	16.6	1
104	08/18/2021	1.13	-122	7.4	1420	16.2	1
105	04/02/2021	0.94	-30.3	7.5	768.4	10.5	5670
105	04/20/2021	0.37	-131	7.5	799.3	12.6	49.1
105	05/11/2021	0.75	-116	7.6	915.7	13.8	31.6
105	06/04/2021	0.80	-185	7.4	841	14.1	9.3
105	08/18/2021	0.84	3	7.4	735	14.1	5.8
17	07/12/2017	1.66	-31	6.9	1800	17.3	9.5
17	09/13/2017	1.39	-38	7.0	1880	17.7	3.2
17	11/08/2017	6.48	48	6.8	1910	11.8	20.7
17	01/24/2018	<1	97	6.6	2490	10.0	7.7
17	03/22/2018	<1	18	6.9	2850	--	32.4
17	05/09/2018	2.78	2	6.7	2490	15.2	23.2
17	03/31/2021	11.27	140	6.7	2456	12.8	28.9
17	04/20/2021	0.34	11.9	7.0	1907	11.7	53.5

TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
17	05/11/2021	4.83	61.5	6.8	2468	12.7	176
17	06/02/2021	1.63	-62	6.8	2410	14.2	72
17	08/16/2021	1.25	-56	6.7	2150	24.6	87
18	07/12/2017	1.75	25	6.8	1510	15.3	8.7
18	09/13/2017	<1	27	6.9	1620	13.3	<1
18	11/08/2017	<1	32	6.8	1900	12.2	<1
18	01/24/2018	<1	79	6.5	2700	12.0	<1
18	03/22/2018	<1	47	6.9	2310	--	<1
18	05/09/2018	<1	36	6.7	1940	14.5	1.9
18	03/29/2021	0.11	84	7.0	1573	12.9	259
18	04/20/2021	0.17	112	7.0	1698	12.4	0
18	05/11/2021	0.16	94.5	6.8	2013	12.8	0.76
18	06/02/2021	0.39	32	6.9	1800	12.8	9.1
18	08/16/2021	0.49	18	6.8	1580	13.4	1
20	07/13/2017	<1	-34	7.2	364	20.5	55.5
20	09/13/2017	<1	-27	7.1	487	13.6	10
20	11/08/2017	<1	-20	7.2	527	15.1	3.3
20	01/24/2018	<1	0	6.7	849	10.9	<1
20	03/22/2018	<1	-31	7.2	585	--	8.1
20	05/09/2018	<1	-21	7.0	550	11.4	9.3
20	03/30/2021	0.04	-13.5	7.1	857.2	10.5	8.41
20	04/19/2021	1.22	39.5	7.1	786.9	10.8	0
20	05/10/2021	0.11	58.6	6.9	1191	11.1	2.17
20	06/02/2021	1.14	-18	7.0	742	10.6	<1
20	06/16/2021	0.41	-76	7.0	678	11.7	<1
20	07/07/2021	1.24	-74	6.9	713	12.5	<1
20	07/26/2021	0.83	-74	6.8	646	13.3	1.9
20	08/16/2021	0.43	-104	7.0	620	13.2	<1
21	07/13/2017	2.60	-88	7.6	573	16.2	1.6
21	09/13/2017	2.49	-46	7.3	516	17.5	<1
21	11/08/2017	<1	-105	7.4	591	12.8	<1
21	01/24/2018	<1	-53	7.3	843	11.6	<1
21	03/22/2018	<1	-134	7.4	732	--	<1
21	05/09/2018	1.40	-75	7.0	654	14.6	1.1
21	03/31/2021	0.46	-174	7.6	745.8	11.8	0
21	04/20/2021	0.34	-174	7.6	725	11.8	0
21	05/11/2021	1.24	-119	7.5	817.2	14.4	1.93
21	06/03/2021	2.38	-124	7.3	749	15.9	6
21	06/16/2021	2.04	-116	7.2	672	15.0	<1
21	07/08/2021	0.92	-73	7.3	759	14.2	2.4
21	07/27/2021	2.83	-64	7.3	728	17.0	<1
21	08/17/2021	2.69	-70	7.3	674	17.3	2.5
34	07/13/2017	6.17	-115	7.3	618	14.2	48.7
34	09/13/2017	<1	-111	7.0	679	12.7	102

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TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
34	11/08/2017	<1	-132	6.9	772	12.3	126
34	01/24/2018	<1	-44	6.6	1120	10.9	33.4
34	03/22/2018	<1	-153	7.2	954	--	52.1
34	05/09/2018	<1	-101	6.9	864	13.1	32.4
34	03/30/2021	0	-142	7.2	952.9	11.4	167
34	04/19/2021	0.04	-127	7.2	412.6	12.3	167
34	05/10/2021	0.05	-155	7.0	1419	12.3	62.8
34	06/02/2021	0.22	-158	7.1	1020	12.1	87
34	06/16/2021	0.30	-159	6.9	916	11.8	89
34	07/07/2021	0.30	-131	6.9	1010	12.6	89
34	07/26/2021	0.31	-125	6.9	955	12.4	160
34	08/16/2021	0.32	-148	7.0	897	12.2	71
36	03/31/2021	0.10	69.4	7.4	2225	11.3	0
36	04/20/2021	0.08	-98	7.3	2064	11.3	22.7
36	05/11/2021	0.07	-106	7.1	2366	11.7	9.4
36	06/02/2021	0.26	-153	7.1	2170	11.9	9.5
36	06/16/2021	0.37	-162	7.0	1920	12.2	2.8
36	07/07/2021	0.37	-126	6.9	2220	12.7	2.6
36	07/26/2021	0.44	-103	6.9	2060	13.2	8.6
36	08/16/2021	0.43	-123	7.1	1880	13.5	1.9
37	03/31/2021	0.11	-139	7.3	1211	11.5	0
37	04/21/2021	0.11	-120	6.9	1242	13.0	58.3
37	05/11/2021	0.11	-121	7.0	1065	13.1	9.79
37	06/02/2021	0.45	-178	7.0	1400	12.7	<1
37	06/16/2021	0.39	-187	6.9	1270	13.4	<1
37	07/07/2021	0.35	-128	6.8	1390	12.9	1.4
37	07/26/2021	0.56	-95	6.8	1340	13.7	3.6
37	08/16/2021	0.49	-112	6.9	1270	14.0	1
38	03/30/2021	0.03	-124	7.2	985.1	11.1	9.74
38	04/19/2021	0.05	-127	7.2	959.1	12.7	83.8
38	05/11/2021	0.07	-144	7.2	1216	11.2	6.97
38	06/02/2021	0.27	-179	7.1	1090	11.4	<1
38	06/16/2021	0.59	-176	7.0	979	11.5	1.2
38	07/07/2021	0.42	-147	6.8	1080	11.8	1.6
38	07/26/2021	0.36	-133	6.8	1010	12.3	1.2
38	08/16/2021	0.42	-137	6.9	951	12.0	6.4
40	03/31/2021	0.10	-92.2	6.6	4514	13.2	2.14
40	04/21/2021	0.08	-99.4	6.5	4018	12.5	9.02
40	05/12/2021	0.07	-100	6.6	4284	13.1	11.5
40	06/03/2021	0.32	-149	6.5	4470	12.4	7.3
40	06/17/2021	0.31	-132	6.4	4060	12.5	2.2
40	07/08/2021	0.29	-117	6.3	4430	13.2	1
40	07/27/2021	0.38	-152	6.6	4440	13.6	<1
40	08/17/2021	0.41	-140	6.5	4120	14.1	7

TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
41	03/30/2021	0.03	-127	7.0	882.4	13.6	9.97
41	04/20/2021	0.09	-134	7.1	1190	12.1	19.7
41	05/10/2021	0.08	-144	7.0	1778	12.2	13.8
41	06/02/2021	0.27	-169	7.1	1260	12.2	3.9
41	06/16/2021	0.49	-176	7.0	1140	12.2	5.1
41	07/07/2021	0.35	-117	6.8	1260	12.4	3.7
41	07/26/2021	0.34	-131	7.0	1190	12.7	1.8
41	08/16/2021	0.45	-123	7.1	1120	12.9	2.2
42	03/31/2021	0.12	-118	7.5	1186	10.8	103
42	04/19/2021	0.19	-118	7.4	1191	11.4	15.8
42	05/11/2021	0.13	-113	7.2	1326	11.7	0.17
42	06/03/2021	0.47	-148	6.8	1220	11.3	<1
42	06/16/2021	0.53	-152	7.1	1120	11.5	<1
42	07/07/2021	0.58	-99	6.8	1210	11.6	<1
42	07/26/2021	0.51	-114	7.0	1170	11.7	1
42	08/17/2021	0.55	-105	7.0	1110	11.5	<1
43	03/31/2021	0.25	-60.2	7.4	1175	8.8	8.97
43	04/20/2021	0.15	-121	7.4	1082	11.3	587
43	05/11/2021	9.97	-100	7.5	0.9	13.3	0.92
43	06/02/2021	0.81	-145	7.2	1180	12.3	1.6
43	06/16/2021	1.49	-141	7.1	1070	13.3	6.9
43	07/07/2021	1.11	-125	6.9	1190	14.7	3.8
43	07/26/2021	1.53	-101	7.0	1110	16.0	4.6
43	08/17/2021	1.46	-34	7.0	1040	13.4	8.6
44	03/31/2021	0.54	-114	7.5	1086	8.8	0
44	04/20/2021	0.14	-97.3	7.5	1069	11.0	340
44	05/11/2021	0.09	-97.9	7.5	642.4	12.8	221
44	06/02/2021	0.63	-159	7.4	1120	13.3	56
44	06/16/2021	0.36	-194	7.3	1020	13.2	33
44	07/07/2021	0.37	-177	7.2	1130	14.5	61
44	07/26/2021	0.77	-151	7.2	1060	15.3	39
44	08/17/2021	0.54	-141	7.3	991	15.9	56

Notes:
Field readings are reported with as many significant figures as provided by analytical laboratory.
-- = data not available
cm = centimeter
deg. C = degrees Celsius
mg/L = milligrams per liter
mV = millivolts
NTU = nephelometric turbidity units
SU = standard units

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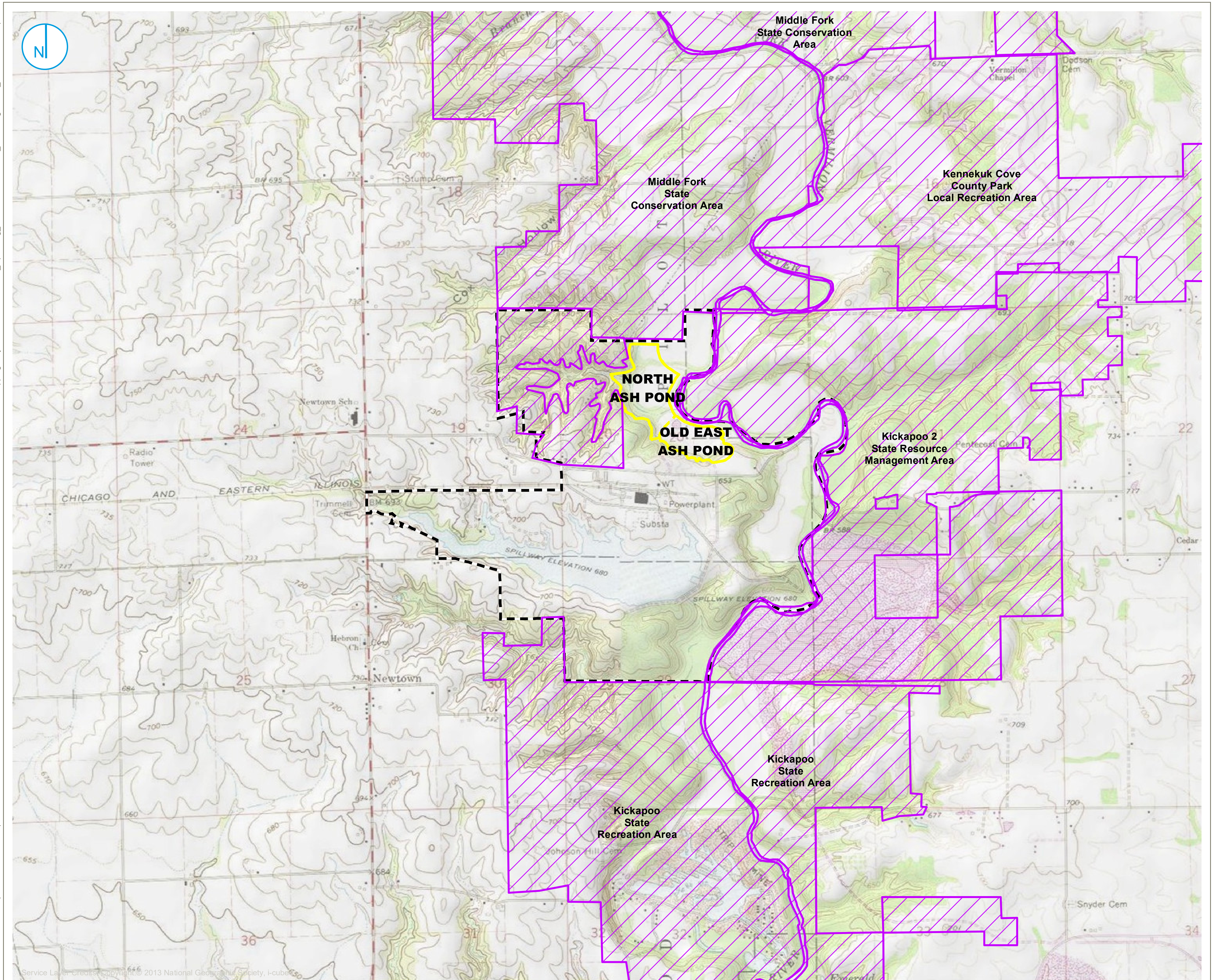
FIGURES



SITE LOCATION MAP

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 1-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 169000XXXX | DATED: 10/5/2021 | DESIGNER: STOLZSD

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure 1-1_Site Location Map.mxd

Y:\MappingProjects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure 1-2_Site Map.mxd

PROJECT: 169000XXXX | DATED: 10/7/2021 | DESIGNER: STOLZSD

SITE MAP

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 1-2

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

10 FOOT ELEVATION CONTOUR
2 FOOT ELEVATION CONTOUR
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 200 400 Feet

SITE TOPOGRAPHIC MAP

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

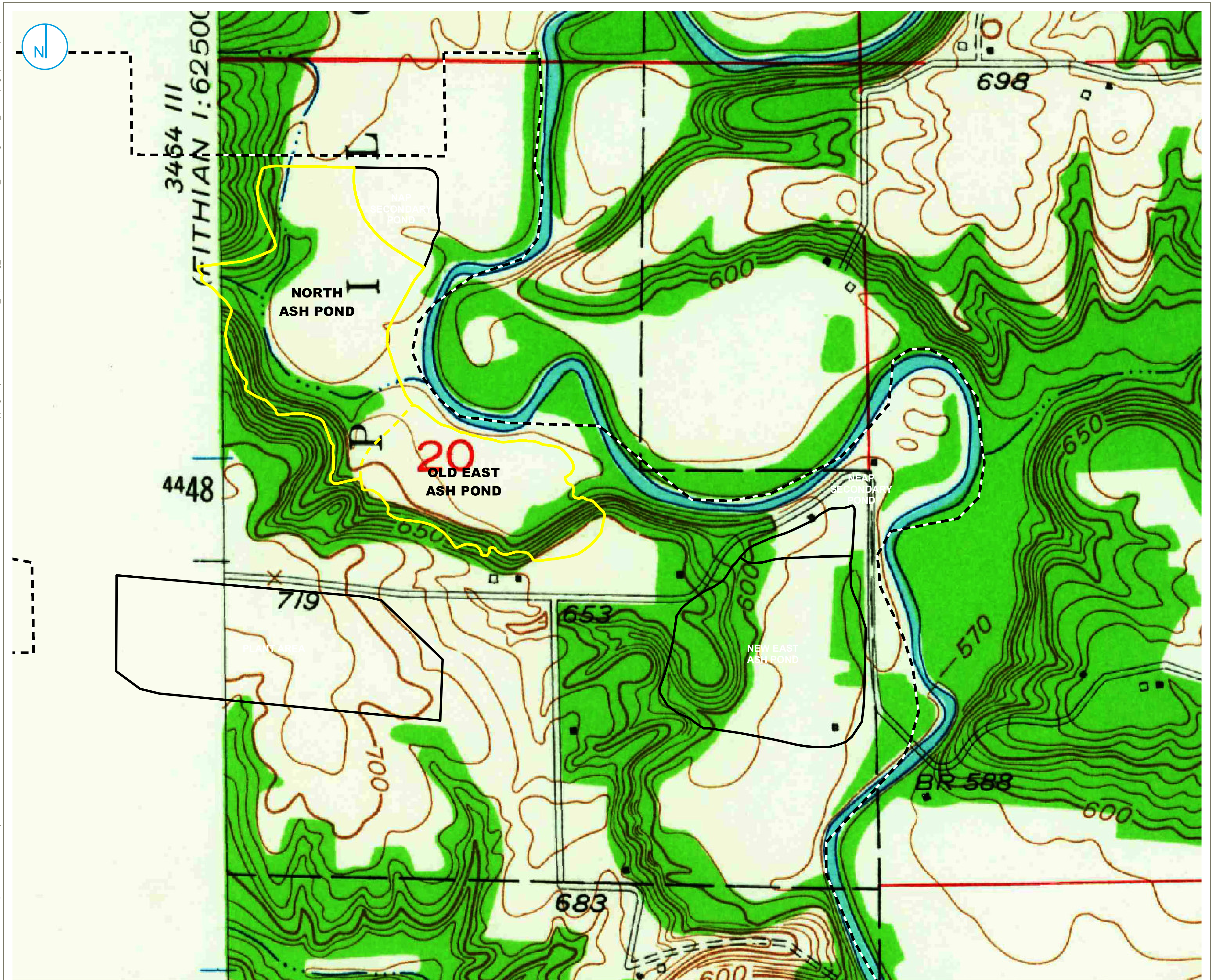
FIGURE 2-1

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure 2-1_Site Topographic Map.mxd

PROJECT: 169000XXXX | DATED: 10/7/2021 | DESIGNER: STOLZSD



PART 845 REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY

0 300 600 Feet

SITE TOPOGRAPHIC MAP 1948 PRE-CONSTRUCTION

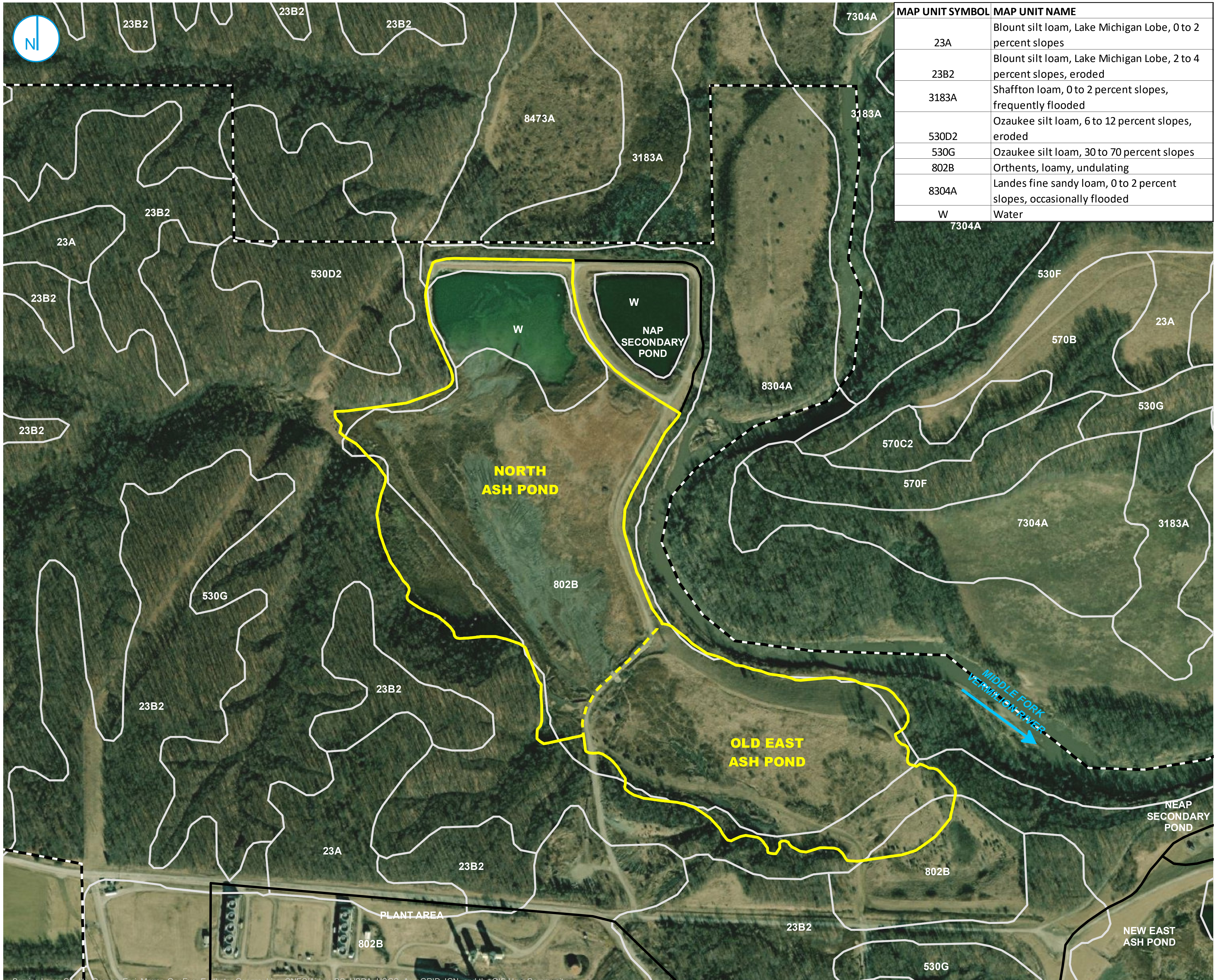
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 2-2

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure 2-2_Site Topographic Map 1948.mxd

PROJECT: 169000XXXX | DATED: 10/7/2021 | DESIGNER: STOLZSD



MAP UNIT SYMBOL	MAP UNIT NAME
23A	Blount silt loam, Lake Michigan Lobe, 0 to 2 percent slopes
23B2	Blount silt loam, Lake Michigan Lobe, 2 to 4 percent slopes, eroded
3183A	Shaffton loam, 0 to 2 percent slopes, frequently flooded
530D2	Ozaukee silt loam, 6 to 12 percent slopes, eroded
530G	Ozaukee silt loam, 30 to 70 percent slopes
802B	Orthents, loamy, undulating
8304A	Landes fine sandy loam, 0 to 2 percent slopes, occasionally flooded
W	Water

PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY
NRCS SOIL SURVEY MAP UNIT BOUNDARY

SOURCE
NATURAL RESOURCES CONSERVATION SERVICE (NRCS)

0 200 400 Feet

SOIL SURVEY MAP

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

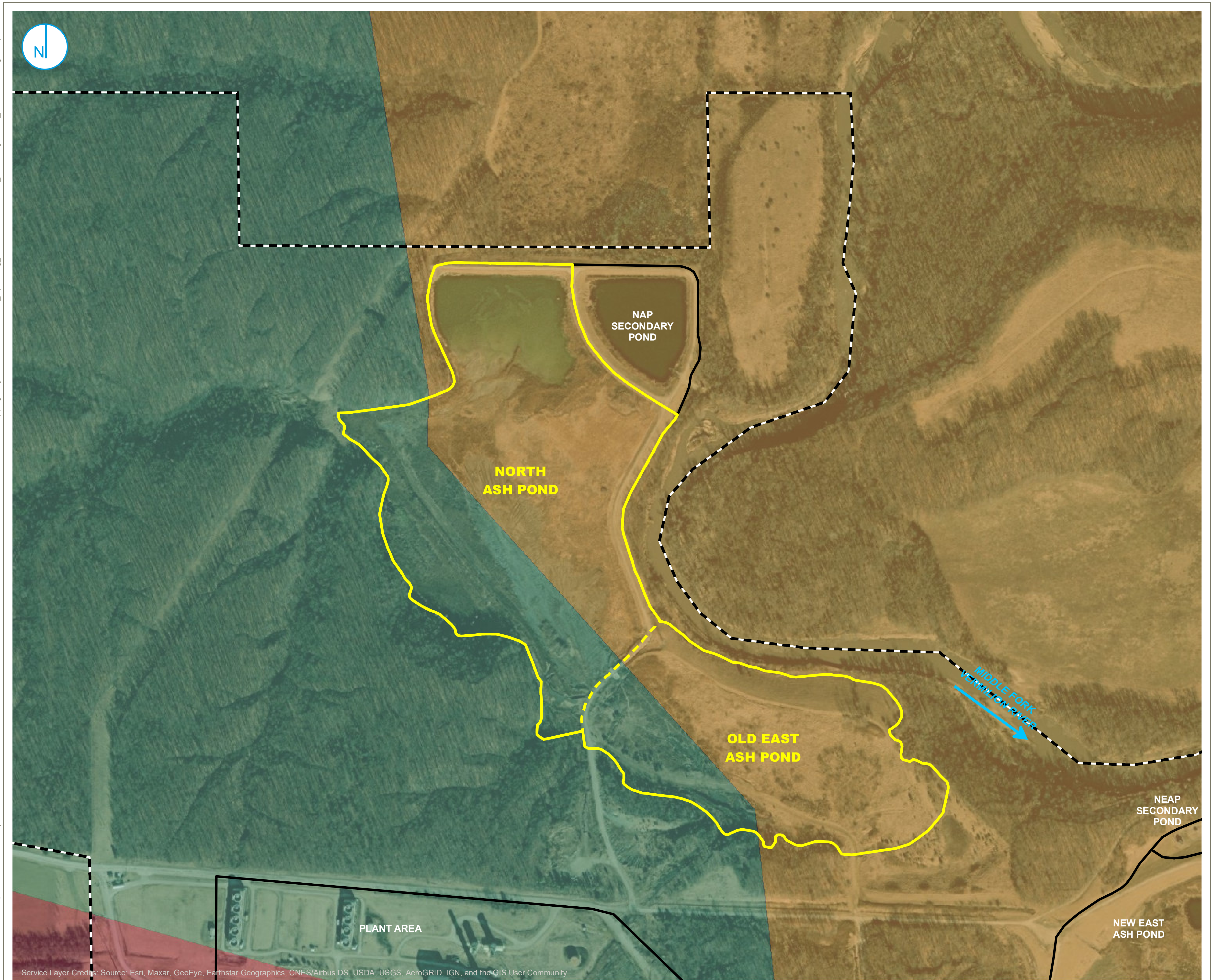
FIGURE 2-3

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure 2-3_Soil Survey Map.mxd

PROJECT: 169000XXXX | DATED: 10/7/2021 | DESIGNER: STOLZSD



PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY
CAHOKIA ALLUVIUM (INCLUDES ALLUVIAL FAN FACIES)
SNIDER TILL MEMBER
SURFACE-MINED AREA

0 200 400
Feet

SURFICIAL GEOLOGIC DEPOSITS

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

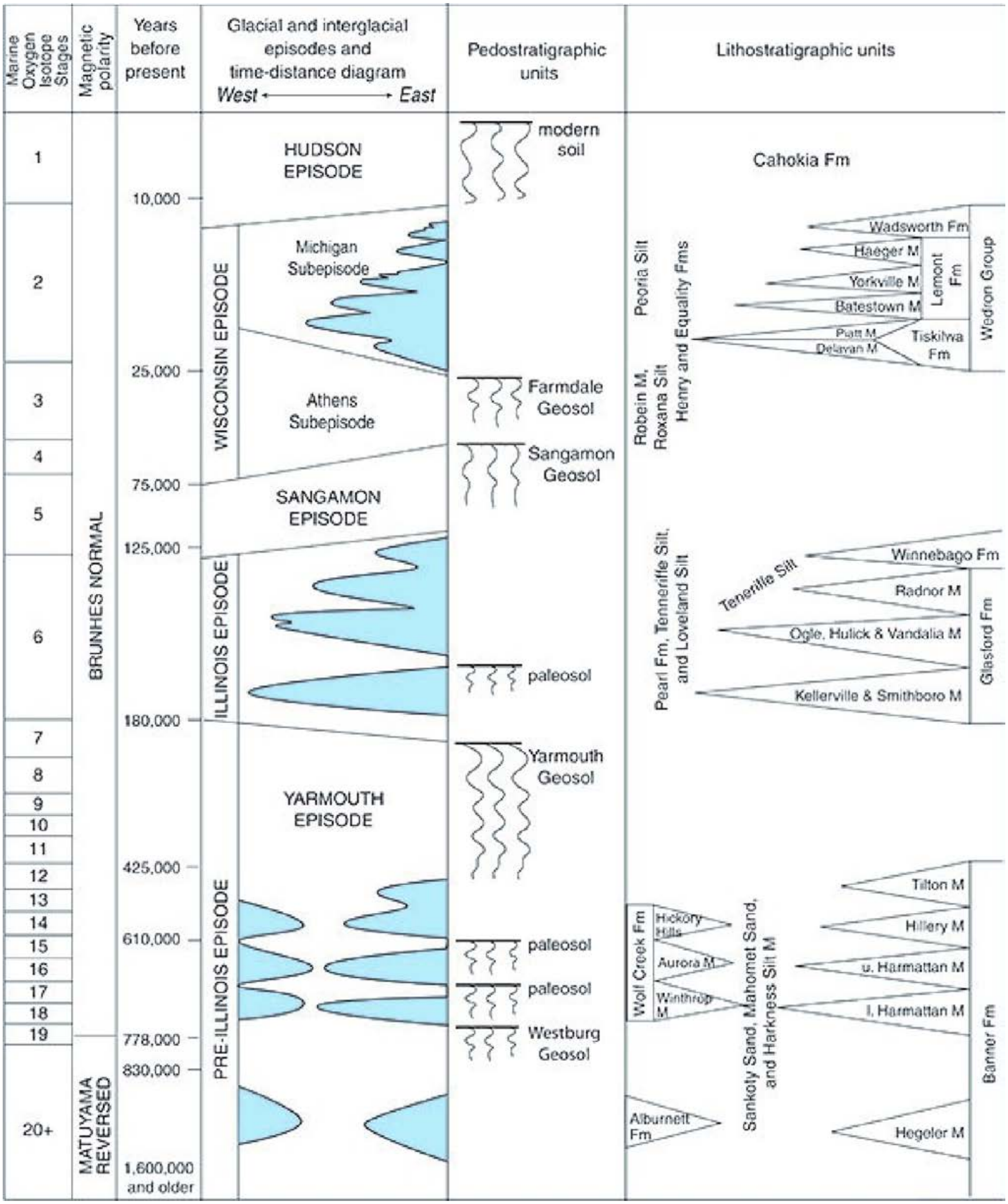
FIGURE 2-4

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure 2-4_Surficial Geologic Deposits.mxd

PROJECT: 169000XXXX | DATED: 10/7/2021 | DESIGNER: STOLZSD



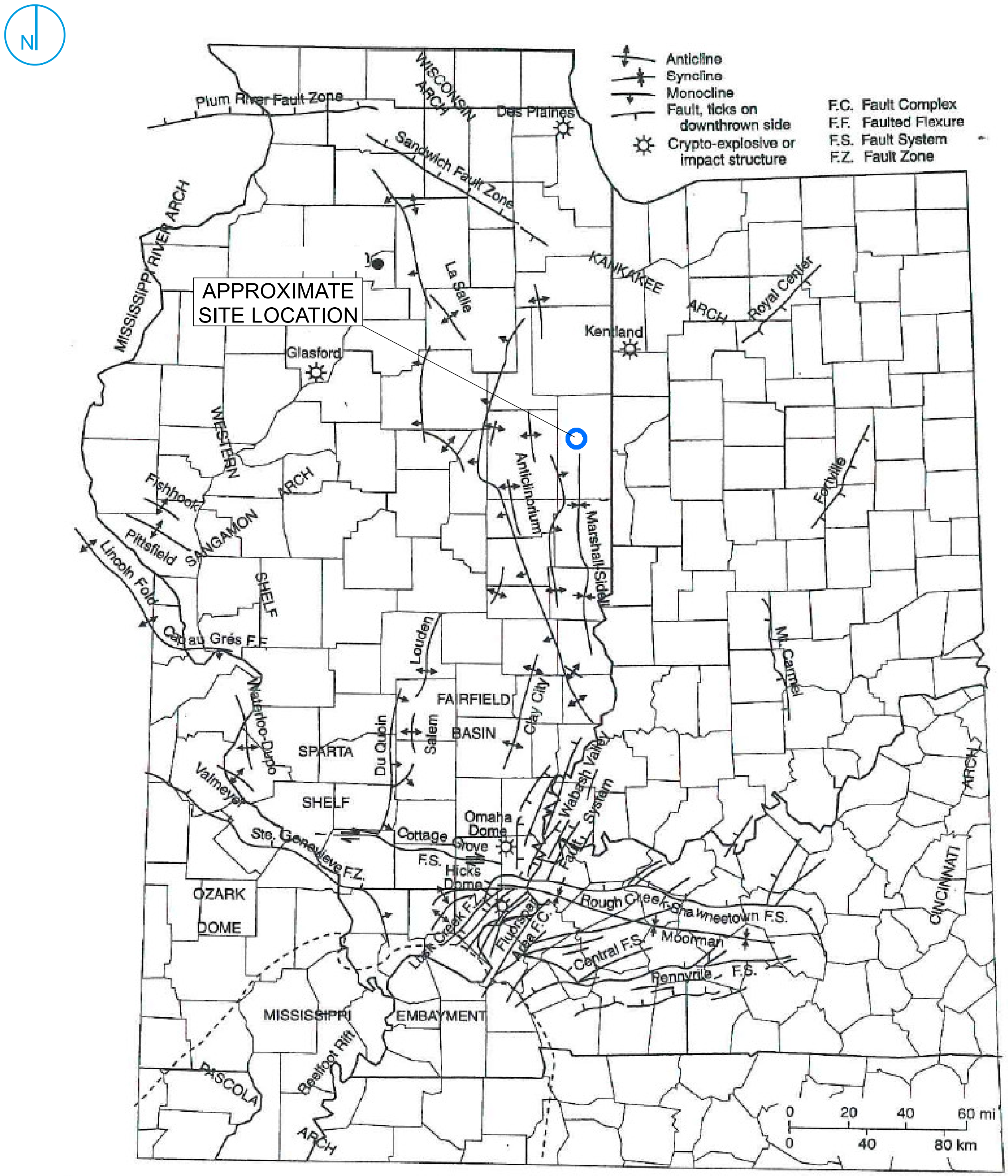
SOURCE NOTE: STRATIGRAPHIC COLUMN IS FROM GEOLOGY OF ILLINOIS, KOLATA AND NIMZ, EDS.(2010).

GENERALIZED STRATIGRAPHIC COLUMN FOR THE VERMILION AREA

FIGURE 2-5

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.



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

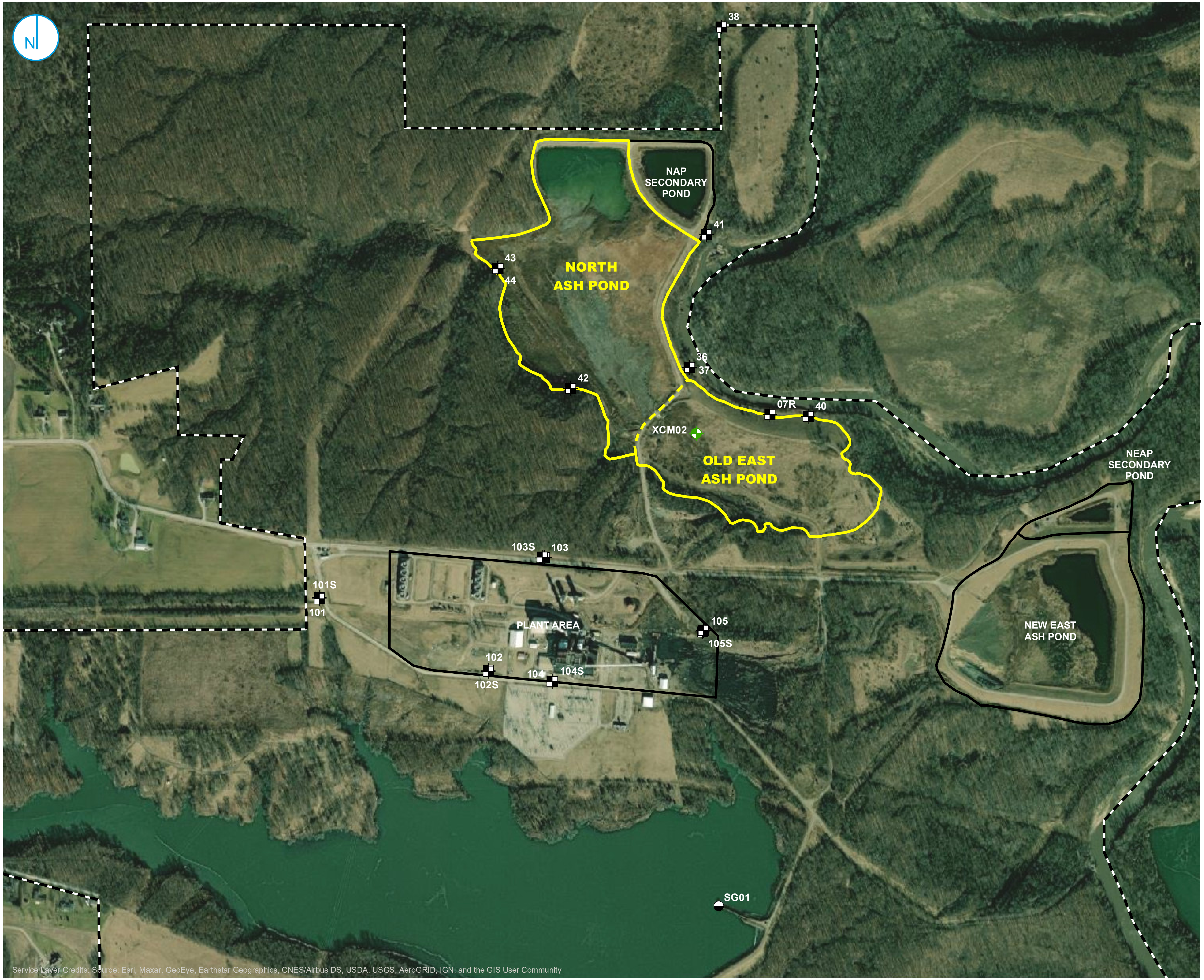
Service Layer Credits:

MAJOR STRUCTURAL FEATURES OF ILLINOIS

FIGURE 2-6

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.



MONITORING WELL
SOIL BORING
STAFF GAGE
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

FIELD INVESTIGATION LOCATIONS

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 2-7

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure 2-7_Field Investigation Locations.mxd

PROJECT: 169000XXXX | DATED: 10/7/2021 | DESIGNER: STOLZSD

10 FOOT ASH ELEVATION CONTOUR
1 FOOT ASH ELEVATION CONTOUR
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

NOTE
BOTTOM OF ASH CONTOURS PROVIDED BY GEOSYNTEC

0 200 400 Feet

BOTTOM OF ASH MAP

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

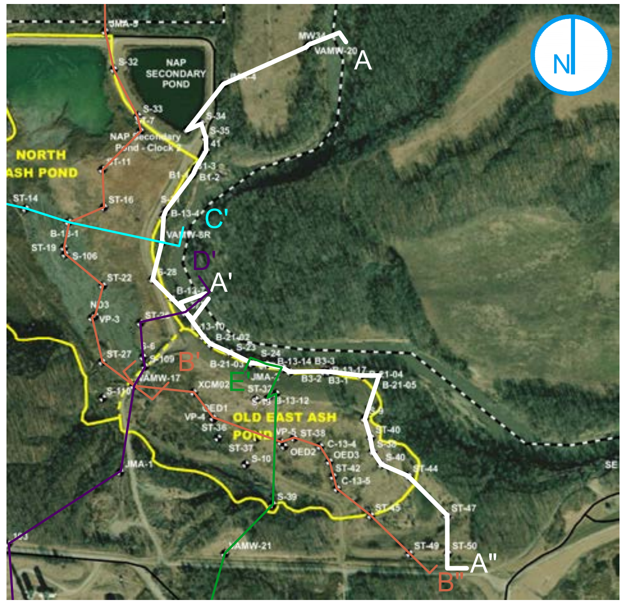
FIGURE 2-8

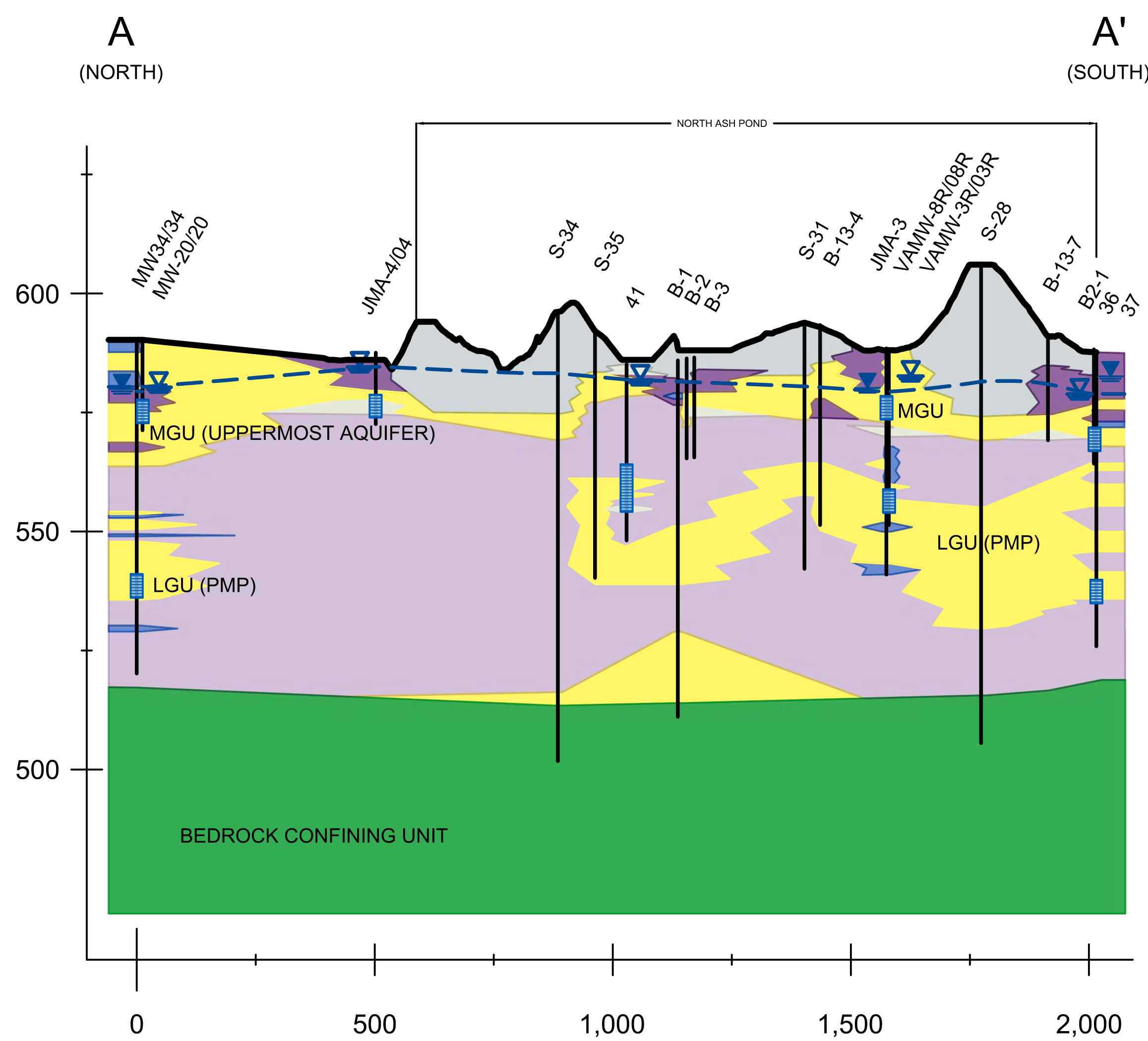
RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

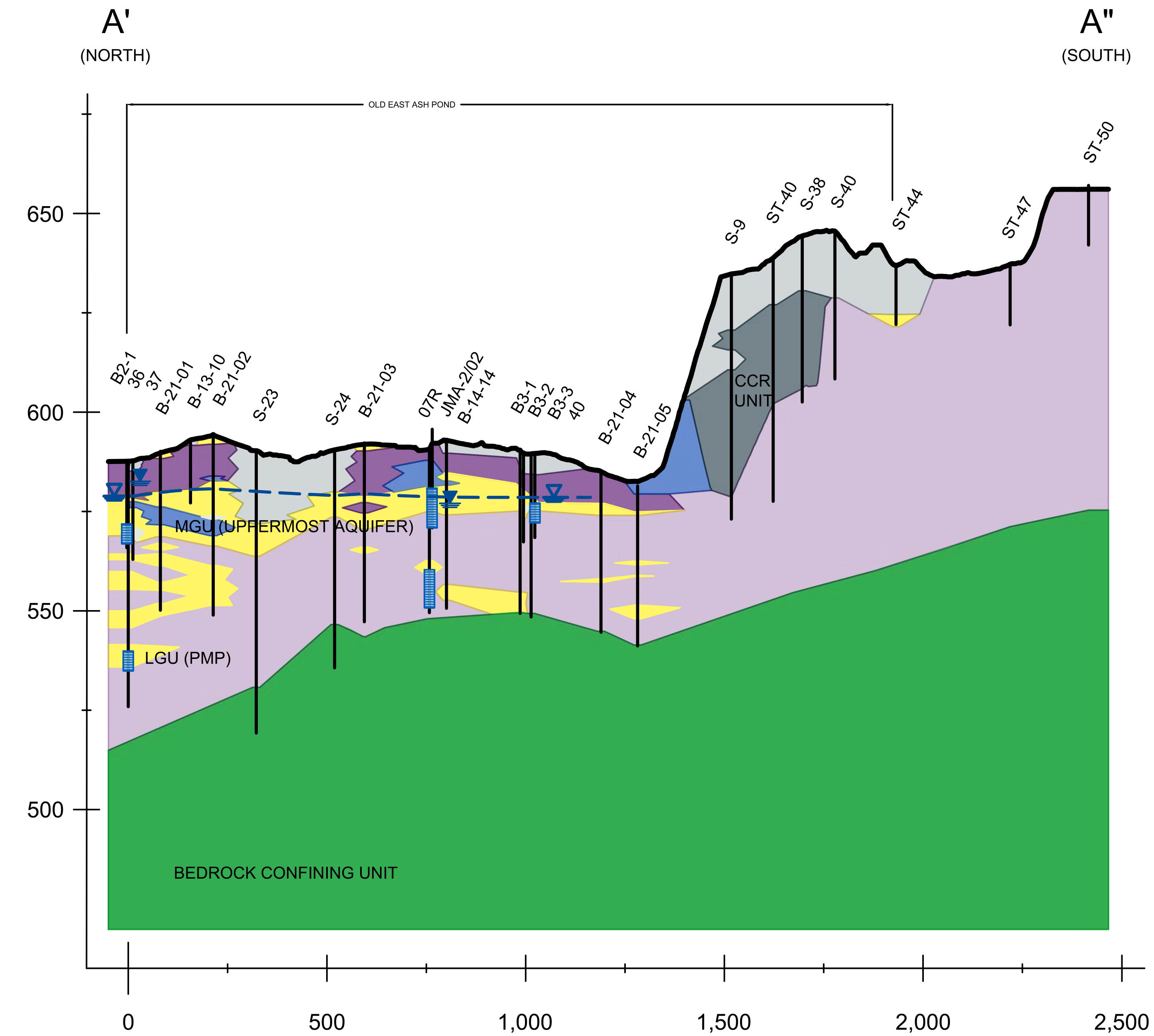
PROJECT: 169000XXXX | DATED: 10/7/2021 | DESIGNER: STOLZSD

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure 2-8_Bottom of Ash.mxd

C:\Users\cawrseag\OneDrive - Ramboll\Desktop\Vermilion-NAP_OEAP-Cross Sections.dwg

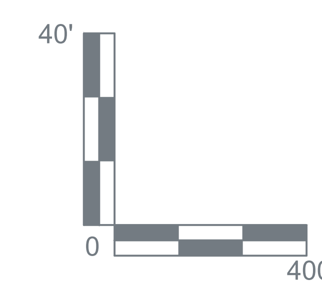






NOTES

1. This profile was developed by interpolation between widely spaced boreholes. Only at the borehole location should it be considered as an approximately accurate representation and then only to the degree implied by the notes on the borehole logs.
2. Scale is approximate.
3. Vertical scale is exaggerated 10X.
4. Groundwater elevations measured on March 29, 2021.
5. LGU = Lower Groundwater Unit
6. MGU = Middle Groundwater Unit
7. PMP = Potential Migration Pathway



PROJECT: 1940100806 DATED: 10/13/2021 DESIGNER: CAWRSEAG

LEGEND

- COAL COMBUSTION RESIDUALS (CCR)
- FILL
- CLAY (CL/CH)
- TILL (CL/CH)
- SILT (ML)
- SAND (SP/SM/SW)
- GRAVEL (GP/GW)
- BEDROCK / WEATHERED BEDROCK (INTERBEDDED SHALE, LIMESTONE, SANDSTONE, V. LITTLE SS)
- WELL SCREEN INTERVAL
- MGU (UPPERMOST AQUIFER) POTENTIOMETRIC SURFACE
- MGU (UPPERMOST AQUIFER) GROUNDWATER ELEVATION
- LGU (PMP) / BEDROCK GROUNDWATER / OTHER GROUNDWATER / SURFACE WATER ELEVATION(S)

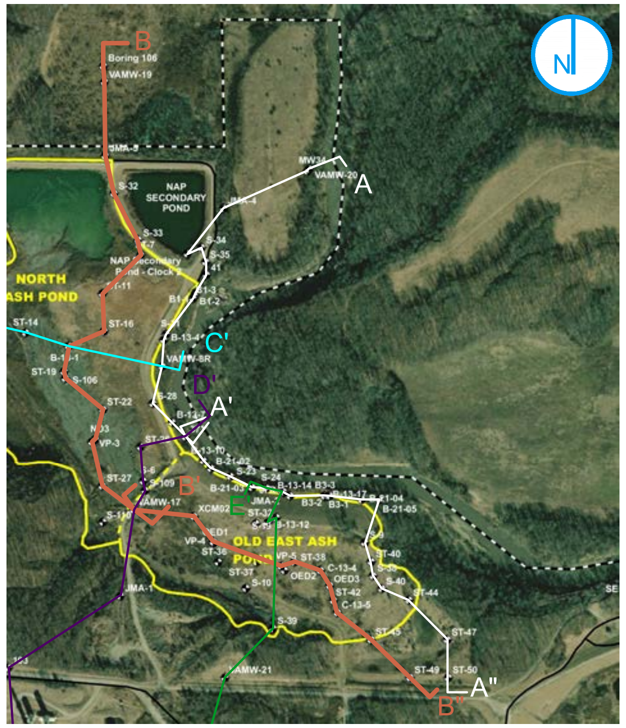
GEOLOGIC CROSS SECTIONS
A-A' & A'-A"

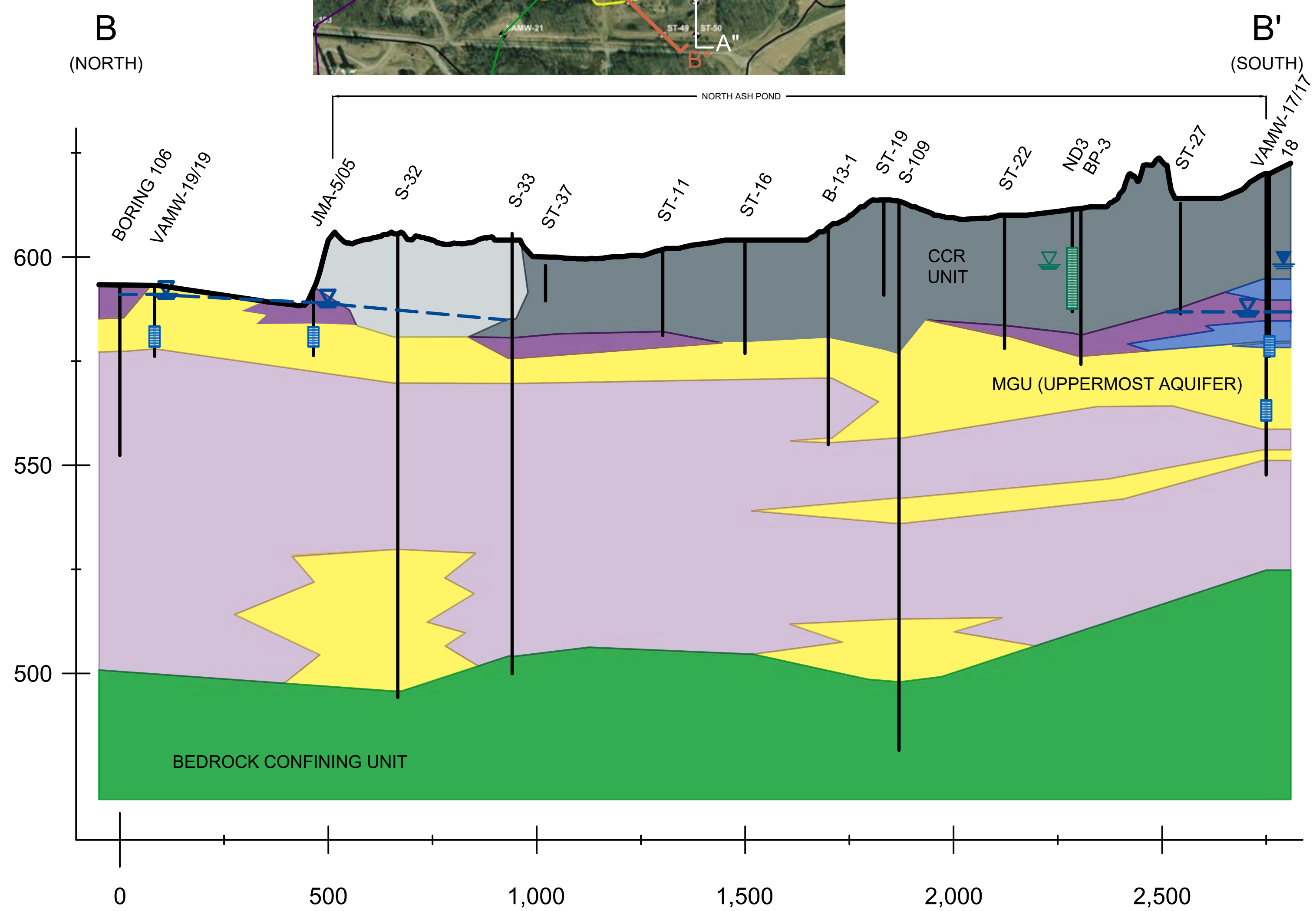
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

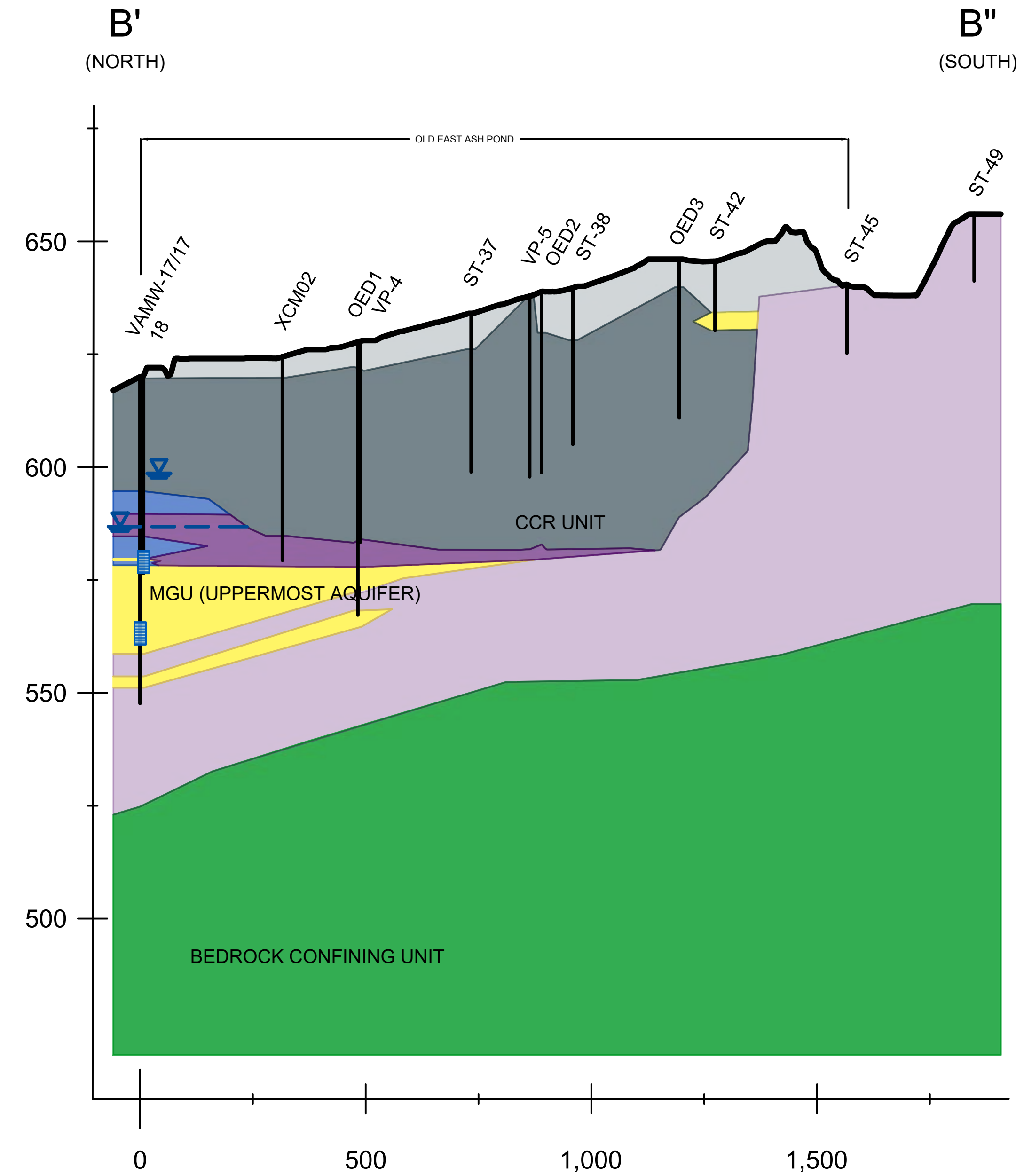
FIGURE 2-9

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

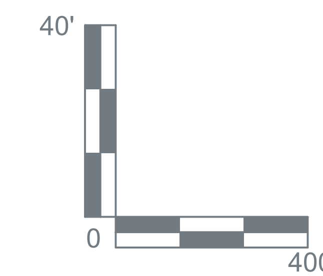
RAMBOLL







NOTES
1. This profile was developed by interpolation between widely spaced boreholes. Only at the borehole location should it be considered as an approximately accurate representation and then only to the degree implied by the notes on the borehole logs.
2. Scale is approximate.
3. Vertical scale is exaggerated 10X.
4. Groundwater elevations measured on March 29, 2021.
5. LGU = Lower Groundwater Unit
6. MGU = Middle Groundwater Unit



LEGEND
- COAL COMBUSTION RESIDUALS (CCR)
- FILL
- CLAY (CL/CH)
- TILL (CL/CH)
- SILT (ML)
- SAND (SP/SM/SW)
- GRAVEL (GP/GW)
- BEDROCK / WEATHERED BEDROCK (INTERBEDDED SHALE, LIMESTONE, SANDSTONE, V. LITTLE SS)
- WELL SCREEN INTERVAL
- MGU (UPPERMOST AQUIFER) POTENTIOMETRIC SURFACE
- MGU (UPPERMOST AQUIFER) GROUNDWATER ELEVATION
- POREWATER ELEVATION
- LGU (PMP) / BEDROCK GROUNDWATER / OTHER GROUNDWATER / SURFACE WATER ELEVATION(S)

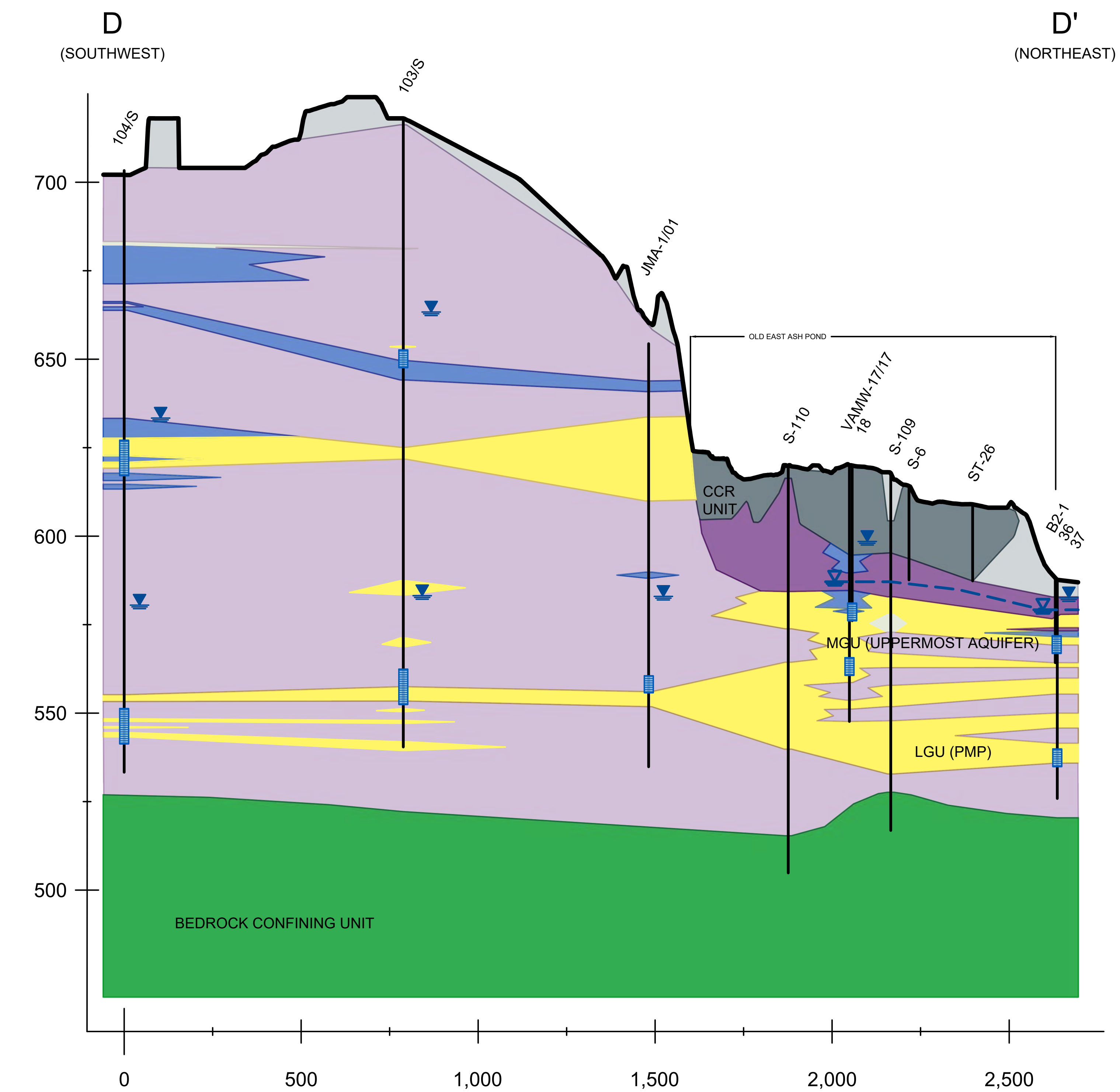
GEOLOGIC CROSS SECTIONS
B-B' & B'-B"

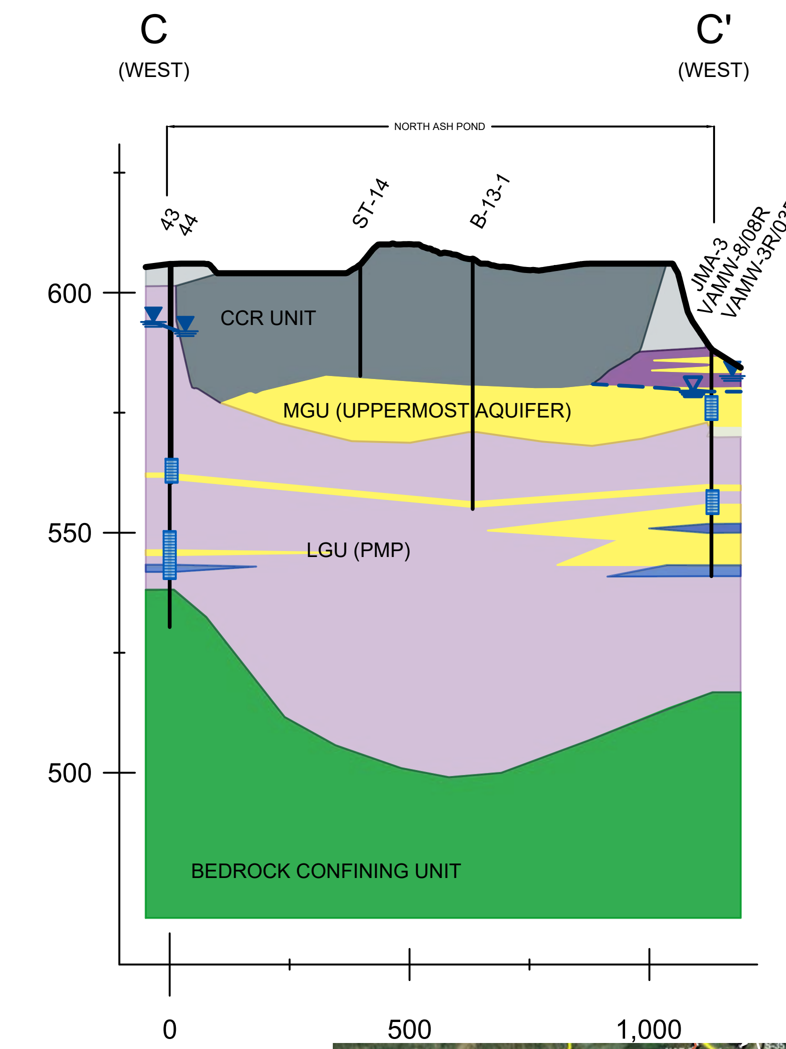
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

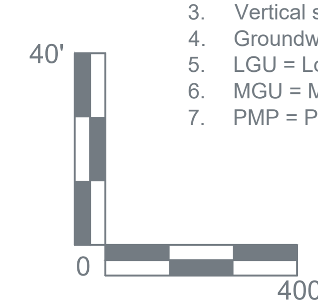
FIGURE 2-10

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

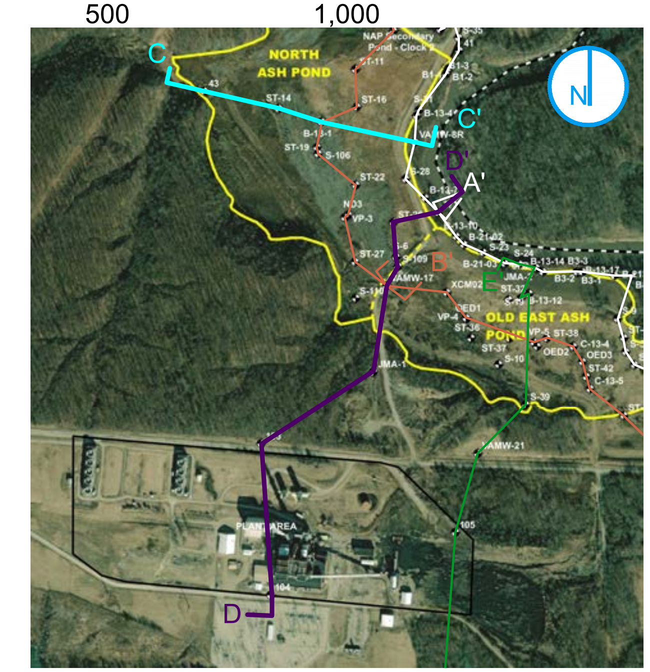






NOTES

1. This profile was developed by interpolation between widely spaced boreholes. Only at the borehole location should it be considered as an approximately accurate representation and then only to the degree implied by the notes on the borehole logs.
2. Scale is approximate.
3. Vertical scale is exaggerated 10X.
4. Groundwater elevations measured on March 29, 2021.
5. LGU = Lower Groundwater Unit
6. MGU = Middle Groundwater Unit
7. PMP = Potential Migration Pathway



LEGEND

- COAL COMBUSTION RESIDUALS (CCR)
- FILL
- CLAY (CL/CH)
- TILL (CL/CH)
- SILT (ML)
- SAND (SP/SM/SW)
- GRAVEL (GP/GW)
- BEDROCK / WEATHERED BEDROCK (INTERBEDDED SHALE, LIMESTONE, SANDSTONE, V. LITTLE SS)
- WELL SCREEN INTERVAL
- MGU (UPPERMOST AQUIFER) POTENTIOMETRIC SURFACE
- MGU (UPPERMOST AQUIFER) GROUNDWATER ELEVATION
- LGU (PMP) / BEDROCK GROUNDWATER / OTHER GROUNDWATER / SURFACE WATER ELEVATION(S)

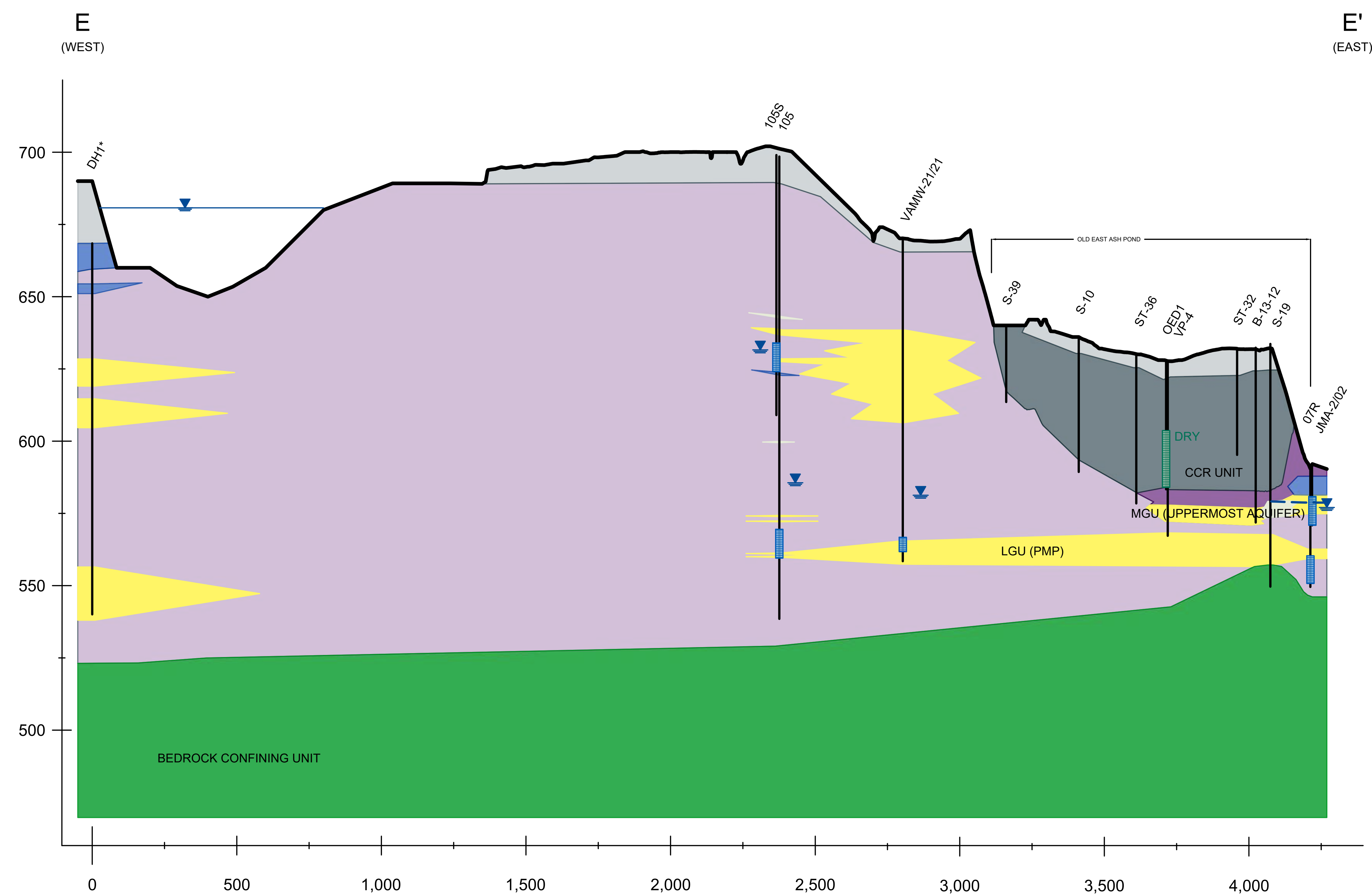
GEOLOGIC CROSS SECTIONS
C-C' & D-D'

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 2-11

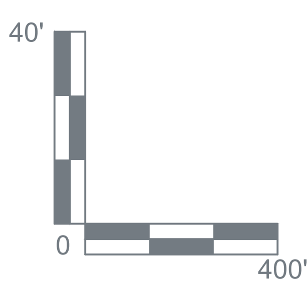
RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



NOTES

1. This profile was developed by interpolation between widely spaced boreholes. Only at the borehole location should it be considered as an approximately accurate representation and then only to the degree implied by the notes on the borehole logs.
2. Scale is approximate.
3. Vertical scale is exaggerated 10X.
4. Groundwater elevations measured on March 29, 2021.
5. LGU = Lower Groundwater Unit
6. MGU = Middle Groundwater Unit
7. PMP = Potential Migration Pathway
8. *DH-1 advanced prior to dam installation.



LEGEND

- COAL COMBUSTION RESIDUALS (CCR)
- FILL
- CLAY (CL/CH)
- TILL (CL/CH)
- SILT (ML)
- SAND (SP/SM/SW)
- GRAVEL (GP/GW)
- BEDROCK / WEATHERED BEDROCK (INTERBEDDED SHALE, LIMESTONE, SANDSTONE, V. LITTLE SS)
- WELL SCREEN INTERVAL
- MGU (UPPERMOST AQUIFER) POTENTIOMETRIC SURFACE
- MGU (UPPERMOST AQUIFER) GROUNDWATER ELEVATION
- LGU (PMP) / BEDROCK GROUNDWATER / OTHER GROUNDWATER / SURFACE WATER ELEVATION(S)

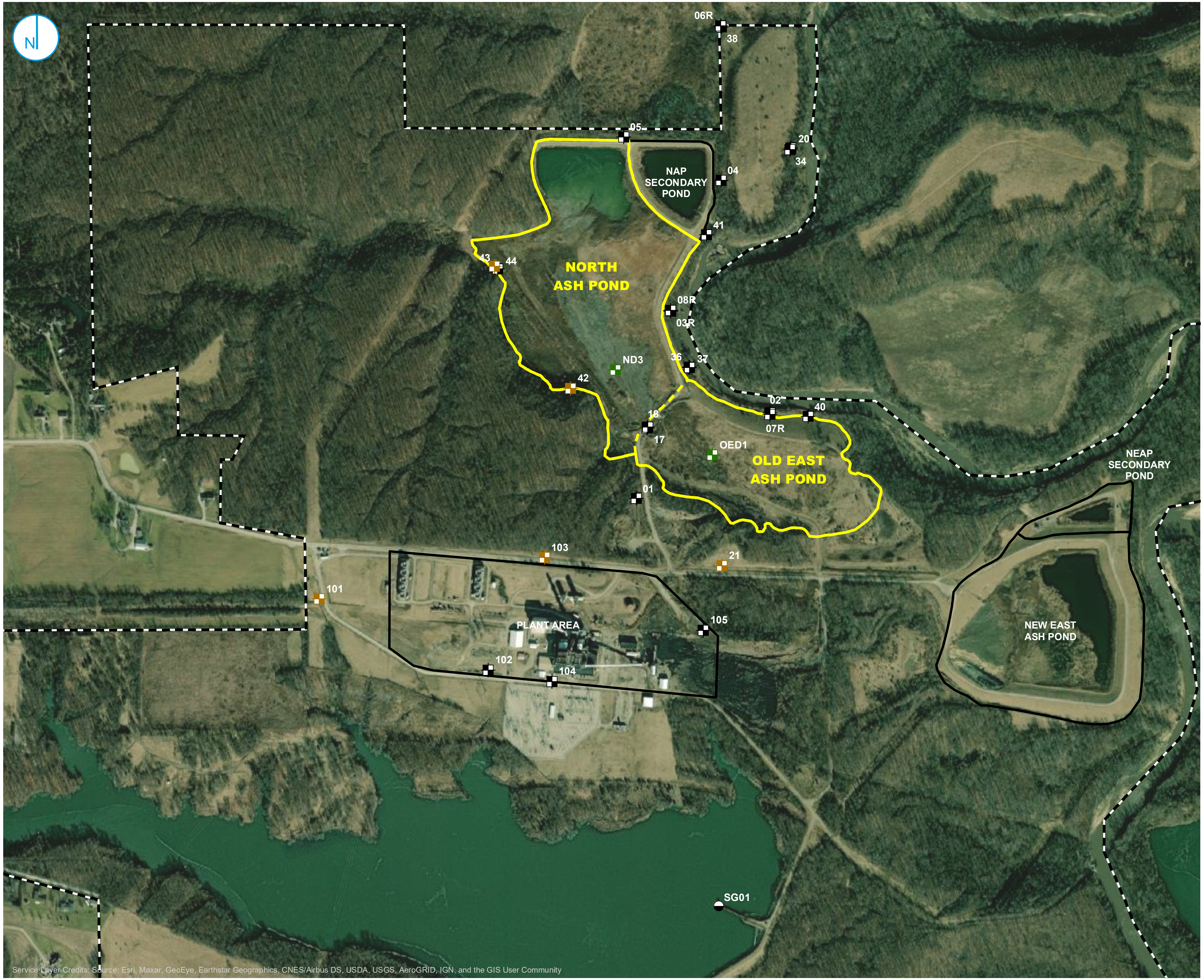
GEOLOGIC CROSS SECTION
E-E'

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 2-12

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
STAFF GAGE
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 300 600 Feet

MONITORING WELL LOCATION MAP

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

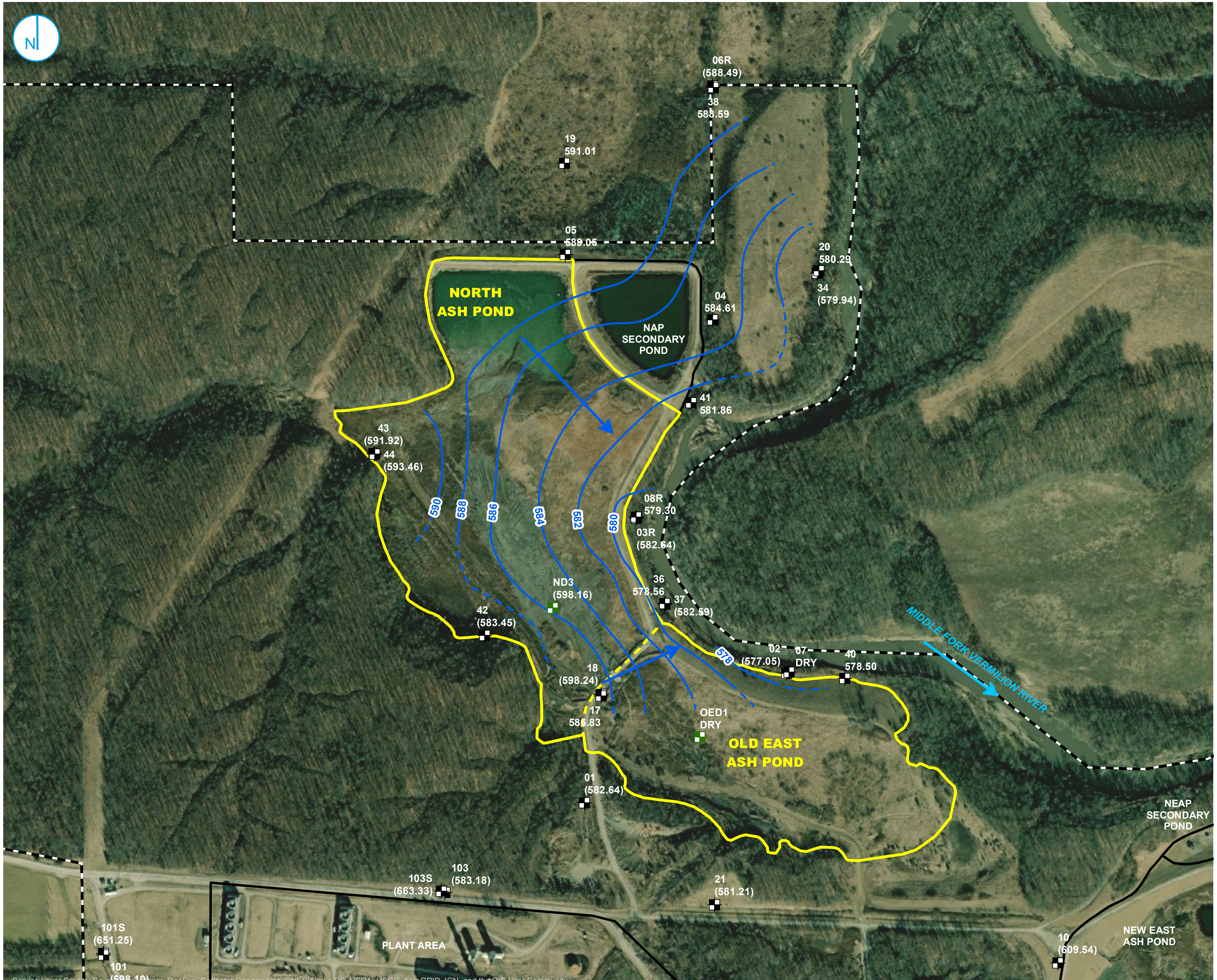
FIGURE 3-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure 3-1_Monitoring Well Location Map.mxd

PROJECT: 169000XXXX | DATED: 10/7/2021 | DESIGNER: STOLZSD



Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure 3-2_UA_GWE Contours Event 1_20210329.mxd

PROJECT: 169000XXXX | DATED: 10/8/2021 | DESIGNER: STOLZSD

BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

NOTE:
ELEVATIONS IN PARENTHESIS WERE NOT USED FOR CONTOURING.
NM = NOT MEASURED

0 200 400 Feet

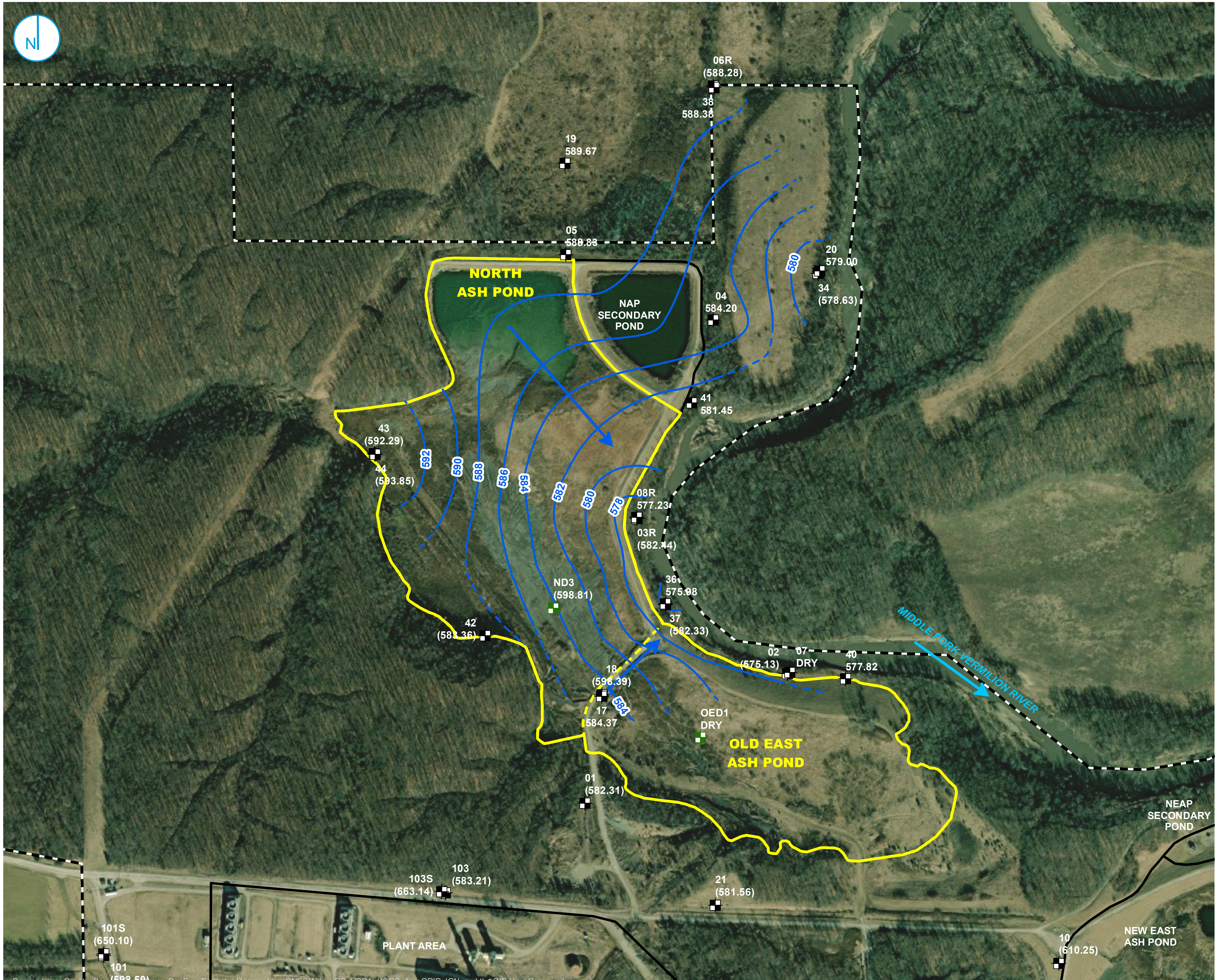
UPPERMOST AQUIFER GROUNDWATER ELEVATION CONTOURS
MARCH 29, 2021

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 3-2

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

NOTE:
ELEVATIONS IN PARENTHESIS WERE NOT USED FOR CONTOURING.
NM = NOT MEASURED

0 200 400
Feet

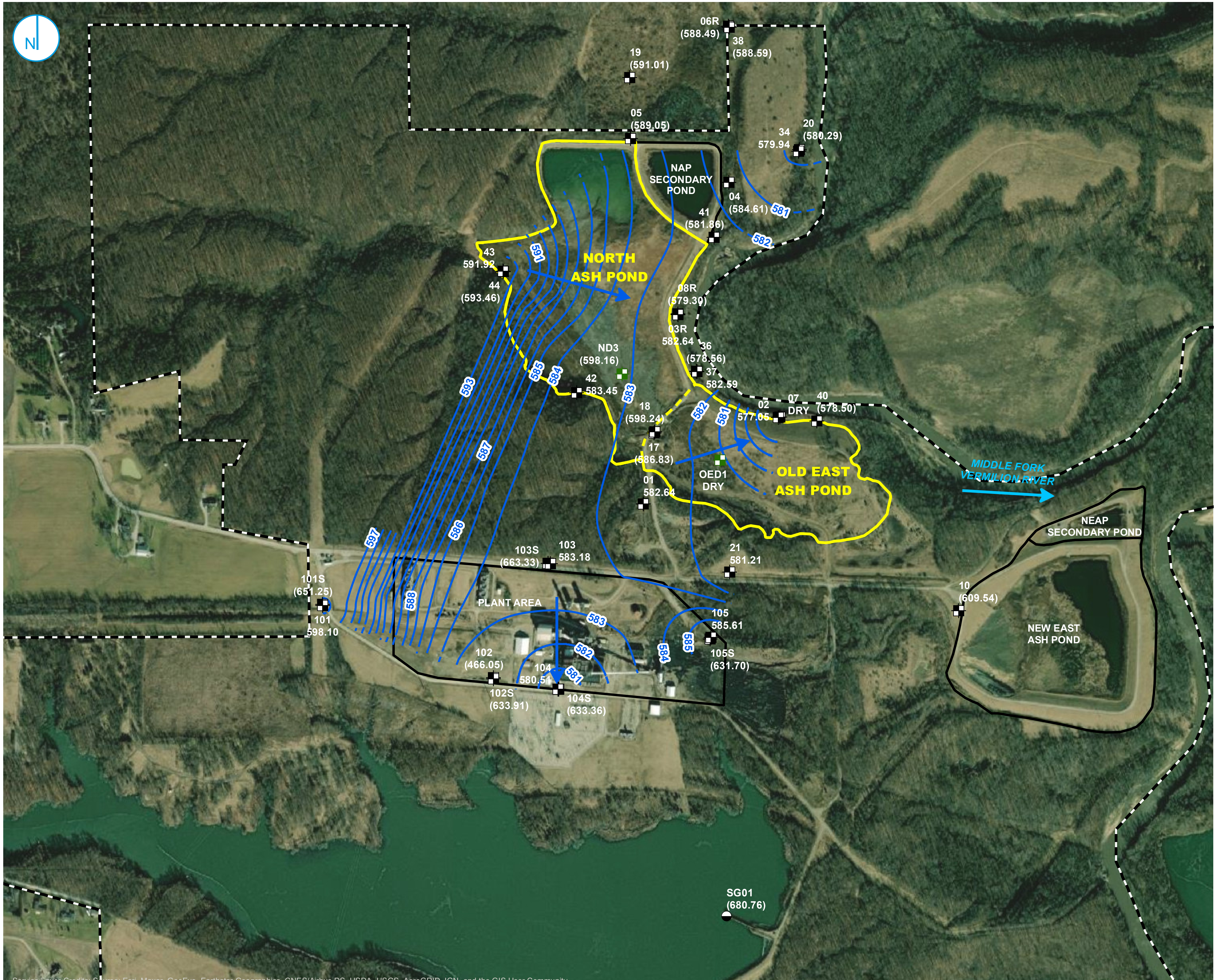
UPPERMOST AQUIFER GROUNDWATER ELEVATION CONTOURS APRIL 12, 2021

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 3-3

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
STAFF GAGE
GROUNDWATER ELEVATION CONTOUR (1-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

NOTE:
ELEVATIONS IN PARENTHESIS WERE NOT USED FOR CONTOURING.
NM = NOT MEASURED

0 300 600 Feet

POTENTIAL MIGRATION PATHWAY GROUNDWATER ELEVATION CONTOURS MARCH 29, 2021

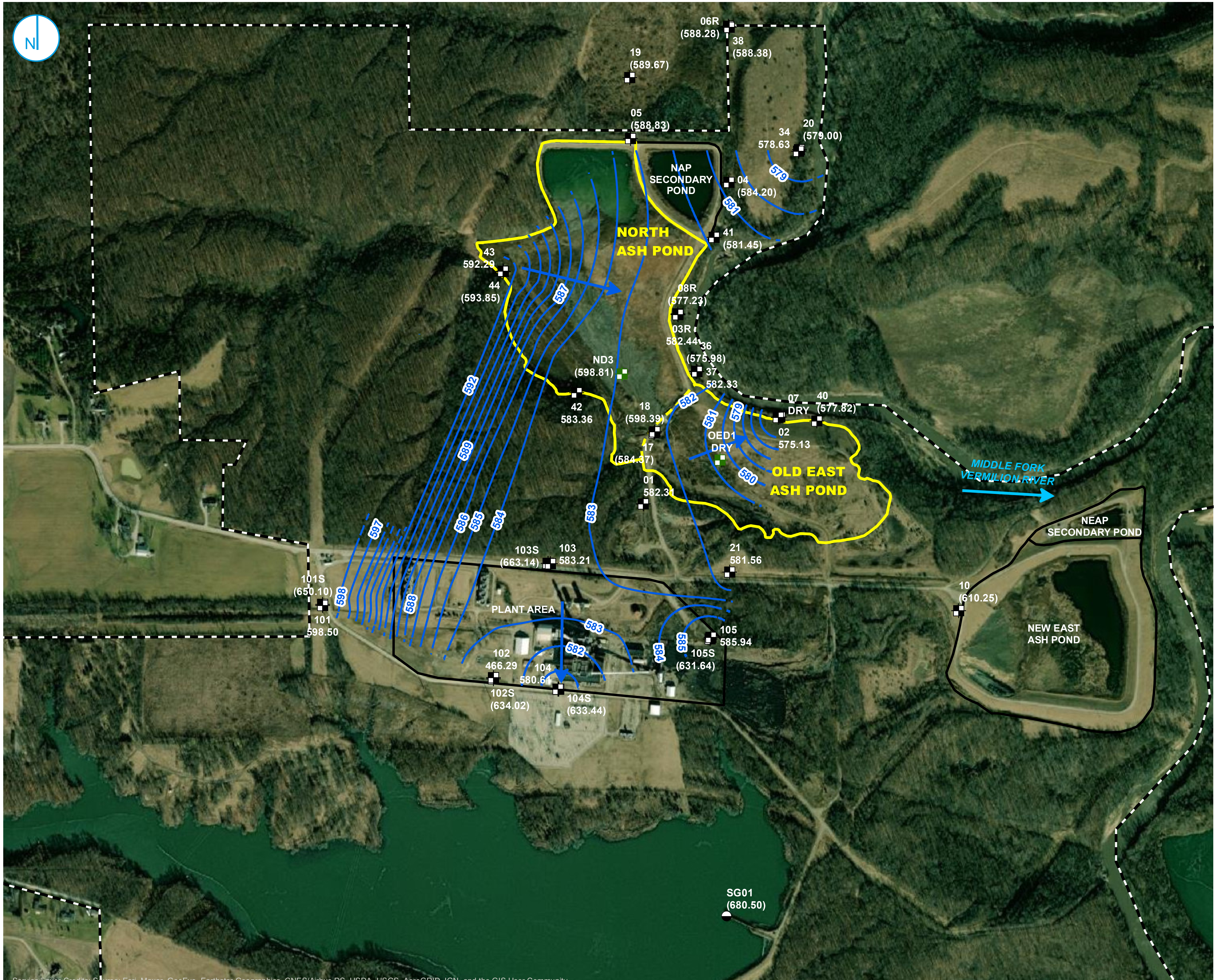
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 3-4

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure 3-4_PMP_GWE Contours Event 1_20210329.mxd

PROJECT: 169000XXXX | DATED: 10/8/2021 | DESIGNER: STOLZSD



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
STAFF GAGE
GROUNDWATER ELEVATION CONTOUR (1-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

NOTE:
ELEVATIONS IN PARENTHESIS WERE NOT USED FOR CONTOURING.
NM = NOT MEASURED

0 300 600 Feet

POTENTIAL MIGRATION PATHWAY GROUNDWATER ELEVATION CONTOURS APRIL 12, 2021

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 3-5

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

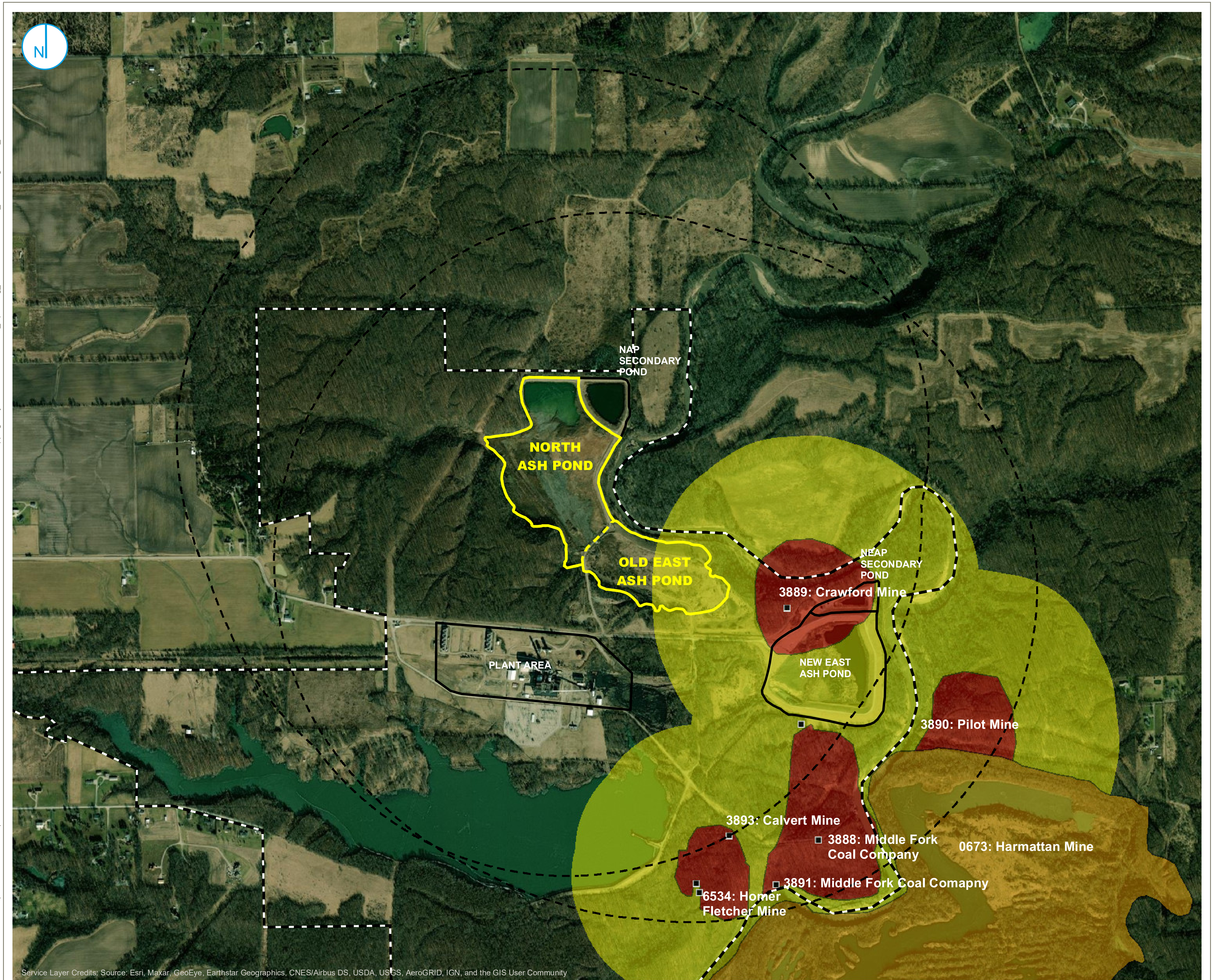
Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure 3-5_PMP_GWE Contours Event 2_20210412.mxd

PROJECT: 169000XXXX | DATED: 10/8/2021 | DESIGNER: STOLZSD

APPENDICES

APPENDIX A
INFORMATION PERTINENT TO 35 I.A.C. § 845.220(a)(3)

MINING ACTIVITIES



COAL MINE SHAFT
SURFACE COAL MINE
UNDERGROUND COAL MINE
UNDERGROUND MINE BUFFER REGION
PART 845 REGULATED UNIT (SUBJECT UNIT)
1000 METER UNIT BUFFER
SITE FEATURE
PROPERTY BOUNDARY

SOURCES: ISGS - ILMINES

0 500 1,000 Feet

ACTIVE AND ABANDONED COAL MINES

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

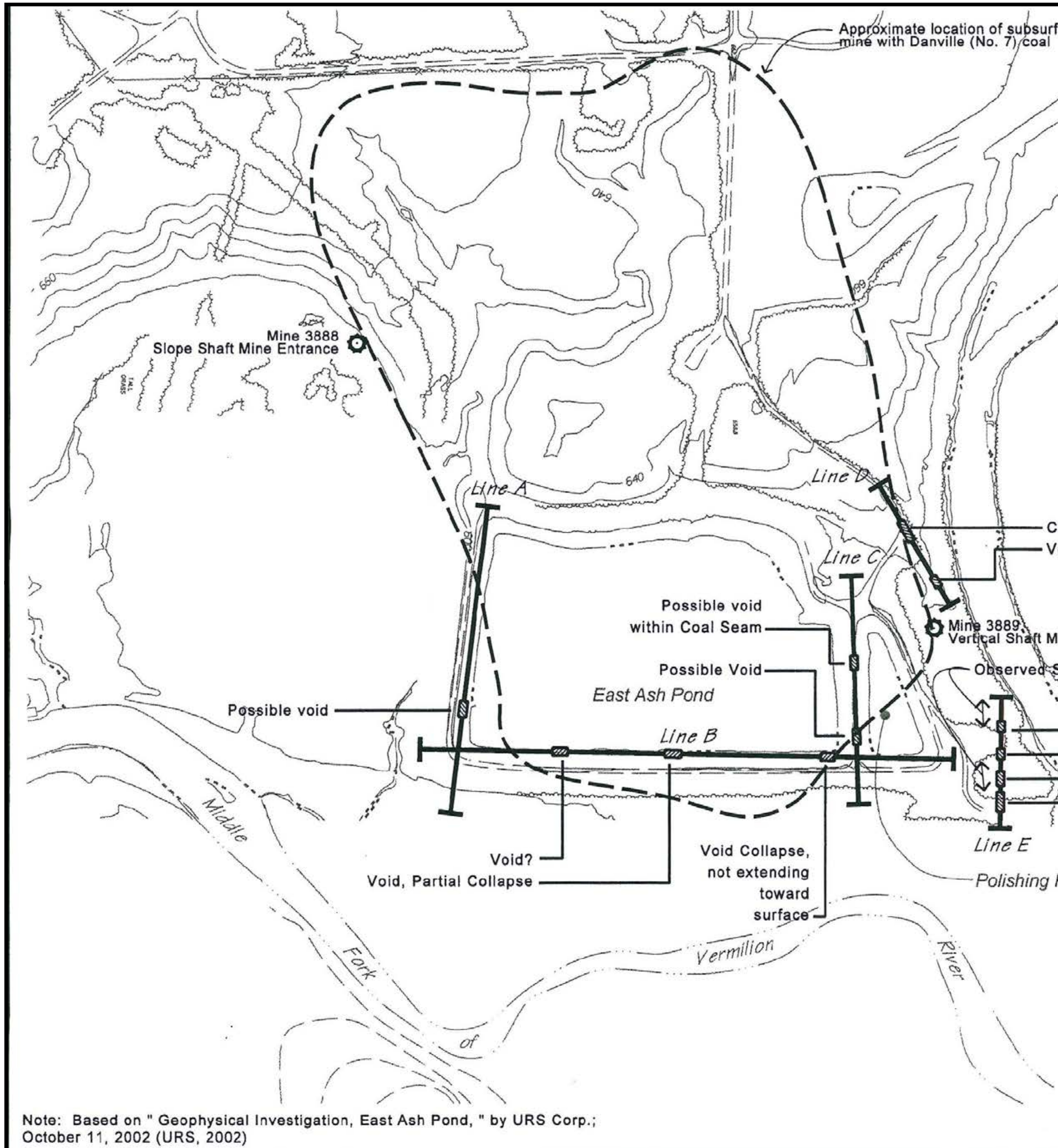
FIGURE A-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure A-1_Active and Abandoned Coal Mines.mxd

PROJECT: 169000XXXX | DATED: 10/8/2021 | DESIGNER: STOLZSD



Kelron Environmental

Bedrock Anomalies Based on Geophysics Investigation

Regional and Local Hydrogeology and Geochemistry
Vermilion Power Plant
Oakwood, Illinois

Date: September 2002 | *Figure 19*

APPROXIMATE LOCATION OF SUBSURFACE MINE

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE A-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

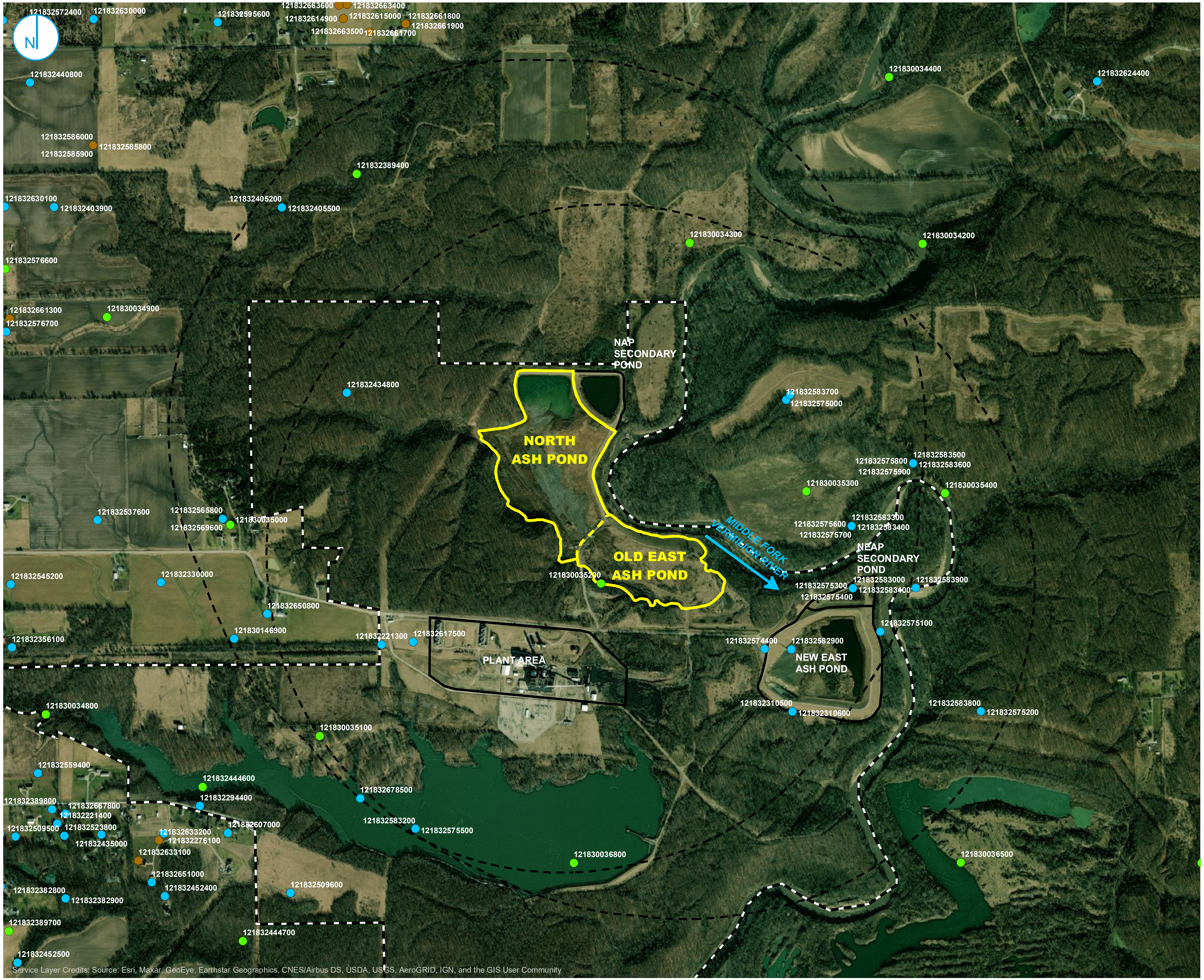
MINES WITHIN 1,000 METERS
DESKTOP STUDY
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION, ILLINOIS

Mine ID	Mine Name	Distance from Unit (ft)	Physical Orientation to Unit	Hydraulic Orientation to Unit	Range of Active Dates	Mine Type	Size (Acres)	Coal Unit Mined	Mine Depth Top (ft BGS)	Mine Depth Bottom (ft BGS)	Production (tons)	Notes
NORTH ASH POND												
3893	Calvert Mine	3278.2	S	Downgradient	-	Underground	2.74	Danville	-	-	-	Abandoned, Depth noted as 70'
3888	Middle Fork Coal Company	2963.9	SE	Downgradient	1939-1948	Underground	26.98	Danville	-	-	7,633	Abandoned, Depth noted as 82'
3889	Crawford Mine	1638.2	SE	Downgradient	-	Underground	27.14	Danville	-	-	-	Abandoned, Depth noted as 106'
6534	Homer Fletcher Mine	3250.1	S	Downgradient	1933-1937	Underground	9.96	Danville	-	-	14,147	Abandoned
OLD EAST ASH POND												
3891	Middle Fork Coal Company	2959.8	SE	Downgradient	1888-1907	Underground	26.98	Danville	86	100	56,350	Abandoned
3893	Calvert Mine	2316.2	S	Downgradient	-	Underground	2.74	Danville	-	-	-	Abandoned, Depth noted as 70'
3888	Middle Fork Coal Company	1565.7	SE	Downgradient	1939-1948	Underground	26.98	Danville	-	-	7,633	Abandoned, Depth noted as 82'
3889	Crawford Mine	300.7	E	Downgradient	-	Underground	27.14	Danville	-	-	-	Abandoned, Depth noted as 106'
3890	Pilot Mine	2391.2	SE	Downgradient	1884-1888	Underground	15.76	Danville	89	95	8,010	Abandoned
0673	Harmattan Mine, Division of AMAX	2395.1	SE	Downgradient	1949-1970	Surface	269.2	Danville	70	102	15,216,438	Abandoned
6534	Homer Fletcher Mine	2527.8	S	Downgradient	1933-1937	Underground	9.96	Danville	-	-	14,147	Abandoned

Notes:
- = no data
ft = feet
N = north
NW = northwest
NE = northeast
E = east
S = south
SW = southwest
SE = southeast
W = west

[O:LTA 7/26/2021; C: EGP 07/27/21]

WATER WELL SURVEY



Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure A-2_Drinking Water Intakes.mxd

PROJECT: 169000XXXX | DATED: 10/8/2021 | DESIGNER: STOLZSD

DRY
WATER
N/A
PART 845 REGULATED UNIT (SUBJECT UNIT)
1000 METER UNIT BUFFER
SITE FEATURE
PROPERTY BOUNDARY

SOURCES: IL WELLS

0 500 1,000
Feet

DRINKING WATER INTAKES, PUMPING WELLS, AND USES OF WATER

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE A-3

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

WATER WELLS WITHIN 1,000 METERS
DESKTOP STUDY
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION, ILLINOIS

Well Number	Date Constructed	Ground Elevation (ft MSL)	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Screen Top Elevation (ft MSL)	Screen Bottom Elevation (ft MSL)	Bottom of Boring Elevation (ft MSL)	Screen Length (ft)	Screen Diameter (inches)	Well Depth from Ground Surface (ft bgs)	Total Boring Depth (ft bgs)	Latitude (DD)	Longitude (DD)	Notes
121830034300	7/1/1911	598	-	-	-	-	425	-	-	173	173	40.190781	-87.742578	Private Water Well
121830035000	10/1/1911	725	-	-	-	-	439	-	-	286	286	40.182695	-87.760034	Private Water Well
121830035100	-	649	-	-	-	-	442	-	-	207	207	40.176549	-87.756693	Private Water Well
121830035200	7/1/1911	605	-	-	-	-	439	-	-	166	166	40.180921	-87.746015	Private Water Well
121830035300	-	600	-	-	-	-	543	-	-	57	57	40.183549	-87.738226	Coal Test
121830035400	9/1/1910	588	-	-	-	-	457	-	-	131	131	40.183465	-87.732967	Private Water Well
121830036800	6/1/1911	629	-	-	-	-	476	-	-	153	153	40.172811	-87.747119	Coal Test
121832582900	11/30/2001	656	80	100	576	556	556	10	2	100	100	40.178973	-87.738835	Water Well Monitoring Well, Dynegy Midwest Generation; 22
121832583000	12/3/2001	599	12	22	587	577	571	10	2	28	28	40.180735	-87.736484	Water Well Monitoring Well, Dynegy Midwest Generation; 23
121832583100	12/3/2001	599	35	55	564	544	544	20	2	55	55	40.180735	-87.736484	Water Well Monitoring Well, Dynegy Midwest Generation; 24
121832583200	12/4/2001	579	19	39	-	-	540	20	2	39	39	40.173838	-87.753102	Water Well Monitoring Well, IL Power Plant
121832583300	11/21/2001	581	8	13	573	568	565	5	2	16	16	40.182543	-87.736517	Water Well Monitoring Well, Dynegy Midwest Generation; 26
121832583400	11/26/2001	581	23	43	558	538	537	20	2	44	44	40.182543	-87.736517	Water Well Monitoring Well, Dynegy Midwest Generation; 27
121832583500	11/26/2001	581	8	13	573	568	566	5	2	15	15	40.18435	-87.734175	Water Well Monitoring Well, Dynegy Midwest Generation; 28
121832583600	11/27/2001	581	23	43	558	538	536	20	2	45	45	40.18435	-87.734175	Water Well Monitoring Well, Dynegy Midwest Generation; 29
121832583700	11/21/2001	646	127	147	519	499	498	5	2	148	148	40.186207	-87.738961	Water Well Monitoring Well, Dynegy Midwest Generation; 30
121832583800	11/29/2001	591	162	182	541	521	519	20	2	184	184	40.177139	-87.73167	Water Well Monitoring Well, IL Power Plant; 31
121832583900	12/4/2001	582	45.8	55.8	536.2	526.2	526	10	2	56	56	40.18073	-87.734105	Water Well Monitoring Well, IL Power Plant; 32
121832575500	12/4/2001	579.397	19.1	38.7	559.7	540.1	539.8	19.6	2	39	39	40.173838	-87.753102	Water Well Monitoring Well, Dynegy Midwest Generation; 25
121832574400	1/7/2002	654	-	-	-	-	554	-	-	100	100	40.178988	-87.739846	Water Well Monitoring Well, IL Power Plant
121832575000	1/7/2002	645	-	-	-	-	497	-	-	148	148	40.186362	-87.738803	Water Well Monitoring Well, IL Power Plant
121832575100	1/7/2002	591	162	182	541	521	519	20	2	184	56	40.179472	-87.735447	Water Well Monitoring Well, IL Power Plant, 32
121832575200	11/29/2001	591	162	182	541	521	519	20	2	184	184	40.177139	-87.73167	Water Well Monitoring Well, IL Power Plant; 31
121832575300	12/3/2001	599.271	11.8	21.8	587.471	577.471	577.3	10	2	28	28	40.180735	-87.736484	Water Well Monitoring Well, IL Power Plant; 23
121832575400	12/3/2001	599	35	55	564	544	544	20	2	55	55	40.180735	-87.736484	Water Well Monitoring Well, Dynegy Midwest Generation; 24
121832575600	11/21/2001	525	-	-	-	-	509	-	-	16	16	40.182543	-87.736517	Water Well Monitoring Well, IL Power Plant; 26
121832575700	11/26/2001	703	-	-	-	-	659	-	-	44	44	40.182543	-87.736517	Water Well Monitoring Well, IL Power Plant; 27
121832575800	11/26/2001	703	-	-	-	-	688	-	-	15	15	40.18435	-87.734175	Water Well Monitoring Well, IL Power Plant; 28
121832575900	11/27/2001	703	-	-	-	-	658	-	-	45	45	40.18435	-87.734175	Water Well Monitoring Well, IL Power Plant; 29
121832678500	5/5/2013	-	-	-	-	-	-	-	5	106	106	40.174733	-87.755183	Private Water Well
121832617500	3/7/2005	-	-	-	-	-	-	-	5	211	211	40.17926	-87.753146	Semi-Private Water Well
121832650800	3/25/2007	-	-	-	-	-	-	-	4	125	125	40.1801	-87.75865	Private Water Well
121830146900	5/1/1968	-	-	-	-	-	-	-	4	105	105	40.179387	-87.759904	Private Water Well
121832310500	12/16/1987	-	-	-	-	-	-	48	4	131	131	40.177165	-87.738801	Private Water Well
121832310600	12/13/1987	-	-	-	-	-	-		4	139	139	40.177165	-87.738801	Private Water Well
121832221300	1/1/1967	-	-	-	-	-	-	-	-	175	175	40.179189	-87.754339	Municipal Water Supply Well
121832405200	12/10/1994	-	-	-	-	-	-	3	4	52	52	40.191892	-87.757994	Private Water Well
121832405500	12/16/1994	-	-	-	-	-	-	-	-	-	--	40.191892	-87.757994	Private Water Well
121832434800	5/2/1995	-	-	-	-	-	-	-	-	152	152	40.186497	-87.755584	Private Water Well
121832569600	6/11/2001	-	-	-	-	-	-	-	-	140	140	40.182868	-87.760306	Private Water Well, Plugged
121832565800	8/21/2001	-	-	-	-	-	-	-	6	83	83	40.182868	-87.760306	Private Water Well
121832389400	-	-	-	-	-	-	-	-	-	-	-	40.192847	-87.755155	Farm: Tom Ellmore, **Test Hole**

RAMBOLL

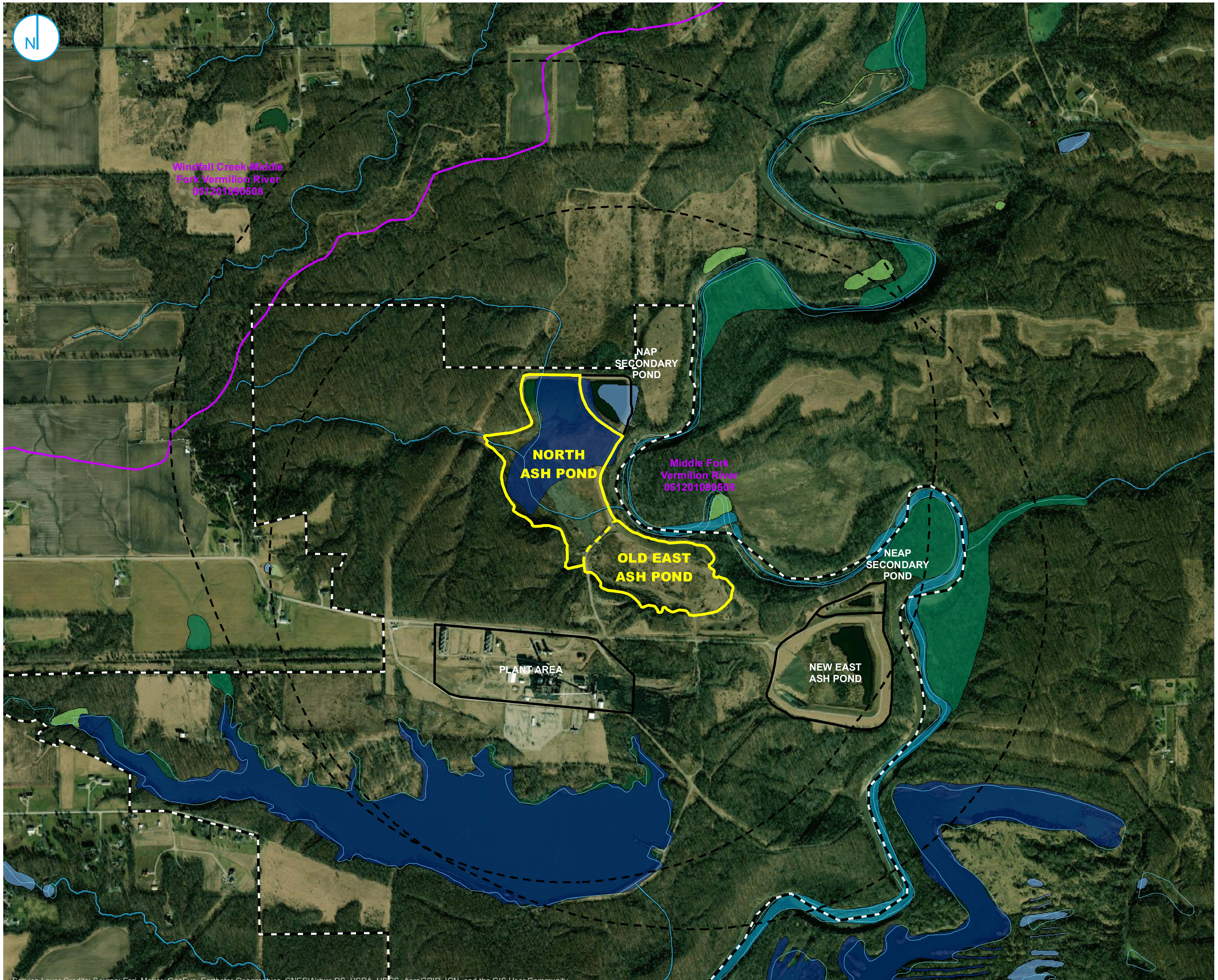
WATER WELLS WITHIN 1,000 METERS
DESKTOP STUDY
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION, ILLINOIS

Well Number	Date Constructed	Ground Elevation (ft MSL)	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Screen Top Elevation (ft MSL)	Screen Bottom Elevation (ft MSL)	Bottom of Boring Elevation (ft MSL)	Screen Length (ft)	Screen Diameter (inches)	Well Depth from Ground Surface (ft bgs)	Total Boring Depth (ft bgs)	Latitude (DD)	Longitude (DD)	Notes

Notes:
- = no data
bgs = below ground surface
DD = decimal degrees
ft = feet
MSL = above Mean Sea Level

[O:LTA 7/26/2021: C: EDP 7/27/21]

SURFACE WATERS



Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure A-3_Surface Waterbodies.mxd

PROJECT: 169000XXXX | DATED: 10/8/2021 | DESIGNER: STOLZSD

PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY
1000 METER UNIT BUFFER
SURFACE WATERBODY
WATERSHED BOUNDARY (HUC 12)

NATIONAL WETLANDS INVENTORY
FRESHWATER EMERGENT WETLAND
FRESHWATER FORESTED/SHRUB WETLAND
FRESHWATER POND
LAKE
RIVERINE

SOURCES: USGS, USFWS

0 500 1,000 Feet

SURFACE WATERBODIES

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE A-4

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

SURFACE WATER FEATURES WITHIN 1,000 METERS
DESKTOP STUDY
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION, ILLINOIS

HUC/NHD ID	Surface Water ID	Distance from NAP Unit (meters)	Distance from OEAP Unit (meters)	Physical Orientation to NAP Unit	Hydraulic Orientation to NAP Unit	Physical Orientation to OEAP Unit	Hydraulic Orientation to OEAP Unit	Classification Code	Size (acres)
155276935	NHD Flowline, Stream/River (Hydrographic Category/intermittent)	0	351.26	Within	Upgradient	NW	Upgradient	46003	257.98
155277012	NHD Flowline, Stream/River (Hydrographic Category/intermittent)	0	741.32	E	--	E	--	46003	390.92
155276987	NHD Flowline, Stream/River (Hydrographic Category/intermittent)	0	42.93	Within	Downgradient	NW	Upgradient	46003	111.44
155276930	NHD Flowline, Stream/River (Hydrographic Category/intermittent)	0	351.26	Within	Upgradient	NW	Upgradient	46003	413.90
155274814	NHD Flowline, Stream/River (Hydrographic Category/intermittent)	800	1367.00	NW	Upgradient	NW	Upgradient	46003	698.07
155274815	NHD Flowline, Stream/River (Hydrographic Category/intermittent)	0	866.70	S	--	S	--	46003	206.58
155281202	NHD Waterbody, Illinois Power Lake, Lake/Pond (Hydrographic Category/intermittent; Stage/high water elevation)	567	403.47	SW	Upgradient	SW	Upgradient	39004	105.76
155281165	NHD Waterbody, Lake/Pond (Hydrographic Category/intermittent; Stage/high water elevation)	0	794.37	SE	--	SE	--	39004	61.28
155281145	NHD Waterbody, Lake/Pond (Hydrographic Category/intermittent; Stage/high water elevation)	768	980.71	W	Upgradient	W	Upgradient	39004	0.25
155282412	NHD Area, Middle Fork Vermilion River	45	16.05	SE	Downgradient	E	Upgradient	46006	1098.38
1691611	Lake (Illinois Power Company Lake)	559	389.58	SW	Upgradient	SW	Upgradient	L1UBHh	108.86
--	Lake (North Ash Pond)	0	176.58	Within	Downgradient	NW	Downgradient	L1UBHh	21.52
--	Freshwater Emergent Wetland	294	84.31	SE	Upgradient	NE	Upgradient	PEM1/USA	1.10
--	Freshwater Emergent Wetland	510	836.16	NE	Upgradient	NE	Upgradient	PEM1A	1.27
--	Freshwater Emergent Wetland	849	934.66	NE	Upgradient	NE	Upgradient	PEM1Af	1.92
--	Freshwater Forested/Shrub Wetland	842	467.65	SE	Downgradient	E	Downgradient	PFO1C	11.07
--	Freshwater Forested/Shrub Wetland	998	589.40	SE	Downgradient	E	Downgradient	PFO1C	21.84
--	Freshwater Forested/Shrub Wetland	353	580.92	NE	Upgradient	NE	Upgradient	PFO1C	10.59
--	Freshwater Forested/Shrub Wetland	856	906.83	NE	Upgradient	NE	Upgradient	PFO1C	5.17
--	Freshwater Pond	781	993.95	W	Upgradient	W	Upgradient	PUBGx	0.14
--	Freshwater Pond	34	303.25	NE	Upgradient	N	Upgradient	PUBHh	2.71
--	Riverine	398	92.77	SE	Downgradient	NE	Upgradient	R2UBH	0.96
--	Riverine	48	18.77	SE	Downgradient	N	Upgradient	R2UBH	20.43
--	Riverine	374	84.94	SE	Downgradient	N	Upgradient	R2USA	0.31
--	Riverine	809	434.18	SE	Downgradient	E	Downgradient	R2USA	1.25
--	Riverine	0	869.31	S	Downgradient	S	Downgradient	R4SBC	1.22
--	Riverine	0	39.95	Within	Downgradient	NW	Downgradient	R4SBC	0.44
--	Riverine	0	377.02	Within	Downgradient	NW	Downgradient	R4SBC	1.51
--	Riverine	0	374.48	Within	Downgradient	NW	Downgradient	R4SBC	0.12
--	Riverine	0	516.69	Within	Downgradient	NW	Downgradient	R4SBC	2.07
--	Riverine	797	50.00	NW	Downgradient	--	--	R4SBC	9.40
--	Riverine	881	542.14	SE	Downgradient	E	Downgradient	R5UBH	0.02
--	Riverine	285	80.64	SE	Downgradient	NE	Upgradient	R5UBH	0.17
--	Lake	0	791.10	--	--	SW	Downgradient	L1UBHx	70.70
3339000	Riverine (Vermilion River)	890	550.79	SE	Downgradient	E	Upgradient	R2UBH	394.85

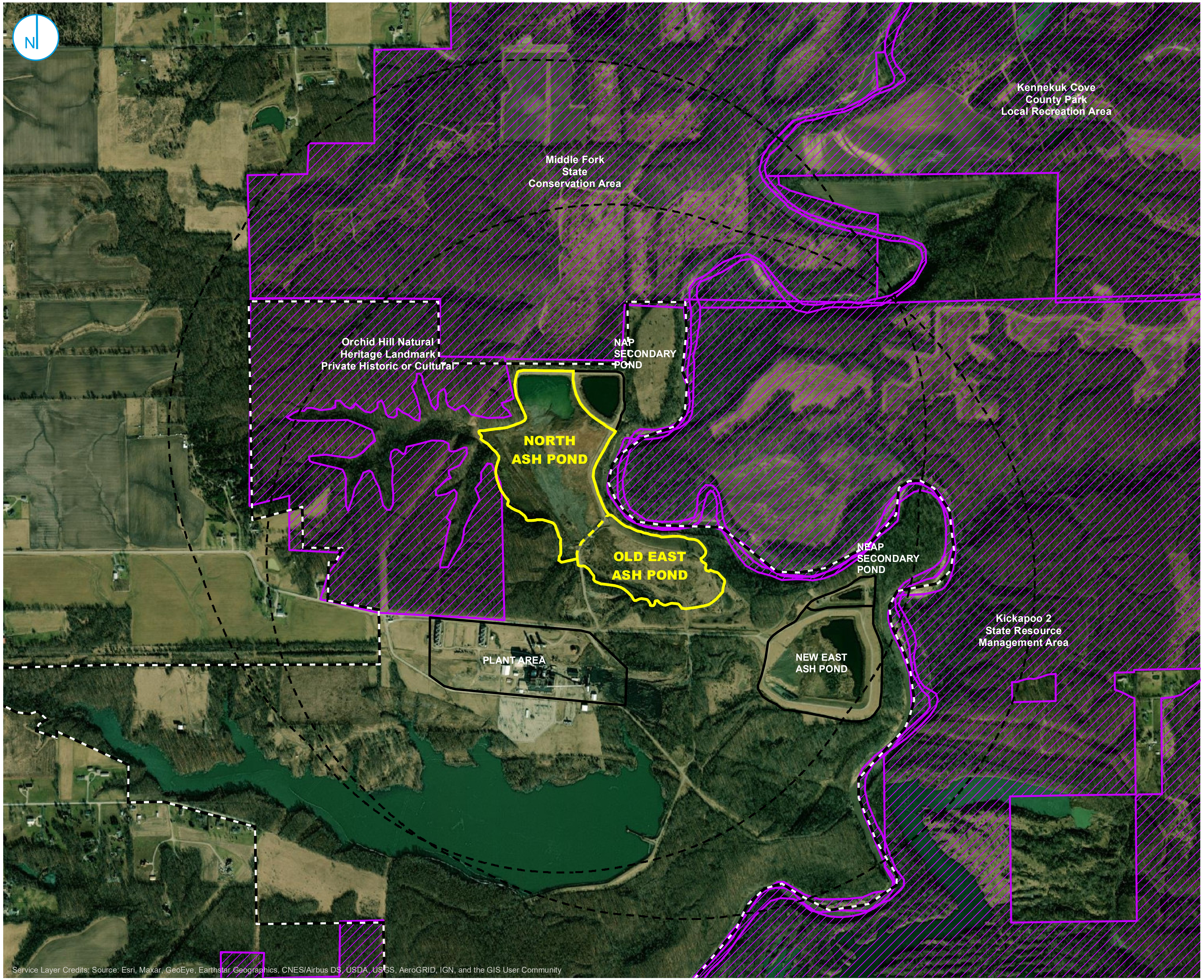
Notes:

[O:LTA 7/26/2021: C: EGP 07/28/21]

-- = not applicable
E = east
ft = feet
HUC = Hydrologic Unit Code
N = north
NE = northeast
NHD = National Hydrography Dataset
NW = northwest
S = south
SE = southeast
SW = southwest
W = west

RAMBOLL

NATURE PRESERVES, HISTORIC SITES, ENDANGERED / THREATENED SPECIES



Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure A-4_Nature Preserves.mxd

PROJECT: 169000XXXX | DATED: 10/8/2021 | DESIGNER: STOLZSD

PROTECTED AREA
PART 845 REGULATED UNIT (SUBJECT UNIT)
1000 METER UNIT BUFFER
SITE FEATURE
PROPERTY BOUNDARY

SOURCES: USGS - PAD-US

0 500 1,000 Feet

NATURE PRESERVES

HYDROGEOLOGIC SITE
CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE A-5

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

NATURE PRESERVES AND HISTORIC SITES WITHIN VERMILION COUNTY

DESKTOP STUDY

VERMILION POWER PLANT

NORTH ASH POND AND OLD EAST ASH POND

VERMILION, ILLINOIS

INAI / INPC Number	INAI / INPC Name	Category / Categories	Size (acres)	Notes
0104	Camp Drake	I	4.76	-
NP191	Carl Flierman's River Nature Preserve	-	-	Privately Owned Nature Preserve
NHL179	Collie - Flower Acres Natural Heritage Lanmdark	-	-	Natural Heritage Landmark
1627	Craver's Seep	I	5.40	-
1587/NP278	Doris Westfall Prarie Restoration Nature Preserve	I-R, III	43.87	Nature Preserve
NHL204	East Conkeytown Natural Heritage Landmark	-	-	Natural Heritage Landmark
1742/LWR050	Edgewood Farm Land and Water Reserve	III	147.5	Land and Water Reserve
1073/NP142	Fairchild Cemetery Prarie/Savanna Nature Preserve	I, III	3.3	Nature Preserve
0879/NP113	Forest Glen Seep Nature Preserve	I,II,III	24.63	Nature Preserve
1534	Harry "Babe" Woodyard State Natural Area	II,III	II,III	-
1540/NP070	Horseshoe Bottom Nature Preserve	III	91.97	Nature Preserve
NP199	Howards Hollow Seep Nature Preserve	-	-	Nature Preserve
1638/NP289	Jordan Creek of the North Fork Nature Preserve	III	46.8	Nature Preserve
NHL137	Jordan Creek of the Salt Fork Natural Heritage Landmark	-	-	Natural Heritage Landmark
1142	Kennekuk Cove County Park	II	851.07	Local Recreation Area
1930	Kennekuk Seep	I	1.89	-
1817	Kickapoo Hill Prarie	I, III	37.09	-
-	Kickapoo 2 State Resource Management Area	-	-	State Resource Management Area
1511/LWR086	Kinney's Ford Seep Land and Water Reserve	I,II,III	793.96	Land and Water Reserve
NHL205	Larimore 40 Natural Heritage Landmark	-	40	Natural Heritage Landmark
LWR146	Larimore's Salt Fk of Vermilion River Land and Water Reserve	-	-	Land and Water Reserve
1140/LWR021	Little Vermilion River Land and Water Reserve	II, III, VI	1227	Land and Water Reserve
0494	Middle Fork of the Vermilion River State Conservation Area	II, III, IV, VI	2700	State Conservation Area
1512	Middle Fork Seeps	I	19.79	-
1955	Middlefork Ephemeral Ponds	II	318.65	-
0810/NP071	Middlefork Woods Nature Preserve	I, II, III	90.06	Nature Preserve
1141	North Fork Vermilion River	II, III	325	-
0805/NHL107	Orchid Hill Natural Heritage Landmark	III	147.45	Natural Heritage Landmark, Private Historic or Cultural

NATURE PRESERVES AND HISTORIC SITES WITHIN VERMILION COUNTY

DESKTOP STUDY

VERMILION POWER PLANT

NORTH ASH POND AND OLD EAST ASH POND

VERMILION, ILLINOIS

INAI / INPC Number	INAI / INPC Name	Category / Categories	Size (acres)	Notes
1420	Pellville Cemetery	I	1.09	-
NHL206	R.W. Larimore's Salt Fork River Natural Heritage Landmark	-	-	Natural Heritage Landmark
1718	Rock Cut Road Botanical Area	II, III	50.55	-
0041/NP033	Russell M. Duffin Natural Area	II, III	217.33	Nature Preserve
1427	Salt Fork Vermilion River Segment	II, III, VI	609.34	-
0495	Vermilion River - Wabash Drainage Danville Segment	II,VI	265.61	-
0023	Willow Creek Seep	I,III	30	-
0804/NP072	Windfall Prairie Nature Preserve	I,II,III	58.64	Nature Preserve

Notes: [OB:LTA 7/26/2021: CB: EGP 07/28/21]

I = High quality natural community and natural community restorations
II = Specific suitable habitat for state-listed species or state-listed species relocations
III = State dedicated Nature Preserves, Land and Water Reserves, & Natural Heritage Landmarks
IV = Outstanding geological features
V = Not used at this time
VI = Unusual concentrations of flora or fauna and high quality streams
-- = not applicable, no data
IDNR = Illinois Department of Natural Resources
INAI = Illinois Natural Areas Inventory
INPC = Illinois Nature Preserves Commission

ENDANGERED / THREATENED SPECIES WITHIN VERMILION COUNTY

DESKTOP STUDY

VERMILION POWER PLANT

NORTH ASH POND AND OLD EAST ASH POND

VERMILION, ILLINOIS

Scientific Name	Common Name	Status	Number of Occurances	Last Observed
Ambystoma platineum	Silvery Salamander	LE	6	8/7/2019
Ammocrypta pellucida	Eastern Sand Darter	LT	11	10/16/2020
Apalone mutica	Smooth Softshell	LT	1	9/13/2012
Asclepias meadii	Mead's Milkweed	LE	1	6/21/2012
Asio flammeus	Short-eared Owl	LE	3	12/14/2014
Bartramia longicauda	Upland Sandpiper	LE	1	7/4/1986
Calephelis muticum	Swamp Metalmark	LE	1	6/18/1989
Carex bromoides	Sedge	LT	1	5/15/2012
Carex prasina	Drooping Sedge	LT	1	7/2/2014
Carex willdenowii	Willdenow's Sedge	LT	1	1998
Circus hudsonius	Northern Harrier	LE	3	6/11/1993
Cyclonaias tuberculata	Purple Wartyback	LT	20	9/16/2020
Cypripedium parviflorum	Small Yellow Lady's Slipper	LE	3	5/18/2018
Diploperla robusta	Robust Springfly	LE	1	4/2009
Emydoidea blandingii	Blanding's Turtle	LE	2	12/9/2017
Epioblasma rangiana	Northern Riffleshell	LE	5	9/23/2019
Erimystax x-punctatus	Gravel Chub	LT	2	10/16/2020
Etheostoma camurum	Bluebreast Darter	LE	18	10/16/2020
Filipendula rubra	Queen-of-the-prairie	LT	2	7/11/2016
Hemidactylium scutatum	Four-toed Salamander	LT	1	2/21/2017
Hybopsis amblops	Bigeye Chub	LT	16	10/16/2020
Ixobrychus exilis	Least Bittern	LT	2	6/14/2012
Lampsilis fasciola	Wavy-rayed Lampmussel	LE	29	10/2020
Lethenteron appendix	American Brook Lamprey	LT	1	1/23/2001
Monarda clinopodia	White Bergamot	LT	1	7/27/1992
Moxostoma carinatum	River Redhorse	LT	9	10/7/2016
Myotis austroriparius	Southeastern Myotis	LE	2	1996
Myotis septentrionalis	Northern Long-eared Myotis	LT	4	9/2/2014
Myotis sodalis	Indiana Bat	LE	5	7/12/2018
Necturus maculosus	Mudpuppy	LT	2	10/7/2015
Nocomis micropogon	River Chub	LE	2	5/19/2001
Notropis boops	Bigeye Shiner	LE	7	8/20/2020
Noturus stigmosus	Northern Madtom	LE	1	8/1962
Pleurobema clava	Clubshell	LE	7	10/2/2019
Poa languida	Weak Bluegrass	LE	1	5/14/2012
Poa wolfii	Wolf's Bluegrass	LE	2	5/14/2012
Poliocitellus franklinii	Franklin's Ground Squirrel	LT	1	5/23/2009
Ptychobranchus fasciolaris	Kidneyshell	LE	4	9/20/2011
Quadrula metanevra	Monkeyface	LT	10	8/26/2020
Reginaia ebenus	Ebonyshell	LE	1	8/30/2016
Scirpus hattorianus	Bulrush	LE	1	9/10/2012
Silene regia	Royal Catchfly	LE	1	7/16/2015
Simpsonaias ambigua	Salamander Mussel	LE	5	11/2/2016

ENDANGERED / THREATENED SPECIES WITHIN VERMILION COUNTY

DESKTOP STUDY

VERMILION POWER PLANT

NORTH ASH POND AND OLD EAST ASH POND

VERMILION, ILLINOIS

Scientific Name	Common Name	Status	Number of Occurances	Last Observed
Theliderma cylindrica	Rabbitsfoot	LE	5	9/16/2020
Toxolasma lividum	Purple Lilliput	LE	11	9/16/2020
Villosa iris	Rainbow	LE	12	10/2020

[O:LTA 7/26/2021: C: EDP 7/27/21]

Notes:
LE = listed endangered
LT = listed threatened

APPENDIX B
BORING LOGS AND WELL CONSTRUCTION LOGS

FIGURE B-1 BORING AND MONITORING WELL LOCATIONS MAP

BORING LOCATION
BACKGROUND WELL
SOURCE SAMPLE LOCATION
MONITORING WELL
PART 845 REGULATED UNIT (SUBJECT UNIT)
OTHER UNIT
PROPERTY BOUNDARY

0 175 350
Feet

BORING AND MONITORING WELL LOCATION MAP

HYDROGEOLOGIC CHARACTERIZATION REPORT
VERMILION NORTH ASH POND (UNIT ID: 910)
AND OLD EAST ASH POND (UNIT ID: 911)
VERMILION SITE
OAKWOOD, ILLINOIS

FIGURE B-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure X_Borings and Monitoring Well Location Map.mxd

PROJECT: 169000XXXX | DATED: 10/8/2021 | DESIGNER: HOTCALD

GEOSYNTEC BORING AND WELL CONSTRUCTION LOGS

Boring Number B-21-01

Client Dynegy
Project Name Seepage Collection Trench Design
Project Number CHE8404B
Drilling Contractor Cascade
Drilling Equipment GEOPROBE 8140DT
Drilling Method Sonic
Logged By I.Vaught **Checked By** ______

Project Location Vermilion, IL
Date Started 4/28/2021 **Completed** 4/28/2021
Inner/Outer Casing Diamter 4.0"/6.0"
GWL at time of drilling 580.1' **Date/Time** N/A
Ground Elevation 590.1' **Elevation Datum** NAVD88
Coordinates: Northing: 1,281,097.63 **Easting**: 1,148,493.06

Geosyntec consultants
engineers | scientists | innovators

Lithology Elevation	Lithology Depth	Graphic Log	Material Description	Core ID	Recovery/ Attempted (in./in.)	Sample ID	PP (tsf)	Remarks
590			SAND: light grey, few gravel, little silt, dry, top soil					
	1							
	2		CLAY: light brown, some silt, moist, low plasticity, very stiff	1	49/60	0-5	2.5 2.5 3.0	
	3							
	4							
585	5		- changes to dark brown					
	6							
	7			2	33/60	5-10	2.5 3.0 2.0	
	8							
	9							
580	10		SAND: light brown, some silt, silt content increasing with depth, wet					
	11					10-15 A		
	12			3	60/60			
	13						0.5 <0.25 <0.25	
	14		SILT: light brown, grey mottling, wet, medium plasticity, very soft			10-15 B		
575	15		- sand lens from 15.4-15.8'			15-20 A		
	16							
	17		LEAN CLAY: dark brown, little silt, trace gravel, moist, low plasticity, very stiff	4	60/60	15-20 B	3.5 2.5 3.5	
	18							
	19		SAND: dark brown, little gravel, wet, stiff, clay seam at 19.6-19.8' - stiff clay seam at 19.6-19.8'			15-20 C		
570	20		- gravel becomes not present					
	21						>4.0	
	22		LEAN CLAY: dark brown, little silt, little sand, moist, low plasticity, hard - few sand, changes to hard			20-25 A		
	23			5	60/60			
	24		SAND: dark brown, some silt, trace gravel, moist			20-25 B	>4.0	

Boring Number B-21-01

Geosyntec consultants
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Client Dynegy
Project Name Seepage Collection Trench Design
Project Number CHE8404B
Drilling Contractor Cascade
Drilling Equipment GEOPROBE 8140DT
Drilling Method Sonic
Logged By I.Vaught **Checked By** ______

Project Location Vermilion, IL
Date Started 4/28/2021 **Completed** 4/28/2021
Inner/Outer Casing Diamter 4.0"/6.0"
GWL at time of drilling 580.1' **Date/Time** N/A
Ground Elevation 590.1' **Elevation Datum** NAVD88
Coordinates: Northing: 1,281,097.63 **Easting**: 1,148,493.06

Lithology: Elevation	Lithology: Depth	Graphic Log	Material Description	Core ID	Recovery/ Attempted (in./in.)	Sample ID	PP (tsf)	Remarks
565	25		LEAN CLAY: dark brown, little silt, little sand, moist, low plastciity, hard					
	26		SAND: dark brown, wet	6	53/60	25-30		
	27							
	28						>4.0 >4.0 >4.0	
	29		LEAN CLAY: dark brown, some sand, wet, low plasticity, hard, sand seam at 29.8 - 30'					
560	30			7	60/60	30-35 A	-	
	31		- trace gravel, sand seam at 31-31.2'					
	32							
	33		SAND: dark brown, some gravel, wet			30-35 B		
	34							
555	35		LEAN CLAY: dark brown, little sand, little silt, moist, low plasticity, hard	8	60/60	35-40 A	>4.0 >4.0 >4.0	
	36							
	37							
	38		SAND: dark brown, some silt, moist			35-40 B		
	39							EOB 40.0': no refusal. Hole abandoned with one 50lbs bag of bentonite quick grout and 30 gallons of water.Tremie poured.
550	40							

Boring Number B-21-02

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Client Dynegy
Project Name Seepage Collection Trench Design
Project Number CHE8404B
Drilling Contractor Cascade
Drilling Equipment GEOPROBE 8140DT
Drilling Method Sonic
Logged By I.Vaught **Checked By** ______

Project Location Vermilion, IL
Date Started 4/28/2021 **Completed** 4/28/2021
Inner/Outer Casing Diamter 4.0"/6.0"
GWL at time of drilling 573.8' **Date/Time** N/A
Ground Elevation 593.8' **Elevation Datum** NAVD88
Coordinates: Northing: 1,280,997.85 **Easting**: 1,148,580.86

Lithology Elevation	Lithology Depth	Graphic Log	Material Description	Core ID	Recovery/ Attempted (in./in.)	Sample ID	PP (tsf)	Remarks
594	0–2		SAND: dark brown, with little silt, organics, topsoil	1	55/60	0-5		
	2–5		CLAY: orange to light brown, some coarse sand, moist, low plasticity, stiff				2.5 2.5 1.5	
589	5–10		- transitioning to dark brown to black, little silt, hard	2	50/60	5-10	>4.0 >4.0 >4.0	
584	10–11.3		SILT: dark brown to black, some clay, moist, low plasticity	3	55/60	10-15 A	N/A	
	11.3–15		SAND: light brown, some silt, moist			10-15 B		
579	15–18.6		- black clay seam 15-15.6' - little gravel 17.6 - 18.6'	4	55/60	15-20 A	N/A	
	18.6–20		SAND: orange to light borwn, some silt, few gravel, moist			15-20 B		
574	20–20.8		GRAVEL: well graded, orange to light brown, wet	5	60/60	20-25	>4.0 >4.0 >4.0	
	20.8–25		CLAY: dark brown to grey, some coarse sand, moist, low plasticity, hard - sand seam at 22.8' - sand seam at 23.8'					

Boring Number B-21-02

Client Dynegy
Project Name Seepage Collection Trench Design
Project Number CHE8404B
Drilling Contractor Cascade
Drilling Equipment GEOPROBE 8140DT
Drilling Method Sonic
Logged By I.Vaught **Checked By** ______

Project Location Vermilion, IL
Date Started 4/28/2021 **Completed** 4/28/2021
Inner/Outer Casing Diamter 4.0"/6.0"
GWL at time of drilling 573.8' **Date/Time** N/A
Ground Elevation 593.8' **Elevation Datum** NAVD88
Coordinates: Northing: 1,280,997.85 **Easting**: 1,148,580.86

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Lithology Elevation	Lithology Depth	Graphic Log	Material Description	Core ID	Recovery/ Attempted (in./in.)	Sample ID	PP (tsf)	Remarks
569	25		SAND: orange to light brown, little gravel, wet	6	57/60	25-30 A		
	26							
	27							
	28		LEAN CLAY: dark brown to grey, some sand, moist, low plasticity, hard					
	29					25-30 B	>4.0 >4.0 >4.0	
564	30							
	31		- sand seam at 31.1'	7	60/60	30-35	N/A	
	32							
	33		SAND: dark brown to grey, little silt, little gravel, wet					
	34							
559	35			8	51/60	35-40 A	N/A	
	36							
	37							
	38							
	39		SAND: dark brown to grey, poorly graded, wet			35-40 B		
554	40			9	60/60	40-45	>4.0 >4.0 >4.0	EOB 45.0'. Hole abandoned with one 50lbs of bentonite grout and 30 gallons of water. Tremie poured.
	41		- silt seam at 41.5 - 41.7'					
	42							
	43		LEAN CLAY: dark brown to grey, little silt, moist, low plasticity, hard					
	44							
549	45							

PRELIMINARY

Boring Number B-21-03

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Client Dynegy
Project Name Seepage Collection Trench Design
Project Number CHE8404B
Drilling Contractor Cascade
Drilling Equipment GEOPROBE 8140DT
Drilling Method Sonic
Logged By I.Vaught **Checked By** ______

Project Location Vermilion, IL
Date Started 4/28/2021 **Completed** 4/28/2021
Inner/Outer Casing Diameter 4.0"/6.0"
GWL at time of drilling 578.9' **Date/Time** N/A
Ground Elevation 592.2' **Elevation Datum** NAVD88
Coordinates: Northing: 1,280,898.69 **Easting**: 1,148,793.77

Lithology: Elevation	Lithology: Depth	Graphic Log	Material Description	Core ID	Recovery/ Attempted (in./in.)	Sample ID	PP (tsf)	Remarks
592	0–2		SAND: light grey, with some silt, dry	1	50/60	0-5A		
	2–7.5		LEAN CLAY: dark brown, little silt, moist, low plasticity, stiff - trace gravel (5)			0-5B	1.0 2.0 1.5	
587	5			2	60/60	5-10	1.25 0.75 0.75	
	7.5–13.3		LEAN CLAY: brown, with sand, moist, low plasticity, medium stiffness					
582	10			3	52/60	10-15 A	0.5 0.5	
	13.3–14		LEAN CLAY: light brown, with sand, wet, low plasticity, soft					
	14–15		SAND: orange brown, with clay, wet			10-15 B		
577	15–17.6		FAT CLAY: dark brown, some silt, trave gravel, moist, high plasticity, stiff	4	40/60	15-20 A	1.5 1.5 >4.0	
	17.6–21.6		SAND: dark brown, wet			15-20 B		
572	20			5	60/60	20-25	1.5 2.0 3.5	
	21.6–24		LEAN CLAY: dark brown, with sand, few silt, low plasticity, very stiff					

PRELIMINARY

Boring Number B-21-03

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Client Dynegy
Project Name Seepage Collection Trench Design
Project Number CHE8404B
Drilling Contractor Cascade
Drilling Equipment GEOPROBE 8140DT
Drilling Method Sonic
Logged By I.Vaught **Checked By** ______

Project Location Vermilion, IL
Date Started 4/28/2021 **Completed** 4/28/2021
Inner/Outer Casing Diameter 4.0"/6.0"
GWL at time of drilling 578.9' **Date/Time** N/A
Ground Elevation 592.2' **Elevation Datum** NAVD88
Coordinates: Northing: 1,280,898.69 **Easting**: 1,148,793.77

Lithology: Elevation	Lithology: Depth	Graphic Log	Material Description	Core ID	Recovery/ Attempted (in./in.)	Sample ID	PP (tsf)	Remarks
567	25–26		- few sand, changes to hard	6	58/60		>4.0 >4.0 >4.0	
	26–27		SAND: dark brown, trace gravel, wet			25-30 A		
	28		LEAN CLAY: dark brown, little sand, trace gravel, trace silt, moist, low plasticity, very stiff			25-30 B	>4.0 >4.0 3.5	
	29							
562	30		- few sands, few silts, hard sand seam at 31.8'	7	57/60	30-35	>4.0 >4.0 >4.0	
	31–34		- 33.4-34.0' clay with sand lenses					
557	35–39		- sand seams at 36.6' and 38.5'	8	60/60	35-40	>4.0	
552	40–45			9	60/60	40-45	>4.0	
547	45							EOB: 45.0', no refusal. Hole abandoned with one 50lbs bag of bentonite quick grout and 30 gallons of water. Tremie poured.

Boring Number B-21-04

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Client Dynegy
Project Name Seepage Collection Trench Design
Project Number CHE8404B
Drilling Contractor Cascade
Drilling Equipment GEOPROBE 8140DT
Drilling Method Sonic
Logged By I.Vaught **Checked By** ______

Project Location Vermilion, IL
Date Started 4/27/2021 **Completed** 4/27/2021
Inner/Outer Casing Diamter 4.0"/6.0"
GWL at time of drilling N/A **Date/Time** N/A
Ground Elevation 584.8' **Elevation Datum** NAVD88
Coordinates: Northing: 1,280,835.79 **Easting**: 1,149,363.88

Elevation	Depth	Graphic Log	Material Description	Core ID	Recovery/ Attempted (in./in.)	Sample ID	PP (tsf)	Remarks
584	1–4		LEAN CLAY: light brown, few silts, some cobbles (0-12"), dry, low plastcity, very stiff	1	20/60	0-5	2.0 2.75	
579	5–7		FAT CLAY: dark brown, trace sand, trace silt, wet (not natural) high plasticity, stiff	2	51/60	5-10A	1.5 2.0 2.5	
	8–10		SAND: orange brown, little clay, wet - some coarse gravel			5-10B		
574	11–15		LEAN CLAY: dark brown, some silt, moist, low plasticity, very stiff	3	60/60	10-15	3.5 3.5 3.5	
569	16–18		- trace coarse sand/ fine gravel	4	63/50	15-20 A	2.0 2.5 3.5	
	19–20		- sand disapperas			15-20 B	1.5 2.0	
564	21–22		LEAN CLAY: dark brown, trace sand, trace fine gravel, moist, medium plasticity, hard					

PRELIMINARY

Boring Number B-21-04

Client Dynegy
Project Name Seepage Collection Trench Design
Project Number CHE8404B
Drilling Contractor Cascade
Drilling Equipment GEOPROBE 8140DT
Drilling Method Sonic
Logged By I.Vaught **Checked By** ______

Project Location Vermilion, IL
Date Started 4/27/2021 **Completed** 4/27/2021
Inner/Outer Casing Diamter 4.0"/6.0"
GWL at time of drilling N/A **Date/Time** N/A
Ground Elevation 584.8' **Elevation Datum** NAVD88
Coordinates: Northing: 1,280,835.79 **Easting**: 1,149,363.88

Geosyntec consultants
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Lithology: Elevation	Lithology: Depth	Graphic Log	Material Description	Core ID	Recovery/ Attempted (in./in.)	Sample ID	PP (tsf)	Remarks
	22			5	60/60	20-25	>4.0 >4.0	
	23							
	24							
	25		- little silt	6	60/60	25-30 A		
559	26							
	27		SAND: dark brown, little silt, wet			25-30 B		
	28		FAT CLAY: dark brown, moist, high plasticity, very stiff				3.0 3.0 3.5	
	29					25-30 C		
	30		- grey, black and green mottling, trace coarse sand	7	60/60	30-35	2.5 3.0 3.0	
554	31							
	32							
	33							
	34							
	35			8	60/60	35-40	N/A	
549	36							
	37		LEAN CLAY: grey, trace silt, dry, low plasticity, brittle, locally lithified					
	38							
	39							
	40							EOB: 40.0', no refusal. Hole abandoned with one 50lbs bag of bentonite quick grout and 30 gallons of water. Tremie poured.

Boring Number B-21-05

Client Dynegy
Project Name Seepage Collection Trench Design
Project Number CHE8404B
Drilling Contractor Cascade
Drilling Equipment GEOPROBE 8140DT
Drilling Method Sonic
Logged By I.Vaught **Checked By** ______

Project Location Vermilion, IL
Date Started 4/27/2021 **Completed** 4/27/2021
Inner/Outer Casing Diamter 4.0"/6.0"
GWL at time of drilling N/A **Date/Time** N/A
Ground Elevation 581.4 **Elevation Datum** NAVD88
Coordinates: Northing: 1,280,836.00 **Easting**: 1,149,456.09

Geosyntec consultants
engineers | scientists | innovators

Lithology Elevation	Lithology Depth	Graphic Log	Material Description	Core ID	Recovery/ Attempted (in./in.)	Sample ID	PP (tsf)	Remarks
581	0		SILT: brown, some sand, trace organics, moist, very soft	1	52/60	0-5A	0.25 <0.25	
	2		FAT CLAY: brown, some sand, few silt, high plasticity, very stiff			0-5B	3.0 3.5 3.5	
576	5			2	52/60			
	6.5		SAND: light brown, some clay, few coarse gravel, wet			5-10A		
	7.5		LEAN CLAY: light brown, few coarse gravel, low plasticity, very stiff			5-10B	2.0 2.5 2.25	
571	10		- transition to brownish grey, few sand; hard, 10-10.5' sand seam	3	60/60	10-15	>4.0 >4.0 >4.0	
566	15		- with sand	4	58/60	15-20 A	>4.0 3.5 4.0	
	19		SAND: dark brown, moist, fine grained			15-20 B		
561	20		LEAN CLAY: dark brown, black and bown mottling, trace gravel, medium plasticity, hard			20-25 A	4.0 >4.0 >4.0	

PRELIMINARY

Boring Number B-21-05

Client Dynegy
Project Name Seepage Collection Trench Design
Project Number CHE8404B
Drilling Contractor Cascade
Drilling Equipment GEOPROBE 8140DT
Drilling Method Sonic
Logged By I.Vaught **Checked By** ______

Project Location Vermilion, IL
Date Started 4/27/2021 **Completed** 4/27/2021
Inner/Outer Casing Diamter 4.0"/6.0"
GWL at time of drilling N/A **Date/Time** N/A
Ground Elevation 581.4 **Elevation Datum** NAVD88
Coordinates: Northing: 1,280,836.00 **Easting**: 1,149,456.09

Geosyntec consultants
engineers | scientists | innovators

Lithology: Elevation	Lithology: Depth	Graphic Log	Material Description	Core ID	Recovery/ Attempted (in./in.)	Sample ID	PP (tsf)	Remarks
	22							
			SAND: dark brown, wet	5	60/60	20-25 B		
	23–24		CLAY: dark brown, some sand, trace fine gravel, wet, low plasticity, very stiff/hard			20-25 C	3.5 >4.0 >4.0	
556	25–29		- blueish gray, no constituents - 28.2-28.8' few sand	6	57/60	25-30 A 25-30 B	>4.0 >4.0 >4.0	
551	30–33		SAND: dark brown, saturated - 31.75' transition to little gravel, wet	7	58/60	30-35 A 30-35 B	N/A	
	34		LEAN CLAY: grey, trace silt, dry, low plasticity, brittle, locally lithified					
546	35–39			8	60/60	35-40	N/A	
541	40							EOB: 40.0', no refusal. Hole abandoned with one 50lbs bag of bentonite quick grout and 30 gallons of water. Hose poured.

PRELIMINARY

Geosyntec consultants

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Client:	**Dynegy**
Project:	**CHE8404B, Vermilion MNA**
Address:	**9878 E 2150 North Rd, Danville, IL**

WELL LOG

Well No. **MW-07R**

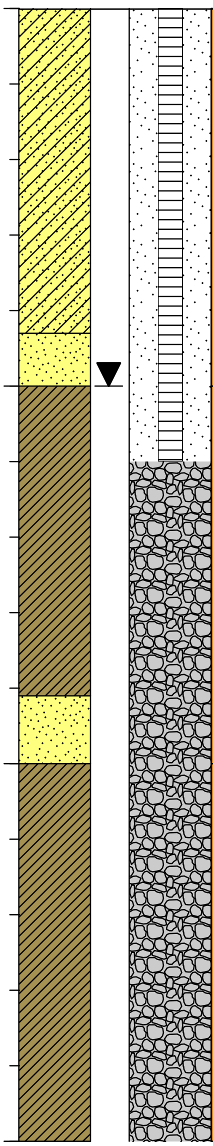
Drilling Start Date:	**04/27/2021**	Boring Depth (ft):	**40**	Well Depth (ft):	**21**
Drilling End Date:	**04/27/2021**	Boring Diameter (in):		Well Diameter (in):	**1**
Drilling Company:	**Cascade Drilling**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Sonic**	DTW After Drilling (ft):	**20**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**Geoprobe 8140 DT**	Top of Casing Elev. (ft)		Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Russ Gordon**	Ground Elev. (ft):		Seal Material(s):	**NA**
Logged By:	**Amanda Toye**	Northing, Easting (NAD83):		Filter Pack:	**Sand**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
0				DP	44/60			(0') No Recovery.		0
								(1.33') GRAVELLY SAND (SP); light gray, dry, fine to coarse grained.		
								(3') CLAYEY SILT (ML); burnt orange with gray and black mottling, ash throughout, trace gravel, moist.		
5				DP	19/60			(5') No Recovery.		5
								(8.4') CLAYEY SILT (ML); brown, trace gravel and sand, higher clay content at toe, moist.		
10				DP				(10') No Recovery.		10
								(11') CLAYEY SAND (SC); brown, damp.	SB-21-07R-(12-14)	
								(13') SAND WITH GRAVEL (SP); reddish brown to light gray, moist, fine to coarse grained.		
15										15

NOTES:

Geosyntec consultants	Client: Dynegy	**WELL LOG**
engineers | scientists | innovators	Project: **CHE8404B, Vermilion MNA**	Well No. **MW-07R**
	Address: **9878 E 2150 North Rd, Danville, IL**	

Drilling Start Date:	**04/27/2021**	Boring Depth (ft):	**40**	Well Depth (ft):	**21**
Drilling End Date:	**04/27/2021**	Boring Diameter (in):		Well Diameter (in):	**1**
Drilling Company:	**Cascade Drilling**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Sonic**	DTW After Drilling (ft):	**20**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**Geoprobe 8140 DT**	Top of Casing Elev. (ft)		Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Russ Gordon**	Ground Elev. (ft):		Seal Material(s):	**NA**
Logged By:	**Amanda Toye**	Northing, Easting (NAD83):		Filter Pack:	**Sand**



DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample	DEPTH (ft)
15	DP	60/60			(15') CLAYEY SAND (SC); gray, wood at 19", moist, fine grained.		15
					(19.3') SAND (SP); gray, saturated, fine grained.		
20	DP	60/60			(20') CLAY WITH SAND (CL); gray, trace fine gravel, saturated, medium plasticity.		20
					(24.1') SAND (SP); gray, saturated, fine grained.		
25	DP	60/60			(25') SILTY CLAY WITH SAND (CL); gray, sand seams present, trace gravel, moist.		25
30							30

NOTES:

Geosyntec consultants

engineers | scientists | innovators

Client:	**Dynegy**
Project:	**CHE8404B, Vermilion MNA**
Address:	**9878 E 2150 North Rd, Danville, IL**

WELL LOG

Well No. **MW-07R**

Drilling Start Date:	**04/27/2021**	Boring Depth (ft):	**40**	Well Depth (ft):	**21**
Drilling End Date:	**04/27/2021**	Boring Diameter (in):		Well Diameter (in):	**1**
Drilling Company:	**Cascade Drilling**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Sonic**	DTW After Drilling (ft):	**20**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**Geoprobe 8140 DT**	Top of Casing Elev. (ft)		Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Russ Gordon**	Ground Elev. (ft):		Seal Material(s):	**NA**
Logged By:	**Amanda Toye**	Northing, Easting (NAD83):		Filter Pack:	**Sand**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
30				DP	60/60			(30') SAND WITH CLAY (SP); gray, moist, fine grained.	SB-21-07R-(30-31)	30
								(31') SILTY CLAY WITH SAND (CL); gray, trace fine to coarse gravel, moist.		
35				DP	60/60			(35') As above: higher sand content.		35
								(39.3') SAND (SP); gray, some clay, saturated, fine grained.		
40								(40') End of Boring.		40
45										45

NOTES:

MONITORING WELL CONSTRUCTION DETAIL

Geosyntec consultants

1420 Kensington Rd., Suite 103
Oak Brook, Illinois 60523
(630) 203-3340

Well ID: MW-07R
Site Location: Vermillion, IL
Project Name: Vermillion Power Station
Field Personnel: A Toye, I Vaught, D Mateas
Project Number: CHE8404B
Recorded By: A Toye

Permit Number: ____
Installation Date(s): 4-27-2021
Drilling Method: Sonic
Borehole Diameter: 6.00"
Drilling Contractor: Cascade
Driller: Russ Gordon
Drilling Fluid: N/A
Fluid Loss During Drilling: N/A Gallons

Materials Used

Riser Pipe: Diameter 2 inches
Construction
☑ PVC schedule 40
☐ Stainless Steel
☐ Other ____

Slotted Area: Length 10 feet
Diameter 2 inches
Slot Size .010 inches
Construction
☑ PVC schedule ____
☐ Stainless Steel
☐ Other ____
Silt Trap Used ☐ Yes ☐ No

Bottom End Cap: ☐ Male ☐ Female ☐ Slip
☑ PVC
☐ Stainless Steel
☐ Other ____

Top Cap: ☐ Male ☐ Female ☐ Slip ☑ J Plug
☐ PVC
☐ Stainless Steel
☐ Other ____

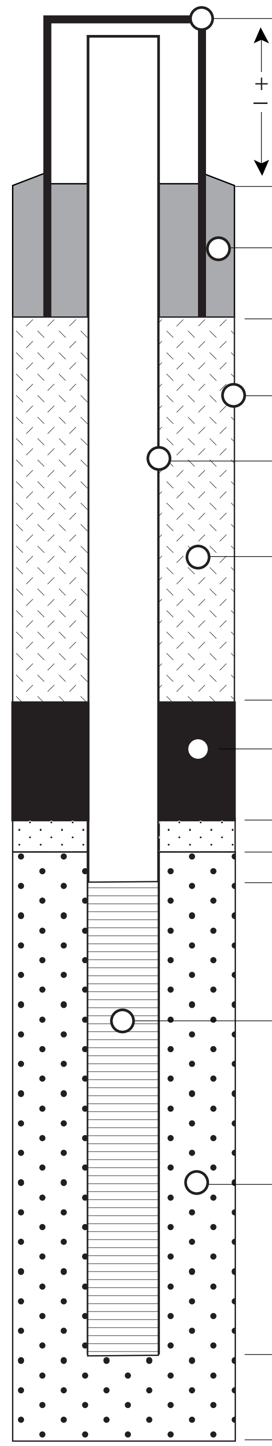
Protective Casing: Length 5 feet
Diameter 4x4 inches
Construction ☐ Cast Aluminum
☑ Cast Steel
☐ Other ____

Casing Installation: Length 24 feet
Diameter 4 inches
Material PVC

Sandpack: Global Drilling Suppliers Inc.
Coarse Sand: __ bags of __ lb per bag Size ____
Fine Sand: 4 bags of 50 lb per bag Size ____

Seal:
Bentonite Pellets: 2 bags of 50 lb per bag Type Bentonite Plug
Bentonite Slurry: __ bags of __ lb per bag Type ____

Grout:
Cement: __ bags of __ lb per bag Type ____
Bentonite: __ bags of __ lb per bag Type ____



☑ above ground protective casing
☐ flush mount protective casing
☐ other ____

+/− 36 ____ inches

ground surface elevation ____
☐ surveyed ☐ estimated

☐ surface seal backfill
☐ surface seal grout

____ feet*

drilled hole 6 inches diameter

well casing 2 inches diameter

☐ backfill
☐ grout ____
☐ density of grout ____

____ feet*

☐ bentonite slurry
☑ bentonite pellets

____ feet*
9 feet*
11 feet*

well screen 2 inches diameter
.010 slot

☐ gravel pack
☑ sand pack
☐ formation collapse

21 feet*

21 feet*

Measuring Point is Top of Well Casing
Unless Otherwise Noted

* Depth Below Ground Surface

RAMBOLL BORING AND WELL CONSTRUCTION LOGS

RAMBOLL

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Plant		36

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Russ Gordon Cascade Drilling	3/3/2021	3/3/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
36	Feet (NAVD88)	587.82 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,281,167.78 N, 1,148,445.57 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R

Lat ° ' "
Long ° ' "

Local Grid Location
Feet ☐N ☐S Feet ☐E ☐W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 28.8		0–1	0 - 1.4' **SANDY LEAN CLAY:** s(CL), dark gray (10YR 4/1), gravel (5-15%), low plasticity, soft, moist.	s(CL)				0.25					CS= Core Sample
			1.4–5	1.4 - 10' **SILTY CLAY:** CL/ML, brown (10YR 5/3), fine to coarse gravel (0-5%), sand (0-5%), low plasticity, hard.					4.5					
2 CS	60 24		5–10	5' grayish brown (10YR 5/2), medium plasticity, soft, moist.	CL/ML				0.5					
3 CS	60 24		10–12	10 - 17' **SILTY SAND:** to **SANDY SILT:** SM, grayish brown (10YR 5/2), clay (5-15%), sand, moist.	SM									

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

Signature: Sft Wb

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

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
4 CS	60 60		13, 14, 15, 16	10 - 17' **SILTY SAND: to SANDY SILT:** SM, grayish brown (10YR 5/2), clay (5-15%), sand, moist. *(continued)* 15' wet.	SM									
			17	17 - 17.9' **POORLY-GRADED SAND:** SP, gray (10YR 5/1), fine sand, silt (5-15%), wet.	SP									
			18, 19	17.9 - 20' **WELL-GRADED SAND WITH GRAVEL:** (SW)g, grayish brown (10YR 5/2), silt (0-5%), wet. 19.8' layer of cobbles.	(SW)g									
5 CS	24 24		20, 21, 22	20 - 22' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), fine to medium sand (5-15%), gravel (5-15%), low plasticity, hard.	CL/ML				4.5					
				22' End of Boring.										

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Plant		37

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Russ Gordon Cascade Drilling	3/3/2021	3/3/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
37	Feet (NAVD88)	587.84 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐		Local Grid Location
State Plane 1,281,164.76 N, 1,148,447.89 E Ⓔ/ W	Lat ° ' "	☐ N ☐ E
1/4 of 1/4 of Section , T N, R	Long ° ' "	Feet ☐ S Feet ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 60		0 - 2.8	0 - 2.8' **SANDY LEAN CLAY:** s(CL), dark gray (10YR 4/1), gravel (5-15%), low plasticity, soft to firm, moist. 1 - 1.5' boulder.	s(CL)				0.5 0.75					CS= Core Sample
			2.8 - 5	2.8 - 5' **SILT WITH SAND:** (ML)s, dark brown (10YR 3/3), clay (0-5%), gravel (0-5%), moist.	(ML)s									
2 SH	24 24		5 - 7	5 - 7' **SANDY LEAN CLAY:** s(CL), dark brown (10YR 3/3), medium plasticity, moist.	s(CL)					19.3	27	10	61	SH= Shelby Tube
3 CS	36 36		7 - 10	7 - 10' **SANDY LEAN CLAY:** s(CL), brown (10YR 5/3), fine sand, low plasticity, soft, moist.	s(CL)				0.25					

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 Street, Milwaukee,WI 53204
Tel: (414) 837-3607
Fax: (414) 837-3608

Boring Number 37

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
4 CS	96 96		10–12.4	10 - 12.4' **SILTY SAND:** SM, brown (10YR 5/3), fine sand, clay (5-15%), wet.	SM									
			12.4–14.8	12.4 - 14.8' **SANDY LEAN CLAY:** s(CL), brown (10YR 5/3), medium plasticity, very soft, moist to wet.	s(CL)				0.25					
			14.8–16.2	14.8 - 16.2' **SILT WITH SAND:** (ML)s, gray (10YR 5/1), wet.	(ML)s									
			16.2–18.5	16.2 - 18.5' **WELL-GRADED SAND WITH GRAVEL:** (SW)g, grayish brown (10YR 5/2), silt (0-5%), wet.	(SW)g									
5 MC	24 24		18.5–19	18.5 - 19' **CLAYEY SAND:** SC, gray clayey sand, gravel (5-15%), clay (15-25%), low plasticity.	SC					3.1	19	8	41	MC= Modified California
			19–20	19 - 20' **SILTY CLAY:** CL/ML.	CL/ML									
6 CS	60 60		20–23.6	20 - 23.6' **SILTY CLAY:** CL/ML, gray (10YR 5/1), gravel (0-5%), sand (0-5%), low plasticity, hard.	CL/ML				4.5					
			23.6–25	23.6 - 25' **SILTY SAND:** SM, dark gray (10YR 4/1), fine sand, wet.	SM									
7 SH	24 24		25–27	25 - 27' **POORLY-GRADED SAND WITH SILT:** SP-SM, grayish brown (10YR /2), gravel (0-5%), clay (0-5%), medium plasticity.	SP-SM					17.7	9		11	

Boring Number 37

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
8 CS	36 36		27.0	27 - 28' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), gravel (0-5%), sand (0-5%), low plasticity, hard.	CL/ML				4.5					
9 CS	60 60		28.0	28 - 32.5' **WELL-GRADED SAND WITH GRAVEL:** (SW)g, dark gray (10YR 4/1), clay (0-5%), silt (0-5%), wet.	(SW)g									
			32.5	32.5 - 35.5' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), gravel (0-5%), sand (0-5%), low plasticity, hard.	CL/ML									
10 MC	24 24		35.5	35.5 - 36' **CLAYEY SAND:** SC, gray (10YR 5/1), gravel (0-5%), clay (15-25%), medium plasticity.	SC					9.9	17	6	48	
11 CS	96 96		36.0	36 - 37.9' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), gravel (0-5%), sand (0-5%), low plasticity, hard.	CL/ML									
			37.9	37.9 - 42.1' **WELL-GRADED SAND WITH GRAVEL:** (SW)g, dark gray (10YR 4/1), clay (0-5%), silt (0-5%), wet.	(SW)g									
			42.1	42.1 - 46.4' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), gravel (5-15%), low plasticity, hard.	CL/ML				4.5					

Depth scale: 27.0, 27.5, 28.0, 28.5, 29.0, 29.5, 30.0, 30.5, 31.0, 31.5, 32.0, 32.5, 33.0, 33.5, 34.0, 34.5, 35.0, 35.5, 36.0, 36.5, 37.0, 37.5, 38.0, 38.5, 39.0, 39.5, 40.0, 40.5, 41.0, 41.5, 42.0, 42.5, 43.0

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
12 CS	60 60		43.5–46.4	42.1 - 46.4' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), gravel (5-15%), low plasticity, hard. *(continued)*	CL/ML									
			46.4–50.0	46.4 - 50' **POORLY-GRADED SAND WITH SILT:** SP-SM, dark gray (10YR 4/1), fine sand, moist to wet.	SP-SM									
13 MC	24 24		50.0–51.0	50 - 51' **POORLY-GRADED SAND WITH CLAY:** SW-SC, grayish brown (10YR 5/2), clay (0-5%), low plasticity.	SW-SC					17.7	13	6	7	
			51.0–52.0	51 - 52' **POORLY-GRADED SAND WITH SILT:** SP-SM, dark gray (10YR 4/1), fine sand, moist to wet.	SP-SM									
14 CS	36 36		52.0–54.3	52 - 54.3' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), fine to coarse gravel (5-10%), low plasticity, hard.	CL/ML				4.5					
			54.3–55.0	54.3 - 55' **LEAN CLAY:** CL, very dark gray (10YR 3/1), silt (15-25%), gravel (0-5%), medium plasticity, soft, moist.	CL									
15 SH	24 24		55.0–57.0	55 - 57' **LEAN CLAY:** CL, gray (10YR 5/1), sand (0-5%), high plasticity, hard, moist.	CL					23.8	31	13	98	
16 CS	60 60		57.0–60.0	57 - 62' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1), low to medium plasticity, hard, moist.	CL				4					
			59.0						4					

Boring Number 37

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
			60.5 61.0 61.5 62.0	57 - 62' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1), low to medium plasticity, hard, moist. *(continued)*	CL				4					
				62' End of Boring.										

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number	
Vermilion Power Plant		38	
Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jason Greer Cascade Drilling	3/2/2021	3/2/2021	Mini Sonic
Common Well Name: 38	Final Static Water Level: Feet (NAVD88)	Surface Elevation: 589.14 Feet (NAVD88)	Borehole Diameter: 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,283,326.04 N, 1,148,648.68 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location ☐ N ☐ S Feet ☐ E ☐ W Feet

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 49		1.5, 3.0, 4.5	0 - 5' **LEAN CLAY:** CL, very dark grayish brown (10YR 3/2), silt (15-25%), organic material (5-10%), stiff, slow dilatancy, low toughness, medium plasticity, moist.	CL				1.75					CS= Core Sample
2 CS	60 51		6.0, 7.5	5 - 8.2' **SANDY SILT:** s(ML), gray (10YR 5/1) and yellowish brown (10YR 5/6), rapid dilatancy, low toughness, non-plastic, moist to wet.	s(ML)				1.75					
3 CS	60 60		9.0, 10.5, 12.0, 13.5	8.2 - 15' **WELL-GRADED SAND WITH GRAVEL:** (SW)g, dark gray (10YR 4/1) to gray (10YR 5/1), subrounded to subangular, medium to coarse sand, loose, wet. 14' cobbles (0-5%).	(SW)g									Attempted Modified California Sample 10'-12' below ground surface (bgs) with no recovery
4 CS	60 60		15.0	15 - 15.4' **POORLY-GRADED GRAVEL:** GP, coarse gravel, cobbles.	GP				2.25					
			16.5, 18.0	15.4 - 18.2' **LEAN CLAY:** CL, dark gray (10YR 4/1) to gray (10YR 5/1), sand (5-15%), gravel (0-5%), stiff, no dilatancy, low toughness, medium plasticity, moist.	CL				2.25					

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 Street, Milwaukee,WI 53204
Tel: (414) 837-3607
Fax: (414) 837-3608

Template: RAMBOLL_IL_BORING LOG - Project: 845_VERMILION_2021 (2).GPJ

Boring Number 38

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			19.5	18.2 - 23.7' **POORLY-GRADED SAND:** SP, dark gray (10YR 4/1) to gray (10YR 5/1), subrounded to rounded, fine to medium sand, loose, wet.	SP									
5 CS	60 60		21.0											Attempted Modified California Sample 20'-22' bgs with no recovery
			22.5											
			24.0	23.7 - 30.2' **POORLY-GRADED SAND:** SP, gray (10YR 5/1), rounded to subrounded, fine sand, gravel (0-5%), loose, wet.	SP									
6 CS	60 60		25.5											Attempted Modified California Sample 25'-27' bgs with no recovery
			27.0											
			28.5											
7 CS	60 60		30.0	30.2 - 35' **LEAN CLAY:** CL, gray (10YR 5/1), sand (0-5%), gravel (0-5%), stiff, no dilatancy, low to medium toughness, medium plasticity, moist.	CL				1.5					
			31.5											
			33.0						1.5					
			34.5											
8 SH	24 24		36.0	35 - 37' **LEAN CLAY:** CL, gray (10YR 5/1), sand (30-45%), gravel (0-5%), medium plasticity, moist.	CL				2.5	12.6	21	9	61	SH= Shelby Tube
				37' End of Boring.										

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Plant		41

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Russ Gordon Cascade Drilling	3/4/2021	3/4/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
41	Feet (NAVD88)	585.07 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,282,007.83 N, 1,148,555.77 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location: Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 60		0	0 - 0.1' **TOPSOIL:**.										CS= Core Sample
				0.1 - 2' **WELL-GRADED GRAVEL WITH CLAY AND SAND:** (GW-GC)s, very pale brown (10YR 7/3), fine to coarse gravel, moist.	(GW-GC)s									
			2	2 - 2.5' **SANDY LEAN CLAY:** s(CL), dark yellowish brown (10YR 4/4), moist.	s(CL)									
				2.5 - 5.2' **POORLY-GRADED SAND:** SP, dark yellowish brown (10YR 4/6), fine to medium sand, moist.	SP									
2 CS	36 36		5.2	5.2 - 6.7' **WELL-GRADED SAND WITH GRAVEL:** (SW)g, yellowish brown (10YR 5/6), subrounded, clay (0-10%), wet.	(SW)g									
			6.7	6.7 - 8' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (5-15%), gravel (5-15%), medium plasticity, very stiff, moist.	CL				2.5					
3 SH	24 24		8	8 - 10' **LEAN CLAY:** CL.	CL					12.8	23	11	55	SH= Shelby Tube
4 CS	60 60		10	10 - 14' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (5-15%), gravel (5-15%), medium plasticity, very stiff, moist.	CL				3					

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

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

Boring Number 41

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			13	10 - 14' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (5-15%), gravel (5-15%), medium plasticity, very stiff, moist. *(continued)*	CL				3					
5 MC	24 24		14, 15, 16	14 - 17' **LEAN CLAY WITH SAND:** (CL)s, dark gray, (10YR 4/1), silt (5-15%), gravel (5-15%), medium plasticity, very stiff, moist.	(CL)s				3					MC= Modified California
6 CS 7 CS	36 36 60 60		17, 18, 19, 20, 21, 22, 23	17 - 24' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (5-15%), gravel (5-15%), medium plasticity, very stiff, moist.	CL				2 2.5 3.5 2					
8 MC	24 24		24, 25, 26	24 - 26.5' **POORLY-GRADED SAND:** SP, gray (10 YR 5/1), fine sand, clay (5-10%), moist.	SP									
				26.5 - 27' **LEAN CLAY:** CL, gray.	CL									
9 CS	36 36		27	27 - 28' **CLAYEY SAND:** SC, gray (10YR 5/1), fine to medium sand, gravel (0-5%), wet.	SC					16	13	9	4	
			28, 29	28 - 29.8' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (5-15%), gravel (5-15%), medium plasticity, hard, moist.	CL				4.5					
10 CS	60 60		30	29.8 - 31' **WELL-GRADED GRAVEL WITH SAND:** (GW)s, gray (10YR 5/1), subrounded, coarse sand, loose, wet.	(GW)s									
			31, 32	31 - 34' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (5-15%), gravel (5-15%), medium plasticity, hard, moist.	CL				4.5					

SOIL BORING LOG INFORMATION SUPPLEMENT

RAMBOLL

Boring Number 41

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	31 - 34' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (5-15%), gravel (5-15%), medium plasticity, hard, moist. *(continued)*	CL				4.5					
			34	34 - 35' **SANDY LEAN CLAY:** s(CL), gray (10YR 5/1), fine sand, low plasticity, stiff, moist.	s(CL)				1					
11 SH	24 24		35	35 - 37' **SILTY CLAY:** CL/ML, gray (10YR 5/1), gravel (0-5%), clay (15-25%), low plasticity, stiff, moist.	CL/ML					12.3	20	6	56	
			36											
			37	37' End of Boring.										

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SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Plant		42

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Dave Gordon Cascade Drilling	3/7/2021	3/7/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
42	Feet (NAVD88)	605.41 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,281,034.19 N, 1,147,692.64 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location: Feet ☐N ☐S Feet ☐E ☐W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample: Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	120 84		0–8.5	0 - 8.5' **FILL, SILTY SAND:** SM, dark gray (10YR 4/1), very soft, wet.	(FILL) SM									7-inch override casing drilled down to 10' below ground surface (bgs) CS= Core Sample
			8.5	8.5 - 12.4' **LEAN CLAY:** CL, very dark gray (10YR 3/1), gravel (5-15%), medium plasticity, hard, wet.	CL				0.5					
2 CS	120 120		10	10' dark grayish brown (10YR 4/2), hard, moist.					4.5					
			12.2	12.2' -12.4 layer of sand, yellowish brown (10YR 5/4), medium to coarse sand, loose, moist.										
			12.4	12.4 - 47.8' **LEAN CLAY:** CL, dark grayish brown (10YR 4/2), gravel (5-15%), low plasticity, hard, moist.	CL				4.5					

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

Signature: [signature]

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

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			15	12.4 - 47.8' **LEAN CLAY:** CL, dark grayish brown (10YR 4/2), gravel (5-15%), low plasticity, hard, moist. *(continued)* 15' dark gray (10YR 4/1).					3.5					
			17						4.5					
3 CS	120 120		20											
			21						4					
			23						4					
			24	24' silt (5-15%), firm to stiff.										
			25						2					
			26		CL									
			27						1					
			29						1.5					
4 CS	120 120		30											
			31						1.5					
			33						1					
			35						2					
			37						1.5					

Boring Number 42

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
5 CS	120 120		38–48	12.4 - 47.8' **LEAN CLAY:** CL, dark grayish brown (10YR 4/2), gravel (5-15%), low plasticity, hard, moist. *(continued)* 44.4' sand (5-15%).	CL				0.5 0.5 0.5 0.5					
6 CS	120 120		48–55.4	47.8 - 55.4' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), gravel (5-15%), medium plasticity firm to hard, moist. 52.5' -52.7 layer of sand, dark gray (10YR 4/1), medium sand, moist to wet.	CL/ML				1.5 1.5 0.5 4.5					
			55.4–56	55.4 - 56' **POORLY-GRADED GRAVEL WITH SAND:** (GP)s, dark gray (10YR 4/1), subangular, fine gravel, sand (5-15%), wet.	(GP)s									
			56–60	56 - 60' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), fine gravel (5-15%), low plasticity, hard, moist.	CL/ML				4.5 4.5					
			60	60' End of Boring.										

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SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number	
Vermilion Power Plant		43	
Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Russ Gordon Cascade Drilling	3/7/2021	3/7/2021	Mini Sonic
Common Well Name: 43	Final Static Water Level: Feet (NAVD88)	Surface Elevation: 605.30 Feet (NAVD88)	Borehole Diameter: 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,281,796.23 N, 1,147,229.11 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location ☐ N ☐ S Feet ☐ E ☐ W Feet

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

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	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 36			0 - 0.9' **LEAN CLAY:** CL, grayish brown (10YR 5/2), silt (20-30%), roots (0-5%), low plasticity, stiff, moist.	CL									CS= Core Sample
			1.5	0.9 - 2.1' **FILL, SILTY CLAY:** CL/ML, brown (10YR 5/3), low plasticity, hard, dry.	(FILL) CL/ML				4.5					
			3.0	2.1 - 4' **FILL, LEAN CLAY:** CL, dark gray (10YR 4/1), silt (15-25%), medium plasticity, stiff, moist. 2.4' - 2.7' large root.	(FILL) CL				1.5					
			4.5	4 - 20' **LEAN CLAY:** CL, reddish brown to brown, gray mottling (5-10%), silt (15-25%), gravel (5-10%), low plasticity, hard, dry.										
2 CS	60 60		6.0						4.5					
			7.5						4.5					
			9.0						4.5					
3 CS	72 72		10.5		CL				4.5					
			12.0	12.8' grayish brown.					4.5					
			13.5											
			15.0	14.6' gray.					4.5					
4 CS	48 48		16.5						4.5					
			18.0											

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

Signature: Sot Wb

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

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
			19.5	4 - 20' **LEAN CLAY:** CL, reddish brown to brown, gray mottling (5-10%), silt (15-25%), gravel (5-10%), low plasticity, hard, dry. *(continued)*	CL				4.5					
5 CS	120 120		21.0	20 - 30' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1), gravel (5-10%), sand (5-10%), low plasticity, hard, dry.					4.5					
			22.5						4.5					
			24.0											
			25.5		CL				4.5					
			27.0						4.5					
			28.5						4.5					
6 CS	60 60		30.0	30 - 35' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), gravel (0-5%), sand (0-5%), low to medium plasticity, very stiff, moist.										
			31.5						3					
			33.0		CL				3.5					
			34.5											
7 SH	24 24			35 - 37' **LEAN CLAY:** CL, grayish brown (10YR 5/2), silt(30-35%), medium plasticity, stiff, moist.						11.8	21	10	57	SH= Shelby Tube
			36.0		CL									
8 CS	96 96		37.5	37 - 50' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), gravel (0-5%), sand (0-5%), low to medium plasticity, very stiff, moist.					3.5					
			39.0						3.5					
			40.5						3.5					
			42.0	41.8' layer of fine sand (1" thick).										
			43.5	43' - 43.7' layer of clayey sand, moist to wet.	CL				3					
9 CS	60 60		45.0						3.5					
			46.5						3.5					
			48.0											

Boring Number 43

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			49.5	37 - 50' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), gravel (0-5%), sand (0-5%), low to medium plasticity, very stiff, moist. *(continued)*	CL				3.5					
10 SH	24 24		51.0	50 - 52' **LEAN CLAY:** CL, gray (10YR 5/1), sand (15-25%), medium plasticity, very stiff, moist.	CL				3	16.3	18	12	77	
11 CS	96 96		52.5	52 - 53.4' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), gravel (0-5%), sand (0-5%), low to medium plasticity, very stiff, moist.	CL				3.5					
			54.0, 55.5, 57.0, 58.5	53.4 - 59' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), low plasticity, hard, dry. 58.1' - 58.5' layer of fine sand.	CL/ML				3.5, 3, 3.5					
				59 - 60' **POORLY-GRADED SAND:** SP, gray (10YR 5/1), clay (5-15%), wet.	SP									
12 SH	24 24		60.0, 61.5	60 - 62' **SILTY CLAY:** CL/ML, brownish gray, gravel (0-5%), high plasticity, stiff, moist.	CL/ML					22.4	33	12	99	
13 CS	60 60		63.0	62 - 63.5' **SILT:** ML, dark gray (10YR 4/1), clay (15-25%), low plasticity, moist.	ML									
			64.5, 66.0	63.5 - 67.2' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), gravel (0-5%), low plasticity, hard, dry.	CL				4.5, 4.5					
14 CS	96 96		67.5, 69.0, 70.5, 72.0, 73.5	67.2 - 75' **WEATHERED BEDROCK** BDX (SS), weathered bedrock.	BDX (SS)									
			75.0	75' End of Boring.										

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SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Plant		44

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Russ Gordon Cascade Drilling	3/8/2021	3/8/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
44	Feet (NAVD88)	605.37 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,281,793.06 N, 1,147,232.40 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R

Lat ___° ___' ___"
Long ___° ___' ___"

Local Grid Location
Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

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
			0 - 0.9	0 - 0.9' **LEAN CLAY:** CL, Blind drilled to 35 feet below ground surface. See boring 43 for detailed lithology.	CL									
			0.9 - 2.1	0.9 - 2.1' **FILL, SILTY CLAY:** CL/ML.	(FILL) CL/ML									
			2.1 - 4	2.1 - 4' **FILL, LEAN CLAY:** CL.	(FILL) CL									
			4 - 20	4 - 20' **LEAN CLAY:** CL.	CL									

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

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

Signature	Firm	
[signature]	Ramboll 234 W. Florida Street, Milwaukee,WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

Boring Number 44

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
			13–19	4 - 20' **LEAN CLAY:** CL. *(continued)*	CL									
			20–29	20 - 30' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									
			30–32	30 - 35' **LEAN CLAY:** CL.	CL									

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				30 - 35' **LEAN CLAY:** CL. *(continued)*	CL									
1 CS	60 60		35	35 - 43.6' **LEAN CLAY:** CL, gray (10YR 5/1), silt (10-20%), gravel (5-15%), medium to high plasticity, stiff to very stiff, moist.	CL				1					
			37						1					
			39						1					
2 CS	60 60		40											
			41						1					
			43						1.5					
			43.6	43.6 - 44.3' **POORLY-GRADED SAND:** SP, gray (10YR 5/1), fine sand, fine gravel (0-5%), loose, wet.	SP									
			44.3	44.3 - 45' **LEAN CLAY:** CL, gray (10YR 5/1), silt (10-20%), fine gravel (5-15%), medium to high plasticity, stiff to very stiff, moist.	CL									
			45	45' End of Boring.										

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Plant		101

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jason Greer Cascade Drilling	3/5/2021	3/5/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
101	Feet (NAVD88)	704.09 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,698.18 N, 1,146,097.60 E (E)/ W
1/4 of 1/4 of Section , T N, R

Lat ° ' "
Long ° ' "

Local Grid Location: Feet ☐ N ☐ S; Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 43			0 - 10.3' **SILTY CLAY:** CL/ML, brown (10YR 5/3), gray (10YR 5/1) mottling (5-10%), sand (0-10%), gravel (0-5%), firm to very stiff, no dilatancy, low to medium toughness, medium to low plasticity, moist.										CS= Core Sample
			1.5						0.75					
			3.0						2.5					
			4.5											
2 CS	60 48				CL/ML				2.5					
			6.0											
			7.5						2.75					
			9.0						2.5					
3 CS	120 120		10.5	10.3 - 49.5' **LEAN CLAY:** CL, gray (10YR 5/1), brown (7.5YR 5/3) mottling (0-5%), silt (15-25%), sand (0-5%), gravel (0-5%), stiff, no dilatancy, low toughness, medium plasticity, moist.					1.5					
			12.0											
			13.5						2.25					
			15.0		CL				1.75					
			16.5						2.25					
			18.0											
			19.5						1.75					

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 Street, Milwaukee,WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

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
4 CS	120 108		21.0	10.3 - 49.5' **LEAN CLAY:** CL, gray (10YR 5/1), brown (7.5YR 5/3) mottling (0-5%), silt (15-25%), sand (0-5%), gravel (0-5%), stiff, no dilatancy, low toughness, medium plasticity, moist. *(continued)*					2.25					
			22.5	22' no mottling.					2.25					
			24.0						2.5					
			25.5						2.5					
			27.0						2.25					
			28.5											
5 SH	24 24		30.0											SH= Shelby Tube
			31.5											
6 CS	96 96		33.0						1.75					
			34.5		CL				2.25					
			36.0						2.5					
			37.5						1.75					
			39.0											
7 CS	120 120		40.5						1.75					
			42.0						1.75					
			43.5						1.75					
			45.0											
			46.5						2					
			48.0						1.5					
			49.5	49.5 - 50' **SILTY CLAY:** CL/ML, gray (10YR 5/1), firm to stiff, slow dilatancy, low toughness, low plasticity, wet.	CL/ML									
8 CS	120 120		51.0	50 - 58' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), stiff, no dilatancy, low toughness, medium plasticity, moist.	CL				2.5					
			52.5											

Boring Number 101

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			54.0	50 - 58' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), stiff, no dilatancy, low toughness, medium plasticity, moist. *(continued)*	CL				2.25					
			55.5						1.75					
			57.0						2					
			58.5	58 - 77.6' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1) to gray (10YR 5/1), sand (0-5%), gravel (0-5%), stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist.	CL/ML				2.25					
9 SH	24 18		60.0											
10 CS	96 96		61.5											
			63.0						4.5					
			64.5											
			66.0						4.25					
			67.5											
			69.0						3.25					
11 CS	120 120		70.5						3.25					
			72.0	72.6' reddish brown (5YR 5/3) mottling (5-10%).										
			73.5						2.75					
			75.0						4.25					
			76.5						4.25					
			78.0	77.6 - 78.3' **POORLY-GRADED SAND:** SP, gray (10YR 5/1), rounded to subrounded, medium sand, silt (5-10%), clay (5-10%), loose, moist.	SP									
			79.5	78.3 - 78.6' **CLAYEY SILT** ML/CL, gray (10YR 5/1), hard, no dilatancy, medium toughness, non-plastic, moist.	ML/CL				4.5					
12 CS	120 120		81.0	78.6 - 144.2' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1) to gray (10YR 5/1), sand (0-5%), gravel (0-5%), hard, no dilatancy, medium to high toughness, medium plasticity, dry.	CL/ML				4.5					
			82.5						4.5					
			84.0											
			85.5	85.9' layer of cobbles.					4.5					

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Boring Number 101

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
			87.0	78.6 - 144.2' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1) to gray (10YR 5/1), sand (0-5%), gravel (0-5%), hard, no dilatancy, medium to high toughness, medium plasticity, dry. *(continued)*					4.5					
			88.5						4.5					
13 MC	24 24		90.0											MC= Modified California
14 CS	96 96		91.5											
			93.0						4.5					
			94.5						4.25					
			96.0						4.5					
			97.5											
			99.0						4.5					
15 CS	120 120		100.5						4.5					
			102.0	102' grayish brown (10YR 5/2), cobbles (0-5%).										
			103.5		CL/ML				4.25					
			105.0						4.5					
			106.5						4.5					
			108.0						4.5					
			109.5											
16 CS	120 120		111.0						4.5					
			112.5						4.5					
			114.0											
			115.5						4.5					
			117.0						4.5					
			118.5						4.5					
			120.0											

Boring Number 101

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
17 CS	120 120		121.5	78.6 - 144.2' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1) to gray (10YR 5/1), sand (0-5%), gravel (0-5%), hard, no dilatancy, medium to high toughness, medium plasticity, dry. *(continued)*			4.5					
			123.0				4.5					
			124.5				4.5					
			126.0	126.2' olive (5Y 5/3) mottling.								
			127.5	127.4' -127.8' sand with silt, rounded to subrounded, medium to coarse sand, moist to wet.			4.5					
			129.0				4.5					
18 MC	24 24		130.5									
19 CS	96 96		132.0	132' stiff, moist.	CL/ML							
			133.5				1.5					
			135.0				1.75					
			136.5				1.5					
			138.0				1.25					
20 CS	120 120		139.5									
			141.0				1.5					
			142.5				1.25					
			144.0									
			145.5	144.2 - 146.8' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), rounded to subrounded, fine to medium sand, loose, wet.	SP-SM							
			147.0	146.8 - 147.3' **SILTY CLAY:** CL/ML, gray (10YR 5/1), sand (0-5%), gravel (0-5%), stiff, slow dilatancy, low toughness, medium plasticity, moist.	CL/ML		1.5					
			148.5	147.3 - 148.1' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), rounded to subrounded, fine to medium sand, loose, wet.	SP-SM		1.5					
21 CS	120 120		150.0	148.1 - 148.9' **SILTY CLAY:** CL/ML, gray (10YR 5/1), sand (0-5%), gravel (0-5%), stiff, slow dilatancy, low toughness, medium plasticity, moist.	CL/ML		2.25					
			151.5	148.9 - 149.5' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), rounded to subrounded, fine to medium sand, loose, wet.	SP-SM							
			153.0		CL/ML							

Boring Number 101

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
				149.5 - 160' **SILTY CLAY:** CL/ML, gray (10YR 5/1), sand (0-5%), gravel (0-5%), no to slow dilatancy, low toughness, medium plasticity, moist. *(continued)*					2.5					
			154.5	154' stiff to very stiff.					3.25					
			156.0		CL/ML									
			157.5						3.25					
			159.0						4.25					
				160' End of Boring.										

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SOIL BORING LOG INFORMATION

Facility/Project Name: Vermilion Power Plant	License/Permit/Monitoring Number:	Boring Number: 101S	
Boring Drilled By: Name of crew chief (first, last) and Firm: Dave Gordon, Cascade Drilling	Date Drilling Started: 3/16/2021	Date Drilling Completed: 3/16/2021	Drilling Method: Mini Sonic
Common Well Name: 101S	Final Static Water Level: Feet (NAVD88)	Surface Elevation: 704.14 Feet (NAVD88)	Borehole Diameter: 6.0 inches
Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐ State Plane 1,279,705.42 N, 1,146,097.45 E (E)/W; 1/4 of 1/4 of Section , T N, R	Lat ° ' " Long ° ' "	Local Grid Location: Feet ☐N ☐S Feet ☐E ☐W	
Facility ID:	County: Vermilion	State: Illinois	Civil Town/City/ or Village: Oakwood

Sample: Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			0	0 - 10.3' **SILTY CLAY:** CL/ML, Blind drilled to 88 feet below ground surface (ft bgs). See boring log 101D for detailed lithology..	CL/ML									
			10.3	10.3 - 49.5' **LEAN CLAY:** CL.	CL									

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

Signature: Sat Wb

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

Boring Number 101S

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
				10.3 - 49.5' **LEAN CLAY:** CL. *(continued)*										
			13											
			14											
			15											
			16											
			17											
			18											
			19											
			20											
			21											
			22		CL									
			23											
			24											
			25											
			26											
			27											
			28											
			29											
			30											
			31											
			32											

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
			33–49	10.3 - 49.5' **LEAN CLAY:** CL. *(continued)*	CL									
			49.5–50	49.5 - 50' **SILTY CLAY:** CL/ML.	CL/ML									
			50–52	50 - 58' **LEAN CLAY:** CL.	CL									

Boring Number 101S

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
				50 - 58' **LEAN CLAY:** CL. *(continued)*										
			53											
			54											
			55		CL									
			56											
			57											
			58	58 - 77.6' **SILTY CLAY:** CL/ML.										
			59											
			60											
			61											
			62											Sand observed 62-65 ft bgs
			63											
			64											
			65		CL/ML									
			66											
			67											
			68											
			69											
			70											
			71											
			72											

Boring Number 101S

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
				58 - 77.6' **SILTY CLAY:** CL/ML. *(continued)* 72.6.	CL/ML									
			73											
			74											
			75											
			76											
			77											
			78	77.6 - 78.3' **POORLY-GRADED SAND:** SP.	SP									
				78.3 - 78.6' **CLAYEY SILT** ML/CL.	ML/CL									
			79	78.6 - 88' **SILTY CLAY:** CL/ML.	CL/ML									
			80											
			81											
			82											
			83											
			84											
			85											
			86											
			87											
			88	88' End of Boring.										

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Plant		102

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Dave Gordon Cascade Drilling	3/6/2021	3/7/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
102	Feet (NAVD88)	702.98 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,245.48 N, 1,147,170.85 E (E)/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location: Feet ☐ N ☐ S; Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	120 120		0–2.3	0 - 2.3' **WELL-GRADED GRAVEL WITH SAND:** (GW)s, very pale brown (10YR 7/4), subrounded, fine to coarse sand, moist.	(GW)s									CS= Core Sample
			2.3–6.6	2.3 - 6.6' **LEAN CLAY:** CL, grayish brown (10YR 5/2), brownish yellow (10YR 6/6) mottling (0-5%), silt (15-25%), gravel (5-15%), low plasticity, hard, dry.	CL				4.5 4.5					
			6.6–10	6.6 - 10' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (15-25%), gravel (0-5%), stiff, low plasticity, moist.	CL				1.5 1.5					
2 CS	240 240		10–18.7	10 - 18.7' **LEAN CLAY:** CL, grayish brown (10YR 5/2), silt (5-15%), gravel (0-5%), medium plasticity, very stiff, moist.	CL				2.5 2.5 2 2 2.5					

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

Signature: Sft Wb

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

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Boring Number 102

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
			17–18	10 - 18.7' **LEAN CLAY:** CL, grayish brown (10YR 5/2), silt (5-15%), gravel (0-5%), medium plasticity, very stiff, moist. *(continued)*	CL				2.5 2					
			19–29	18.7 - 30' **LEAN CLAY:** CL, gray (10YR 5/1), silt (5-15%), gravel (0-5%), medium plasticity, very stiff, moist.	CL				2.5 2 2 2.5 2.5 2.5 2.5					
3 SH	24 24		30–31	30 - 32' **LEAN CLAY:** CL.	CL									SH= Shelby Tube
4 CS	216 216		32–42	32 - 60' **LEAN CLAY:** CL, gray (10YR 5/1), silt (5-15%), gravel (0-5%), medium plasticity, very stiff, moist. 32.5' - 33.8' sand (5-10%).	CL				2.5 2 2.5 2 2					

SOIL BORING LOG INFORMATION SUPPLEMENT

Boring Number 102

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			43	32 - 60' **LEAN CLAY:** CL, gray (10YR 5/1), silt (5-15%), gravel (0-5%), medium plasticity, very stiff, moist. *(continued)*					2.5					
			45						2					
			47						2.5					
			49						2.5					
5 CS	120 120		50											
			51		CL				2.5					
			53						2.5					
			55						2.5					
			57						2.5					
			59						2.5					
6 SH	24 24		60	60 - 62' **LEAN CLAY:** CL.	CL									
7 CS	96 96		62	62 - 70' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (5-15%), gravel (0-5%), medium plasticity, hard.										
			63						4.5					
			65						4.5					
			66		CL									
			67						4.5					
			69											

Boring Number 102

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
									4.5					
8 CS	240 240		70	70 - 71.4' **POORLY-GRADED SAND:** SP, dark gray (10YR 4/1), fine to medium sand, silt (0-5%), clay (0-5%), moist to wet.	SP									
			71	71.4 - 81.4' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (15-25%), gravel (0-5%), sand (0-5%), medium plasticity, very stiff, moist.	CL				3					
			75						2.75					
			77						2.5					
			79						3					
			81	81.4 - 85.3' **CLAYEY SILT** ML/CL, gray (10YR 5/1), sand (0-5%), moist to wet.	ML/CL									
			84	84.1' clay content decreasing with depth.										
			85	85.3 - 87.5' **SILT:** ML, gray (10YR 5/1), sand (5-15%), moist to wet.	ML									
			87	87.5 - 88.6' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), low plasticity, hard.	CL/ML									
			88	88.6 - 90' **SANDY LEAN CLAY WITH GRAVEL:** s(CL)g, dark gray (10YR 4/1), silt(30-45%), low plasticity, hard.	s(CL)g				4.5					
9 MC	24 24		90	90 - 93' **POORLY-GRADED SAND WITH SILT:** SP-SM, fine to medium sand, gravel (0-5%), wet.	SP-SM									MC= Modified California
10 MC	24 24		92											
			93	93 - 130' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), fine to coarse gravel (0-5%), low plasticity, hard.	CL									
11 CS	312 312		94											
			95						4.5					

Boring Number 102

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
			97	93 - 130' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), fine to coarse gravel (0-5%), low plasticity, hard. *(continued)*					4.5					
			98											
			99						4.5					
			100											
			101						4.5					
			102											
			103						4.5					
			104											
			105						4.5					
			106											
			107						4.5					
			108											
			109		CL				4.5					
			110											
			111						4.5					
			112											
			113						4.5					
			114											
			115						4.5					
			116											
			117						4.5					
			118											
			119						4.5					
12 CS	360 360		120											
			121						4.5					
			122											

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
			123	93 - 130' **LEAN CLAY: to SILTY CLAY:** CL, dark gray (10YR 4/1), fine to coarse gravel (0-5%), low plasticity, hard. *(continued)*	CL				4.5					
			124											
			125						4.5					
			126											
			127						4.5					
			128	128.1' -128.4' layer of fine sand.										
			129						4.5					
			130	130 - 130.7' g(CL), gravelly clay.	g(CL)									
			131	130.7 - 149.4' **LEAN CLAY: to SILTY CLAY:** CL, dark gray (10YR 4/1), fine to coarse gravel (0-5%), low plasticity, hard.	CL				4.5					
			132											
			133						4.5					
			134											
			135						4.5					
			136											
			137						4.5					
			138											
			139						4.5					
			140											
			141						4.5					
			142											
			143						4.5					
			144											
			145						4.5					
			146											
			147						4.5					
			148											
			149											

SOIL BORING LOG INFORMATION SUPPLEMENT

Boring Number 102

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
				149' layer of well-graded sand with gravel (1" thick).					4.5					
13 CS	120 120		150	149.4 - 150' (SW)g, well-graded sand with gravel.	(SW)g									
			151	150 - 156' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), fine to coarse gravel (0-5%), low plasticity, hard.					4.5					
			152											
			153		CL				4.5					
			154											
			155	154.8' -155.1' layer of fine to medium sand.					4.5					
			156	156 - 156.7' **POORLY-GRADED SAND:** SP, fine to medium sand.	SP									
			157	156.7 - 160' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), fine to coarse gravel (0-5%), low plasticity, hard.					4.5					
			158		CL									
			159						4.5					
			160	160' End of Boring.										

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Plant		102S

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Dave Gordon Cascade Drilling	3/16/2021	3/16/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
102S	Feet (NAVD88)	702.92 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,239.28 N, 1,147,169.25 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location ☐N ☐S Feet ☐E ☐W Feet

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample: Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			0 - 2.3	0 - 2.3' **WELL-GRADED GRAVEL WITH SAND:** (GW)s, Blind drilled to 90 feet below ground surface (ft bgs). See boring log 102D for detailed lithology..	(GW)s									
			2.3 - 6.6	2.3 - 6.6' **LEAN CLAY:** CL.	CL									
			6.6 - 10	6.6 - 10' **LEAN CLAY:** CL.	CL									
			10 - 12	10 - 18.7' **LEAN CLAY:** CL.	CL									

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

Signature [signature] | Firm Ramboll
234 W. Florida Street, Milwaukee,WI 53204
Tel: (414) 837-3607
Fax: (414) 837-3608

Boring Number 102S

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
			13 14 15 16 17 18	10 - 18.7' **LEAN CLAY:** CL. *(continued)*	CL									
			19 20 21 22 23 24 25 26 27 28 29	18.7 - 30' **LEAN CLAY:** CL.	CL									
			30 31 32	30 - 32' **LEAN CLAY:** CL.	CL									

Boring Number 102S

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
				32 - 60' **LEAN CLAY:** CL. 32.5' - 33.8' sand (5-10%).	CL									
			33											
			34											
			35											
			36											
			37											
			38											
			39											
			40											
			41											
			42											
			43											
			44											
			45											
			46											
			47											
			48											
			49											
			50											
			51											
			52											

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
			52–60	32 - 60' **LEAN CLAY:** CL. *(continued)*	CL									
			60–62	60 - 62' **LEAN CLAY:** CL.	CL									
			62–70	62 - 70' **LEAN CLAY:** CL.	CL									
			70–71.4	70 - 71.4' **POORLY-GRADED SAND:** SP.	SP									
			71.4–72	71.4 - 81.4' **LEAN CLAY:** CL.	CL									

RAMBOLL

Boring Number 102S

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				71.4 - 81.4' **LEAN CLAY:** CL. *(continued)*	CL									
			73											
			74	73.5' -75' bgs. No other sand layers observed in boring.										Sand observed 73.5-75 ft bgs
			75											
			76											
			77											
			78											
			79											
			80											
			81											
			82	81.4 - 85.3' **CLAYEY SILT** ML/CL.	ML/CL									
			83											
			84	84.1' clay content decreasing with depth.										
			85											
			86	85.3 - 87.5' **SILT:** ML.	ML									
			87											
			88	87.5 - 88.6' **SILTY CLAY:** CL/ML.	CL/ML									
			89	88.6 - 90' **SANDY LEAN CLAY WITH GRAVEL:** s(CL)g.	s(CL)g									
			90	90' End of Boring.										

Facility/Project Name	License/Permit/Monitoring Number	Boring Number	
Vermilion Power Plant		103	
Boring Drilled By: Name of crew chief (first, last) and Firm Jason Greer Cascade Drilling	**Date Drilling Started** 3/7/2021	**Date Drilling Completed** 3/9/2021	**Drilling Method** Mini Sonic
Common Well Name 103	**Final Static Water Level** Feet (NAVD88)	**Surface Elevation** 717.38 Feet (NAVD88)	**Borehole Diameter** 6.0 inches
Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐ State Plane 1,279,960.01 N, 1,147,526.10 E (E)/ W 1/4 of 1/4 of Section , T N, R	Lat ° ' " Long ° ' "	Local Grid Location Feet ☐ N ☐ S	Feet ☐ E ☐ W
Facility ID	**County** Vermilion	**State** Illinois	**Civil Town/City/ or Village** Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 44			0 - 1.2' **TOPSOIL:** ML/CL, dark brown (10YR 3/3), sand (0-5%), gravel (0-5%), roots (0-5%), firm, slow dilatancy, low toughness, low plasticity, moist.	ML/CL									CS= Core Sample
			1.5	1.2 - 15' **SILTY CLAY:** CL/ML, yellowish brown (10YR 5/4), gray (10YR5/1) mottling (5-10%), sand (0-10%), gravel (0-5%), very stiff, no dilatancy, low to medium toughness, medium plasticity, moist.	CL/ML				1.5					
			3.0						2.5					
			4.5											
2 CS	60 60								2.75					
			6.0	6' yellowish brown (10YR 5/6) mottling (0-5%).										
			7.5						3					
			9.0						3					
3 CS	60 60		10.5											
			12.0						2.75					
			13.5						3.25					
4 SH	24 18		15.0	15 - 17' **LEAN CLAY:** CL, grayish browon (10YR /2), sand (5-15%), silt (25-30%), high plasticity, moist.	CL				3.25	16.6	30	15	85.3	SH= Shelby Tube
			16.5											
5 CS	96 96			17 - 20' **SILTY CLAY:** CL/ML, yellowish brown (10YR 5/4), gray (10YR5/1) mottling (5-10%), sand (0-10%), gravel (0-5%), very stiff, no dilatancy, low to medium toughness, medium plasticity, moist.	CL/ML									
			18.0											
			19.5						2.5					

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 Street, Milwaukee,WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

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
			21.0	20 - 36.1' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1), sand (0-10%), gravel (0-5%), stiff to very stiff, slow to no dilatancy, low toughness, medium plasticity, moist.					2.5					
			22.5						2.25					
			24.0											
6 CS	60 60		25.5						1.75					
			27.0						1.75					
			28.5		CL				2.25					
7 SH	24 24		30.0											
8 CS	96 96		31.5											
			33.0						1.75					
			34.5						1.5					
			36.0	36.1 - 36.3' **POORLY-GRADED GRAVEL WITH SILT AND SAND:** (GP-GM)s, gray (10YR 5/1), subrounded to subangular, loose, wet.	(GP-GM)s				1.75					
			37.5	36.3 - 63.7' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1), sand (0-10%), gravel (0-5%), stiff to very stiff, slow to no dilatancy, low toughness, medium plasticity, moist.										
			39.0						1.75					
9 CS	120 120		40.5						2.25					
			42.0						2.25					
			43.5											
			45.0		CL				2.5					
			46.5						2.5					
			48.0											
			49.5						2.5					
10 CS	120 120		51.0						2.75					
			52.5											

Boring Number 103

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
			54.0	36.3 - 63.7' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1), sand (0-10%), gravel (0-5%), stiff to very stiff, slow to no dilatancy, low toughness, medium plasticity, moist. *(continued)*					3.25					
			55.5						3					
			57.0						3.25					
			58.5		CL				2.75					
11 SH	24 24		60.0											
12 CS	36 36		61.5											
			63.0						2.25					
			64.5	63.7 - 64.1' **SILTY SAND:** to **SANDY SILT:** SM, gray (10YR 5/1), subrounded to rounded, fine to medium sand, loose, wet.	SM									
13 CS	60 60		66.0	64.1 - 67.8' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1), sand (0-10%), gravel (0-5%), stiff to very stiff, slow to no dilatancy, low toughness, medium plasticity, moist.	CL				1.5					
			67.5						1.5					
			69.0	67.8 - 73.3' **SILT:** ML, gray (10YR 5/1), sand (0-5%), stiff, slow dilatancy, low toughness, non-plastic, moist to wet.					1.25					
14 CS	60 60		70.5		ML				1.5					
			72.0											
			73.5	73.3 - 92.3' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1), sand (0-5%), gravel (0-5%), very stiff, no dilatancy, medium toughness, dry to moist.					3.25					
15 CS	60 60		75.0						3.25					
			76.5						3.25					
			78.0											
			79.5						3.25					
16 CS	60 60		81.0		CL				2.75					
			82.5											
			84.0						3					
17 CS	60 60		85.5						2.25					

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			87.0	73.3 - 92.3' **LEAN CLAY: to SILTY CLAY:** CL, gray (10YR 5/1), sand (0-5%), gravel (0-5%), very stiff, no dilatancy, medium toughness, dry to moist. *(continued)*	CL				2.25					
			88.5						1.75					
18 SH	12 12		90.0											
19 CS	48 48		91.5											
			93.0	92.3 - 95.5' **POORLY-GRADED SAND:** SP, grayish brown (10YR 5/2), rounded to subrounded, fine sand, silt (5-10%), loose, wet.	SP									
			94.5											
20 MC	24 24		96.0	95.5 - 96' **SILTY CLAY:** CL/ML, grayish brown (10YR 5/2) to gray (10YR 5/1), olive (5Y 5/3) mottling (5-10%), sand (0-10%), gravel (0-5%), stiff to very stiff, no dilatancy, low to medium toughness, medium plasticity, dry to moist.	CL/ML					13.9	17	7	51.8	MC= Modified California
21 CS	36 36		97.5	96 - 130.5' **SILTY CLAY:** CL/ML, grayish brown (10YR 5/2) to gray (10YR 5/1), olive (5Y 5/3) mottling (5-10%), sand (0-10%), gravel (0-5%), stiff to very stiff, no dilatancy, low to medium toughness, medium plasticity, dry to moist.	CL/ML				4.25					
			99.0						4.25					
22 MC	24 24		100.5											
23 CS	96 96		102.0											
			103.5						2.5					
			105.0						4.5					
			106.5						4.5					
			108.0						4.5					
24 CS	240 240		109.5											
			111.0						4.25					
			112.5						4					
			114.0						4.5					
			115.5						4.5					
			117.0						4.5					
			118.5											
			120.0											

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			121.5	96 - 130.5' **SILTY CLAY:** CL/ML, grayish brown (10YR 5/2) to gray (10YR 5/1), olive (5Y 5/3) mottling (5-10%), sand (0-10%), gravel (0-5%), stiff to very stiff, no dilatancy, low to medium toughness, medium plasticity, dry to moist. *(continued)*	CL/ML				4.5					
			123.0						4.5					
			124.5						4.5					
			126.0											
			127.5						4.5					
			129.0	128.9' -129' layer of sand, grayish brown (10YR 5/2).					4.5					
25 MC	24 24		130.5	130.5 - 131' **CLAYEY SAND:** SC, gray (10YR 5/1), gravel (30-45%), silt (5-15%), clay (5-15%), medium plasticity loose, wet.	SC					8.9	16	5	5.7	
26 MC	24 24		132.0	131 - 132.5' **POORLY-GRADED SAND:** SP, grayish brown (10YR 5/2), rounded to subrounded, fine sand, silt (5-10%), loose, wet. 131.8' -132' layer of clay.	SP					15.3	14	7	35.2	
27 CS	72 72		133.5	132.5 - 133' **POORLY-GRADED SAND WITH CLAY:** SP-SC, grayish brown (10YR 5/2), silt (0-5%), clay (0-5%), low plasticity.	SP-SC									
			135.0	133 - 146.2' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), stiff to very stiff, no dilatancy, low to medium toughness, medium plasticity, dry to moist.	CL				2.5					
			136.5						3					
			138.0											
			139.5						3.25					
28 MC	24 24		141.0	140.5 - 141' **LEAN CLAY:** CL, grayish brown (10YR 5/2), silt (15-25%), clay (15-25%), medium plasticity, dry to moist.	CL					10.8	23	12	12.6	
29 CS	192 192		142.5	141 - 146.2' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), stiff to very stiff, no dilatancy, low to medium toughness, medium plasticity, dry to moist.	CL				3					
			144.0											
			145.5						2.25					
			147.0	146.2 - 148.6' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), subrounded to rounded, fine sand, loose, moist.	SP-SM									
			148.5	148.6 - 150.2' **SILT WITH SAND:** (ML)s, gray (10YR 5/1), firm, slow dilatancy, low toughness, non-plastic, moist.	(ML)s				0.75					
			150.0	150.2 - 158' **SILTY CLAY:** CL/ML, gray (10YR 5/1), sand (0-10%), gravel (0-5%), stiff to very stiff, no dilatancy, medium to low toughness, medium plasticity, moist to dry.	CL/ML				4					
			151.5											
			153.0											

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			154.5, 156.0, 157.5	150.2 - 158' **SILTY CLAY:** CL/ML, gray (10YR 5/1), sand (0-10%), gravel (0-5%), stiff to very stiff, no dilatancy, medium to low toughness, medium plasticity, moist to dry. *(continued)*	CL/ML				3.5, 4.25, 4.25					
30 NR	24 0		159.0	158 - 160' No recovery.										NR= No recovery Core casing dropped to 160' below ground surface (bgs) while collecting sample
31 MC	24 6		160.5	160 - 161' **POORLY-GRADED SAND:** SP, gray (10YR 5/1), subrounded to rounded, fine sand, loose, wet.	SP									
32 MC	24 24		162.0	161 - 163' **SILTY SAND:** to **SANDY SILT:** SM.	SM									
			163.5	163 - 163.5' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), silt (15-25%), clay (15-25%), medium plasticity, dry to moist.	SP-SM					13.8	17	6	81.9	
33 CS	72 72		165.0	163.5 - 166.2' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1), sand (5-10%), gravel (0-5%), hard, no dilatancy, medium toughness, medium plasticity, dry to moist.	CL				4.5					
			166.5	166.2 - 167' **WELL-GRADED SAND:** SW, gray (10YR 5/1), subrounded to rounded, gravel (0-5%), loose, wet.	SW				4.5					
			168.0	167 - 169.5' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1), sand (5-10%), gravel (0-5%), hard, no dilatancy, medium toughness, medium plasticity, dry to moist.	CL				4.5					
34 CS	60 60		169.5	169.5 - 170.3' **WELL-GRADED SAND:** SW, gray (10YR 5/1), subrounded to rounded, fine to coarse sand, gravel (0-5%), loose, wet.	SW									
			171.0, 172.5, 174.0	170.3 - 175.5' **SILTY CLAY:** CL/ML, gray (10YR 5/1) to dark gray (10YR 4/1), sand (5-10%), gravel (0-5%), very stiff to hard, no dilatancy, medium toughness, medium plasticity, dry to moist.	CL/ML				3.5, 4.5, 4.25					
35 MC	24 24		175.5	175.5 - 177' **POORLY-GRADED SAND:** SP.	SP									
			177.0	177' End of Boring.										

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Plant		103S

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jason Greer Cascade Drilling	3/15/2021	3/15/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
103S	Feet (NAVD88)	717.62 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,964.21 N, 1,147,511.40 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location ☐ N ☐ S Feet ☐ E ☐ W Feet

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			1.5	0 - 1.2' **TOPSOIL:** ML/CL, Blind drilled to 80 feet below ground surface. See 103D boring log for detailed lithology..	ML/CL									No sand observed during drilling
			3.0 4.5 6.0 7.5 9.0 10.5 12.0 13.5	1.2 - 15' **SILTY CLAY:** CL/ML.	CL/ML									
			15.0 16.5	15 - 17' **LEAN CLAY:** CL.	CL									
			18.0 19.5	17 - 20' **SILTY CLAY:** CL/ML.	CL/ML									

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

Signature	Firm	
[signature]	Ramboll 234 W. Florida Street, Milwaukee,WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

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Boring Number 103S

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
			21.0, 22.5, 24.0, 25.5, 27.0, 28.5, 30.0, 31.5, 33.0, 34.5	20 - 36.1' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									
			36.0	36.1 - 36.3' **POORLY-GRADED GRAVEL WITH SILT AND SAND:** (GP-GM)s.	(GP-GM)s									
			37.5, 39.0, 40.5, 42.0, 43.5, 45.0, 46.5, 48.0, 49.5, 51.0, 52.5	36.3 - 63.7' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									

Boring Number 103S

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
			54.0 – 63.0	36.3 - 63.7' **LEAN CLAY:** to **SILTY CLAY:** CL. *(continued)*	CL									
				63.7 - 64.1' **SILTY SAND:** to **SANDY SILT:** SM.	SM									
			64.5 – 67.5	64.1 - 67.8' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									
			69.0 – 72.0	67.8 - 73.3' **SILT:** ML.	ML									
			73.5 – 79.5	73.3 - 80' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									
				80' End of boring.										

Depth scale: 54.0, 55.5, 57.0, 58.5, 60.0, 61.5, 63.0, 64.5, 66.0, 67.5, 69.0, 70.5, 72.0, 73.5, 75.0, 76.5, 78.0, 79.5

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SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Plant		104

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Dave Gordon Cascade Drilling	3/8/2021	3/8/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
104	Feet (NAVD88)	703.24 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,172.79 N, 1,147,573.87 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R

Lat ___° ___' ___"
Long ___° ___' ___"

Local Grid Location
Feet ☐ N ☐ S
Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	120 120			0 - 0.8' **SANDY LEAN CLAY:** s(CL), very dark brown (10YR 3/2), very fine to coarse sand, gravel (0-5%), low to meidum plasticity, stiff, moist.	s(CL)				1.5					CS= Core Sample
			1	0.8 - 20' **LEAN CLAY:** CL, grayish brown (10YR 5/2), silt (15-25%), gravel (5-10%), medium plasticity, very stiff to hard, moist.					3.5					
			2											
			3						3					
			4											
			5						4.5					
			6		CL									
			7						4					
			8											
			9						3.5					
2 CS	120 120		10	10' gray (10YR 5/1).										
			11						2					
			12											

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

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

Boring Number 104

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
				0.8 - 20' **LEAN CLAY:** CL, grayish brown (10YR 5/2), silt (15-25%), gravel (5-10%), medium plasticity, very stiff to hard, moist. *(continued)*	CL				2					
			13						2					
			14											
			15						2.5					
			16											
			17						2					
			18											
			19						2.5					
3 CS	120 120		20	20 - 21' **CLAYEY GRAVEL:** GC, moist to wet.	GC				2					
			21	21 - 25.4' **LEAN CLAY:** CL, grayish brown (10YR 5/2), silt (15-25%), fine to coarse gravel (5-10%), medium plasticity, very stiff to hard, moist.	CL				2.5					
			22											
			23						2					
			24						2					
			25						2.5					
			26	25.4 - 27.5' **CLAYEY SILT** ML/CL, grayish brown (10YR 5/2), low plasticity, moist.	ML/CL									
			27											
			28	27.5 - 30' **SILT:** ML, gray (10YR 5/1), sand (0-5%), clay (0-5%).	ML									
			29											
4 SH	24 24		30	30 - 32' **LEAN CLAY:** CL.	CL									SH= Shelby Tube
			31											
			32											

Boring Number 104

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
5 CS	216 216			32 - 37' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), fine to coarse gravel (5-10%), low plasticity, very stiff.	CL				2.5, 2					
			37	37 - 37.5' **SILT:** ML.	ML				2.5					
			38	37.5 - 38.5' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), fine to coarse gravel (5-10%), low plasticity, very stiff.	CL									
			39	38.5 - 39.5' **SILT:** ML.	ML				3.5					
			40	39.5 - 40' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-20%), fine to coarse gravel (5-10%), low plasticity, very stiff.	CL									
			41–52	40 - 60' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1) to dark gray (10YR 4/1), gravel (5-10%), low plasticity, hard.	CL				4.5, 4.5, 4.5, 4.5, 4.5, 4.5					
6 CS	120 120		50											

Depth scale: 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52

RAMBOLL

Boring Number 104

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			52-60	40 - 60' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1) to dark gray (10YR 4/1), gravel (5-10%), low plasticity, hard. *(continued)*	CL				4.5 4.5 4.5 4.5					
7 MC	24 24		60-62	60 - 62' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									MC= Modified California
8 CS	96 96		62-70	62 - 70' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1) to dark gray (10YR 4/1), gravel (5-10%), low plasticity, hard.	CL				4.5 4.5 4.5 4.5					
9 CS	120 120		70-72	70 - 75.6' **SANDY SILT:** s(ML), dark gray (10YR 4/1), fine sand, clay (5-10%), wet, fine sand seams (0-5%).	s(ML)									

SOIL BORING LOG INFORMATION SUPPLEMENT

Boring Number 104

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			73–75	70 - 75.6' **SANDY SILT:** s(ML), dark gray (10YR 4/1), fine sand, clay (5-10%), wet, fine sand seams (0-5%). *(continued)*	s(ML)									
			76–80	75.6 - 80.6' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), fine sand, wet.	SP-SM									
10 CS	120 120													
			81–82	80.6 - 82.4' **SILT:** ML, gray (10YR 5/1), sand (0-5%), wet.	ML									
			83	82.4 - 83.5' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), fine to medium sand, wet.	SP-SM									
			84	83.5 - 84.1' **SILTY SAND:** SM, gray (10YR 5/1), medium sand, wet.	SM									
			85	84.1 - 85.5' **SILTY CLAY:** CL/ML, dark gray (10YR 5/2), gravel (0-5%), low plasticity, hard.	CL/ML									
			86–87	85.5 - 87.6' **SILTY SAND:** SM, gray (10YR 5/1), sand, moist to wet.	SM									
			88	87.6 - 88.6' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), gravel (0-5%), low plasticity, hard.	CL/ML									
			89	88.6 - 90' **SILT:** ML, gray (10YR 5/1), fine sand (0-10%), moist to wet.	ML									
11 MC	24 24		90–92	90 - 92' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									

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
12 CS	216 216			92 - 148.1' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), low plasticity, hard, dry.										
			93						4.5					
			94											
			95						4.5					
			96											
			97						4.5					
			98											
			99						4.5					
			100											
			101						4.5					
			102		CL									
			103						4.5					
			104											
			105						4.5					
			106											
			107						4.5					
			108											
			109						4.5					
13 CS	240 240		110											
			111						4.5					
			112											

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				92 - 148.1' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), low plasticity, hard, dry. *(continued)*										
			113						4.5					
			114											
			115						4.5					
			116											
			117						4.5					
			118											
			119						4.5					
			120											
			121						4.5					
			122		CL									
			123						4.5					
			124											
			125						4.5					
			126											
			127						4.5					
			128											
			129						4.5					
14 CS	240 240		130											
			131						4.5					
			132											

Boring Number 104

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				92 - 148.1' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), low plasticity, hard, dry. *(continued)*										
			133						4.5					
			134											
			135						4.5					
			136											
			137						4.5					
			138											
			139						4.5					
			140		CL									
			141						4.5					
			142											
			143						4.5					
			144											
			145						4.5					
			146											
			147	147.3' layer of fine sand, wet (1" thick).					4.5					
			148	148.1 - 150' **POORLY-GRADED SAND:** SP, fine to medium sand, gravel (0-5%), wet.										
			149	149.1' -149.4' layer of silty clay.	SP				4.5					
15 CS	120 120		150	150 - 154.9' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), low plasticity, hard.										
			151		CL				4.5					
			152											

Boring Number 104

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
			153	150 - 154.9' **LEAN CLAY: to SILTY CLAY:** CL, dark gray (10YR 4/1), low plasticity, hard. *(continued)*	CL				4.5					
			154											
			155	154.9 - 155.6' **POORLY-GRADED SAND:** SP, wet.	SP				4.5					
			156	155.6 - 158.8' **LEAN CLAY: to SILTY CLAY:** CL, dark gray (10YR 4/1), low plasticity, hard.										
			157	157.1' layer of fine sand, wet.	CL				4.5					
			158											
			159	158.8 - 160' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), very fine to fine sand, clay (0-10%), wet.	SP-SM				4.5					
16 CS	120 120		160	160 - 170' **LEAN CLAY: to SILTY CLAY:** CL, dark gray (10YR 4/1), fine to coarse gravel (0-10%), low plasticity, hard.										
			161						4.5					
			162											
			163						4.5					
			164											
			165		CL				4.5					
			166											
			167						4.5					
			168											
			169						4.5					
			170	170' End of Boring.										

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SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number	
Vermilion Power Plant		104S	
Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Dave Gordon Cascade Drilling	3/15/2021	3/15/2021	Mini Sonic
Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
104S	Feet (NAVD88)	703.10 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,172.50 N, 1,147,579.42 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R

Lat ___ ° ___ ' ___ "
Long ___ ° ___ ' ___ "

Local Grid Location: Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

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
			0–1	0 - 0.8' **SANDY LEAN CLAY:** s(CL), Blind drilled to 70 feet below ground surface. See 104D boring log for detailed lithology..	s(CL)									
			1–12	0.8 - 20' **LEAN CLAY:** CL.	CL									

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

Signature	Firm	
[signature]	Ramboll 234 W. Florida Street, Milwaukee,WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

Boring Number 104S

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
			13–20	0.8 - 20' **LEAN CLAY:** CL. *(continued)*	CL									
			20–21	20 - 21' **CLAYEY GRAVEL:** GC.	GC									
			21–25.4	21 - 25.4' **LEAN CLAY:** CL.	CL									
			25.4–27.5	25.4 - 27.5' **CLAYEY SILT** ML/CL.	ML/CL									
			27.5–30	27.5 - 30' **SILT:** ML.	ML									
			30–32	30 - 32' **LEAN CLAY:** CL.	CL									

Boring Number 104S

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, 34, 35, 36	32 - 37' **LEAN CLAY:** CL.	CL									
			37	37 - 37.5' **SILT:** ML.	ML									
			38	37.5 - 38.5' **LEAN CLAY:** CL.	CL									
			39	38.5 - 39.5' **SILT:** ML.	ML									
				39.5 - 40' **LEAN CLAY:** CL.	CL									
			40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52	40 - 60' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									

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
			53–59	40 - 60' **LEAN CLAY:** to **SILTY CLAY:** CL. *(continued)*	CL									
			60–61	60 - 62' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									
			62–69	62 - 70' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									
			70–72	70 - 74' **LEAN CLAY:** CL.	CL									

Boring Number 104S

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
			73	70 - 74' **LEAN CLAY:** CL. *(continued)*	CL									
			74, 75	74 - 76' **POORLY-GRADED SAND:** ML, fine to medium sand.	ML									
			76, 77	76 - 77.6' **SILT:** ML, wet.	ML									
			78	77.6 - 78.8' **POORLY-GRADED SAND:** ML, fine to medium sand, silt (5-15%).	ML									
			79	78.8 - 80' **SILT WITH SAND:** ML.	ML									
			80, 81, 82, 83	80 - 84' **POORLY-GRADED SAND:** SP, fine to medium sand. 83' fine sand.	SP									
			84, 85	84 - 86' **SILT WITH SAND:** ML, wet.	ML									
			86, 87, 88	86 - 88.5' **LEAN CLAY:** CL.	CL									
			89	88.5 - 90' **SILT WITH SAND:** ML, dry.	ML									
			90	90' End of Boring.										

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Plant		105

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jason Greer Cascade Drilling	3/5/2021	3/6/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
105	Feet (NAVD88)	698.46 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,498.42 N, 1,148,535.89 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R

Lat ° ' "
Long ° ' "

Local Grid Location: Feet ☐ N ☐ S; Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 36		0	0 - 0.4' ASH.	(FILL) ASH									Drilled 7" override casing to 15' below ground surface (bgs)
			0.4–5	0.4 - 5' **FILL, GRAVELLY SILT:** g(ML), brown (10YR 4/3), angular, gravel, clay (10-30%), non-plastic, moist.	(FILL) g(ML)									
2 CS	60 48		5	5 - 9.5' **FILL, GRAVELLY SILT:** g(ML), very dark gray (10YR 3/1), clay (5-15%), sand (5-10%), ash and slag-like material, non-plastic, moist.	(FILL) g(ML)									CS= Core Sample
			7	7' black (10YR 2/1).										
			9.5	9.5 - 10' **LEAN CLAY:** CL, gray (10YR 5/1), silt (5-15%), very stiff, medium plasticity, moist.	CL				2					
3 SH	24 24		10	10 - 12.										SH= Shelby Tube

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 Street, Milwaukee,WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

Boring Number 105

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
4 CS	60 0		12	12 - 17' No Recovery.										
			13											
			14											
			15											
			16											
5 CS	36 36		17	17 - 20' **LEAN CLAY:** CL, gray (10YR 6/1), gravel (5-10%), firm to stiff, high plasticity, moist.					1					
			18		CL									
			19						0.5					
6 CS	60 60		20	20 - 30' **LEAN CLAY:** CL, pale brown (10YR 6/3), silt (10-20%), hard, low plasticity, moist.										
			21						4.5					
			22											
			23						4.5					
			24	24' dark gray (10YR 4/1).										
7 CS	60 60		25	25' gravel (0-5%).	CL				4.5					
			26						4.5					
			27						4.5					
			28											
			29						4.5					
8 MC	24 24		30	30 - 32' Advanced Modified California sample.										MC= Modified California
			31											
			32											

Boring Number 105

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
9 CS	36 36			32 - 55.4' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (10-20%), gravel (5-15%), hard, low plasticity, moist.										
			33						4.5					
			34											
10 CS	60 60		35						4.5					
			36						4.5					
			37						4.5					
			38						4					
			39											
11 CS	60 60		40	40' very stiff to hard.					2					
			41						4					
			42		CL									
			43						4.5					
			44											
12 CS	60 60		45						3.5					
			46											
			47						3					
			48											
			49						3					
13 CS	60 60		50											
			51						1					
			52											

Boring Number 105

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
				32 - 55.4' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (10-20%), gravel (5-15%), hard, low plasticity, moist. *(continued)*	CL				3.5					
			53						2.5					
			54											
14 CS	60 60		55						3.5					
				55.4 - 56' **CLAYEY GRAVEL:** GC, gray (10YR 5/1), rounded, fine to coarse gravel, loose, moist to wet.	GC									
			56	56 - 60' **LEAN CLAY:** CL, gray (10YR 5/1), gravel (5-15%), hard, high plasticity, moist. 56.6' - 56.8' layer of fine gravel, wet.	CL									
			57						4					
			58											
			59						4.5					
15 MC	24 24		60	60 - 61.75' **POORLY-GRADED SAND WITH GRAVEL:** (SP)g, gray (10YR 5/1), subrounded, coarse sand, fine gravel, loose, wet.	(SP)g									
			61											
16 MC	24 18		62	61.75 - 70' **LEAN CLAY:** CL, gray (10YR 5/1), silt (10-20%), gravel (5-15%), hard, low plasticity, dry to moist.										
			63											
17 CS	72 72		64	64 - 70' **LEAN CLAY:** CL, gray (10YR 5/1), gravel (5-15%), hard, high plasticity, moist.										
			65						4.5					
			66		CL									
			67	67.3' -67.5 layer of fine to coarse sand, moist to wet.	CL				4.5					
			68											
			69						3.5					
18 CS	60 60		70	70 - 71' **CLAYEY SAND:** SC, gray (10YR 6/1), fine sand, loose, moist to wet.	SC									
			71	71 - 75' **SILTY CLAY:** CL/ML, gray (10YR 6/1), gravel (5-15%), hard, low plasticity, moist.	CL/ML									
			72											

Boring Number 105

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				71 - 75' **SILTY CLAY:** CL/ML, gray (10YR 6/1), gravel (5-15%), hard, low plasticity, moist. *(continued)*	CL/ML				4.5					
			73						4.5					
			74											
19 CS	60 60		75	75 - 75.8' **SILT:** ML, gray (10YR 6/1), moist.	ML				4.5					
			76	75.8 - 90' **LEAN CLAY:** CL, gray (10YR 5/1), gravel (5-15%), hard, low plasticity, moist.										
			77						4.5					
			78											
			79											
20 CS	60 60		80											
			81						4.5					
			82											
			83		CL				4.5					
			84											
21 CS	60 60		85						4.5					
			86											
			87						4.5					
			88											
			89						4.5					
22 MC	24 24		90	90 - 92.										
			91											
			92											

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
23 CS	96 96			92 - 124.2' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist.										
			93						2.5					
			94											
			95						2.5					
			96											
			97						4.5					
			98											
			99	98.6' -99.0 layer of cobbles.					4.5					
24 CS	240 240		100											
			101						4					
			102		CL									
			103						4.25					
			104											
			105						4					
			106											
			107						3.75					
			108											
			109						4.25					
			110											
			111						4.5					
			112											

Boring Number 105

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
25 CS	240 240		113–124	92 - 124.2' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist. *(continued)*	CL				4.5, 4.5, 4.5, 4.5, 4, 3.75					
			124–125	124.2 - 124.6' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), rounded to subrounded, medium sand, gravel (0-5%), loose, wet.	SP-SM				4.25					
			125–126	124.6 - 126.4' gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist. 126.1' -126.4' layer of coarse sand.										
			127–132	126.4 - 137.2' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist.	CL				3.5, 2.75, 4					

Boring Number 105

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			133	126.4 - 137.2' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist. *(continued)*	CL				4					
			134											
			135						3.25					
			136											
			137	137.2 - 137.6' **POORLY-GRADED SAND WITH GRAVEL:** (SP)g, gray (10YR 5/1), subrounded to round, medium to coarse sand, loose, wet.	(SP)g				2.75					
			138	137.6 - 138.3' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist.	CL									
			139	138.3 - 138.7' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), subrounded to rounded, medium sand, silt (0-5%), clay nodules (0-5%), loose, wet.	SP-SM				2.75					
26 CS	240 240		140	138.7 - 160' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist.	CL									
			141						1.5					
			142											
			143						1.25					
			144											
			145						1.5					
			146											
			147						2.25					
			148											
			149						2.25					
			150											
			151						2.25					
			152											

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
			153	138.7 - 160' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist. *(continued)*					2.5					
			154											
			155						2.5					
			156		CL									
			157						2.5					
			158											
			159						2.5					
			160	160' End of Boring.										

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Plant		105S

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jason Greer Cascade Drilling	3/16/2021	3/16/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
105S	Feet (NAVD88)	698.97 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,488.62 N, 1,148,530.35 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location
Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample: Number and Type	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
			0	0 - 0.4' ASH, Blind drilled to 90 feet below ground surface. See 105D boring log for detailed lithology.	(FILL) ASH									No sand observed during drilling
			0.4	0.4 - 5' FILL, GRAVELLY SILT: g(ML).	(FILL) g(ML)									
			5	5 - 9.5' FILL, GRAVELLY SILT: g(ML).	(FILL) g(ML)									
			9.5	9.5 - 17' LEAN CLAY: CL.	CL									

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

Signature	Firm	
[signature]	Ramboll 234 W. Florida Street, Milwaukee, WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

Boring Number 105S

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
			13 – 17	9.5 - 17' **LEAN CLAY:** CL. *(continued)*	CL									
			17 – 20	17 - 20' **LEAN CLAY:** CL.	CL									
			20 – 32	20 - 32' **LEAN CLAY:** CL.	CL									

Boring Number 105S

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 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52	32 - 55.4' **LEAN CLAY:** CL.	CL									

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
				32 - 55.4' **LEAN CLAY:** CL. *(continued)*	CL									
				55.4 - 56' **CLAYEY GRAVEL:** GC.	GC									
				56 - 60' **LEAN CLAY:** CL.	CL									
				60 - 61.75' **POORLY-GRADED SAND WITH GRAVEL:** (SP)g.	(SP)g									
				61.75 - 70' **LEAN CLAY:** CL.	CL									
				64 - 70' **LEAN CLAY:** CL.	CL									
				70 - 71' **CLAYEY SAND:** SC.	SC									
				71 - 75' **SILTY CLAY:** CL/ML.	CL/ML									

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
			73–75	71 - 75' **SILTY CLAY:** CL/ML. *(continued)*	CL/ML									
			75	75 - 75.8' **SILT:** ML.	ML									
			76–90	75.8 - 90' **LEAN CLAY:** CL.	CL									
			90	90' End of Boring.										

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number	
Vermilion Power Plant		38A	
Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jason Greer Cascade Drilling	3/3/2021	3/3/2021	Mini Sonic
Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
	Feet (NAVD88)	Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane N, E Ⓔ/ W
1/4 of 1/4 of Section , T N, R

Lat ___° ___' ___"
Long ___° ___' ___"

Local Grid Location: Feet ☐ N ☐ S; Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				0 - 5' **LEAN CLAY:** CL, Blind driled to 5 feet below ground surface (ft bgs). See 38 boring log for detailed lithology.	CL									
1 SH	24 24			5 - 7' **SILTY SAND:** SM.	SM					17.1	31	13	44	SH= Shelby Tube
				7 - 8.2' **SANDY SILT:** s(ML).	s(ML)									
				8.2 - 15' **WELL-GRADED SAND WITH GRAVEL:** (SW)g, Blind drilled 7-21 feet bgs. See 38 boring log for detailed lithology.	(SW)g									
				15 - 15.4' **POORLY-GRADED GRAVEL:** GP.	GP									
				15.4 - 18.2' **LEAN CLAY:** CL.	CL									
				18.2 - 21' **POORLY-GRADED SAND:** SP.	SP									
2 MC	24 24			21 - 23' **POORLY-GRADED SAND WITH CLAY:** SP-SC.	SP-SC					12.6	11	4	9	MC= Modified California
				23' End of Boring.										

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 Street, Milwaukee,WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

RAMBOLL

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Plant		XCM02

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Russ Gordon Cascade Drilling	3/4/2021	3/4/2021	Mini Sonic

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

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane N, E Ⓔ/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location ☐ N ☐ S Feet ☐ E ☐ W Feet

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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 48			0 - 0.4' **TOPSOIL:**.										CS= Core Sample
			1	0.4 - 3.5' **FILL, SANDY SILT:** s(ML), brown (10YR 4/3), clay (0-30%), soft, moist.	(FILL) s(ML)									
			4	3.5 - 4.5' **FILL, LEAN CLAY:** CL, very dark grayish brown (10YR 3/2), fine sand (5-15%), medium plasticity, very stiff, moist.	(FILL) CL				2.5					
2 CS	60 60		5	4.5 - 15' ASH, gray (10YR 5/1), moist to wet.	(FILL) ASH									
			6	5.9' wet.										
			9	9' moist.										
3 CS	60 60		10											

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 Street, Milwaukee,WI 53204
Tel: (414) 837-3607
Fax: (414) 837-3608

SOIL BORING LOG INFORMATION SUPPLEMENT

Boring Number XCM02

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
				4.5 - 15' ASH, gray (10YR 5/1), moist to wet. *(continued)*										
			13	12.7' wet.										
				13.4' moist.	(FILL) ASH									
			14											
4 MC	24 24		15	15 - 17' ASH, gray (10YR 5/1), silt sized grains, wet.										MC= Modified California
										30.7	26		94.9	
			16		(FILL) ASH									
5 CS	96 96		17	17 - 35' ASH, gray (10YR 5/1), wet.										
			18											
			19											
			20											
			21											
			22											
			23											
			24		(FILL) ASH									
6 CS	60 60		25											
			26											
			27	27.5' -29' moist.										
			28											
			29	29' wet.										
7 CS	60 12		30											
			31											
			32											

Boring Number XCM02

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			33, 34	17 - 35' ASH, gray (10YR 5/1), wet. *(continued)*	(FILL) ASH									
8 MC	24 24		35, 36	35 - 37' ASH, gray (10YR 5/1), silt sized grains, wet.	(FILL) ASH					64.2	53		81.9	
9 CS	36 36		37, 38, 39	37 - 39.6' ASH, gray (10YR 5/1), wet.	(FILL) ASH									
10 CS	60 60		40, 41	39.6 - 42' **LEAN CLAY:** CL, yellowish brown (10YR 5/6), medium plasticity, stiff, moist.	CL				1.5					
			42, 43, 44, 45	42 - 45' **SANDY LEAN CLAY:** s(CL), yellowish brown (10YR 5/6), fine to medium sand, low plasticity, moist. 44.5' soft, wet.	s(CL)									
				45' End of Boring.										

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name Vermilion Power Plant	Local Grid Location of Well ____ft. ☐ N. ☐ S. ____ft. ☐ E. ☐ W.	Well Name
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___° ___' ___" Long. ___° ___' ___" or	36
Facility ID	St. Plane 1,281,168 ft. N, 1,148,446 ft. E. (E)/W	Date Well Installed 03/03/2021
Type of Well Well Code 11/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) Russ Gordon Cascade Drilling
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	

A. Protective pipe, top elevation 590.21 ft. MSL

B. Well casing, top elevation 589.96 ft. MSL

C. Land surface elevation 587.8 ft. MSL

D. Surface seal, bottom 586.8 ft. MSL 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 ☐
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):
Potable City Water

E. Bentonite seal, top 575.8 ft. MSL or 12.0 ft.

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

G. Filter pack, top 573.8 ft. MSL or 14.0 ft.

H. Screen joint, top 571.8 ft. MSL or 16.0 ft.

I. Well bottom 566.8 ft. MSL or 21.0 ft.

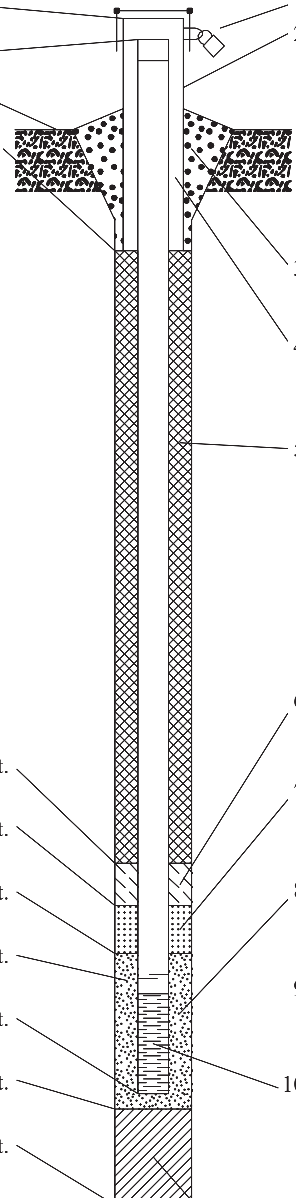
J. Filter pack, bottom 565.8 ft. MSL or 22.0 ft.

K. Borehole, bottom 565.8 ft. MSL or 22.0 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: 4 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. ____% 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. ____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. NA
b. Volume added 0 ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. FILTERSIL 0.85
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 ☐
Other ☐
b. Manufacturer Johnson Screens
c. Slot size: 0.010 in.
d. Slotted length: 5.0 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: 3/31/2021

Signature	Firm	
[signature]	Ramboll 234 W. Florida Street, Milwaukee,WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name: Vermilion Power Plant	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: 37
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___° ___' ___" Long. ___° ___' ___" or	
Facility ID	St. Plane 1,281,165 ft. N, 1,148,448 ft. E. Ⓔ/W	Date Well Installed: 03/03/2021
Type of Well: Well Code 12/pz	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) Russ Gordon, Cascade Drilling
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	

A. Protective pipe, top elevation 590.22 ft. MSL

B. Well casing, top elevation 589.71 ft. MSL

C. Land surface elevation 587.8 ft. MSL

D. Surface seal, bottom 586.8 ft. MSL 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 ☐ 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): Potable City Water

E. Bentonite seal, top 543.8 ft. MSL or 44.0 ft.

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

G. Filter pack, top 541.8 ft. MSL or 46.0 ft.

H. Screen joint, top 539.8 ft. MSL or 48.0 ft.

I. Well bottom 534.8 ft. MSL or 53.0 ft.

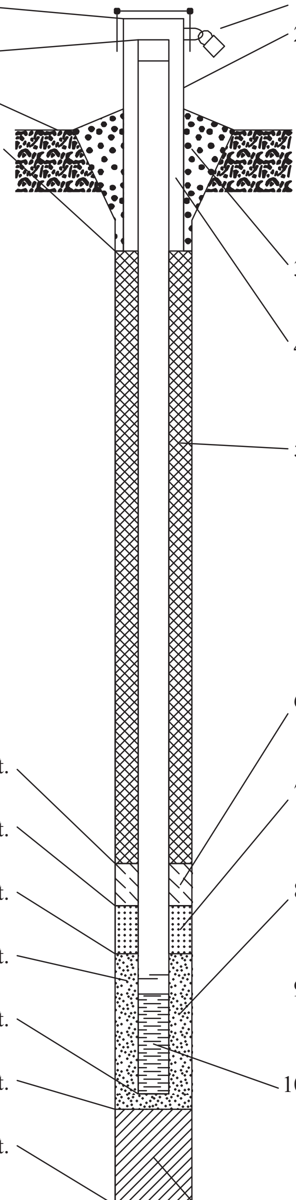
J. Filter pack, bottom 532.8 ft. MSL or 55.0 ft.

K. Borehole, bottom 525.8 ft. MSL or 62.0 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: 4 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. ____ 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. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐ Other ☐
    b. Manufacturer Johnson Screens
    c. Slot size: 0.010 in.
    d. Slotted length: 5.0 ft.
11. Backfill material (below filter pack): None ☐ Bentonite Chips Other ☐

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

Date Modified: 3/31/2021

Signature: [signature] | Firm: Ramboll, 234 W. Florida Street, Milwaukee,WI 53204 | Tel: (414) 837-3607 Fax: (414) 837-3608

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name Vermilion Power Plant	Local Grid Location of Well ______ft. ☐ N. ☐ S. ______ft. ☐ E. ☐ W.	Well Name
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___° ___' ___" Long. ___° ___' ___" or	38
Facility ID	St. Plane 1,283,326 ft. N, 1,148,649 ft. E. Ⓔ/W	Date Well Installed 03/03/2021
Type of Well Well Code 11/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) Jason Greer Cascade Drilling
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	

A. Protective pipe, top elevation 591.99 ft. MSL

B. Well casing, top elevation 591.69 ft. MSL

C. Land surface elevation 589.1 ft. MSL

D. Surface seal, bottom 588.1 ft. MSL 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 ☐
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):
Potable City Water

E. Bentonite seal, top 572.1 ft. MSL or 17.0 ft.

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

G. Filter pack, top 570.1 ft. MSL or 19.0 ft.

H. Screen joint, top 568.1 ft. MSL or 21.0 ft.

I. Well bottom 558.1 ft. MSL or 31.0 ft.

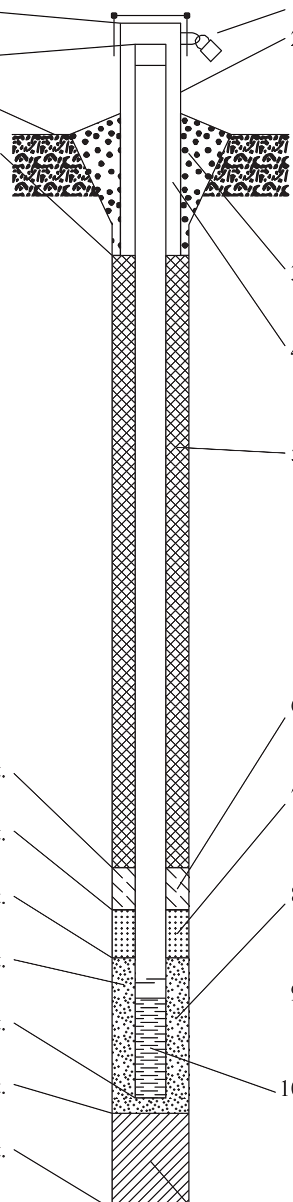
J. Filter pack, bottom 556.1 ft. MSL or 33.0 ft.

K. Borehole, bottom 552.1 ft. MSL or 37.0 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: 4 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. ____% 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. ____ Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
   a. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐
    Other ☐
    b. Manufacturer Johnson Screens
    c. Slot size: 0.010 in.
    d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☐
    Bentonite Chips Other ☒

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

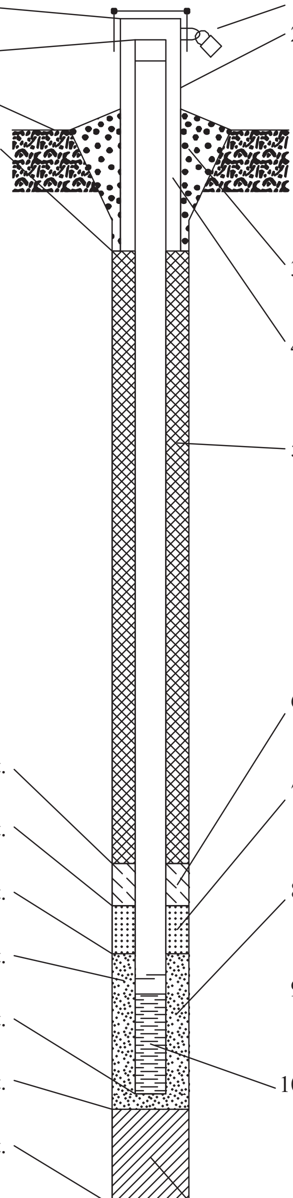
Date Modified: 3/31/2021

Signature	Firm	
[signature]	Ramboll 234 W. Florida Street, Milwaukee,WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name	Local Grid Location of Well	Well Name
Vermilion Power Plant	____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	41
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or	
Facility ID	St. Plane 1,282,008 ft. N, 1,148,556 ft. E. Ⓔ/W	Date Well Installed: 03/04/2021
Type of Well: Well Code 11/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) Russ Gordon, Cascade Drilling
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: ___	



A. Protective pipe, top elevation 587.66 ft. MSL

B. Well casing, top elevation 587.17 ft. MSL

C. Land surface elevation 585.1 ft. MSL

D. Surface seal, bottom 584.1 ft. MSL 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 ☐; 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):

    Potable City Water

E. Bentonite seal, top 568.1 ft. MSL or 17.0 ft.

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

G. Filter pack, top 566.1 ft. MSL or 19.0 ft.

H. Screen joint, top 564.1 ft. MSL or 21.0 ft.

I. Well bottom 554.1 ft. MSL or 31.0 ft.

J. Filter pack, bottom 552.1 ft. MSL or 33.0 ft.

K. Borehole, bottom 548.1 ft. MSL or 37.0 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: 4 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. ____ % 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. ____ Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
   a. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐; Other ☐
    b. Manufacturer Johnson Screens
    c. Slot size: 0.010 in.
    d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☐; Bentonite Chips Other ☒

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

Date Modified: 3/31/2021

Signature: [signature]

Firm: Ramboll
234 W. Florida Street, Milwaukee,WI 53204

Tel: (414) 837-3607
Fax: (414) 837-3608

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name: Vermilion Power Plant	Local Grid Location of Well: ______ ft. ☐ N. ☐ S. ______ ft. ☐ E. ☐ W.	Well Name: 42
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___° ___' ___" Long. ___° ___' ___" or St. Plane 1,281,034 ft. N, 1,147,693 ft. E. Ⓔ/W	
Facility ID		Date Well Installed: 03/08/2021
Type of Well: Well Code 12/pz	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): Dave Gordon, Cascade Drilling
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	

A. Protective pipe, top elevation 608.64 ft. MSL

B. Well casing, top elevation 608.40 ft. MSL

C. Land surface elevation 605.4 ft. MSL

D. Surface seal, bottom 604.4 ft. MSL 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 ☐
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):
Potable City Water

E. Bentonite seal, top 560.4 ft. MSL or 45.0 ft.

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

G. Filter pack, top 557.4 ft. MSL or 48.0 ft.

H. Screen joint, top 555.4 ft. MSL or 50.0 ft.

I. Well bottom 545.4 ft. MSL or 60.0 ft.

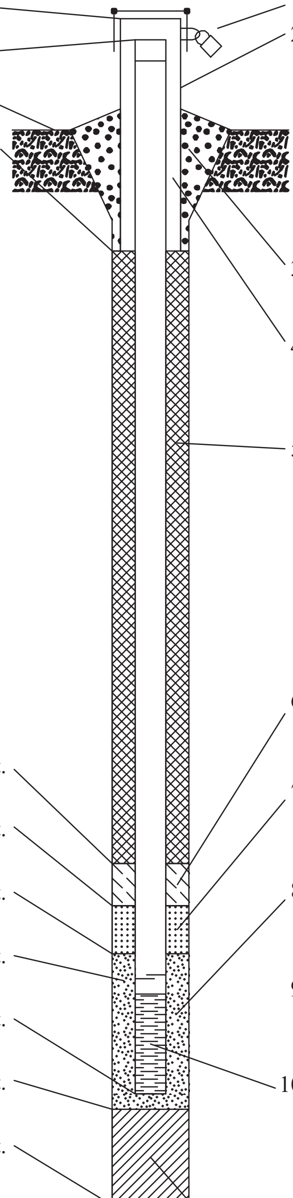
J. Filter pack, bottom 545.4 ft. MSL or 60.0 ft.

K. Borehole, bottom 545.4 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: 4 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. ______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. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐ Other ☐
    b. Manufacturer Johnson Screens
    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: 3/31/2021

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

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name: Vermilion Power Plant	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: 43
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ____ ° ____ ' ____ " Long. ____ ° ____ ' ____ " or	
Facility ID	St. Plane 1,281,796 ft. N, 1,147,229 ft. E. (E)/W	Date Well Installed: 03/08/2021
Type of Well: Well Code 12/pz	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) Russ Gordon, Cascade Drilling
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	

A. Protective pipe, top elevation 608.36 ft. MSL

B. Well casing, top elevation 607.84 ft. MSL

C. Land surface elevation 605.3 ft. MSL

D. Surface seal, bottom 604.3 ft. MSL 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 ☐; 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): Potable City Water

E. Bentonite seal, top 555.3 ft. MSL or 50.0 ft.

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

G. Filter pack, top 552.3 ft. MSL or 53.0 ft.

H. Screen joint, top 550.3 ft. MSL or 55.0 ft.

I. Well bottom 540.3 ft. MSL or 65.0 ft.

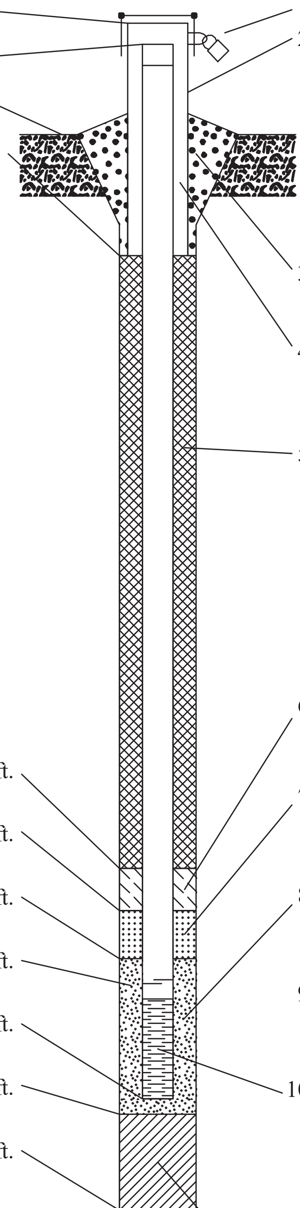
J. Filter pack, bottom 538.3 ft. MSL or 67.0 ft.

K. Borehole, bottom 530.3 ft. MSL or 75.0 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: 4 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. ____ 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. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐; Other ☐
    b. Manufacturer Johnson Screens
    c. Slot size: 0.010 in.
    d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☐; Bentonite Chips Other ☒

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

Date Modified: 3/31/2021

Signature: [signature]

Firm: Ramboll, 234 W. Florida Street, Milwaukee, WI 53204

Tel: (414) 837-3607
Fax: (414) 837-3608

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name: Vermilion Power Plant

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

Well Name: 44

Facility License, Permit or Monitoring No.:

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

Lat. ___° ___' ___" Long. ___° ___' ___" or

Facility ID:

St. Plane 1,281,793 ft. N, 1,147,232 ft. E. Ⓔ/W

Date Well Installed: 03/08/2021

Type of Well: Well Code 12/pz

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): Russ Gordon, Cascade Drilling

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:

A. Protective pipe, top elevation 608.24 ft. MSL

B. Well casing, top elevation 607.89 ft. MSL

C. Land surface elevation 605.4 ft. MSL

D. Surface seal, bottom 604.4 ft. MSL 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 ☐; 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): Potable City Water

E. Bentonite seal, top 565.4 ft. MSL or 40.0 ft.

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

G. Filter pack, top 562.4 ft. MSL or 43.0 ft.

H. Screen joint, top 560.4 ft. MSL or 45.0 ft.

I. Well bottom 555.4 ft. MSL or 50.0 ft.

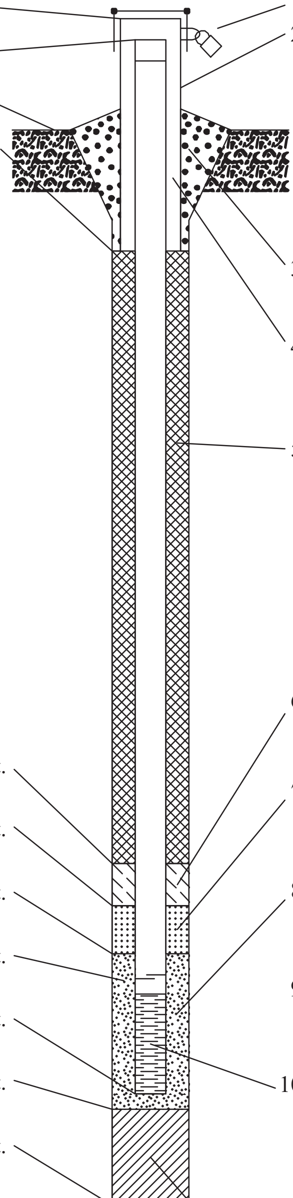
J. Filter pack, bottom 555.4 ft. MSL or 50.0 ft.

K. Borehole, bottom 555.4 ft. MSL or 50.0 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: 4 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. ____ 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. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐; Other ☐
    b. Manufacturer Johnson Screens
    c. Slot size: 0.010 in.
    d. Slotted length: 5.0 ft.
11. Backfill material (below filter pack): None ☐; Bentonite Chips Other ☒

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

Date Modified: 3/31/2021

Signature: [signature]

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

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name: Vermilion Power Plant	Local Grid Location of Well: ____ft. ☐ N. ☐ S. ____ft. ☐ E. ☐ W.	Well Name: 101
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___° ___' ___" Long. ___° ___' ___" or	
Facility ID	St. Plane 1,279,698 ft. N, 1,146,098 ft. E. Ⓔ/W	Date Well Installed: 03/06/2021
Type of Well: Well Code 12/pz	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) Jason Greer Cascade Drilling
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	

A. Protective pipe, top elevation 707.04 ft. MSL

B. Well casing, top elevation 706.67 ft. MSL

C. Land surface elevation 704.1 ft. MSL

D. Surface seal, bottom 703.1 ft. MSL 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 ☐; 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):
Potable City Water

E. Bentonite seal, top 571.1 ft. MSL or 133.0 ft.

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

G. Filter pack, top 567.1 ft. MSL or 137.0 ft.

H. Screen joint, top 563.1 ft. MSL or 141.0 ft.

I. Well bottom 553.1 ft. MSL or 151.0 ft.

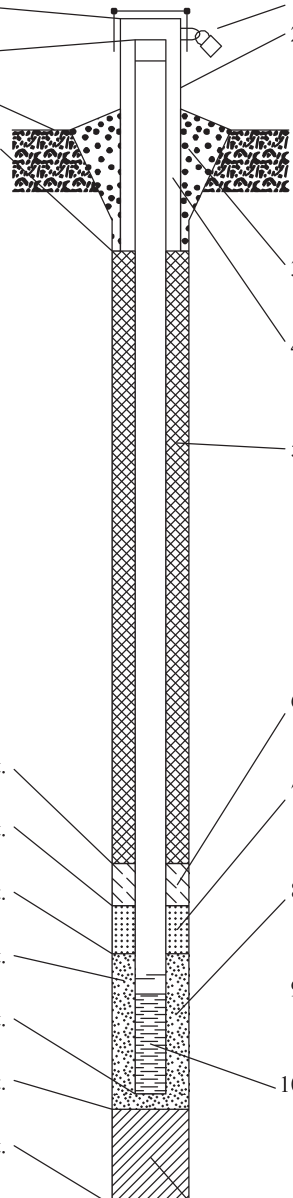
J. Filter pack, bottom 552.1 ft. MSL or 152.0 ft.

K. Borehole, bottom 544.1 ft. MSL or 160.0 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: 4 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. 9.1 Lbs/gal mud weight . . . Bentonite slurry ☒
   d. ____% 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. ____ Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
   a. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐; Other ☐
    b. Manufacturer Johnson Screens
    c. Slot size: 0.010 in.
    d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☐; Bentonite Grout Other ☒

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

Date Modified: 3/31/2021

Signature	Firm
[signature]	Ramboll 234 W. Florida Street, Milwaukee,WI 53204 Tel: (414) 837-3607 Fax: (414) 837-3608

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name: Vermilion Power Plant	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: 102
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ____ ° ____ ' ____ " Long. ____ ° ____ ' ____ " or	
Facility ID	St. Plane 1,279,245 ft. N, 1,147,171 ft. E. Ⓔ/W	Date Well Installed: 03/07/2021
Type of Well: Well Code 12/pz	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) Dave Gordon Cascade Drilling
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	

A. Protective pipe, top elevation 706.39 ft. MSL

B. Well casing, top elevation 705.97 ft. MSL

C. Land surface elevation 703.0 ft. MSL

D. Surface seal, bottom 702.0 ft. MSL 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 ☐ 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): Potable City Water

E. Bentonite seal, top 561.0 ft. MSL or 142.0 ft.

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

G. Filter pack, top 558.0 ft. MSL or 145.0 ft.

H. Screen joint, top 555.0 ft. MSL or 148.0 ft.

I. Well bottom 545.0 ft. MSL or 158.0 ft.

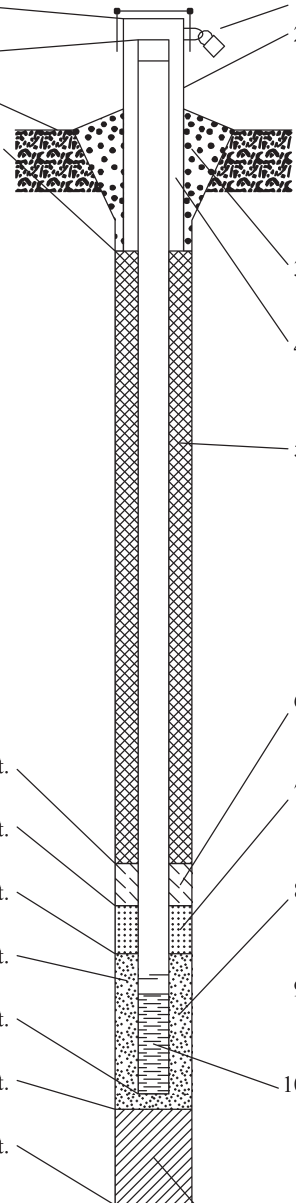
J. Filter pack, bottom 544.0 ft. MSL or 159.0 ft.

K. Borehole, bottom 543.0 ft. MSL or 160.0 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: 4 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. ____ 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. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐ Other ☐
    b. Manufacturer Johnson Screens
    c. Slot size: 0.010 in.
    d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☐ Formation Materials Other ☒

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

Date Modified: 3/25/2021

Signature	Firm	
[signature]	Ramboll 234 W. Florida Street, Milwaukee, WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name: Vermilion Power Plant	Local Grid Location of Well: ___ ft. ☐ N. ☐ S. ___ ft. ☐ E. ☐ W.	Well Name
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or	103
Facility ID	St. Plane 1,279,960 ft. N, 1,147,526 ft. E. Ⓔ/W	Date Well Installed: 03/09/2021
Type of Well: Well Code 12/pz	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) Jason Greer Cascade Drilling
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	

A. Protective pipe, top elevation 720.90 ft. MSL

B. Well casing, top elevation 720.38 ft. MSL

C. Land surface elevation 717.4 ft. MSL

D. Surface seal, bottom 716.4 ft. MSL 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 ☐
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):
Potable City Water

E. Bentonite seal, top 571.4 ft. MSL or 146.0 ft.

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

G. Filter pack, top 565.4 ft. MSL or 152.0 ft.

H. Screen joint, top 562.4 ft. MSL or 155.0 ft.

I. Well bottom 552.4 ft. MSL or 165.0 ft.

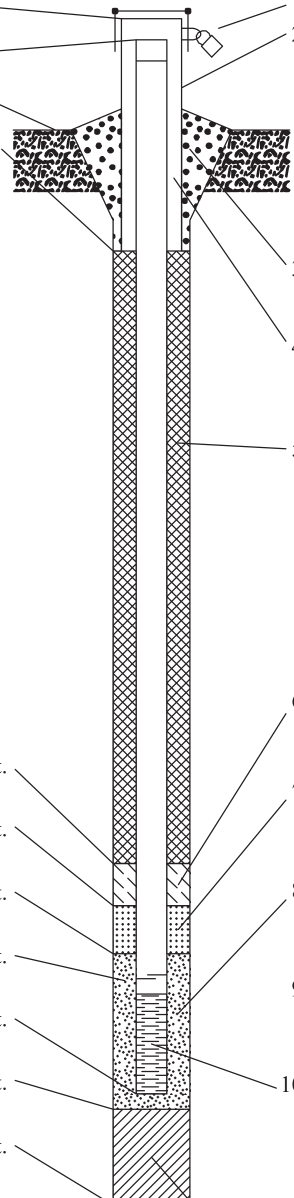
J. Filter pack, bottom 550.4 ft. MSL or 167.0 ft.

K. Borehole, bottom 540.4 ft. MSL or 177.0 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: 4 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. 9.2 Lbs/gal mud weight . . . Bentonite slurry ☒
   d. ___ % 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. ___ Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
   a. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐ Other ☐
    b. Manufacturer Johnson Screens
    c. Slot size: 0.010 in.
    d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☐
    Bentonite Chips Other ☒

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

Date Modified: 3/31/2021

Signature

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

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name: Vermilion Power Plant	Local Grid Location of Well: ____ft. ☐ N. ☐ S. ____ft. ☐ E. ☐ W.	Well Name: 104
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___° ___' ___" Long. ___° ___' ___" or St. Plane 1,279,173 ft. N, 1,147,574 ft. E. Ⓔ/W	
Facility ID	Section Location of Waste/Source: ____1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E ☐ W	Date Well Installed: 03/09/2021
Type of Well: Well Code 12/pz		Well Installed By: (Person's Name and Firm): Dave Gordon, Cascade Drilling
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	

A. Protective pipe, top elevation 706.43 ft. MSL

B. Well casing, top elevation 705.88 ft. MSL

C. Land surface elevation 703.2 ft. MSL

D. Surface seal, bottom 702.2 ft. MSL 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 ☐; 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): Potable City Water

E. Bentonite seal, top 558.2 ft. MSL or 145.0 ft.

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

G. Filter pack, top 556.2 ft. MSL or 147.0 ft.

H. Screen joint, top 551.2 ft. MSL or 152.0 ft.

I. Well bottom 541.2 ft. MSL or 162.0 ft.

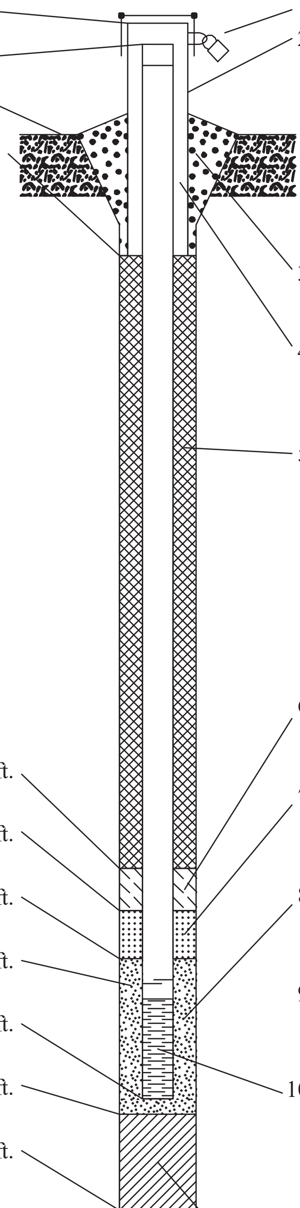
J. Filter pack, bottom 540.2 ft. MSL or 163.0 ft.

K. Borehole, bottom 533.2 ft. MSL or 170.0 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: 4 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. ____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. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐; Other ☐
   b. Manufacturer Johnson Screens
   c. Slot size: 0.010 in.
   d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☐; Bentonite Chips Other ☒

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

Date Modified: 3/25/2021

Signature: [signature]

Firm: Ramboll, 234 W. Florida Street, Milwaukee, WI 53204

Tel: (414) 837-3607
Fax: (414) 837-3608

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name: Vermilion Power Plant	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___° ___' ___" Long. ___° ___' ___" or St. Plane 1,279,498 ft. N, 1,148,536 ft. E. Ⓔ/W	105
Facility ID		Date Well Installed: 03/07/2021
Type of Well: Well Code 12/pz	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) Jason Greer Cascade Drilling
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: ____	

A. Protective pipe, top elevation 702.04 ft. MSL

B. Well casing, top elevation 701.55 ft. MSL

C. Land surface elevation 698.5 ft. MSL

D. Surface seal, bottom 697.5 ft. MSL 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 ☐
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):
Potable City Water

E. Bentonite seal, top 576.5 ft. MSL or 122.0 ft.

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

G. Filter pack, top 571.5 ft. MSL or 127.0 ft.

H. Screen joint, top 569.5 ft. MSL or 129.0 ft.

I. Well bottom 559.5 ft. MSL or 139.0 ft.

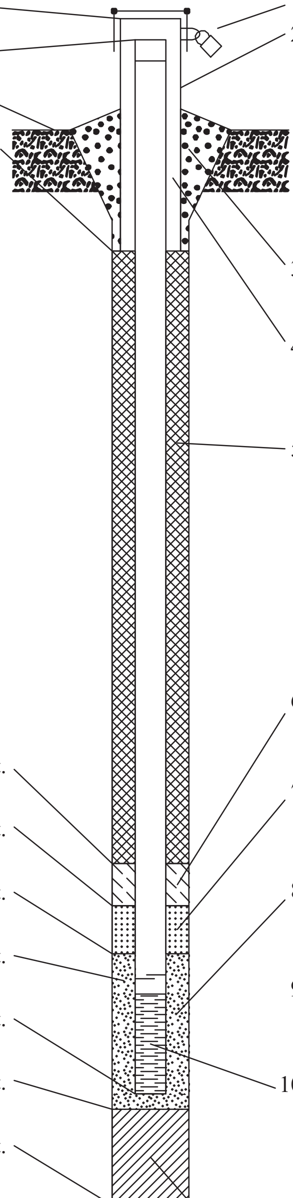
J. Filter pack, bottom 557.0 ft. MSL or 141.5 ft.

K. Borehole, bottom 538.5 ft. MSL or 160.0 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: 4 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. 9.2 Lbs/gal mud weight . . . Bentonite slurry ☒
   d. ____ % 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. ____ Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
   a. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐ Other ☐
    b. Manufacturer Johnson Screens
    c. Slot size: 0.010 in.
    d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☐
    Bentonite Chips Other ☒

I hereby certify that the information on this form is true and correct to the best of my knowledge. Date Modified: 3/31/2021

Signature	Firm	
[signature]	Ramboll 234 W. Florida Street, Milwaukee, WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name Vermilion Power Plant	Local Grid Location of Well ______ft. ☐ N. ☐ S. ______ft. ☐ E. ☐ W.	Well Name
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___° ___' ___" Long. ___° ___' ___" or	101S
Facility ID	St. Plane 1,279,705 ft. N, 1,146,097 ft. E. Ⓔ/W	Date Well Installed 03/16/2021
Type of Well Well Code 12/pz	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) Dave Gordon Cascade Drilling
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	

A. Protective pipe, top elevation 707.70 ft. MSL

B. Well casing, top elevation 707.21 ft. MSL

C. Land surface elevation 704.1 ft. MSL

D. Surface seal, bottom 703.1 ft. MSL 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 ☐
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):
Potable City Water

E. Bentonite seal, top 649.1 ft. MSL or 55.0 ft.

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

G. Filter pack, top 646.1 ft. MSL or 58.0 ft.

H. Screen joint, top 643.1 ft. MSL or 61.0 ft.

I. Well bottom 638.1 ft. MSL or 66.0 ft.

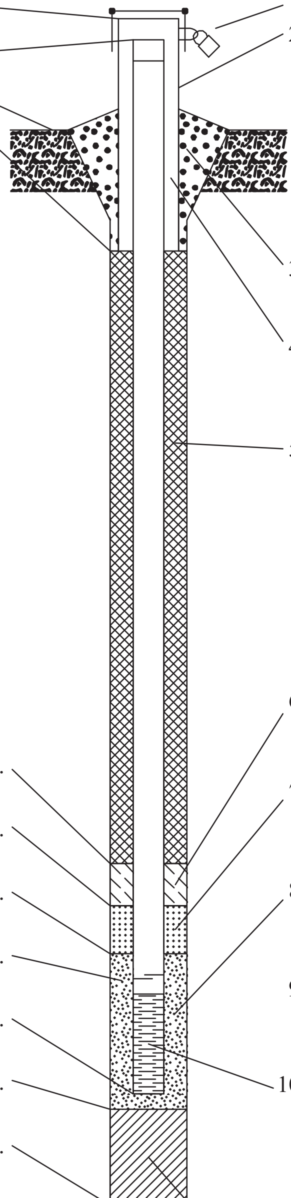
J. Filter pack, bottom 636.1 ft. MSL or 68.0 ft.

K. Borehole, bottom 616.1 ft. MSL or 88.0 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: 4 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. ___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. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐
    Other ☐
    b. Manufacturer Johnson Screens
    c. Slot size: 0.010 in.
    d. Slotted length: 5.0 ft.
11. Backfill material (below filter pack): None ☐
    Bentonite Chips Other ☒

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

Date Modified: 3/25/2021

Signature

Firm Ramboll
234 W. Florida Street, Milwaukee,WI 53204

Tel: (414) 837-3607
Fax: (414) 837-3608

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name: Vermilion Power Plant	Local Grid Location of Well: ___ft. ☐ N. ☐ S. ___ft. ☐ E. ☐ W.	Well Name
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___° ___' ___" Long. ___° ___' ___" or	102S
Facility ID	St. Plane 1,279,239 ft. N, 1,147,169 ft. E. (E)/W	Date Well Installed: 03/16/2021
Type of Well: Well Code 12/pz	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) Dave Gordon, Cascade Drilling
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	

A. Protective pipe, top elevation 706.44 ft. MSL

B. Well casing, top elevation 705.90 ft. MSL

C. Land surface elevation 702.9 ft. MSL

D. Surface seal, bottom 701.9 ft. MSL 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 ☐ 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): Potable City Water

E. Bentonite seal, top 636.9 ft. MSL or 66.0 ft.

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

G. Filter pack, top 633.9 ft. MSL or 69.0 ft.

H. Screen joint, top 630.9 ft. MSL or 72.0 ft.

I. Well bottom 625.9 ft. MSL or 77.0 ft.

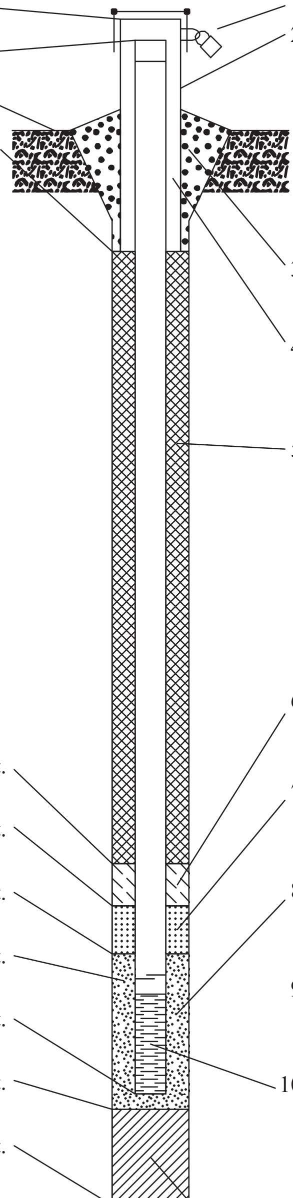
J. Filter pack, bottom 624.9 ft. MSL or 78.0 ft.

K. Borehole, bottom 612.9 ft. MSL or 90.0 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: 4 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. ___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. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐ Other ☐
    b. Manufacturer Johnson Screens
    c. Slot size: 0.010 in.
    d. Slotted length: 5.0 ft.
11. Backfill material (below filter pack): None ☐ Bentonite Chips Other ☒

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

Date Modified: 3/25/2021

Signature: [signature]

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

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name Vermilion Power Plant	Local Grid Location of Well ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name 103S
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or	
Facility ID	St. Plane 1,279,964 ft. N, 1,147,511 ft. E. (E)/W	Date Well Installed 03/15/2021
Type of Well Well Code 12/pz	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) Jason Greer Cascade Drilling
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	

A. Protective pipe, top elevation 721.47 ft. MSL

B. Well casing, top elevation 721.00 ft. MSL

C. Land surface elevation 717.6 ft. MSL

D. Surface seal, bottom 716.6 ft. MSL 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 ☐
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):
Potable City Water

E. Bentonite seal, top 659.6 ft. MSL or 58.0 ft.

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

G. Filter pack, top 655.6 ft. MSL or 62.0 ft.

H. Screen joint, top 652.6 ft. MSL or 65.0 ft.

I. Well bottom 647.6 ft. MSL or 70.0 ft.

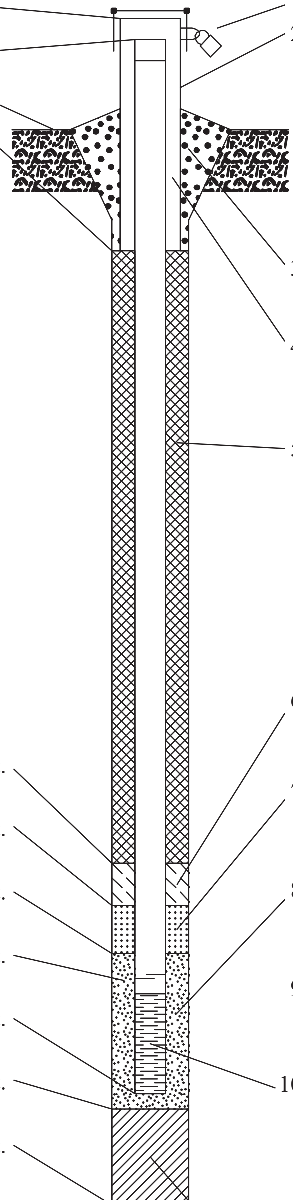
J. Filter pack, bottom 645.6 ft. MSL or 72.0 ft.

K. Borehole, bottom 637.6 ft. MSL or 80.0 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: 4 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. 9.2 Lbs/gal mud weight . . . Bentonite slurry ☒
   d. ____ % 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. ____ Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
   a. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐
    Other ☐
    b. Manufacturer Johnson Screens
    c. Slot size: 0.010 in.
    d. Slotted length: 5.0 ft.
11. Backfill material (below filter pack): None ☐
    Bentonite Grout Other ☒

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

Date Modified: 3/31/2021

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

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name	Local Grid Location of Well	Well Name
Vermilion Power Plant	______ft. ☐ N. ☐ S. ______ft. ☐ E. ☐ W.	
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐	104S
	Lat. ___° ___' ___" Long. ___° ___' ___" or	
Facility ID	St. Plane 1,279,172 ft. N, 1,147,579 ft. E. Ⓔ/W	Date Well Installed: 03/16/2021
	Section Location of Waste/Source	
Type of Well: Well Code 12/pz	___1/4 of ___ 1/4 of Sec. ___, T. ___ N, R. ___ ☐ E ☐ W	Well Installed By: (Person's Name and Firm) Dave Gordon
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	Cascade Drilling

A. Protective pipe, top elevation 706.08 ft. MSL

B. Well casing, top elevation 705.71 ft. MSL

C. Land surface elevation 703.1 ft. MSL

D. Surface seal, bottom 702.1 ft. MSL 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 ☐
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):
Potable City Water

E. Bentonite seal, top 633.1 ft. MSL or 70.0 ft.

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

G. Filter pack, top 630.1 ft. MSL or 73.0 ft.

H. Screen joint, top 627.1 ft. MSL or 76.0 ft.

I. Well bottom 617.1 ft. MSL or 86.0 ft.

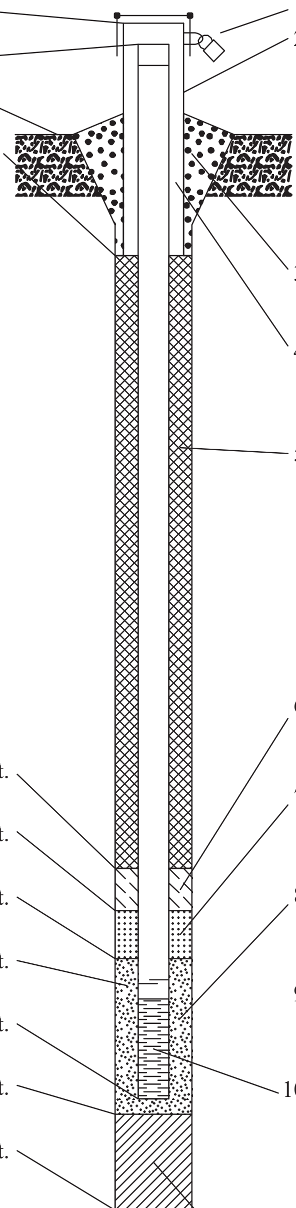
J. Filter pack, bottom 616.1 ft. MSL or 87.0 ft.

K. Borehole, bottom 613.1 ft. MSL or 90.0 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: 4 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. ______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. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐ Other ☐
    b. Manufacturer Johnson Screens
    c. Slot size: 0.010 in.
    d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☐
    Bentonite Chips Other ☒

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

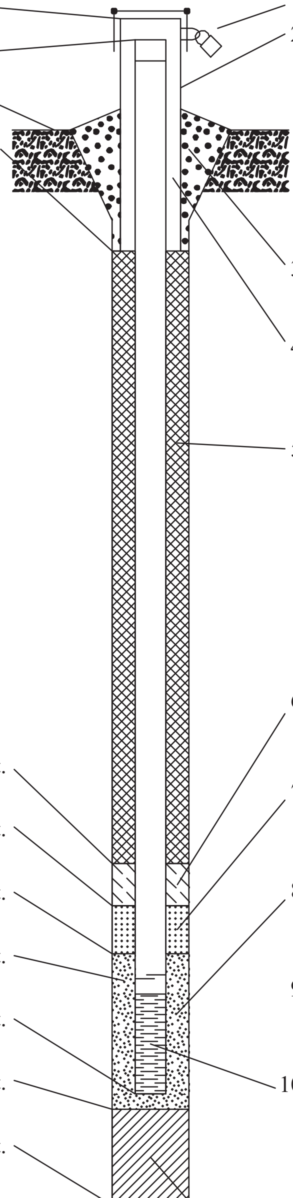
Date Modified: 3/25/2021

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

RAMBOLL

MONITORING WELL CONSTRUCTION

Facility/Project Name	Local Grid Location of Well	Well Name
Vermilion Power Plant	____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	105S
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐	
	Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or	
Facility ID	St. Plane 1,279,489 ft. N, 1,148,530 ft. E. Ⓔ/W	Date Well Installed: 03/16/2021
Type of Well: Well Code 12/pz	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) Jason Greer, Cascade Drilling
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



A. Protective pipe, top elevation 702.55 ft. MSL

B. Well casing, top elevation 702.10 ft. MSL

C. Land surface elevation 699.0 ft. MSL

D. Surface seal, bottom 698.0 ft. MSL 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 ☐ 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): Potable City Water

E. Bentonite seal, top 639.0 ft. MSL or 60.0 ft.

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

G. Filter pack, top 636.0 ft. MSL or 63.0 ft.

H. Screen joint, top 634.0 ft. MSL or 65.0 ft.

I. Well bottom ____ ft. MSL or ____ ft.

J. Filter pack, bottom 622.0 ft. MSL or 77.0 ft.

K. Borehole, bottom 609.0 ft. MSL or 90.0 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: 4 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. 9.2 Lbs/gal mud weight . . . Bentonite slurry ☒
   d. ____ % 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. ____ Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
   a. NA
   b. Volume added 0 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. FILTERSIL 0.85
   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 ☐ Other ☐
   b. Manufacturer Johnson Screens
   c. Slot size: 0.010 in.
   d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☐ Bentonite Grout Other ☒

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

Date Modified: 3/31/2021

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

HISTORIC BORING AND WELL CONSTRUCTION LOGS

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Vermilion Well #: ND1

Site Name: Vermilion Power Station Borehole #: ND1

State Plane Coordinate: X 1,147,744.9 Y 1,281,592.6 (or) Latitude: 40° 11' 3.550" Longitude: 87° 44' 53.430"

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: B Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/4/2019 Date Finished: 2/4/2019

Report Form Completed By: Rhonald W. Hasenyager Date: 3/6/2019

ANNULAR SPACE DETAILS

Type of Surface Seal: Bentonite chips

Type of Annular Sealant: ______

Installation Method: ______

Setting Time: ______

Type of Bentonite Seal -- Granular (circled) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: +24 hrs.

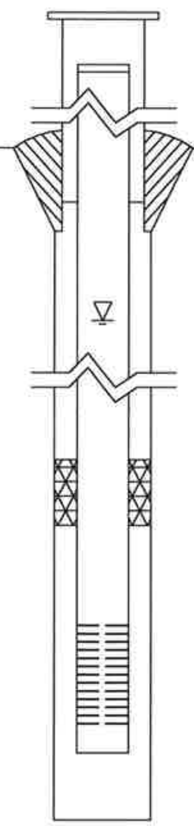
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
		Top of Protective Casing
616.28	-2.96	Top of Riser Pipe
613.32	0.00	Ground Surface
		Top of Annular Sealant
594.70	18.62	Static Water Level (After Completion) 2/20/2019
613.32	0.00	Top of Seal
601.11	12.21	Top of Sand Pack
599.41	13.91	Top of Screen
584.80	28.52	Bottom of Screen
584.31	29.01	Bottom of Well
583.30	30.02	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	n/a
Riser Pipe Length	(feet)	16.82
Bottom of Screen to End Cap	(feet)	0.49
Screen Length (1st slot to last slot)	(feet)	14.65
Total Length of Casing	(feet)	31.96
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: None (circled)
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC (circled)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC (circled)	OTHER:
Screen	SS304	SS316	PTFE	PVC (circled)	OTHER:

Well Completion Form (revised 02/06/02)

FIELD BORING LOG

HANSON

CLIENT: Vistra Energy Corp.
Site: Vermilion Power Station
Location: Oakwood, IL
Project: 18E0141
DATES: Start: 2/4/2019
Finish: 2/4/2019
WEATHER: Overcast, mild (mid-50's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 4¼" Hollow Stem Auger

FIELD STAFF: Driller: B Williamson
Helper: D Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ND1
Well ID: ND1
Surface Elev: 613.32 ft. MSL
Completion: 30.02 ft. BGS
Station: 1,281,592.61N
1,147,744.85E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, Tier 20N.; Range 12W.

WATER LEVEL INFORMATION:
▼ = 16.00 - durring drilling
▼ = 18.62 - 2/20/2019
▽ =

SAMPLE			TESTING								
Number	Recov / Total (in) % Recovery	Type	Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/60 0%	BD					0–6	Dark gray, moist, ASH.			
	0/60 0%	BD					6–16	Dark gray, moist to wet, ASH.			
	0/60 0%	BD									
	0/60 0%	BD					16–20	Dark gray, wet, ASH.			

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20
Elevation scale: 612, 610, 608, 606, 604, 602, 600, 598, 596, 594

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Vistra Energy Corp.
Site: Vermilion Power Station
Location: Oakwood, IL
Project: 18E0141
DATES: Start: 2/4/2019
Finish: 2/4/2019
WEATHER: Overcast, mild (mid-50's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 4¼" Hollow Stem Auger

FIELD STAFF: Driller: B Williamson
Helper: D Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ND1
Well ID: ND1
Surface Elev: 613.32 ft. MSL
Completion: 30.02 ft. BGS
Station: 1,281,592.61N
1,147,744.85E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, **Tier** 20N.; **Range** 12W.

WATER LEVEL INFORMATION:
▼ = 16.00 - durring drilling
▼ = 18.62 - 2/20/2019
∇ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/60 *0%*	BD					22–24	Dark gray, wet, ASH. *[Continued from previous page]*		592, 590	
	0/36 *0%*	BD					26–28			588, 586	
	24/24 *100%*	SS	*1-0* *1-0* N=1				28–30	Dark gray, wet, laminated ASH.		584	

End of Boring = 30 ft.

NOTE(S):

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Vermilion Well #: ND2

Site Name: Vermilion Power Station Borehole #: ND2

State Plane Coordinate: X 1,147,871.8 Y 1,281,395.3 (or) Latitude: 40° 11' 1.590" Longitude: 87° 44' 51.810"

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: B Williamson

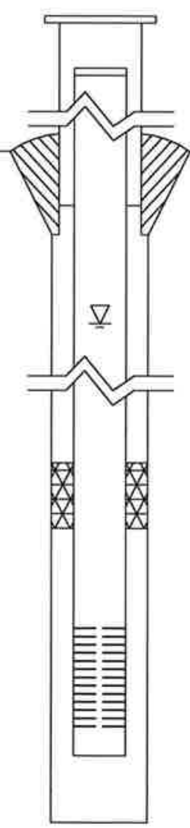
Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/5/2019 Date Finished: 2/5/2019

Report Form Completed By: Rhonald W. Hasenyager Date: 3/6/2019

ANNULAR SPACE DETAILS



	Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
			Top of Protective Casing
	612.07	-1.80	Top of Riser Pipe
Type of Surface Seal: Bentonite chips	610.27	0.00	Ground Surface
Type of Annular Sealant: ______			Top of Annular Sealant
Installation Method: ______			
Setting Time: ______	592.47	17.80	Static Water Level (After Completion) 2/20/2019
Type of Bentonite Seal -- Granular (circled) / Pellet / Slurry (choose one)			
Installation Method: Gravity	610.27	0.00	Top of Seal
Setting Time: +24 hrs.	596.29	13.98	Top of Sand Pack
Type of Sand Pack: Quartz sand			
Grain Size: 10/20 (sieve size)	595.10	15.17	Top of Screen
Installation Method: Gravity			
	580.44	29.83	Bottom of Screen
Type of Backfill Material: ______ (if applicable)	579.95	30.32	Bottom of Well
Installation Method: ______	579.95	30.32	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	n/a
Riser Pipe Length	(feet)	16.96
Bottom of Screen to End Cap	(feet)	0.49
Screen Length (1st slot to last slot)	(feet)	14.66
Total Length of Casing	(feet)	32.11
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: None
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC (circled)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC (circled)	OTHER:
Screen	SS304	SS316	PTFE	PVC (circled)	OTHER:

FIELD BORING LOG

HANSON

CLIENT: Vistra Energy Corp.
Site: Vermilion Power Station
Location: Oakwood, IL
Project: 18E0141
DATES: Start: 2/5/2019
Finish: 2/5/2019
WEATHER: Overcast, cool (lo-30's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 4¼" Hollow Stem Auger

FIELD STAFF: Driller: B Williamson
Helper: D Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ND2
Well ID: ND2
Surface Elev: 610.27 ft. MSL
Completion: 30.32 ft. BGS
Station: 1,281,395.27N
1,147,871.78E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, **Tier** 20N.; **Range** 12W.

WATER LEVEL INFORMATION:
▼ = 8.00 - durring drilling
▼ = 17.80 - 2/20/2019
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/60 0%	BD					0–8	Dark gray, moist, ASH.			
	0/60 0%	BD									
	0/60 0%	BD					8–17	Dark gray, wet, ASH.			
	0/60 0%	BD					17–20	Dark gray, wet (fluid), ASH.			

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20
Elevation scale: 610, 608, 606, 604, 602, 600, 598, 596, 594, 592

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT:	Vistra Energy Corp.
Site:	Vermilion Power Station
Location:	Oakwood, IL
Project:	18E0141
DATES: Start:	2/5/2019
Finish:	2/5/2019
WEATHER:	Overcast, cool (lo-30's)
CONTRACTOR:	Ramsey Geotechnical Engineering, LLC
Rig mfg/model:	CME-550 ATV Drill
Drilling Method:	4¼" Hollow Stem Auger
FIELD STAFF: Driller:	B Williamson
Helper:	D Crump
Eng/Geo:	R. Hasenyager
BOREHOLE ID:	ND2
Well ID:	ND2
Surface Elev:	610.27 ft. MSL
Completion:	30.32 ft. BGS
Station:	1,281,395.27N 1,147,871.78E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, **Tier** 20N.; **Range** 12W.

WATER LEVEL INFORMATION:
▼ = 8.00 - durring drilling
▼ = 17.80 - 2/20/2019
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
										590	
	0/60 0%	BD					22			588	
							24			586	
								Dark gray, wet (fluid), ASH. *[Continued from previous page]*			
							26			584	
	0/60 0%	BD					28			582	
	0/4 0%	NR					30			580	

End of Boring = 30 ft.

NOTE(S):

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Vermilion Well #: ND3

Site Name: Vermilion Power Station Borehole #: ND3

State Plane Coordinate: X 1,147,978.3 Y 1,281,149.5 (or) Latitude: 40° 10' 59.160" Longitude: 87° 44' 50.460"

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: B Williamson

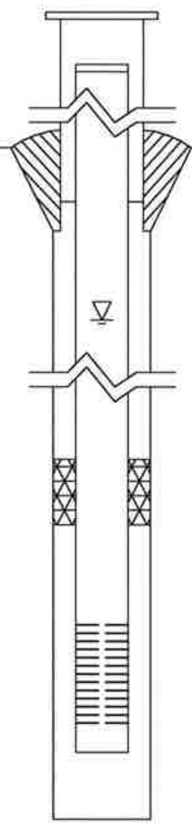
Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/5/2019 Date Finished: 2/5/2019

Report Form Completed By: Rhonald W. Hasenyager Date: 3/6/2019

ANNULAR SPACE DETAILS



	Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
			Top of Protective Casing
	614.42	-3.55	Top of Riser Pipe
Type of Surface Seal: Bentonite chips	610.87	0.00	Ground Surface
Type of Annular Sealant:			Top of Annular Sealant
Installation Method:			
Setting Time:	601.98	8.89	Static Water Level (After Completion) 2/20/2019
Type of Bentonite Seal -- Granular (circled) Pellet Slurry (choose one)			
Installation Method: Gravity	610.87	0.00	Top of Seal
Setting Time: +24 hrs.	604.37	6.50	Top of Sand Pack
Type of Sand Pack: Quartz sand			
Grain Size: 10/20 (sieve size)	602.22	8.65	Top of Screen
Installation Method: Gravity			
	587.56	23.31	Bottom of Screen
Type of Backfill Material: (if applicable)	587.00	23.87	Bottom of Well
Installation Method:	587.00	23.87	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	n/a
Riser Pipe Length	(feet)	12.36
Bottom of Screen to End Cap	(feet)	0.39
Screen Length (1st slot to last slot)	(feet)	14.66
Total Length of Casing	(feet)	27.41
Screen Slot Size **	(inches)	0.010

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: None
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

**Hand-Slotted Well Screens Are Unacceptable

FIELD BORING LOG

HANSON

CLIENT: Vistra Energy Corp.
Site: Vermilion Power Station
Location: Oakwood, IL
Project: 18E0141
DATES: Start: 2/5/2019
Finish: 2/5/2019
WEATHER: Overcast, cool (lo-30's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 4¼" Hollow Stem Auger

FIELD STAFF: Driller: B Williamson
Helper: D Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ND3
Well ID: ND3
Surface Elev: 610.87 ft. MSL
Completion: 23.87 ft. BGS
Station: 1,281,149.46N
1,147,978.28E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, **Tier** 20N.; **Range** 12W.

WATER LEVEL INFORMATION:
▼ = 8.00 - durring drilling
▼ = 8.89 - 2/20/2019
∇ =

SAMPLE: Number	SAMPLE: Recov / Total (in) % Recovery	SAMPLE: Type	TESTING: Blows / 6 in N - Value RQD	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft³)	TESTING: Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/60 0%	BD					0–5	Dark gray, wet, ASH.		610.87–605.87	
	0/60 0%	BD					5–10	Dark gray, wet, ASH. (▼ 8.00; ▼ 8.89)			
	0/60 0%	BD					10–15	Dark gray, wet (fluid), ASH.			
	0/60 0%	BD					15–20	Dark gray, wet (fluid), ASH.			

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Vistra Energy Corp.
Site: Vermilion Power Station
Location: Oakwood, IL
Project: 18E0141
DATES: Start: 2/5/2019
Finish: 2/5/2019
WEATHER: Overcast, cool (lo-30's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 4¼" Hollow Stem Auger

FIELD STAFF: Driller: B Williamson
Helper: D Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: ND3
Well ID: ND3
Surface Elev: 610.87 ft. MSL
Completion: 23.87 ft. BGS
Station: 1,281,149.46N
1,147,978.28E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, **Tier** 20N.; **Range** 12W.

WATER LEVEL INFORMATION:
▼ = 8.00 - durring drilling
▼ = 8.89 - 2/20/2019
▽ =

SAMPLE			TESTING									
Number	Recov / Total (in) / % Recovery	Type	Blows / 6 in / N - Value / RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/48 / 0%	BD					22	Dark gray, wet (fluid), ASH. *[Continued from previous page]*		590 / 588	

End of Boring = 24 ft.

NOTE(S):

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Vermilion Well #: NED1

Site Name: Vermilion Power Station Borehole #: NED1

State Plane Coordinate: X 1,150,574.4 Y 1,279,841.7 (or) Latitude: 40° 10' 46.060" Longitude: 87° 44' 17.120"

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: B Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Joe Kimlinger Date Started: 2/12/2019 Date Finished: 2/12/2019

Report Form Completed By: Rhonald W. Hasenyager Date: 3/6/2019

ANNULAR SPACE DETAILS

Type of Surface Seal: Bentonite chips

Type of Annular Sealant: ______

Installation Method: ______

Setting Time: ______

Type of Bentonite Seal -- Granular (circled) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: +24 hrs.

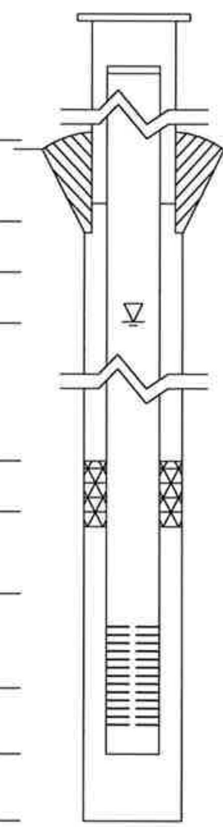
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: ______ (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
		Top of Protective Casing
599.87	-1.94	Top of Riser Pipe
597.93	0.00	Ground Surface
		Top of Annular Sealant
595.84	2.09	Static Water Level (After Completion) 2/20/2019
597.93	0.00	Top of Seal
594.43	3.50	Top of Sand Pack
592.61	5.32	Top of Screen
582.98	14.95	Bottom of Screen
582.49	15.44	Bottom of Well
582.49	15.44	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	n/a
Riser Pipe Length	(feet)	7.26
Bottom of Screen to End Cap	(feet)	0.49
Screen Length (1st slot to last slot)	(feet)	9.63
Total Length of Casing	(feet)	17.38
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: None (circled)
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC (circled)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC (circled)	OTHER:
Screen	SS304	SS316	PTFE	PVC (circled)	OTHER:

FIELD BORING LOG

HANSON

CLIENT: Vistra Energy Corp.
Site: Vermilion Power Station
Location: Oakwood, IL
Project: 18E0141
DATES: Start: 2/12/2019
Finish: 2/12/2019
WEATHER: Overcast, cool (hi-30's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 4¼" Hollow Stem Auger

FIELD STAFF: Driller: B Williamson
Helper: D Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: NED1
Well ID: NED1
Surface Elev: 597.93 ft. MSL
Completion: 15.44 ft. BGS
Station: 1,279,841.66N
1,150,574.39E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, **Tier** 20N.; **Range** 12W.

WATER LEVEL INFORMATION:
▼ = 3.00 - durring drilling
▼ = 2.09 - 2/20/2019
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0–3	Dark gray, moist, ASH.			
	0/60 0%	BD					0–5				
	0/60 0%	BD					5–10	Dark gray, wet, ASH. (3–15.5)			
	0/60 0%	BD					10–15				
	0/5 0%	NR					15–15.5				

End of Boring = 15.5 ft.

NOTE(S):

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Vermilion Well #: NED2

Site Name: Vermilion Power Station Borehole #: NED2

State Plane Coordinate: X 1,150,619.3 Y 1,279,587.4 (or) Latitude: 40° 10' 43.550" Longitude: 87° 44' 16.560"

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: B Williamson

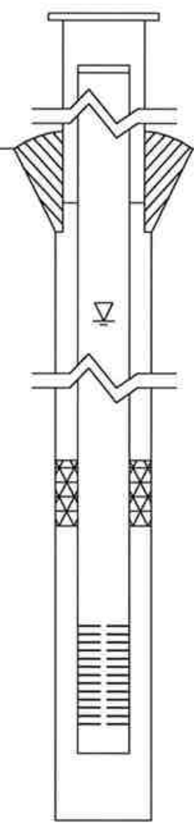
Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Joe Kimlinger Date Started: 2/12/2019 Date Finished: 2/12/2019

Report Form Completed By: Rhonald W. Hasenyager Date: 3/6/2019

ANNULAR SPACE DETAILS



Type of Surface Seal: Bentonite chips

Type of Annular Sealant: ______

Installation Method: ______

Setting Time: ______

Type of Bentonite Seal -- Granular / Pellet / Slurry (choose one): Granular

Installation Method: Gravity

Setting Time: +24 hrs.

Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: ______ (if applicable)

Installation Method: ______

Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
		Top of Protective Casing
600.81	-1.98	Top of Riser Pipe
598.83	0.00	Ground Surface
		Top of Annular Sealant
597.12	1.71	Static Water Level (After Completion) 2/20/2019
598.83	0.00	Top of Seal
596.03	2.80	Top of Sand Pack
593.94	4.89	Top of Screen
584.38	14.45	Bottom of Screen
583.89	14.94	Bottom of Well
583.89	14.94	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	n/a
Riser Pipe Length	(feet)	6.87
Bottom of Screen to End Cap	(feet)	0.49
Screen Length (1st slot to last slot)	(feet)	9.56
Total Length of Casing	(feet)	16.92
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: None
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC (selected)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC (selected)	OTHER:
Screen	SS304	SS316	PTFE	PVC (selected)	OTHER:

FIELD BORING LOG

HANSON

CLIENT: Vistra Energy Corp.
Site: Vermilion Power Station
Location: Oakwood, IL
Project: 18E0141
DATES: Start: 2/12/2019
Finish: 2/12/2019
WEATHER: Overcast, cool (hi-30's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 4¼" Hollow Stem Auger

FIELD STAFF: Driller: B Williamson
Helper: D Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: NED2
Well ID: NED2
Surface Elev: 598.83 ft. MSL
Completion: 14.94 ft. BGS
Station: 1,279,587.42N
1,150,619.28E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, **Tier** 20N.; **Range** 12W.

WATER LEVEL INFORMATION:
▼ = 3.00 - durring drilling
▼ = 1.71 - 2/20/2019
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/60 0%	BD					0–3	Dark gray, moist, ASH.		598–596	
							3–15	Dark gray, wet, ASH.		596–584	
	0/60 0%	BD									
	0/60 0%	BD									

End of Boring = 15.0 ft.

NOTE(S):

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Vermilion Well #: OED1

Site Name: Vermilion Power Station Borehole #: OED1

State Plane Coordinate: X 1,148,593.0 Y 1,280,610.5 (or) Latitude: 40° 10' 53.790" Longitude: 87° 44' 42.580"

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: B Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/6/2019 Date Finished: 2/6/2019

Report Form Completed By: Rhonald W. Hasenyager Date: 3/6/2019

ANNULAR SPACE DETAILS

Type of Surface Seal: Bentonite chips

Type of Annular Sealant: Bentonite grout

Installation Method: Tremie

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 15 hrs.

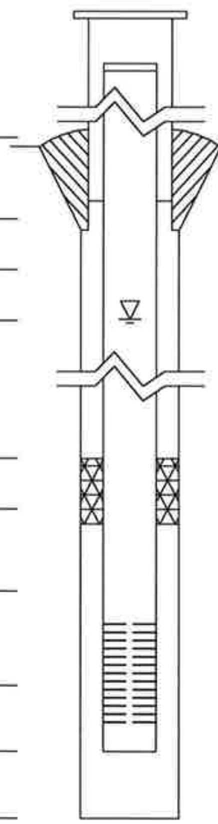
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: ______ (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
		Top of Protective Casing
630.24	-2.98	Top of Riser Pipe
627.26	0.00	Ground Surface
627.26	0.00	Top of Annular Sealant
591.16	36.10	Static Water Level (After Completion) 2/20/2019
607.58	19.68	Top of Seal
605.43	21.83	Top of Sand Pack
603.58	23.68	Top of Screen
583.92	43.34	Bottom of Screen
583.43	43.83	Bottom of Well
583.43	43.83	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	n/a
Riser Pipe Length	(feet)	26.92
Bottom of Screen to End Cap	(feet)	0.22
Screen Length (1st slot to last slot)	(feet)	19.66
Total Length of Casing	(feet)	46.80
Screen Slot Size **	(inches)	0.010

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: None
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

Well Completion Form (revised 02/06/02)

**Hand-Slotted Well Screens Are Unacceptable

FIELD BORING LOG

HANSON

CLIENT: Vistra Energy Corp.
Site: Vermilion Power Station
Location: Oakwood, IL
Project: 18E0141
DATES: Start: 2/6/2019
Finish: 2/6/2019
WEATHER: Overcast, cool (lo-30's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 4¼" Hollow Stem Auger

FIELD STAFF: Driller: B Williamson
Helper: D Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OED1
Well ID: OED1
Surface Elev: 627.26 ft. MSL
Completion: 43.83 ft. BGS
Station: 1,280,610.54N
1,148,592.98E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, **Tier** 20N.; **Range** 12W.

WATER LEVEL INFORMATION:
▼ = 9.00 - durring drilling
▼ = 36.10 - 2/20/2019
∇ =

SAMPLE: Number	SAMPLE: Recov / Total (in) % Recovery	SAMPLE: Type	TESTING: Blows / 6 in N - Value RQD	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft³)	TESTING: Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
	0/60 0%	BD					0–6	Yellowish brown, moist, medium, CLAY with some silt, little sand, and trace gravel.		
	0/60 0%	BD					6–9	Dark gray, moist, ASH.		
							9–11.5	Dark gray, wet, ASH.		
	0/60 0%	BD					11.5–13	Dark gray, moist, ASH.		
	0/60 0%	BD					13–20	Dark gray, wet, ASH.		

Depth ft. BGS: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20
Elevation ft. MSL: 626, 624, 622, 620, 618, 616, 614, 612, 610, 608

Borehole Detail


NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Vistra Energy Corp.
Site: Vermilion Power Station
Location: Oakwood, IL
Project: 18E0141
DATES: Start: 2/6/2019
Finish: 2/6/2019
WEATHER: Overcast, cool (lo-30's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 4¼" Hollow Stem Auger

FIELD STAFF: Driller: B Williamson
Helper: D Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OED1
Well ID: OED1
Surface Elev: 627.26 ft. MSL
Completion: 43.83 ft. BGS
Station: 1,280,610.54N
1,148,592.98E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, **Tier** 20N.; **Range** 12W.

WATER LEVEL INFORMATION:
▼ = 9.00 - durring drilling
▼ = 36.10 - 2/20/2019
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/60 0%	BD					22			606, 604	
	0/60 0%	BD					24–28			602, 600	
	0/60 0%	BD					30–34	Dark gray, wet, ASH. *[Continued from previous page]*		598, 596, 594	
	0/60 0%	BD					▼ 36, 38, 40			592, 590, 588	

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Vistra Energy Corp.
Site: Vermilion Power Station
Location: Oakwood, IL
Project: 18E0141
DATES: Start: 2/6/2019
Finish: 2/6/2019
WEATHER: Overcast, cool (lo-30's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 4¼" Hollow Stem Auger

FIELD STAFF: Driller: B Williamson
Helper: D Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OED1
Well ID: OED1
Surface Elev: 627.26 ft. MSL
Completion: 43.83 ft. BGS
Station: 1,280,610.54N
1,148,592.98E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, **Tier** 20N.; **Range** 12W.

WATER LEVEL INFORMATION:
▼ = 9.00 - durring drilling
▼ = 36.10 - 2/20/2019
▽ =

SAMPLE			TESTING								
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/46 *0%*	BD					42	Dark gray, wet, ASH. *[Continued from previous page]*		586	
								Yellowish brown, moist, medium, CLAY with some silt, little sand, and trace gravel.		584	

End of Boring = 44 ft.

NOTE(S):

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Vermilion Well #: OED2

Site Name: Vermilion Power Station Borehole #: OED2

State Plane Coordinate: X 1,148,961.7 Y 1,280,466.5 (or) Latitude: 40° 10' 52.340" Longitude: 87° 44' 37.840"

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: B Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/7/2019 Date Finished: 2/7/2019

Report Form Completed By: Rhonald W. Hasenyager Date: 3/6/2019

ANNULAR SPACE DETAILS

Type of Surface Seal: Bentonite chips

Type of Annular Sealant: ______

Installation Method: ______

Setting Time: ______

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: +24 hrs.

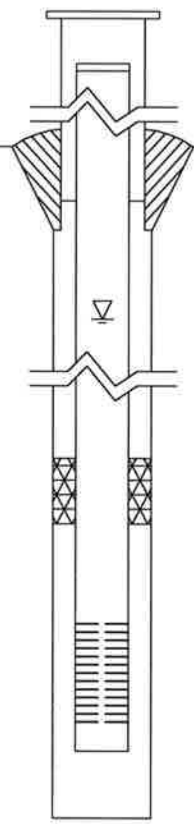
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: ______ (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
		Top of Protective Casing
640.99	-2.27	Top of Riser Pipe
638.72	0.00	Ground Surface
		Top of Annular Sealant
600.93	37.79	Static Water Level (After Completion) 2/20/2019
638.72	0.00	Top of Seal
620.51	18.21	Top of Sand Pack
618.60	20.12	Top of Screen
598.97	39.75	Bottom of Screen
628.48	10.24	Bottom of Well
598.48	40.24	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	n/a
Riser Pipe Length	(feet)	22.46
Bottom of Screen to End Cap	(feet)	0.41
Screen Length (1st slot to last slot)	(feet)	19.63
Total Length of Casing	(feet)	42.50
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: None
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

FIELD BORING LOG

HANSON

CLIENT: Vistra Energy Corp.
Site: Vermilion Power Station
Location: Oakwood, IL
Project: 18E0141
DATES: Start: 2/7/2019
Finish: 2/7/2019
WEATHER: Foggy, cool (lo-40's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 4¼" Hollow Stem Auger

FIELD STAFF: Driller: B Williamson
Helper: D Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OED2
Well ID: OED2
Surface Elev: 638.72 ft. MSL
Completion: 40.24 ft. BGS
Station: 1,280,466.48N
1,148,961.66E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, **Tier** 20N.; **Range** 12W.

WATER LEVEL INFORMATION:
▼ = 14.00 - durring drilling
▼ = 37.79 - 2/20/2019
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/60 0%	BD					0–7	Yellowish brown, moist, medium, CLAY with some silt, little sand, and trace gravel.		638–632	
	0/60 0%	BD					7–9	Yellowish brown, moist, medium, CLAY with some silt and trace sand.			
	0/60 0%	BD					9–14	Dark gray, moist, ASH.		630–626	
	0/60 0%	BD					14–21	Dark gray, wet, ASH.		624–618	

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20
Elevation scale: 638, 636, 634, 632, 630, 628, 626, 624, 622, 620, 618

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Vistra Energy Corp.
Site: Vermilion Power Station
Location: Oakwood, IL
Project: 18E0141
DATES: Start: 2/7/2019
Finish: 2/7/2019
WEATHER: Foggy, cool (lo-40's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 4¼" Hollow Stem Auger

FIELD STAFF: Driller: B Williamson
Helper: D Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OED2
Well ID: OED2
Surface Elev: 638.72 ft. MSL
Completion: 40.24 ft. BGS
Station: 1,280,466.48N
1,148,961.66E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, **Tier** 20N.; **Range** 12W.

WATER LEVEL INFORMATION:
▼ = 14.00 - durring drilling
▼ = 37.79 - 2/20/2019
▽ =

Number	Recov / Total (in) % Recovery	Type	Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/60 0%	BD					22–25	Dark gray, wet, ASH. [Continued from previous page]		616, 614	
	0/60 0%	BD					25–30			612, 610	
	0/60 0%	BD					30–35			608, 606, 604	Ash appears more granular with depth.
	0/60 0%	BD					35–40 (▼ 37.79)			602, 600	
	0/3 0%	NR					40				

End of Boring = 40 ft.

NOTE(S):

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Vermilion Well #: OED3

Site Name: Vermilion Power Station Borehole #: OED3

State Plane Coordinate: X 1,149,198.1 Y 1,280,388.2 (or) Latitude: 40° 10' 51.550" Longitude: 87° 44' 34.800"

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: B Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/7/2019 Date Finished: 2/7/2019

Report Form Completed By: Rhonald W. Hasenyager Date: 3/6/2019

ANNULAR SPACE DETAILS

Type of Surface Seal: Bentonite chips

Type of Annular Sealant: Bentonite grout

Installation Method: Tremie

Setting Time: +24 hrs.

Type of Bentonite Seal -- Granular (circled) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 30 min.

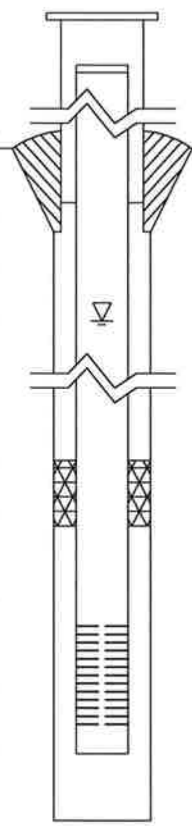
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: ______ (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
		Top of Protective Casing
648.04	-2.18	Top of Riser Pipe
645.86	0.00	Ground Surface
645.86	0.00	Top of Annular Sealant
	dry	Static Water Level (After Completion) 2/20/2019
635.14	10.72	Top of Seal
632.71	13.15	Top of Sand Pack
630.79	15.07	Top of Screen
611.12	34.74	Bottom of Screen
610.63	35.23	Bottom of Well
610.63	35.23	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	n/a
Riser Pipe Length	(feet)	17.28
Bottom of Screen to End Cap	(feet)	0.45
Screen Length (1st slot to last slot)	(feet)	19.67
Total Length of Casing	(feet)	37.40
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: None (circled)
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC (circled)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC (circled)	OTHER:
Screen	SS304	SS316	PTFE	PVC (circled)	OTHER:

Well Completion Form (revised 02/06/02)

FIELD BORING LOG

HANSON

CLIENT: Vistra Energy Corp.
Site: Vermilion Power Station
Location: Oakwood, IL
Project: 18E0141
DATES: Start: 2/7/2019
Finish: 2/7/2019
WEATHER: Foggy, cool (lo-40's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 4¼" Hollow Stem Auger

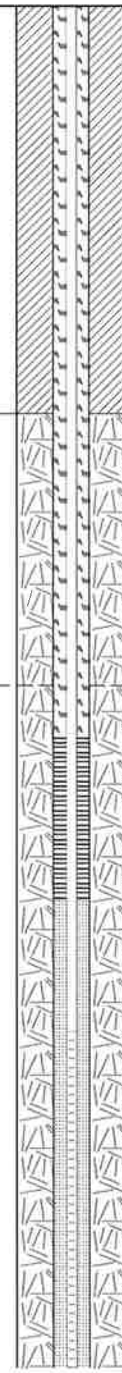
FIELD STAFF: Driller: B Williamson
Helper: D Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OED3
Well ID: OED3
Surface Elev: 645.86 ft. MSL
Completion: 35.23 ft. BGS
Station: 1,280,388.15N
1,149,198.09E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, **Tier** 20N.; **Range** 12W.

WATER LEVEL INFORMATION:
▼ = 6.00 - durring drilling
▼ = Dry - 2/20/2019
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) % Recovery	SAMPLE: Type	TESTING: Blows / 6 in N - Value RQD	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft³)	TESTING: Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/60 0%	BD					0–6	Yellowish brown, moist, medium, CLAY with some silt, little sand, and trace gravel.		645.86–640	
	0/60 0%	BD					6–10 (water level ▼ at 6)	Dark gray, moist, ASH.		640–636	
	0/60 0%	BD					10–20	Dark gray, wet, granular ASH.		636–626	
	0/60 0%	BD									



NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Vistra Energy Corp.
Site: Vermilion Power Station
Location: Oakwood, IL
Project: 18E0141
DATES: Start: 2/7/2019
Finish: 2/7/2019
WEATHER: Foggy, cool (lo-40's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: 4¼" Hollow Stem Auger

FIELD STAFF: Driller: B Williamson
Helper: D Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OED3
Well ID: OED3
Surface Elev: 645.86 ft. MSL
Completion: 35.23 ft. BGS
Station: 1,280,388.15N
1,149,198.09E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Danville NW
Township: Blount
Section 20, **Tier** 20N.; **Range** 12W.

WATER LEVEL INFORMATION:
▼ = 6.00 - durring drilling
▼ = Dry - 2/20/2019
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	0/60 0%	BD					22			624	
							24			622	
							26			620	
	0/60 0%	BD					28	Dark gray, wet, granular ASH. *[Continued from previous page]*		618	
							30			616	
	0/60 0%	BD					32			614	
							34			612	
	0/3 0%	NR									

End of Boring = 35 ft.

NOTE(S):

Project Number	175657154	Location	N 1281915.14, E 1148500.76
Project Name	Vermilion Power Station	Boring No.	B1-1
		Total Depth	74.9 ft
County	Vermilion, Illinois	Surface Elevation	585.9 ft
Project Type	Geotechnical Exploration	Date Started	10/4/18
		Completed	10/4/18
Supervisor	T. Ward	Depth to Water	13.4 ft
Driller	D. Bowles	Date/Time	10/4/18
Logged By	T. Ward	Depth to Water	N/A
		Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Sample # / RQD	Depth / Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
585.9	0.0	Top of Hole						
		Silty Clay with Gravel (Fill) (Visual), brown, dry, very stiff	SPT-1	0.0 - 1.5	1.4	8-12-15	--	Boring advanced using 3.25-inch ID HSA to 21.0 feet, mud rotary from 21.0 to 74.9 feet
			SPT-2	1.5 - 3.0	0.9	9-14-17	--	
582.2	3.7		SPT-3	3.0 - 4.5	1.0	6-8-7	--	
		Sandy Lean Clay (Visual), some sand, brown, moist, medium stiff	SPT-4	4.5 - 6.0	1.2	6-2-2	--	
579.0	6.9		SPT-5	6.0 - 7.5	0.6	1-1-2	--	
577.8	8.1	Silt with Sand (Visual), some sand, brown and light gray, wet, loose	SPT-6	7.5 - 9.0	1.3	8-5-6	--	
576.5	9.4	Lean Clay (Visual), some gravel, brown and gray, moist, stiff	SPT-7	9.0 - 10.5	1.1	6-5-6	--	
			SPT-8	10.5 - 12.0	1.5	6-5-6	--	
		Lean Clay (Till) (Visual), sandy, trace gravel, gray, moist, medium stiff to very stiff	SPT-9	12.0 - 13.5	1.4	4-6-9	--	
			SPT-10	13.5 - 15.0	1.5	3-5-6	--	
			SPT-11	15.0 - 16.5	1.5	4-5-7	--	
			SPT-12	16.5 - 18.0	1.4	5-5-5	--	
			SPT-13	18.0 - 19.5	1.5	3-3-5	--	
			SPT-14	19.5 - 21.0	1.0	2-3-4	--	
			SPT-15	23.5 - 25.0	1.5	5-7-7	--	
		-coarse sand from 29.7'-30.0'	SPT-16	28.5 - 30.0	1.4	5-8-21	--	
551.1	34.8	-fine sand from 34.2'-34.6'	SPT-17	33.5 - 35.0	1.0	16-18-23	--	

Project Number	175657154	Location	N 1281915.14, E 1148500.76
Project Name	Vermilion Power Station	Boring No.	**B1-1** Total Depth 74.9 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
543.9	42.0	Sand with Gravel (Visual), light brown, wet, medium dense *(Continued)*		SPT-18	38.5 - 40.0	1.5	13-17-19	--	
538.9	47.0	Gravelly Sand (Visual), light gray, wet, medium dense		SPT-19	43.5 - 45.0	1.0	9-15-20	--	
528.9	57.0	Lean Clay (Visual), some sand light to dark gray mottled, moist, stiff		SPT-20	48.5 - 50.0	0.6	3-2-2	--	
				SPT-21	53.5 - 55.0	1.5	4-4-6	--	
518.9	67.0	Sand (Visual), fine grained, light gray to brown, wet, medium dense		SPT-22	58.5 - 60.0	0.8	6-12-20	--	
				SPT-23	63.5 - 65.0	1.0	6-10-12	--	
513.9	72.0	Gravelly Sand (Visual), medium to coarse grained, light gray to brown, wet, dense		SPT-24	68.5 - 70.0	1.5	23-36-33	--	
		Shale							

SUBSURFACE LOG (DRAFT)

Project Number	175657154	Location	N 1281915.14, E 1148500.76
Project Name	Vermilion Power Station	Boring No.	**B1-1**
		Total Depth	74.9 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
511.0	74.9			SPT-25	73.5 - 74.9	0.4	21-32-50/0.4'	--	

Auger Refusal /
Bottom of Hole

Boring backfilled with grout upon completion.

SUBSURFACE LOG (DRAFT)

Project Number	175657154	Location	N 1281898.05, E 1148493.77
Project Name	Vermilion Power Station	Boring No.	**B1-2** Total Depth 21.0 ft
County	Vermilion, Illinois	Surface Elevation	586.3 ft
Project Type	Geotechnical Exploration	Date Started	10/3/18 Completed 10/3/18
Supervisor	T. Ward Driller D. Bowles	Depth to Water	7.5 ft Date/Time 10/3/18
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
586.3	0.0	Top of Hole						
		Silty Clay with Gravel and Sand (Fill) (Visual), brown, dry, very stiff	SPT-1	0.0 - 1.5	1.5	5-14-23	--	Boring advanced using 3.25-inch ID HSA
			SPT-2	1.5 - 3.0	1.5	14-10-7	--	
			SPT-3	3.0 - 4.5	1.5	9-9-10	--	
581.3	5.0	Lean Clay (Visual), trace gravel, brown, moist, medium stiff	SPT-4	4.5 - 6.0	1.1	7-4-4	--	
579.2	7.1	Sand with Silt (Visual), coarse grained, brown, moist to wet, loose	SPT-5	6.0 - 7.5	0.7	2-2-2	--	
			SPT-6	7.5 - 9.0	0.2	2-2-2	--	
576.0	10.3	Gravelly Sand (Visual), coarse grained sand, fine to medium grained gravel, wet, loose to medium dense	SPT-7	9.0 - 10.5	0.4	2-3-5	--	
			SPT-8	10.5 - 12.0	0.6	4-5-7	--	
			SPT-9	12.0 - 13.5	1.1	3-3-3	--	
571.9	14.4	Lean Clay (Till) (Visual), sand lenses throughout, some gravel, gray, moist, stiff to very stiff	SPT-10	13.5 - 15.0	1.0	4-7-12	--	
			SPT-11	15.0 - 16.5	0.0	6-23-30	--	No recovery, apparent cobble
			SPT-12	16.5 - 18.0	1.3	8-10-8	--	
			SPT-13	18.0 - 19.5	1.5	4-5-9	--	
565.3	21.0		SPT-14	19.5 - 21.0	1.5	2-4-4	--	

No Refusal /
Bottom of Hole

Boring backfilled with grout upon completion.

STANTEC/FMSM_LEGACY 175657154.GPJ FMSM-GRAPHIC LOG.GDT 10/5/18

SUBSURFACE LOG (DRAFT)

Project Number	175657154	Location	N 1281883.60, E 1148487.06
Project Name	Vermilion Power Station	Boring No.	**B1-3**
		Total Depth	21.0 ft
County	Vermilion, Illinois	Surface Elevation	586.5 ft
Project Type	Geotechnical Exploration	Date Started	10/3/18
		Completed	10/3/18
Supervisor	T. Ward	Depth to Water	7.5 ft
Driller	D. Bowles	Date/Time	10/3/18
Logged By	T. Ward	Depth to Water	N/A
		Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
586.5	0.0	Top of Hole						
		Silty Clay with Gravel (Fill) (Visual), roots, dark brown, moist, very stiff -gravel from 0.3'-1.5'	SPT-1	0.0 - 1.5	1.3	12-31-20	--	Boring advanced using 4.25-inch ID HSA
584.0	2.5		SPT-2	1.5 - 3.0	1.0	6-11-12	--	
		Sandy Lean Clay (Visual), brown, dry to moist, medium stiff to stiff	SPT-3	3.0 - 4.5	1.1	7-7-7	--	
			SPT-4	4.5 - 6.0	0.6	5-3-2	--	
579.3	7.2		SPT-5	6.0 - 7.5	1.1	2-1-2	--	
		Clayey Sand (Visual), fine grained, brown, wet, loose	SPT-6	7.5 - 9.0	0.4	3-2-2	--	
576.0	10.5		SPT-7	9.0 - 10.5	0.5	3-2-3	--	
		Gravel with Sand (Visual), fine grained with saturated coarse sand, brown, wet, medium dense	SPT-8	10.5 - 12.0	0.5	3-10-12	--	
573.9	12.6		SPT-9	12.0 - 13.5	0.9	6-5-7	--	
		Lean Clay (Till) (Visual), sand lenses throughout, gray with some brown, moist, stiff	SPT-10	13.5 - 15.0	0.9	7-4-4	--	
			SPT-11	15.0 - 16.5	1.1	2-5-7	--	
			SPT-12	16.5 - 18.0	1.5	4-4-5	--	
			SPT-13	18.0 - 19.5	1.2	2-4-5	--	
565.5	21.0		SPT-14	19.5 - 21.0	1.5	2-4-5	--	

No Refusal /
Bottom of Hole

Monitoring well installed to a depth of 16.0 feet.

SUBSURFACE LOG (DRAFT)

Project Number	175657154	Location	N 1281165.96, E 1148441.77
Project Name	Vermilion Power Station	Boring No.	**B2-1** Total Depth 24.0 ft
County	Vermilion, Illinois	Surface Elevation	588.2 ft
Project Type	Geotechnical Exploration	Date Started	10/3/18 Completed 10/3/18
Supervisor	T. Ward Driller D. Bowles	Depth to Water	11.6 ft Date/Time 10/3/18
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
588.2	0.0	Top of Hole						
585.2	3.0	Silty Clay with Gravel (Fill) (Visual), dark brown, dry to moist, stiff to very stiff	SPT-1	0.0 - 1.5	0.3	2-3-3	--	Boring advanced using 3.25-inch ID HSA
			SPT-2	1.5 - 3.0	1.2	5-6-10	--	
582.8	5.4	Lean Clay (Fill) (Visual), trace to some sand, moist to dry, very stiff	SPT-3	3.0 - 4.5	0.3	8-13-11	--	Apparent cobble
			SPT-4	4.5 - 6.0	0.9	6-5-5	--	
576.6	11.6	Sandy Lean Clay (Visual), some fine gravel, gray and brown, moist, medium stiff	SPT-5	6.0 - 7.5	1.1	3-3-3	--	
			SPT-6	7.5 - 9.0	1.2	3-2-2	--	
			SPT-7	9.0 - 10.5	0.5	2-3-2	--	
			SPT-8	10.5 - 12.0	1.4	2-2-1	--	
574.1	14.1	Clayey Sand (Visual), medium to coarse grained, brown, wet, very loose	SPT-9	12.0 - 13.5	1.5	WOH-WOH-1	--	
573.2	15.0	Sandy Lean Clay (Visual), some roots, gray with some brown, moist, soft	SPT-10	13.5 - 15.0	1.5	WOH-1-1	--	
			SPT-11	15.0 - 16.5	1.0	WOH-1-1	--	
569.2	19.0	Sand with Gravel (Visual), medium to coarse grained, trace gravel, brown, wet, very loose to medium dense	SPT-12	16.5 - 18.0	1.2	6-10-12	--	
			SPT-13	18.0 - 19.5	1.2	11-6-5	--	
564.2	24.0	Lean Clay (Visual), with coarse sand lenses throughout, trace gravel, brown to gray, moist, very stiff -sand from 19.5'-19.7' -fine sand from 21.5'-21.8' -coarse sand from 22.5'-22.8'	SPT-14	19.5 - 21.0	1.4	3-5-10	--	
			SPT-15	21.0 - 22.5	1.5	8-9-12	--	
			SPT-16	22.5 - 24.0	1.5	7-10-13	--	
		No Refusal / Bottom of Hole						

Boring backfilled with grout upon completion.

SUBSURFACE LOG (DRAFT)

Project Number	175657154	Location	N 1281153.56, E 1148452.38
Project Name	Vermilion Power Station	Boring No.	**B2-2** Total Depth 25.0 ft
County	Vermilion, Illinois	Surface Elevation	587.9 ft
Project Type	Geotechnical Exploration	Date Started	10/3/18 Completed 10/3/18
Supervisor	T. Ward Driller D. Bowles	Depth to Water	12.0 ft Date/Time 10/3/18
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
587.9	0.0	Top of Hole						
		Silty Clay (Fill) (Visual), some sand and gravel, brown, dry to moist, stiff to very stiff	SPT-1	0.0 - 1.5	1.2	2-4-7	--	Boring advanced using 3.25-inch ID HSA
585.1	2.8	-some roots at 1.5'	SPT-2	1.5 - 3.0	1.5	4-7-9	--	
		Lean Clay (Visual), some sand and gravel, brown and gray, moist, soft to very stiff	SPT-3	3.0 - 4.5	1.0	4-10-10	--	
			SPT-4	4.5 - 6.0	1.4	5-4-5	--	
			SPT-5	6.0 - 7.5	1.1	2-2-2	--	
		-increased sand, wet at 9.0'	SPT-6	7.5 - 9.0	1.5	2-1-2	--	
577.4	10.5		SPT-7	9.0 - 10.5	1.5	1-1-2	--	
575.9	12.0	Silt (Visual), trace gravel, brown, wet, soft	SPT-8	10.5 - 12.0	1.3	1-2-1	--	
574.4	13.5	Clayey Sand (Visual), light gray and brown, wet, very loose	SPT-9	12.0 - 13.5	1.5	1-1-1	--	
			SPT-10	13.5 - 15.0	1.2	1-2-2	--	
570.9	17.0	Sand with Gravel (Visual), fine to coarse grained, wet, loose	SPT-11	15.0 - 16.5	0.1	3-4-5	--	
		Gravel with Sand (Visual), coarse to fine grained, brown, wet, medium dense	SPT-12	16.5 - 18.0	1.5	8-10-15	--	
			SPT-13	18.0 - 19.5	0.1	12-6-7	--	
567.1	20.8		SPT-14	19.5 - 21.0	0.2	5-7-11	--	
		Lean Clay (Till) (Visual), sand lenses throughout, some gravel, gray with some brown, moist, stiff	SPT-15	21.0 - 22.5	1.5	3-5-6	--	
562.9	25.0		SPT-16	23.5 - 25.0	1.2	7-7-8	--	

No Refusal /
Bottom of Hole

Boring backfilled with grout upon completion.

STANTEC/FMSM_LEGACY 175657154.GPJ FMSM-GRAPHIC LOG.GDT 10/5/18

SUBSURFACE LOG (DRAFT)

Project Number	175657154	Location	N 1280855.93, E 1149170.11
Project Name	Vermilion Power Station	Boring No.	**B3-1** Total Depth 22.5 ft
County	Vermilion, Illinois	Surface Elevation	589.8 ft
Project Type	Geotechnical Exploration	Date Started	10/2/18 Completed 10/2/18
Supervisor	T. Ward Driller D. Bowles	Depth to Water	11.0 ft Date/Time 10/2/18
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
589.8	0.0	Top of Hole							
		Silty Clay (Fill) (Visual), with cobbles, dark brown to brown, dry, stiff to very stiff		SPT-1	0.0 - 1.5	0.7	5-12-10	--	Boring advanced using 3.25-inch ID HSA
				SPT-2	1.5 - 3.0	0.0	9-5-4	--	
		-fine gray sand from 4.5'-5.0'		SPT-3	3.0 - 4.5	0.6	5-5-5	--	
584.5	5.3			SPT-4	4.5 - 6.0	1.0	9-1-2	--	
		Sandy Lean Clay (Visual), brown with sand gray, moist to wet, medium stiff to stiff		SPT-5	6.0 - 7.5	1.3	3-6-6	--	
				SPT-6	7.5 - 9.0	1.5	2-2-2	--	
579.6	10.2			SPT-7	9.0 - 10.5	1.4	1-2-4	--	
578.8	11.0	Sand (Visual), coarse grained, brown, moist, very loose		SPT-8	10.5 - 12.0	1.0	3-2-1	--	
576.3	13.5			SPT-9	12.0 - 13.5	0.9	3-3-6	--	
		Sand with Gravel (Visual), fine to medium grained, rounded gravel, gray to brown, wet, loose		SPT-10	13.5 - 15.0	0.9	6-5-5	--	
574.8	15.0			SPT-11	15.0 - 16.5	1.3	12-3-12	--	
573.3	16.5	Gravel with Sand (Visual), fine to coarse grained, brown, wet, loose		SPT-12	16.5 - 18.0	0.8	4-6-8	--	
		Sand with Gravel (Visual), fine to medium grained sand, coarse gravel, brown, wet, loose		SPT-13	18.0 - 19.5	0.8	8-12-21	--	
				SPT-14	19.5 - 21.0	0.0	19-16-17	--	
567.3	22.5	Lean Clay with Sand (Visual), trace gravel, coarse grained sand lenses with gravel throughout, occasional cobble, light brown to gray, moist, stiff to very stiff		SPT-15	21.0 - 22.5	1.4	7-11-15	--	

No Refusal /
Bottom of Hole

Boring backfilled with grout upon completion.

STANTEC/FMSM_LEGACY 175657154.GPJ FMSM-GRAPHIC LOG.GDT 10/5/18

SUBSURFACE LOG (DRAFT)

Project Number	175657154	Location	N 1280855.40, E 1149189.20
Project Name	Vermilion Power Station	Boring No.	**B3-2** Total Depth 40.9 ft
County	Vermilion, Illinois	Surface Elevation	589.3 ft
Project Type	Geotechnical Exploration	Date Started	10/2/18 Completed 10/2/18
Supervisor	T. Ward Driller D. Bowles	Depth to Water	11.4 ft Date/Time 10/2/18
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
589.3	0.0	Top of Hole						
		Silty Clay (Fill) (Visual), gravelly, roots, cobbles in the top 2', brown, moist, medium stiff to very stiff -fine aggregate from 1.3'-3.0' -coarse sand from 3.3'-3.5' -fine aggregate from 3.6'-4.3'	SPT-1	0.0 - 1.5	0.6	12-17-3	--	Boring advanced using 3.25-inch ID HSA to 19.5 feet, mud rotary from 19.5 to 40.9 feet
			SPT-2	1.5 - 3.0	1.3	5-3-5	--	
			SPT-3	3.0 - 4.5	1.4	5-2-2	--	
583.8	5.5		SPT-4	4.5 - 6.0	1.1	5-3-2	--	
		Sandy Silty Clay (Visual), brown to gray, wet to moist, medium stiff	SPT-5	6.0 - 7.5	1.4	2-4-4	--	
581.3	8.0		SPT-6	7.5 - 9.0	1.4	1-2-1	--	
		Lean Clay (Visual), some sand, trace gravel, brown to light brown, moist to wet, soft to medium stiff	SPT-7	9.0 - 10.5	1.5	1-2-2	--	
577.9	11.4							
577.3	12.0		SPT-8	10.5 - 12.0	1.5	2-3-2	--	
		Sand with Silt (Visual), fine to medium grained, some gravel, gray, wet, very loose	SPT-9	12.0 - 13.5	0.8	3-10-35	--	
575.3	14.0		SPT-10	13.5 - 15.0	1.3	4-4-3	--	
		Sand with Gravel (Visual), coarse grained, cobbles, brown with gray, wet, loose	SPT-11	15.0 - 16.5	1.1	4-6-5	--	
			SPT-12	16.5 - 18.0	1.5	3-5-7	--	
		Lean Clay (Visual), sand lenses throughout, trace fine to coarse gravel, gray with some brown, moist, very stiff -coarse sand from 16.3'-16.5' -fine to medium sand from 21.8'-22.5'	SPT-13	18.0 - 19.5	1.4	4-5-6	--	
			SPT-14	19.5 - 21.0	1.5	4-8-10	--	
			SPT-15	21.0 - 22.5	1.4	5-13-17	--	
			SPT-16	22.5 - 24.0	1.5	6-7-10	--	
			SPT-17	24.0 - 25.5	1.5	5-7-11	--	
			SPT-18	25.5 - 27.0	0.9	4-9-14	--	
			SPT-19	27.0 - 28.5	1.5	11-11-12	--	
			SPT-20	28.5 - 30.0	1.2	6-9-10	--	
			SPT-21	30.0 - 31.5	1.5	8-11-13	--	
			SPT-22	31.5 - 33.0	1.5	5-6-8	--	
		-medium to coarse sand with gravel from 34.0'-35.8'	SPT-23	33.0 - 34.5	0.8	6-13-14	--	

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SUBSURFACE LOG (DRAFT)

Project Number	175657154	Location	N 1280855.40, E 1149189.20
Project Name	Vermilion Power Station	Boring No.	**B3-2**
		Total Depth	40.9 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		-fine sand with gravel from 35.6'-35.8' Lean Clay (Visual), sand lenses throughout, trace fine to coarse gravel, gray with some brown, moist, very stiff *(Continued)*		SPT-24	34.5 - 36.0	1.4	9-14-10	--	
				SPT-25	36.0 - 37.5	0.9	6-11-17	--	
				SPT-26	37.5 - 39.0	0.8	16-30-33	--	
549.3	40.0			SPT-27	39.0 - 40.4	0.4	21-39-50/0.4'	--	
548.4	40.9	Gray Shale		SPT-28	40.5 - 40.9	0.4	50/0.4'	--	

Auger Refusal / Bottom of Hole

Boring backfilled with grout upon completion.

STANTEC/FMSM_LEGACY 175657154.GPJ FMSM-GRAPHIC LOG.GDT 10/5/18

SUBSURFACE LOG (DRAFT)

Project Number	175657154	Location	N 1280854.89, E 1149198.44
Project Name	Vermilion Power Station	Boring No.	**B3-3** Total Depth 21.0 ft
County	Vermilion, Illinois	Surface Elevation	589.4 ft
Project Type	Geotechnical Exploration	Date Started	10/3/18 Completed 10/3/18
Supervisor	T. Ward Driller D. Bowles	Depth to Water	12.2 ft Date/Time 10/3/18
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
589.4	0.0	Top of Hole							
584.2	5.2	Silty Clay (Fill) (Visual), some gravel and cobble to 3.0', roots to 1.5', dark brown, moist, very stiff to medium stiff -silt from 2.5'-3.0' -wet silt from 4.0'-4.5'		SPT-1	0.0 - 1.5	0.6	7-8-13	--	Boring advanced using 4.25-inch ID HSA
				SPT-2	1.5 - 3.0	1.2	5-3-3	--	
				SPT-3	3.0 - 4.5	1.1	3-2-2	--	
578.7	10.7	Sandy Lean Clay (Visual), some roots, brown and gray, moist, soft to stiff -clayey sand from 10.1'-10.7'		SPT-4	4.5 - 6.0	1.4	4-2-1	--	
				SPT-5	6.0 - 7.5	0.0	4-7-6	--	
				SPT-6	7.5 - 9.0	1.4	2-1-3	--	
				SPT-7	9.0 - 10.5	1.0	1-2-1	--	
577.2	12.2	Lean Clay (Visual), gray and brown mottled, moist, soft		SPT-8	10.5 - 12.0	1.3	2-1-2	--	
575.1	14.3	Sand with Silt (Visual), medium to coarse grained, apparent cobbles, brown and gray, wet, dense		SPT-9	12.0 - 13.5	0.7	3-11-21	--	
				SPT-10	13.5 - 15.0	0.7	4-3-3	--	
568.4	21.0	Sandy Lean Clay (Till) (Visual), trace gravel, coarse sand lenses throughout, appareent cobbles, gray with some brown, moist, stiff to very stiff -sand from 16.6'-16.9' -fine sand from 20.6'-21.0'		SPT-11	15.0 - 16.5	0.4	11-8-5	--	
				SPT-12	16.5 - 18.0	1.5	6-8-10	--	
				SPT-13	18.0 - 19.5	1.5	5-7-11	--	
				SPT-14	19.5 - 21.0	1.0	4-7-8	--	

No Refusal / Bottom of Hole

Monitoring well installed to a depth of 17.5 feet.

SUBSURFACE LOG (DRAFT)

Project Number	175657154	Location	N 1280855.40, E 1149189.20
Project Name	Vermilion Power Station	Boring No.	**B3-2** Total Depth 40.9 ft
County	Vermilion, Illinois	Surface Elevation	589.3 ft
Project Type	Geotechnical Exploration	Date Started	10/2/18 Completed 10/2/18
Supervisor	T. Ward Driller D. Bowles	Depth to Water	11.4 ft Date/Time 10/2/18
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
589.3	0.0	Top of Hole						
		Silty Clay (Fill) (Visual), gravelly, roots, cobbles in the top 2', brown, moist, medium stiff to very stiff -fine aggregate from 1.3'-3.0' -coarse sand from 3.3'-3.5' -fine aggregate from 3.6'-4.3'	SPT-1	0.0 - 1.5	0.6	12-17-3	--	Boring advanced using 3.25-inch ID HSA to 19.5 feet, mud rotary from 19.5 to 40.9 feet
			SPT-2	1.5 - 3.0	1.3	5-3-5	--	
			SPT-3	3.0 - 4.5	1.4	5-2-2	--	
583.8	5.5		SPT-4	4.5 - 6.0	1.1	5-3-2	--	
		Sandy Silty Clay (Visual), brown to gray, wet to moist, medium stiff	SPT-5	6.0 - 7.5	1.4	2-4-4	--	
581.3	8.0		SPT-6	7.5 - 9.0	1.4	1-2-1	--	
		Lean Clay (Visual), some sand, trace gravel, brown to light brown, moist to wet, soft to medium stiff	SPT-7	9.0 - 10.5	1.5	1-2-2	--	
577.9	11.4							
577.3	12.0		SPT-8	10.5 - 12.0	1.5	2-3-2	--	
		Sand with Silt (Visual), fine to medium grained, some gravel, gray, wet, very loose	SPT-9	12.0 - 13.5	0.8	3-10-35	--	
575.3	14.0		SPT-10	13.5 - 15.0	1.3	4-4-3	--	
		Sand with Gravel (Visual), coarse grained, cobbles, brown with gray, wet, loose	SPT-11	15.0 - 16.5	1.1	4-6-5	--	
			SPT-12	16.5 - 18.0	1.5	3-5-7	--	
		Lean Clay (Visual), sand lenses throughout, trace fine to coarse gravel, gray with some brown, moist, very stiff -coarse sand from 16.3'-16.5' -fine to medium sand from 21.8'-22.5'	SPT-13	18.0 - 19.5	1.4	4-5-6	--	
			SPT-14	19.5 - 21.0	1.5	4-8-10	--	
			SPT-15	21.0 - 22.5	1.4	5-13-17	--	
			SPT-16	22.5 - 24.0	1.5	6-7-10	--	
			SPT-17	24.0 - 25.5	1.5	5-7-11	--	
			SPT-18	25.5 - 27.0	0.9	4-9-14	--	
			SPT-19	27.0 - 28.5	1.5	11-11-12	--	
			SPT-20	28.5 - 30.0	1.2	6-9-10	--	
			SPT-21	30.0 - 31.5	1.5	8-11-13	--	
			SPT-22	31.5 - 33.0	1.5	5-6-8	--	
		-medium to coarse sand with gravel from 34.0'-35.8'	SPT-23	33.0 - 34.5	0.8	6-13-14	--	

STANTEC/FMSM_LEGACY 175657154.GPJ FMSM-GRAPHIC LOG.GDT 10/5/18

SUBSURFACE LOG (DRAFT)

Project Number	175657154	Location	N 1280855.40, E 1149189.20
Project Name	Vermilion Power Station	Boring No.	**B3-2** Total Depth 40.9 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		-fine sand with gravel from 35.6'-35.8' Lean Clay (Visual), sand lenses throughout, trace fine to coarse gravel, gray with some brown, moist, very stiff *(Continued)*		SPT-24	34.5 - 36.0	1.4	9-14-10	--	
				SPT-25	36.0 - 37.5	0.9	6-11-17	--	
				SPT-26	37.5 - 39.0	0.8	16-30-33	--	
549.3	40.0			SPT-27	39.0 - 40.4	0.4	21-39-50/0.4'	--	
548.4	40.9	Gray Shale		SPT-28	40.5 - 40.9	0.4	50/0.4'	--	

Auger Refusal /
Bottom of Hole

Boring backfilled with grout upon completion.

SUBSURFACE LOG (DRAFT)

Stantec

Project Number	175657154	Location	N 1280854.89, E 1149198.44
Project Name	Vermilion Power Station	Boring No.	**B3-3**
		Total Depth	21.0 ft
County	Vermilion, Illinois	Surface Elevation	589.4 ft
Project Type	Geotechnical Exploration	Date Started	10/3/18
		Completed	10/3/18
Supervisor	T. Ward	Driller	D. Bowles
Depth to Water	12.2 ft	Date/Time	10/3/18
Logged By	T. Ward	Depth to Water	N/A
		Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
589.4	0.0	Top of Hole						
		Silty Clay (Fill) (Visual), some gravel and cobble to 3.0', roots to 1.5', dark brown, moist, very stiff to medium stiff -silt from 2.5'-3.0' -wet silt from 4.0'-4.5'	SPT-1	0.0 - 1.5	0.6	7-8-13	--	Boring advanced using 4.25-inch ID HSA
			SPT-2	1.5 - 3.0	1.2	5-3-3	--	
			SPT-3	3.0 - 4.5	1.1	3-2-2	--	
584.2	5.2		SPT-4	4.5 - 6.0	1.4	4-2-1	--	
		Sandy Lean Clay (Visual), some roots, brown and gray, moist, soft to stiff -clayey sand from 10.1'-10.7'	SPT-5	6.0 - 7.5	0.0	4-7-6	--	
			SPT-6	7.5 - 9.0	1.4	2-1-3	--	
578.7	10.7		SPT-7	9.0 - 10.5	1.0	1-2-1	--	
		Lean Clay (Visual), gray and brown mottled, moist, soft	SPT-8	10.5 - 12.0	1.3	2-1-2	--	
577.2	12.2		SPT-9	12.0 - 13.5	0.7	3-11-21	--	
575.1	14.3	Sand with Silt (Visual), medium to coarse grained, apparent cobbles, brown and gray, wet, dense	SPT-10	13.5 - 15.0	0.7	4-3-3	--	
			SPT-11	15.0 - 16.5	0.4	11-8-5	--	
		Sandy Lean Clay (Till) (Visual), trace gravel, coarse sand lenses throughout, appareent cobbles, gray with some brown, moist, stiff to very stiff -sand from 16.6'-16.9' -fine sand from 20.6'-21.0'	SPT-12	16.5 - 18.0	1.5	6-8-10	--	
			SPT-13	18.0 - 19.5	1.5	5-7-11	--	
568.4	21.0		SPT-14	19.5 - 21.0	1.0	4-7-8	--	

No Refusal / Bottom of Hole

Monitoring well installed to a depth of 17.5 feet.

STANTEC/FMSM_LEGACY 175657154.GPJ FMSM-GRAPHIC LOG.GDT 10/5/18

Project Number	175667038	Location	N 1281947.20, E 1147034.63
Project Name	Vermilion Power Station	Boring No.	**S-1** Total Depth 36.5 ft
County	Vermilion	Surface Elevation	615.4 ft
Project Type	Geotechnical Exploration	Date Started	6/28/17 Completed 6/28/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	21.0 ft Date/Time 6/28/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core: Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
615.4	0.0	Top of Hole						
		LEAN CLAY with Sand (CL) (FILL), brown to gray, dry to moist, medium stiff to stiff, trace gravel	SPT-1	0.0 - 1.5	1.5	3-4-7	11	
			SPT-2	5.0 - 6.5	1.5	4-3-4	15	Gravel=4.1%, Sand=19%, Fines=76.9%, LL=26, PI=11
			SPT-3	10.0 - 11.5	1.5	4-6-6	15	
			SPT-4	15.0 - 16.5	1.5	9-7-6	16	
594.4	21.0		SPT-5	20.0 - 21.5	1.5	3-3-4	--	
		FLY ASH with Bottom Ash (CCR), gray, wet, medium stiff, trace sand						

Project Number	175667038	Location	N 1281947.20, E 1147034.63
Project Name	Vermilion Power Station	Boring No.	**S-1**
		Total Depth	36.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		FLY ASH with Bottom Ash (CCR), gray, wet, medium stiff, trace sand *(Continued)*		SPT-6	25.0 - 26.5	1.5	2-3-4	21	
584.9	30.5								
		SILTY SAND with Gravel (SM), gray, wet, loose, coarse grained		SPT-7	30.0 - 31.5	1.5	1-2-5	27	
581.4	34.0								
		SILTY CLAY (CL-ML), gray, moist, stiff		SPT-8	35.0 - 36.5	1.5	3-5-7	12	
578.9	36.5								
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282010.83, E 1148381.02
Project Name	Vermilion Power Station	Boring No.	S-3
		Total Depth	16.5 ft
County	Vermilion	Surface Elevation	600.0 ft
Project Type	Geotechnical Exploration	Date Started	7/2/17
		Completed	7/2/17
Supervisor	T. Ward	Depth to Water	10.0 ft
Driller	T. Caudill	Date/Time	7/2/17
Logged By	B. Herries	Depth to Water	N/A
		Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
600.0	0.0	Top of Hole							
599.0	1.0	Topsoil		SPT-1	0.0 - 1.5	1.5	1-1-1	63	
595.0	5.0	FLY ASH (CCR), gray, saturated, very soft, some bottom ash, fine to medium grained							
589.5	10.5	LEAN CLAY (CL) (FILL), browish gray to gray, moist, soft		SPT-2	5.0 - 6.5	1.2	WOH-WOH-2	18	
584.5	15.5	SANDY LEAN CLAY (CL) (FILL), gray, moist, stiff		SPT-3	10.0 - 11.5	1.1	3-6-7	12	
583.5	16.5	SILTY SAND (SM), gray, moist, medium dense, fine grained		SPT-4	15.0 - 16.5	1.5	3-4-5	--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281992.51, E 1148339.38		
Project Name	Vermilion Power Station	Boring No.	**S-3A**	Total Depth	16.5 ft
County	Vermilion	Surface Elevation	600.0 ft		
Project Type	Geotechnical Exploration	Date Started	7/2/17	Completed	7/2/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	5.0 ft	Date/Time	7/2/17
Logged By	B. Herries	Depth to Water	N/A	Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core: Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
600.0	0.0	Top of Hole						
		FLY ASH (CCR), gray, saturated, very soft, some bottom ash	SPT-1	0.0 - 1.5	1.4	WOH-WOH-WOH	47	
			SPT-2	5.0 - 6.5	1.3	WOH-WOH-WOH	--	
			SPT-3	10.0 - 11.5	1.5	WOH-WOH-WOH	44	Sand=2.5%, Fines=97.5%
584.4	15.6							
583.5	16.5	SILTY SAND (SM), grayish brown to brown, moist, loose	SPT-4	15.0 - 16.5	1.5	2-4-4	--	
		No Refusal / Bottom of Hole						

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

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SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281558.24, E 1147400.02
Project Name	Vermilion Power Station	Boring No.	**S-4** Total Depth 36.5 ft
County	Vermilion	Surface Elevation	607.9 ft
Project Type	Geotechnical Exploration	Date Started	7/1/17 Completed 7/1/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	15.0 ft Date/Time 7/1/17
Logged By	B. Herries	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
607.9	0.0	Top of Hole						
		FLY ASH (CCR), gray to grayish brown, moist to wet, very soft to stiff	SPT-1	0.0 - 1.5	1.0	1-1-1	--	
			SPT-2	5.0 - 6.5	1.5	4-4-6	15	
		-clay lense from 8.0 to 9.0 ft						
			SPT-3	10.0 - 11.5	1.5	1-1-1	--	
			SPT-4	15.0 - 16.5	0.7	WOR-WOR-WOR	35	
			SPT-5	20.0 - 21.5	0.2	WOH-WOH-WOH	--	

Project Number	175667038	Location	N 1281558.24, E 1147400.02
Project Name	Vermilion Power Station	Boring No.	**S-4**
		Total Depth	36.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		FLY ASH (CCR), gray to grayish brown, moist to wet, very soft to stiff *(Continued)* -bottom ash lense at 26.2 ft		SPT-6	25.0 - 26.5	1.5	WOH-1-2	32	
576.9	31.0			SPT-7	30.0 - 31.5	1.5	2-2-4	--	
		SILTY SAND (SM), light brown, wet, medium dense, coarse grained		SPT-8	35.0 - 36.5	0.0	2-4-7	--	No recovery, apparent cobble.
571.4	36.5								
		No Refusal / Bottom of Hole							

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SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281165.36, E 1147700.48
Project Name	Vermilion Power Station	Boring No.	S-5 — Total Depth 36.5 ft
County	Vermilion	Surface Elevation	609.7 ft
Project Type	Geotechnical Exploration	Date Started	7/1/17 — Completed 7/1/17
Supervisor	T. Ward — Driller T. Caudill	Depth to Water	5.5 ft — Date/Time 7/1/17
Logged By	D. Clements	Depth to Water	N/A — Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
609.7	0.0	Top of Hole						
		SANDY SILTY CLAY (CL) (FILL), brown, moist, medium stiff	SPT-1	0.0 - 1.5	1.5	1-2-4	21	
604.2	5.5							
		FLY ASH (CCR), gray, moist to saturated, very soft	SPT-2	5.0 - 6.5	1.5	2-2-2	--	
			SPT-3	10.0 - 11.5	1.5	WOH-WOH-WOH	40	
			SPT-4	15.0 - 16.5	1.5	WOH-WOH-1	--	
			SPT-5	20.0 - 21.5	1.5	1-1-WOH	41	
			SPT-6	25.0 - 26.5	1.5	WOH-WOH-WOH	--	

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SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281165.36, E 1147700.48
Project Name	Vermilion Power Station	Boring No.	**S-5**
		Total Depth	36.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
577.2	32.5	FLY ASH (CCR), gray, moist to saturated, very soft *(Continued)*		SPT-7	30.0 - 31.5	1.5	1-1-2	21	
573.2	36.5	SILTY CLAY (CL-ML), brown to gray, moist, stiff		SPT-8	35.0 - 36.5	1.2	3-3-5	12	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280932.32, E 1148226.99
Project Name	Vermilion Power Station	Boring No.	S-6
		Total Depth	26.5 ft
County	Vermilion	Surface Elevation	614.1 ft
Project Type	Geotechnical Exploration	Date Started	7/1/17
		Completed	7/1/17
Supervisor	T. Ward	Depth to Water	Dry
Driller	T. Caudill	Date/Time	7/1/17
Logged By	D. Clements	Depth to Water	N/A
		Date/Time	N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
614.1	0.0	Top of Hole							
		FLY ASH AND BOTTOM ASH (CCR), gray, moist to saturated, very soft to stiff, some roots near the surface		SPT-1	0.0 - 1.5	1.5	1-1-1	--	
				SPT-2	5.0 - 6.5	1.5	2-6-5	24	Gravel=12.5%, Sand=40.7%, Fines=46.8%
				SPT-3	10.0 - 11.5	1.5	2-4-2	43	
				SPT-4	15.0 - 16.5	1.5	3-5-6	--	
593.6	20.5								
		SANDY SILTY CLAY (CL-ML), gray to brown, moist, stiff		SPT-5	20.0 - 21.5	1.5	2-4-4	24	
587.6	26.5			SPT-6	25.0 - 26.5	1.5	2-3-5	--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

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SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280763.54, E 1148008.06
Project Name	Vermilion Power Station	Boring No.	S-7 Total Depth 21.5 ft
County	Vermilion	Surface Elevation	619.6 ft
Project Type	Geotechnical Exploration	Date Started	6/30/17 Completed 6/30/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	5.0 ft Date/Time 6/30/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
619.6	0.0	Top of Hole							
		FLY ASH (CCR), gray, moist to wet, soft to stiff		SPT-1	0.0 - 1.5	1.5	3-6-7	25	
				SPT-2	5.0 - 6.5	1.5	2-2-2	--	
				SPT-3	10.0 - 11.5	1.5	2-1-2	29	
604.1	15.5								
		SILTY CLAY (CL-ML), gray to brown, moist, medium stiff, some roots, some sand		SPT-4	15.0 - 16.5	1.5	1-1-3	--	
598.1	21.5			SPT-5	20.0 - 21.5	1.5	2-2-3	23	
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280526.25, E 1148270.03
Project Name	Vermilion Power Station	Boring No.	S-8
		Total Depth	31.5 ft
County	Vermilion	Surface Elevation	629.7 ft
Project Type	Geotechnical Exploration	Date Started	6/27/17
		Completed	6/27/17
Supervisor	T. Ward	Driller	T. Caudill
Depth to Water	Dry	Date/Time	6/27/17
Logged By	D. Clements		
Depth to Water	N/A	Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
629.7	0.0	Top of Hole						
		SANDY LEAN CLAY (CL) (FILL), brown, dry to moist, very stiff, gravel	SPT-1	0.0 - 1.5	1.5	7-9-11	8	
623.2	6.5		SPT-2	5.0 - 6.5	0.8	9-3-4	15	
		FLY ASH with Bottom Ash (CCR), gray, moist to wet, soft to stiff						
			SPT-3	10.0 - 11.5	1.5	5-3-3	39	
			SPT-4	15.0 - 16.5	1.5	2-5-3	--	
			SPT-5	20.0 - 21.5	1.5	1-2-2	38	
			SPT-6	25.0 - 26.5	1.5	1-1-2	--	
600.2	29.5							
		SILTY CLAY (CL-ML), brown, moist, medium stiff	SPT-7	30.0 - 31.5	1.5	3-3-5	22	
598.2	31.5							
		No Refusal / Bottom of Hole						

Project Number	175667038	Location	N 1280612.45, E 1149380.63
Project Name	Vermilion Power Station	Boring No.	S-9
		Total Depth	61.5 ft
County	Vermilion	Surface Elevation	634.6 ft
Project Type	Geotechnical Exploration	Date Started	6/18/17
		Completed	6/18/17
Supervisor	T. Ward	Depth to Water	40.0 ft
Driller	S. Bradford	Date/Time	6/18/17
Logged By	J. Stepina	Depth to Water	N/A
		Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
634.6	0.0	Top of Hole							
630.6	4.0	SANDY LEAN CLAY (CL) (FILL), brown, moist, medium stiff, some organics		SPT-1	0.0 - 1.5	1.0	1-2-3	--	
620.6	14.0	SILTY CLAY with Gravel (CL-ML) (FILL), brown to gray, moist, medium stiff to stiff		SPT-2	5.0 - 6.5	0.9	2-3-6	19	
		-light gray, some fly ash, some bottom ash		SPT-3	10.0 - 11.5	1.5	3-4-3	--	
615.6	19.0	FLY ASH with Clay (CCR), light gray, moist, medium stiff, trace gravel		SPT-4	15.0 - 16.5	0.7	2-2-3	19	
610.6	24.0	SILTY CLAY (CL-ML) (FILL), brownish gray, moist, stiff, trace fly ash, trace gravel		SPT-5	20.0 - 21.5	1.5	3-7-8	--	
605.6	29.0	FLY ASH with Clay (CCR), light gray to brownish gray, moist, medium stiff, layered, trace gravel		SPT-6	25.0 - 26.5	1.5	2-3-2	--	
		FLY ASH (CCR), light gray to dark gray, saturated, very soft to medium stiff		SPT-7	30.0 - 31.5	1.5	3-3-4	--	

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SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280612.45, E 1149380.63
Project Name	Vermilion Power Station	Boring No.	S-9
		Total Depth	61.5 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		-bottom ash lense from 35.0 to 35.3 ft FLY ASH (CCR), light gray to dark gray, saturated, very soft to medium stiff *(Continued)*		SPT-8	35.0 - 36.5	1.5	4-5-2	58	Gravel=0.5%, Sand=11.4%, Fines=88.1%
				SPT-9	40.0 - 41.5	1.5	2-3-3	65	
				SPT-10	45.0 - 46.5	1.5	3-3-4	--	
				SPT-11	50.0 - 51.5	1.5	WOR-WOR-WOR	93	
578.6	56.0			SPT-12	55.0 - 56.5	1.5	3-3-4	--	
		SILTY CLAY (CL-ML), brownish gray, moist, stiff							
573.1	61.5			SPT-13	60.0 - 61.5	1.5	3-4-9	12	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1280373.67, E 1148762.80
Project Name	Vermilion Power Station	Boring No.	**S-10** Total Depth 46.5 ft
County	Vermilion	Surface Elevation	635.8 ft
Project Type	Geotechnical Exploration	Date Started	6/27/17 Completed 6/27/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 6/27/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
635.8	0.0	Top of Hole							
		SILTY CLAY with Gravel (CL-ML) (FILL), brown, dry, very stiff		SPT-1	0.0 - 1.5	1.5	10-18-20	8	
630.3	5.5								
		BOTTOM ASH with Fly Ash (CCR), gray, dry to moist, dense to very dense, coarse grained		SPT-2	5.0 - 6.5	1.5	6-13-13	--	
				SPT-3	10.0 - 11.5	1.5	13-19-12	12	
				SPT-4	15.0 - 16.5	1.5	17-34-22	--	
				SPT-5	20.0 - 21.5	1.5	29-42-50	8	
				SPT-6	25.0 - 26.5	1.5	14-24-24	--	
				SPT-7	30.0 - 31.5	1.5	13-26-22	5	
602.8	33.0								
		FLY ASH (CCR), gray, wet, soft to medium stiff							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280373.67, E 1148762.80
Project Name	Vermilion Power Station	Boring No.	**S-10**
		Total Depth	46.5 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		FLY ASH (CCR), gray, wet, soft to medium stiff *(Continued)*		SPT-8	35.0 - 36.5	1.5	2-2-2	--	
				SPT-9	40.0 - 41.5	1.5	3-3-5	28	
593.3	42.5	SILTY CLAY (CL-ML), gray, wet, stiff							
589.3	46.5			SPT-10	45.0 - 46.5	1.5	3-6-8	26	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1279663.19, E 1150345.54
Project Name	Vermilion Power Station	Boring No.	S-11 — Total Depth 11.5 ft
County	Vermilion	Surface Elevation	605.4 ft
Project Type	Geotechnical Exploration	Date Started	6/7/17 — Completed 6/7/17
Supervisor	T. Ward — Driller S. Bradford	Depth to Water	1.0 ft — Date/Time 6/7/17
Logged By	J. Stepina	Depth to Water	N/A — Date/Time N/A

Lithology: Elevation	Lithology: Depth	Description	Overburden / Rock Core: Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
605.4	0.0	Top of Hole						
604.9	0.5	TOPSOIL	SPT-1	0.0 - 1.5	0.9	2-3-2	--	
604.5	0.9	FLY ASH (CCR), light brown, moist to wet, soft, some gravel, bottom ash, gypsum						
599.9	5.5	BOTTOM ASH (CCR), black, wet, very loose	SPT-2	5.0 - 6.5		1-WOH-WOH	51	
598.9	6.5	FLY ASH (CCR), light gray, saturated, very soft						
		SILTY CLAY with Gravel (CL-ML), brown, moist, very stiff						
593.9	11.5		SPT-3	10.0 - 11.5		5-8-23	12	
		No Refusal / Bottom of Hole						

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1279503.34, E 1150495.25
Project Name	Vermilion Power Station	Boring No.	**S-13** Total Depth 11.5 ft
County	Vermilion	Surface Elevation	605.5 ft
Project Type	Geotechnical Exploration	Date Started	6/16/17 Completed 6/16/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	1.4 ft Date/Time 6/16/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
605.5	0.0	Top of Hole							
		BOTTOM ASH (CCR), gray, wet, very loose, some gravel		SPT-1	0.0 - 1.5	1.5	1-1-1	--	
601.0	4.5								
		SANDY SILTY CLAY (CL-ML), brown, moist, medium stiff to very stiff		SPT-2	5.0 - 6.5	1.5	4-4-5	14	
594.0	11.5			SPT-3	10.0 - 11.5	1.5	16-18-19	--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1279274.47, E 1150343.85
Project Name	Vermilion Power Station	Boring No.	**S-14** Total Depth 25.9 ft
County	Vermilion	Surface Elevation	607.1 ft
Project Type	Geotechnical Exploration	Date Started	6/6/17 Completed 6/6/17
Supervisor	T. Ward Driller S. Bradford	Depth to Water	6.0 ft Date/Time 6/6/17
Logged By	J. Stepina	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
607.1	0.0	Top of Hole						
		FLY ASH (CCR), brown, saturated, medium stiff, some gravel, bottom ash, coal fragments, gypsum	SPT-1	0.0 - 1.5	1.5	2-5-2	54	
601.7	5.4	BOTTOM ASH (CCR), light brown to bluish gray, wet, very loose, coarse grained, some fly ash	SPT-2	5.0 - 6.5	1.5	1-1-1	--	
597.1	10.0	FLY ASH (CCR), light gray, saturated, very soft	SPT-3	10.0 - 11.5	1.0	WOH-WOH-WOH	69	Sand=10.3%, Fines=89.7%, Gs=2.66
			SPT-4	15.0 - 16.5	0.7	WOR-WOR-WOR	61	
586.1	21.0	SILTY CLAY (CL-ML), light gray, dry to moist, very soft	SPT-5	20.0 - 21.5	1.2	WOR-WOR-2	--	
581.5	25.6	SHALE, light gray, weathered	SPT-6	25.0 - 25.9	0.9	44-50/0.4	--	
581.2	25.9	Auger Refusal / Bottom of Hole Top of Rock = 25.6 Elevation (581.5)						

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

9/5/17

Project Number	175667038	Location	N 1281881.87, E 1148399.07
Project Name	Vermilion Power Station	Boring No.	**S-16** Total Depth 80.0 ft
County	Vermilion	Surface Elevation	605.3 ft
Project Type	Geotechnical Exploration	Date Started	6/1/17 Completed 6/3/17
Supervisor	T. Ward Driller S. Bradford	Depth to Water	16.0 ft Date/Time 6/3/17
Logged By	J. Stepina	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
605.3	0.0	Top of Hole							
604.9	0.4	SANDY GRAVEL (GP) (FILL)		SPT-1	0.0 - 1.5	1.2	15-12-10	11	
		LEAN CLAY (CL) (FILL), grayish brown, dry to moist, very stiff, some sand		SPT-2	1.5 - 3.0	1.0	8-9-14	10	
				SPT-3	3.0 - 4.5	1.2	4-10-14	11	LL=19, PI=7, Gs=2.39
599.9	5.4			SPT-4	4.5 - 6.0	1.2	6-8-11	13	
		SILTY SAND (SM) (FILL), black, dry to moist, medium dense to dense, coarse grained, some wood fragments, trace fly ash, trace gravel		SPT-5	6.0 - 7.5	1.2	11-9-8	11	
				SPT-6	7.5 - 9.0	1.2	5-7-12	11	Gravel=0.5%, Sand=56.3%, Fines=43.2%
				SPT-7	9.0 - 10.5	1.5	10-12-12	10	
				SPT-8	10.5 - 12.0	1.5	12-19-12	10	LL=19, PI=5, DD=117.1 pcf, MC=15%, Gs=2.66
				ST-1	12.0 - 14.0	1.8	1100 psi	--	
589.8	15.5			SPT-9	14.0 - 15.5	1.2	6-16-14	13	DD=121.5 pcf, MC=13%
		SANDY LEAN CLAY (FILL), light brown, moist, very stiff		SPT-10	15.5 - 17.0	1.3	16-19-18	13	
				SPT-11	17.0 - 18.5	1.5	5-19-22	15	Added drilling fluid at 17.0 ft.
				SPT-12	18.5 - 20.0	1.3	12-17-7	12	
583.8	21.5			SPT-13	20.0 - 21.5	1.5	12-9-10	13	
		SANDY LEAN CLAY (CL), light brown, moist, soft		SPT-14	21.5 - 23.0	1.5	2-3-2	14	
580.8	24.5			SPT-15	23.0 - 24.5	1.1	3-2-1	20	
		GRAVELLY SAND (SP), light brown, moist, dense to very dense, coarse grained		SPT-16	24.5 - 26.0	1.5	1-1-2	--	
				ST-2	26.0 - 28.0	1.5	800 psi	19	
				SPT-17	28.0 - 29.5	1.0	5-12-22	17	Gravel=45.5%, Sand=49.6%, Fines=4.9%
				SPT-18	29.5 - 31.0	0.1	32-19-3	6	
573.8	31.5			SPT-19	31.0 - 32.5	1.2	4-9-12	17	
		SILT with Sand (ML), light gray, wet, stiff to very stiff, fine grained -gravel at 32.5 ft		SPT-20	32.5 - 34.0	0.1	10-5-6	--	
571.3	34.0			SPT-21	34.0 - 35.5	1.5	5-4-4	13	

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281881.87, E 1148399.07
Project Name	Vermilion Power Station	Boring No.	**S-16**
		Total Depth	80.0 ft

Lithology: Elevation	Lithology: Depth	Description	Overburden: Sample # / Rock Core: RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SILTY CLAY (CL-ML), light gray, moist to wet, medium stiff to very stiff, some gravel *(Continued)*	SPT-22	35.5 - 37.0	1.5	6-7-6	14	
			SPT-23	37.0 - 38.5	1.5	WOR-2-4	16	
			SPT-24	38.5 - 40.0	0.5	3-5-5	13	
			SPT-25	40.0 - 41.5	1.5	14-6-6	11	
		-gravel lense at 42.0 ft	SPT-26	41.5 - 43.0	1.5	11-17-15	12	
			SPT-27	43.0 - 44.5	1.5	9-10-12	15	
			SPT-28	44.5 - 46.0	0.6	4-8-6	9	
557.8	47.5	-gravel lense at 46.0 ft	SPT-29	46.0 - 47.5	1.3	11-10-15	18	
556.3	49.0	SILTY SAND with Gravel (SM), light gray, moist, very dense	SPT-30	47.5 - 49.0	1.2	37-28-24	14	
		SANDY LEAN CLAY with Gravel (CL), light gray, dry to moist, very stiff	SPT-31	49.0 - 50.5	1.5	12-35-21	--	
			SPT-32	50.5 - 52.0	1.0	23-30-25	--	
			SPT-33	52.0 - 53.5	1.5	8-8-15	11	
			SPT-34	53.5 - 55.0	1.3	8-21-28	--	
			SPT-35	55.0 - 56.5	1.5	15-41-48	11	
			SPT-36	56.5 - 58.0	1.0	27-50/0.5	--	
			SPT-37	58.0 - 59.5	1.3	12-22-50/0.2	9	
			SPT-38	59.5 - 61.0	1.5	24-40-43	--	
542.8	62.5		SPT-39	61.0 - 62.5	0.7	27-50/0.1	17	
		SILTY CLAY (CL-ML), light gray, moist to wet, very stiff, some sand	SPT-40	62.5 - 64.0	1.5	10-19-22	--	
			SPT-41	64.0 - 65.5	1.5	24-28-27	15	
			SPT-42	65.5 - 67.0	1.5	21-37-50	--	
			SPT-43	67.0 - 68.5	1.5	20-18-15	13	
			SPT-44	68.5 - 70.0	1.5	10-11-7	--	
			SPT-45	70.0 - 71.5	1.5	7-20-31	20	
			SPT-46	71.5 - 73.0	1.3	10-18-28	--	
			SPT-47	73.0 - 74.5	1.5	6-11-16	33	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281881.87, E 1148399.07
Project Name	Vermilion Power Station	Boring No.	**S-16**
		Total Depth	80.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SILTY CLAY (CL-ML), light gray, moist to wet, very stiff, some sand *(Continued)*		SPT-48	74.5 - 76.0	1.5	4-10-11	--	
				SPT-49	76.0 - 78.5	1.5	8-12-14	22	
525.3	80.0			SPT-50	78.5 - 80.0	1.5	WOH-WOH-2	--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281498.57, E 1148234.61
Project Name	Vermilion Power Station	Boring No.	**S-17** Total Depth 80.5 ft
County	Vermilion	Surface Elevation	606.1 ft
Project Type	Geotechnical Exploration	Date Started	6/5/17 Completed 6/6/17
Supervisor	T. Ward Driller S. Bradford	Depth to Water	28.7 ft Date/Time 6/5/17
Logged By	J. Stepina	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
606.1	0.0	Top of Hole						
605.8	0.3	SANDY GRAVEL (GP) (FILL), moist, stiff, organics	SPT-1	0.0 - 1.5	1.0	3-6-7	14	
601.6	4.5	SILTY CLAY (CL-ML) (FILL), grayish brown, moist, stiff, some sand, some gravel	SPT-2	1.5 - 3.0	1.3	4-7-7	16	
			SPT-3	3.0 - 4.5	1.5	5-5-7	16	
583.1	23.0	SILTY, CLAYEY SAND (SC-SM) (FILL), black, moist, medium dense to dense, trace gravel	SPT-4	4.5 - 6.0	1.1	6-10-12	19	
			SPT-5	6.0 - 7.5	1.5	4-5-9	13	
			SPT-6	7.5 - 9.0	1.5	2-10-10	14	
			SPT-7	9.0 - 10.5	1.5	7-16-11	11	Gravel=2.7%, Sand=56.0%, Fines=41.3%, LL=19, PI=4, Gs=2.69
			SPT-8	10.5 - 12.0	1.5	9-18-17	12	
			SPT-9	12.0 - 13.5	1.5	8-11-13	12	
			SPT-10	13.5 - 15.0	1.5	13-9-9	15	
			SPT-11	15.0 - 16.5	1.5	2-2-8	18	
			SPT-12	16.5 - 18.0	1.5	9-11-12	16	
			SPT-13	18.0 - 19.5	1.5	2-6-4	13	
			SPT-14	19.5 - 21.0	1.5	5-11-10	12	
			ST-1	21.0 - 23.0	1.3	1000 psi	12	DD=121.0 pcf
577.1	29.0	SILT with Sand (ML) (FILL), black, moist to wet, soft to very stiff, trace fly ash	SPT-15	23.0 - 24.5	1.5	3-9-9	16	
			SPT-16	24.5 - 26.0	1.5	4-6-7	24	Sand=21.5%, Fines=78.5%
			SPT-17	26.0 - 27.5	1.5	6-7-6	28	
			SPT-18	27.5 - 29.0	1.5	1-1-3	--	
572.6	33.5	SILTY SAND (SM), light brown, moist, loose, fine to medium grained, well sorted	SPT-19	29.0 - 30.5	1.5	WOH-3-3	21	Added drilling fluid at 29.0 ft.
			SPT-20	30.5 - 32.0	1.3	2-4-4	--	
			SPT-21	32.0 - 33.5	1.0	2-2-5	20	
			SPT-22	33.5 - 35.0	0.9	10-37-40	--	

Project Number	175667038	Location	N 1281498.57, E 1148234.61		
Project Name	Vermilion Power Station	Boring No.	**S-17**	Total Depth	80.5 ft

Lithology: Elevation	Lithology: Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
569.6	36.5	SANDY GRAVEL (GP), brown, wet, medium dense to dense *(Continued)*		SPT-23	35.0 - 36.5	1.3	7-7-9	13	
				SPT-24	36.5 - 38.0	1.5	7-7-8	--	
		SANDY GRAVEL with Clay (GW), brown, moist to wet, medium dense, medium to coarse grained		SPT-25	38.0 - 39.5	1.2	3-6-8	12	Auger refusal at 38.0 ft, offset 12.0 ft and continued.
564.6	41.5			ST-2	39.5 - 41.5	0.7	1200 psi	21	
		SILTY SAND (SM), light gray, moist, dense, trace gravel		SPT-26	41.5 - 43.0	1.5	6-14-21	14	
				SPT-27	43.0 - 44.5	1.2	5-21-30	--	
				SPT-28	44.5 - 46.0	1.5	22-21-27	15	
558.1	48.0			SPT-29	46.0 - 47.5	1.3	23-39-27	--	
		SAND with Gravel and Silt (SP-SM), light gray, moist, dense, coarse grained		SPT-30	47.5 - 49.0	1.5	5-8-16	--	
				SPT-31	49.0 - 50.5	1.2	13-21-31	13	
				SPT-32	50.5 - 52.0	1.5	17-27-24	--	
553.1	53.0			SPT-33	52.0 - 53.5	1.2	10-22-24	--	
551.1	55.0	SILTY SAND (SM), light gray, moist, dense, trace gravel		SPT-34	53.5 - 55.0	1.1	7-18-26	13	
		SAND with Gravel and Silt (SP-SM), light gray, moist to wet, dense, medium to coarse grained		SPT-35	55.0 - 56.5	1.4	12-43-39	--	
548.1	58.0			SPT-36	56.5 - 58.0	1.5	23-41-47	--	
		SILTY CLAY (CL-ML), gray, moist, stiff to very stiff, some gravel		SPT-37	58.0 - 59.5	1.1	6-7-10	--	
				SPT-38	59.5 - 61.0	1.5	13-10-11	13	
				SPT-39	61.0 - 62.5	1.5	6-13-10	13	LL=19, PI=5, Gs=2.62
				SPT-40	62.5 - 64.0	1.2	3-5-7	14	
540.6	65.5			SPT-41	64.0 - 65.5	1.5	2-5-18	--	
		SILTY SAND (SM), light gray, moist, dense to very dense, fine grained, trace gravel		SPT-42	65.5 - 67.0	1.5	8-20-22	--	
				SPT-43	67.0 - 68.5	1.5	18-25-26	16	
536.1	70.0			SPT-44	68.5 - 70.0	1.5	12-15-23	--	
		SILTY CLAY (CL-ML), gray, moist, soft to very stiff, trace gravel		SPT-45	70.0 - 71.5	1.5	13-12-13	--	
				SPT-46	71.5 - 73.0	1.3	7-7-5	25	
				SPT-47	73.0 - 74.5	1.5	3-2-WOH	--	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1281498.57, E 1148234.61
Project Name	Vermilion Power Station	Boring No.	**S-17**
		Total Depth	80.5 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		SILTY CLAY (CL-ML), gray, moist, soft to very stiff, trace gravel *(Continued)*		SPT-48	76.0 - 77.5	1.5	12-8-12	--	
		-some fine grained sand at 74.5 ft		SPT-49	77.5 - 79.0	1.5	4-10-18	21	
525.6	80.5	-wet at 79.5 ft		SPT-50	79.0 - 80.5	1.5	6-14-12	--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1280842.29, E 1148662.40
Project Name	Vermilion Power Station	Boring No.	**S-18** Total Depth 100.7 ft
County	Vermilion	Surface Elevation	628.6 ft
Project Type	Geotechnical Exploration	Date Started	6/12/17 Completed 6/16/17
Supervisor	T. Ward Driller S. Bradford	Depth to Water	48.0 ft Date/Time 6/15/17
Logged By	J. Stepina	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
628.6	0.0	Top of Hole							
		LEAN CLAY with Sand and Gravel (CL) (FILL), grayish brown, dry to moist, stiff to very stiff		SPT-1	0.0 - 1.5	0.9	4-9-5	9	
				SPT-2	1.5 - 3.0	1.1	5-5-4	12	
				SPT-3	3.0 - 4.5	1.5	7-5-7	13	
				SPT-4	4.5 - 6.0	1.5	4-10-7	15	
622.1	6.5	-trace bottom ash at 5.5 ft							
		FLY ASH (CCR), light gray to dark gray, dry to moist, stiff to very stiff, some bottom ash		SPT-5	6.0 - 7.5	1.5	6-7-11	20	
620.2	8.4			ST-1	7.5 - 9.5	2.0	700 psi	--	DD=83.4 pcf, MC=27%, Gs=2.47
		LEAN CLAY with Gravel (CL) (FILL), brownish gray, moist, stiff to very stiff, some fly ash		SPT-6	9.5 - 11.0	1.5	3-5-8	13	DD=119.2 pcf, MC=14%
				SPT-7	11.0 - 12.5	1.2	5-8-9	14	
				SPT-8	12.5 - 14.0	1.5	3-21-16	--	
		-bottom ash lense from 13.5 to 13.8 ft		SPT-9	14.0 - 15.5	1.5	4-8-8	14	
				SPT-10	15.5 - 17.0	1.5	5-7-7	17	
611.1	17.5								
		FLY ASH (CCR), light gray, moist to saturated, very soft to very stiff, some bottom ash		SPT-11	17.0 - 18.5	1.5	1-2-2	38	
				SPT-12	18.5 - 20.0	1.5	2-1-2	--	
				SPT-13	20.0 - 21.5	1.5	2-1-1	25	
		-bottom ash lense from 21.5 to 21.9 ft		SPT-14	21.5 - 23.0	1.5	1-1-1	--	
				SPT-15	23.0 - 24.5	1.5	1-1-1	27	
				SPT-16	24.5 - 26.0	1.5	2-2-2	--	
				SPT-17	26.0 - 27.5	1.5	2-1-2	25	
				SPT-18	27.5 - 29.0	1.5	1-1-1	--	
				SPT-19	29.0 - 30.5	1.5	3-6-11	41	
				SPT-20	30.5 - 32.0	1.5	6-9-9	--	
				SPT-21	32.0 - 33.5	1.0	2-3-10	36	
				SPT-22	33.5 - 35.0	1.5	4-10-11	--	

Project Number	175667038	Location	N 1280842.29, E 1148662.40		
Project Name	Vermilion Power Station	Boring No.	**S-18**	Total Depth	100.7 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		FLY ASH (CCR), light gray, moist to saturated, very soft to very stiff, some bottom ash *(Continued)*		SPT-23	35.0 - 36.5	1.5	3-2-5	55	
				SPT-24	36.5 - 38.0	1.5	11-3-2	--	
				SPT-25	38.0 - 39.5	1.5	2-2-5	51	
				SPT-26	39.5 - 41.0	1.5	9-10-8	--	
				SPT-27	41.0 - 42.5	1.5	3-8-8	53	DD=93.9 pcf, MC=25%
583.6	45.0			ST-2	42.5 - 44.5	2.0	1000 psi	--	DD=74.4 pcf, MC=42%
		SILTY CLAY (CL-ML), brownish gray, moist, very soft to very stiff, some fine to medium grained sand lenses		SPT-28	44.5 - 46.0	1.5	3-11-14	--	DD=63.6 pcf, MC=55%
				SPT-29	46.0 - 47.5	1.4	9-9-9	17	
				SPT-30	47.5 - 49.0	0.9	WOR-WOR-WOR	--	Added drilling fluid at 53.5 ft.
578.1	50.5			SPT-31	49.0 - 50.5	1.0	WOH-1-4	18	
		SILTY SAND with Clay (SM-SC), brown, wet, medium dense to very dense, trace gravel		SPT-32	50.5 - 52.0	1.5	2-4-8	--	
				SPT-33	52.0 - 53.5	1.5	7-8-15	10	
				SPT-34	53.5 - 55.0	1.3	20-22-39	--	
		-gray at 55.0 ft		SPT-35	55.0 - 56.5	0.7	20-29-15	--	
		-gravelly lense from 57.0 to 57.4 ft		SPT-36	56.5 - 58.0	1.5	12-18-19	5	
		-clay lense from 58.5 to 58.9 ft		SPT-37	58.0 - 59.5	1.5	10-24-23	--	Vibrating-wire piezometer installed at a depth of 60.0 ft.
				SPT-38	59.5 - 61.0	1.2	10-16-25	--	
				SPT-39	61.0 - 62.5	1.5	18-43-48	9	Gravel=4.9%, Sand=49.6%, Fines=45.5%
		-clay lense from 62.5 to 63.3 ft		SPT-40	62.5 - 64.0	1.5	18-21-36	--	
				SPT-41	64.0 - 65.5	1.5	16-21-24	--	
		-clay lense from 65.5 to 66.5 ft		SPT-42	65.5 - 67.0	1.5	17-23-26	10	
560.1	68.5			SPT-43	67.0 - 68.5	1.5	32-49-32	--	
		SILTY CLAY with Gravel (CL-ML), light gray, moist, very stiff, some sand lenses		SPT-44	68.5 - 70.0	1.5	13-15-19	--	
				SPT-45	70.0 - 71.5	1.5	9-11-12	12	
				SPT-46	71.5 - 73.0	1.5	12-15-21	--	
				SPT-47	73.0 - 74.5	1.5	5-10-14	--	

Project Number	175667038	Location	N 1280842.29, E 1148662.40
Project Name	Vermilion Power Station	Boring No.	**S-18** Total Depth 100.7 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SILTY CLAY with Gravel (CL-ML), light gray, moist, very stiff, some sand lenses *(Continued)*		SPT-48	74.5 - 76.0	1.5	20-25-32	14	
				SPT-49	76.0 - 77.5	1.5	38-27-48	--	
				SPT-50	77.5 - 79.0	1.5	10-15-24	--	
				SPT-51	79.0 - 80.5	1.5	16-21-30	10	
				SPT-52	80.5 - 82.0	1.5	10-19-20	--	
				SPT-53	82.0 - 83.5	1.5	9-17-27	--	
				SPT-54	83.5 - 85.0	1.5	8-17-22	18	
				SPT-55	85.0 - 86.5	1.5	14-19-26	--	
				SPT-56	86.5 - 88.0	1.5	15-22-38	--	
				SPT-57	88.0 - 89.5	1.5	15-19-34	18	
537.9	90.7			SPT-58	89.5 - 90.7	1.2	20-30-50/0.2	--	Began Core
		SHALE, light gray, slightly weathered		SPT-59	91.0 - 91.4	0.4	50/0.4	--	
				94	5.0	5.0	100	95.7	
527.9	100.7			74	5.0	5.0	100	100.7	

Bottom of Hole

Top of Rock = 90.7
Elevation (537.9)

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280743.16, E 1148920.66
Project Name	Vermilion Power Station	Boring No.	**S-19** Total Depth 84.0 ft
County	Vermilion	Surface Elevation	633.6 ft
Project Type	Geotechnical Exploration	Date Started	5/31/17 Completed 5/31/17
Supervisor	T. Ward Driller S. Bradford	Depth to Water	48.0 ft Date/Time 6/16/17
Logged By	J. Stepina	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden / Rock Core Sample #	RQD Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
633.6	0.0	Top of Hole						
		SAND with Gravel and Silt (SP-SM) (FILL), brown to gray, dry to moist, loose to medium dense	SPT-1	0.0 - 1.5	0.9	3-3-4	10	
			SPT-2	1.5 - 3.0	0.7	2-4-6	--	
			SPT-3	3.0 - 4.5	1.5	3-5-6	14	
			SPT-4	4.5 - 6.0	1.5	4-8-9	--	
			ST-1	6.0 - 8.0	1.3	1000 psi	20	DD=111.7 pcf
624.6	9.0		SPT-5	8.0 - 9.5	1.5	13-13-12	14	Auger refusal at 8.0 ft, offset 4.0 ft and continued.
		FLY ASH (CCR), light gray to black, moist to saturated, very soft to very stiff, some bottom ash, some lenses of medium to coarse angular sand, coal fragments	SPT-6	9.5 - 11.0	1.5	3-8-5	--	
			SPT-7	11.0 - 12.5	1.5	5-3-3	18	
			ST-2	12.5 - 14.5	1.5	1000 psi	16	DD=116.1 pcf
			SPT-8	14.5 - 16.0	1.5	2-4-2	--	
			SPT-9	16.0 - 17.5	1.5	1-2-2	31	
			SPT-10	17.5 - 19.0	1.2	1-1-1	--	
			SPT-11	19.0 - 20.5	1.3	WOH-WOH-WOH	35	
			SPT-12	20.5 - 22.0	1.1	1-3-4	--	
			SPT-13	22.0 - 23.5	1.2	4-5-6	39	
			SPT-14	23.5 - 25.0	1.3	4-4-4	--	
			SPT-15	25.0 - 26.5	1.5	2-2-2	34	Gravel=0.7%, Sand=14.3%, Fines=85.0%
			SPT-16	26.5 - 28.0	1.3	1-2-2	34	
			SPT-17	28.0 - 29.5	1.5	4-7-6	20	
			SPT-18	29.5 - 31.0	1.5	4-6-6	--	
			SPT-19	31.0 - 32.5	1.0	2-8-9	45	
			SPT-20	32.5 - 34.0	1.5	4-7-7	--	
			SPT-21	34.0 - 35.5	1.5	6-10-16	45	

Project Number	175667038	Location	N 1280743.16, E 1148920.66
Project Name	Vermilion Power Station	Boring No.	**S-19**
		Total Depth	84.0 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		FLY ASH (CCR), light gray to black, moist to saturated, very soft to very stiff, some bottom ash, some lenses of medium to coarse angular sand, coal fragments *(Continued)*		SPT-22	35.0 - 37.0	1.5	2-3-4	--	
				SPT-23	37.0 - 38.5	1.5	5-8-9	45	
				SPT-24	38.5 - 40.0	1.5	5-6-7	--	
				SPT-25	40.0 - 41.5	1.5	3-5-28	65	
				SPT-26	41.5 - 43.0	1.5	10-11-6	--	
				SPT-27	43.0 - 44.5	1.5	1-3-1	69	
				SPT-28	44.5 - 46.0	1.5	1-2-2	--	
				SPT-29	46.0 - 47.5	1.5	3-4-2	--	
				SPT-30	47.5 - 49.0	1.3	WOR-1-3	--	
583.1	50.5			SPT-31	49.0 - 50.5	1.0	WOH-WOH-1	92	
		SILTY CLAY with Gravel and Sand (CL-ML), brownish gray, moist, stiff to very stiff		SPT-32	50.5 - 52.0	1.3	6-11-9	19	
				SPT-33	52.0 - 53.5	1.5	3-4-6	--	
579.1	54.5			SPT-34	53.5 - 55.0	1.2	12-14-11	24	
		SANDY GRAVEL (GP), brown, moist, medium dense		SPT-35	55.0 - 56.5	0.8	3-5-7	--	
				ST-3	56.5 - 58.5	1.3	1400 psi	20	
573.6	60.0			SPT-36	58.5 - 60.0	0.8	5-6-9	17	
		SANDY LEAN CLAY with Gravel (CL), gray, moist to dry, stiff to very stiff, with some fine to medium sand lenses throughout		SPT-37	60.0 - 61.5	1.4	4-6-8	--	
				SPT-38	61.5 - 63.0	1.5	2-3-10	14	
				SPT-39	63.0 - 64.5	1.5	2-4-9	12	
567.6	66.0			SPT-40	64.5 - 66.0	1.5	6-10-11	12	
		SAND with Gravel and Silt (SP-SM), brown, dry, very dense, some lenses of fine sand		SPT-41	66.0 - 67.5	1.5	11-27-30	--	
				SPT-42	67.5 - 68.5	1.2	31-50/0.5	--	
				SPT-43	69.0 - 70.0	1.3	39-50/0.5	10	
				SPT-44	70.5 - 72.0	1.2	31-33-43	--	
				SPT-45	72.0 - 73.5	1.5	17-40-50	--	

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280743.16, E 1148920.66
Project Name	Vermilion Power Station	Boring No.	**S-19**
		Total Depth	84.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
				SPT-46	73.5 - 75.0	1.5	9-25-29	--	
				SPT-47	75.0 - 75.1	0.0	50/0.1	--	
557.1	76.5								
		HIGHLY WEATHERED SHALE, gray with greenish blue, moist, very stiff, with rock fragments		SPT-48	76.5 - 78.0	1.5	11-22-25	--	
				SPT-49	78.0 - 79.5	1.5	8-20-33	--	
				SPT-50	79.5 - 81.0	1.5	7-23-25	16	
				SPT-51	81.0 - 81.9	0.8	25-50/0.4	--	
550.6	83.0								
549.6	84.0	SHALE, light gray, weathered		SPT-52	82.5 - 84.0	1.2	10-22-48	17	

Auger Refusal / Bottom of Hole

Top of Rock = 83.0 Elevation (550.6)

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1279815.48, E 1151166.70
Project Name	Vermilion Power Station	Boring No.	**S-20** — Total Depth 42.5 ft
County	Vermilion	Surface Elevation	619.7 ft
Project Type	Geotechnical Exploration	Date Started	6/1/17 — Completed 6/1/17
Supervisor	T. Ward — Driller S. Bradford	Depth to Water	Dry — Date/Time 6/1/17
Logged By	J. Stepina	Depth to Water	N/A — Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
619.7	0.0	Top of Hole							
619.2	0.5	SANDY GRAVEL (GP) (FILL)		SPT-1	0.0 - 1.5	1.3	16-10-8	--	
		LEAN CLAY (CL) (FILL), grayish brown, dry to moist, medium stiff to very stiff, some sand, some gravel		SPT-2	1.5 - 3.0	0.8	8-7-8	12	
				SPT-3	3.0 - 4.5	0.9	6-12-9	8	
				SPT-4	4.5 - 6.0	1.5	5-6-11	10	
				SPT-5	6.0 - 7.5	0.8	10-11-7	9	
				ST-1	7.5 - 9.5	1.0	950 psi	9	LL=19, PI=7, DD=131.8 pcf, Gs=2.72
				SPT-6	9.5 - 11.0	1.5	4-9-6	8	
				SPT-7	11.0 - 12.5	1.1	4-10-10	9	
				SPT-8	12.5 - 14.0	1.1	2-7-11	8	
				SPT-9	14.0 - 15.5	1.2	5-6-3	11	Bulk sample from 14.0 to 19.0 ft.
				SPT-10	15.5 - 17.0	1.3	5-9-12	12	DD=126.3 pcf, MC=12%,
				ST-2	17.0 - 19.0	1.5	950 psi	--	Gs=2.72 DD=121.0 pcf, MC=16%
				SPT-11	19.0 - 20.5	1.2	6-5-4	16	LL=27, PI=13
				SPT-12	20.5 - 22.0	1.4	4-8-6	10	
				SPT-13	22.0 - 23.5	1.4	3-5-10	14	
				SPT-14	23.5 - 25.0	1.4	9-15-16	12	
				SPT-15	25.0 - 26.5	1.5	7-10-8	14	
				SPT-16	26.5 - 28.0	1.3	10-11-12	15	
				SPT-17	28.0 - 29.5	1.5	4-5-6	13	
				SPT-18	29.5 - 31.0	1.4	4-9-10	14	
				SPT-19	31.0 - 32.5	1.3	8-9-11	13	
585.7	34.0			SPT-20	32.5 - 34.0	1.4	5-5-7	13	
				SPT-21	34.0 - 35.5	1.4	4-3-3	13	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1279815.48, E 1151166.70
Project Name	Vermilion Power Station	Boring No.	**S-20**
		Total Depth	42.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		LEAN CLAY (CL), dark brown to gray, moist, very soft to stiff, some gravel *(Continued)*		SPT-22	35.5 - 37.0	1.1	2-4-5	18	
				SPT-23	37.0 - 38.5	0.4	WOR-WOR-1	13	
				SPT-24	38.5 - 40.0	0.2	WOH-WOH-WOH	12	
578.2	41.5			SPT-25	40.0 - 41.5	1.1	WOH-WOH-WOH	22	
577.2	42.5	SHALE, light gray, weathered		SPT-26	41.5 - 42.5	1.0	WOH-50/0.5	--	

Auger Refusal / Bottom of Hole

Top of Rock = 41.5 Elevation (578.2)

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1279037.42, E 1150938.43
Project Name	Vermilion Power Station	Boring No.	**S-21** Total Depth 47.7 ft
County	Vermilion	Surface Elevation	619.5 ft
Project Type	Geotechnical Exploration	Date Started	5/31/17 Completed 5/31/17
Supervisor	T. Ward Driller S. Bradford	Depth to Water	45.0 ft Date/Time 5/31/17
Logged By	J. Stepina	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
619.5	0.0	Top of Hole							
		LEAN CLAY (CL) (FILL), grayish brown, dry to moist, medium stiff to very stiff, some sand lenses, trace gravel		SPT-1	0.0 - 1.5	1.1	10-10-6	12	
				SPT-2	1.5 - 3.0	0.9	10-7-8	13	
				SPT-3	3.0 - 4.5	1.3	6-7-6	11	
				SPT-4	4.5 - 6.0	1.5	6-5-8	9	
				SPT-5	6.0 - 7.5	1.5	11-11-11	11	DD=120.0 pcf, MC=13%
				ST-1	7.5 - 9.5	1.8	800 psi	--	DD=131.2 pcf, MC=10%
				SPT-6	9.5 - 11.0	1.5	11-6-5	8	
				SPT-7	11.0 - 12.5	0.6	4-6-14	15	
				SPT-8	12.5 - 14.0	0.7	6-5-7	8	
				SPT-9	14.0 - 15.5	1.2	3-1-7	16	
		-some rock fragments at 15.5 ft		SPT-10	15.5 - 17.0	0.9	2-2-5	18	
				ST-2	17.0 - 19.0	2.0	850 psi	20	DD=106.8 pcf
				SPT-11	19.0 - 20.5	1.5	4-5-6	13	
				SPT-12	20.5 - 22.0	1.3	5-10-9	11	
				SPT-13	22.0 - 23.5	1.5	4-6-9	14	
				SPT-14	23.5 - 25.0	1.3	7-11-11	10	
				SPT-15	25.0 - 26.5	1.5	5-4-6	13	
				SPT-16	26.5 - 28.0	1.3	8-10-10	10	
				SPT-17	28.0 - 29.5	1.5	4-6-10	15	
				SPT-18	29.5 - 30.8	1.3	10-10-50/0.3	17	
				SPT-19	31.0 - 32.5	1.5	10-11-18	15	
585.5	34.0	-sand lenses at 32.5 ft		SPT-20	32.5 - 34.0	1.5	14-12-11	12	
				SPT-21	34.0 - 35.5	0.9	14-16-25	12	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1279037.42, E 1150938.43		
Project Name	Vermilion Power Station	Boring No.	**S-21**	Total Depth	47.7 ft

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		LEAN CLAY (CL), blackish brown, moist, stiff to very stiff *(Continued)*		SPT-22	35.0 - 37.0	1.3	21-30-26	12	
				SPT-23	37.0 - 38.5	1.5	14-9-11	20	
				SPT-24	38.5 - 40.0	1.5	8-13-15	18	
				SPT-25	40.0 - 41.5	1.5	3-4-6	17	LL=25, PI=11
		-thin sand lenses at 41.5 ft		SPT-26	41.5 - 43.0	1.5	6-5-3	22	
		-some rock fragments at 43.0 ft		SPT-27	43.0 - 44.5	1.5	2-3-8	19	
				SPT-28	44.5 - 46.0	1.5	5-22-71	14	
572.3	47.2			SPT-29	46.0 - 47.2	0.7	6-12-50/0.2	17	
571.8	47.7	SHALE, dark gray, weathered		SPT-30	47.0 - 47.7	0.7	38-50/0.2	--	

Auger Refusal / Bottom of Hole

Top of Rock = 47.2 Elevation (572.3)

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281898.93, E 1147288.62
Project Name	Vermilion Power Station	Boring No.	**S-22** Total Depth 26.5 ft
County	Vermilion	Surface Elevation	604.0 ft
Project Type	Geotechnical Exploration	Date Started	6/29/17 Completed 6/29/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	1.0 ft Date/Time 6/29/11
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
604.0	0.0	Top of Hole						
		FLY ASH (CCR), gray, saturated, very soft to soft	SPT-1	0.0 - 1.5	1.0	WOH-WOH-WOH	44	
			SPT-2	5.0 - 6.5	1.0	WOR-WOR-WOR	--	
			SPT-3	10.0 - 11.5	0.2	WOR-WOR-WOR	40	
			SPT-4	15.0 - 16.5	0.8	WOH-WOH-WOH	--	Vibrating-wire piezometer installed at a depth of 18.0 ft.
			SPT-5	20.0 - 21.5	1.0	1-1-2	43	
581.0	23.0	LEAN CLAY (CL), brown to gray, moist, stiff						
577.5	26.5		SPT-6	25.0 - 26.5	1.2	4-5-6	14	
		No Refusal / Bottom of Hole						

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280955.69, E 1148680.57
Project Name	Vermilion Power Station	Boring No.	**S-23** Total Depth 70.8 ft
County	Vermilion	Surface Elevation	590.0 ft
Project Type	Geotechnical Exploration	Date Started	6/13/17 Completed 6/14/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	11.0 ft Date/Time 6/14/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
590.0	0.0	Top of Hole							
		LEAN CLAY with Sand (CL) (FILL), brown to gray, moist to wet, soft to stiff, occasional sand lenses, sand is fine to coarse grained, brown to black, saturated		SPT-1	0.0 - 1.5	0.9	2-2-2	15	
				SPT-2	1.5 - 3.0	0.8	2-5-5	19	
				SPT-3	3.0 - 4.5	1.5	2-1-2	36	
				SPT-4	4.5 - 6.0	1.5	2-2-6	22	
				SPT-5	6.0 - 7.5	1.2	4-9-7	15	
				SPT-6	7.5 - 9.0	1.5	3-6-9	21	
				SPT-7	9.0 - 10.5	1.5	2-1-2	23	
				SPT-8	10.5 - 12.0	1.5	1-1-2	21	
				SPT-9	12.0 - 13.5	1.1	4-3-7	11	
				SPT-10	13.5 - 15.0	1.0	7-7-9	13	
				SPT-11	15.0 - 16.5	0.9	5-11-15	11	
571.8	18.2			SPT-12	16.5 - 18.0	1.1	12-13-15	19	
		SAND, brown to black, dry to moist, coarse grained, abundant layers of clay ranging from 0.1' to 0.4' in thickness		SPT-13	18.0 - 19.5	1.0	5-10-12	--	
				SPT-14	19.5 - 21.0	1.3	4-6-9	12	
				SPT-15	21.0 - 22.5	1.4	14-13-11	--	
				SPT-16	22.5 - 24.0	1.2	9-13-15	11	
				SPT-17	24.0 - 25.5	1.5	14-23-35	--	
				SPT-18	25.5 - 26.3	0.5	47-50/0.3	--	
				SPT-19	27.0 - 28.5	1.4	19-35-38	10	
				SPT-20	28.5 - 30.0	1.3	19-23-25	--	
				SPT-21	30.0 - 31.5	1.2	5-7-12	--	Vibrating-wire piezometer installed at a depth of 30.0 ft.
				SPT-22	31.5 - 33.0	1.1	18-36-40	11	
				SPT-23	33.0 - 34.5	1.0	21-21-22	--	

Project Number	175667038	Location	N 1280955.69, E 1148680.57		
Project Name	Vermilion Power Station	Boring No.	**S-23**	Total Depth	70.8 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SAND, brown to black, dry to moist, coarse grained, abundant layers of clay ranging from 0.1' to 0.4' in thickness *(Continued)*		SPT-24	34.5 - 36.0	1.2	12-20-22	--	
				SPT-25	36.0 - 37.5	1.2	10-22-31	12	
				SPT-26	37.5 - 39.0	1.2	14-28-34	--	
				SPT-27	39.0 - 40.5	1.5	9-20-23	--	
				SPT-28	40.5 - 42.0	1.5	13-24-35	11	
				SPT-29	42.0 - 43.5	1.3	14-19-24	--	
				SPT-30	43.5 - 45.0	1.4	13-33-39	--	
				SPT-31	45.0 - 46.5	1.5	17-45-37	8	
				SPT-32	46.5 - 48.0	0.0	13-18-21	--	No recovery.
540.5	49.5			SPT-33	48.0 - 49.5	1.5	13-25-24	--	
		LEAN CLAY with Sand, brown to gray, moist, very stiff, fine to medium grained sand lenses (up to 0.8' thick) throughout		SPT-34	49.5 - 51.0	1.0	9-22-24	14	
				SPT-35	51.0 - 52.5	1.4	11-17-25	--	
				SPT-36	52.5 - 54.0	1.5	10-20-23	12	
				SPT-37	54.0 - 55.5	1.5	7-18-25	--	
				SPT-38	55.5 - 57.0	1.5	11-23-22	18	
				SPT-39	57.0 - 58.5	1.5	7-8-12	--	
530.7	59.3			SPT-40	58.5 - 59.3	0.9	18-50/0.3	12	
		SHALE, light gray, thin bedded, weathered, fractured							Began Core
519.2	70.8			69	10.0	10.0	100	70.8	

Bottom of Hole

Top of Rock = 59.3
Elevation (530.7)

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280895.40, E 1148868.40		
Project Name	Vermilion Power Station	Boring No.	**S-24**	Total Depth	54.2 ft
County	Vermilion	Surface Elevation	589.8 ft		
Project Type	Geotechnical Exploration	Date Started	6/12/17	Completed	6/13/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry	Date/Time	6/13/17
Logged By	D. Clements	Depth to Water	N/A	Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden Rock Core Sample #	RQD	Depth Run	Rec. Ft.	Blows Rec. %	Mois.Cont. % Run Depth	Remarks
589.8	0.0	Top of Hole							
		SANDY LEAN CLAY (CL) (FILL), reddish brown to brown, moist, soft to stiff, some gravel to cobble sized rock	SPT-1		0.0 - 1.5	1.1	2-2-3	17	
			SPT-2		1.5 - 3.0	0.8	4-5-6	19	
			SPT-3		3.0 - 4.5	1.5	4-5-7	17	
			SPT-4		4.5 - 6.0	1.5	4-8-9	12	
			SPT-5		6.0 - 7.5	1.5	8-5-6	14	
			SPT-6		7.5 - 9.0	1.5	2-1-1	--	
579.8	10.0		SPT-7		9.0 - 10.5	1.5	3-3-6	--	
		SAND with Gravel and Silt (SP-SM), brown and black, moist, medium dense	SPT-8		10.5 - 12.0	1.1	6-8-9	17	
			SPT-9		12.0 - 13.5	1.5	7-12-12	--	
			SPT-10		13.5 - 15.0	0.7	4-4-6	13	
573.5	16.3		SPT-11		15.0 - 16.5	0.0	4-8-11	--	No recovery.
		LEAN CLAY with Gravel (CL), gray, dry to moist, stiff to very stiff	SPT-12		16.5 - 18.0	1.0	10-11-11	15	
			SPT-13		18.0 - 19.5	1.4	3-6-7	12	
			SPT-14		19.5 - 21.0	1.5	5-8-12	11	
			SPT-15		21.0 - 22.5	1.5	9-12-15	11	
			SPT-16		22.5 - 24.0	1.3	4-9-9	12	
			SPT-17		24.0 - 25.5	1.5	3-4-5	13	
			SPT-18		25.5 - 27.0	1.3	4-7-8	14	
			SPT-19		27.0 - 28.5	0.8	1-3-5	13	
			SPT-20		28.5 - 30.0	1.0	2-4-6	11	
			SPT-21		30.0 - 31.5	1.5	4-6-5	13	
			SPT-22		31.5 - 33.0	1.5	3-5-7	14	
			SPT-23		33.0 - 34.5	1.5	2-5-10	12	

Project Number	175667038	Location	N 1280895.40, E 1148868.40
Project Name	Vermilion Power Station	Boring No.	S-24
		Total Depth	54.2 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		LEAN CLAY with Gravel (CL), gray, dry to moist, stiff to very stiff *(Continued)*		SPT-24	34.5 - 36.0	1.2	3-5-15	12	
				SPT-25	36.0 - 37.5	1.5	4-9-11	14	
				SPT-26	37.5 - 39.0	1.0	5-11-18	11	
				SPT-27	39.0 - 40.5	1.1	6-12-24	11	
				SPT-28	40.5 - 42.0	1.2	14-23-28	10	
546.5	43.3			SPT-29	42.0 - 43.3	1.3	5-15-50/0.3	15	
		SHALE, gray, very thin bedded							Began Core
535.6	54.2			67	10.0	9.8	98	54.2	

Bottom of Hole

Top of Rock = 43.3
Elevation (546.5)

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1279828.60, E 1151274.70
Project Name	Vermilion Power Station	Boring No.	**S-25** Total Depth 32.9 ft
County	Vermilion	Surface Elevation	587.5 ft
Project Type	Geotechnical Exploration	Date Started	6/15/17 Completed 6/16/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 6/16/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
587.5	0.0	Top of Hole						
587.3	0.2	TOPSOIL	SPT-1	0.0 - 1.5	0.8	4-7-18	11	
		LEAN CLAY (CL), brown, moist, medium stiff to very stiff, some sand and gravel	SPT-2	1.5 - 3.0	0.5	6-11-11	9	
			SPT-3	3.0 - 4.5	0.8	4-4-6	11	
			SPT-4	4.5 - 6.0	1.3	4-7-11	11	
			SPT-5	6.0 - 7.5	1.4	10-11-12	9	
			SPT-6	7.5 - 9.0	1.3	4-9-14	8	
			SPT-7	9.0 - 10.5	1.5	4-8-12	9	
			SPT-8	10.5 - 12.0	1.5	8-7-9	11	
			SPT-9	12.0 - 13.5	1.5	6-7-7	15	
			SPT-10	13.5 - 15.0	1.1	3-11-9	15	
			SPT-11	15.0 - 16.5	1.3	2-3-5	16	
			SPT-12	16.5 - 18.0	1.5	5-5-8	17	
568.0	19.5		SPT-13	18.0 - 19.5	1.5	2-2-4	17	Vibrating-wire piezometer installed at a depth of 18.0 ft.
		SILTY SAND (SM), brown, moist, loose to medium dense, fine grained	SPT-14	19.5 - 21.0	1.0	1-2-3	--	
565.0	22.5		SPT-15	21.0 - 22.5	1.0	4-6-11	18	
		SHALE, gray, sandy	SPT-16	22.5 - 22.9	0.4	50/0.4	--	Began Core

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1279828.60, E 1151274.70
Project Name	Vermilion Power Station	Boring No.	**S-25** Total Depth 32.9 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
554.6	32.9	SHALE, gray, sandy *(Continued)*		74	10.0	10.0	100	32.9	

Bottom of Hole

Top of Rock = 22.9
Elevation (564.6)

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280813.17, E 1148857.41
Project Name	Vermilion Power Station	Boring No.	**S-26** Total Depth 10.0 ft
County	Vermilion	Surface Elevation	616.7 ft
Project Type	Geotechnical Exploration	Date Started	6/13/17 Completed 6/13/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 6/13/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
616.7	0.0	Top of Hole							
613.2	3.5	SANDY LEAN CLAY (CL) (FILL), brown, moist							
606.7	10.0	FLY ASH with Bottom Ash (CCR), gray, moist							
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Stantec

Project Number	175667038	Location	N 1280875.27, E 1148687.33
Project Name	Vermilion Power Station	Boring No.	**S-27** Total Depth 10.0 ft
County	Vermilion	Surface Elevation	615.6 ft
Project Type	Geotechnical Exploration	Date Started	6/15/17 Completed 6/15/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 6/15/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
615.6	0.0	Top of Hole							
611.8	3.8	SANDY LEAN CLAY with Gravel (CL) (FILL), brown, moist							
605.6	10.0	FLY ASH with Bottom Ash (CCR), gray							
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281337.47, E 1148278.20
Project Name	Vermilion Power Station	Boring No.	**S-28** Total Depth 100.6 ft
County	Vermilion	Surface Elevation	606.1 ft
Project Type	Geotechnical Exploration	Date Started	7/10/17 Completed 7/12/17
Supervisor	T. Ward Driller S. Bradford	Depth to Water	32.0 ft Date/Time 7/10/17
Logged By	J. Stepina	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
			Rock Core RQD	Run	Rec. Ft.	Rec. %	Run Depth	
606.1	0.0	Top of Hole						
605.9	0.2	CRUSHED LIMESTONE	SPT-1	0.0 - 1.5	1.2	7-13-9	7	
		SILTY CLAY with Sand (CL-ML) (FILL), brownish gray, dry to moist, stiff to very stiff, some gravel throughout, fine grained	SPT-2	1.5 - 3.0	1.0	10-9-6	13	
			SPT-3	3.0 - 4.5	1.5	3-5-8	18	
			SPT-4	4.5 - 6.0	1.5	3-7-8	16	
			SPT-5	6.0 - 7.5	1.5	9-10-12	18	
598.1	8.0		SPT-6	7.5 - 9.0	1.1	3-4-4	15	
		SILTY CLAY with Sand (CL-ML) (FILL), dark gray, moist to wet, medium stiff to very stiff, some fly ash and bottom ash, fine to medium grained sand lenses throughout	ST-1	9.0 - 11.0	1.8	800 psi	--	
			SPT-7	11.0 - 12.5	1.5	14-6-12	12	
			SPT-8	12.5 - 14.0	1.5	3-6-4	13	
			SPT-9	14.0 - 15.5	1.5	3-8-8	15	
			SPT-10	15.5 - 17.0	1.5	3-10-9	14	
			SPT-11	17.0 - 18.5	1.5	5-7-8	13	
		-wood debris at 19.0 ft.	SPT-12	18.5 - 20.0	1.5	9-11-11	20	
			SPT-13	20.0 - 21.5	1.5	4-7-7	15	
			SPT-14	21.5 - 23.0	1.5	9-14-15	12	
			SPT-15	23.0 - 24.5	1.5	4-5-8	12	
			SPT-16	24.5 - 26.0	1.5	2-3-4	26	
			SPT-17	26.0 - 27.5	1.5	5-6-7	26	
			SPT-18	27.5 - 29.0	1.5	3-2-5	28	
		-primarily fly ash with coal fragments from 29.0 to 32.0 ft.	SPT-19	29.0 - 30.5	1.5	2-3-4	31	
574.1	32.0		SPT-20	30.5 - 32.0	1.5	3-5-5	37	
		GRAVELLY SAND (SW), moist, medium dense to dense, cobbles, medium to coarse grained	SPT-21	32.0 - 33.5	0.3	13-19-16	--	
			SPT-22	33.5 - 35.0	0.4	13-18-38	20	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281337.47, E 1148278.20
Project Name	Vermilion Power Station	Boring No.	**S-28**
		Total Depth	100.6 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
569.1	37.0			SPT-23	35.0 - 36.5	0.6	9-8-12	--	Drilling fluid added at 35.0 ft.
		LEAN CLAY (CL), gray, moist, stiff to very stiff, some gravel		SPT-24	36.5 - 38.0	1.5	5-6-9	13	
				SPT-25	38.0 - 39.5	0.3	5-8-6	18	
				SPT-26	39.5 - 41.0	1.1	7-9-9	13	
				ST-2	45.0 - 47.0	1.7	1000 psi	--	LL=19, PI=7, DD=121.9 pcf, MC=14.5%, Gs=2.73 DD=132.5 pcf, MC=12% DD=138.9 pcf, MC=11%
555.1	51.0			SPT-27	50.0 - 51.5	1.5	7-14-19	14	
		SILTY SAND (SM), brown, dry to wet, medium dense to dense, medium to coarse grained, trace gravel							
		-fine sand at 55.0 ft.		SPT-28	55.0 - 56.5	1.3	11-22-30	9	
				SPT-29	60.0 - 61.5	1.5	12-12-17	--	Gravel=4.7%, Sand=76.6%, Fines=18.7%
		-fine sand at 65.0 ft.		SPT-30	65.0 - 66.5	1.5	5-18-21	19	
		-silt layer at 70.0 ft		SPT-31	70.0 - 71.5	1.5	7-11-13	--	

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281337.47, E 1148278.20
Project Name	Vermilion Power Station	Boring No.	**S-28** Total Depth 100.6 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
529.6	76.5		ST-3	75.0 - 77.0	2.0	800 psi	--	DD=103.1 pcf, MC=25%, Gs=2.70 DD=97.2 pcf, MC=30% DD=93.1 pcf, MC=31%
		SILTY CLAY (CL-ML), gray, moist, very stiff, some gravel	SPT-32	80.0 - 81.5	1.5	7-17-21	14	
		-fine sand at 86.0 ft.	SPT-33	85.0 - 86.5	1.5	10-16-14	17	
515.5	90.6	-medium to coarse sand layer from 90.0 to 90.2 ft.	SPT-34	90.0 - 91.5	1.5	9-16-33	--	Began Core
		SHALE, gray, moderately weathered	68	5.0	5.0	100	95.6	
505.5	100.6		76	5.0	4.6	92	100.6	
		Bottom of Hole						

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SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281361.46, E 1148319.73		
Project Name	Vermilion Power Station	Boring No.	**S-29**	Total Depth	51.5 ft
County	Vermilion	Surface Elevation	592.7 ft		
Project Type	Geotechnical Exploration	Date Started	7/9/17	Completed	7/10/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	19.0 ft	Date/Time	7/9/17
Logged By	D. Clements	Depth to Water	N/A	Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
592.7	0.0	Top of Hole						
		SANDY LEAN CLAY (CL) (FILL), brown, dry to moist, medium stiff to very stiff	SPT-1	0.0 - 1.5	1.5	2-2-3	11	
			SPT-2	1.5 - 3.0	1.5	5-7-7	8	
			SPT-3	3.0 - 4.5	1.5	6-8-6	8	
			SPT-4	4.5 - 6.0	1.5	8-8-15	15	
			SPT-5	6.0 - 7.5	1.5	10-9-9	19	
			SPT-6	7.5 - 9.0	1.5	9-11-13	11	
			SPT-7	9.0 - 10.5	1.5	10-11-17	16	
581.2	11.5		SPT-8	10.5 - 12.0	1.5	11-13-9	20	
		LEAN CLAY (CL) (FILL), gray, moist to wet, stiff	SPT-9	12.0 - 13.5	1.5	3-5-8	28	
			SPT-10	13.5 - 15.0	1.5	3-4-5	25	
			SPT-11	15.0 - 16.5	1.5	2-3-5	29	
			SPT-12	16.5 - 18.0	1.5	6-6-5	31	
574.2	18.5		SPT-13	18.0 - 19.5	1.5	2-8-13	29	
		SILTY SAND (SM), brown to gray, dry to moist, medium dense to very dense, coarse grained, some cobbles and boulders	SPT-14	19.5 - 21.0	1.0	7-11-26	--	
			SPT-15	21.0 - 22.5	1.3	12-40-30	10	
			SPT-16	25.0 - 26.5	1.0	5-5-7	12	Vibrating-wire piezometer installed at a depth of 25.0 ft.
562.7	30.0							
		SANDY LEAN CLAY (CL), gray, moist, stiff	SPT-17	30.0 - 31.5	1.3	4-7-7	12	

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281361.46, E 1148319.73
Project Name	Vermilion Power Station	Boring No.	**S-29** Total Depth 51.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
557.2	35.5	SILTY SAND (SM), gray, moist, medium dense		SPT-18	35.0 - 36.5	1.0	4-8-7	12	
				SPT-19	40.0 - 41.5	1.5	3-9-13	--	
				SPT-20	45.0 - 46.5	1.4	4-5-9	15	
541.2	51.5			SPT-21	50.0 - 51.5	1.5	4-7-11	--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281720.32, E 1148307.02
Project Name	Vermilion Power Station	Boring No.	**S-30** Total Depth 90.5 ft
County	Vermilion	Surface Elevation	606.0 ft
Project Type	Geotechnical Exploration	Date Started	6/20/17 Completed 6/20/17
Supervisor	T. Ward Driller S. Bradford	Depth to Water	26.0 ft Date/Time 6/20/17
Logged By	J. Stepina	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
606.0	0.0	Top of Hole						
605.8	0.2	CRUSHED LIMESTONE	SPT-1	0.0 - 1.5	1.3	7-13-7	13	
		LEAN CLAY with Sand and Gravel (CL) (FILL), brownish gray to blackish gray, moist, medium stiff to very stiff, some construction debris	SPT-2	5.0 - 6.5	1.5	2-4-4	15	
			SPT-3	10.0 - 11.5	1.5	9-6-13	14	
			ST-1	15.0 - 17.0	1.0	1200 psi	12	DD=120.0 pcf
586.0	20.0	SILTY, CLAYEY SAND (SM-SC), brownish black, dry, medium dense	SPT-4	20.0 - 21.5	1.5	4-5-5	8	
580.0	26.0		SPT-5	25.0 - 26.5	1.5	1-4-7	--	
		SAND with Gravel and Silt (SP-SM), brown, wet, medium dense						
576.0	30.0	SILTY CLAY with Gravel (CL-ML), light gray, moist, stiff	SPT-6	30.0 - 31.5	1.5	4-7-8	13	

Project Number	175667038	Location	N 1281720.32, E 1148307.02
Project Name	Vermilion Power Station	Boring No.	**S-30** Total Depth 90.5 ft

Lithology: Elevation	Lithology: Depth	Description	Overburden: Sample # / Rock Core: RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SILTY CLAY with Gravel (CL-ML), light gray, moist, stiff *(Continued)*	SPT-7	35.0 - 36.5	1.5	4-5-5	23	
			SPT-8	40.0 - 41.5	0.0	19-43-47	--	No recovery.
561.0	45.0	SILTY, CLAYEY SAND with Gravel (SM-SC), brown to black, dry to moist, medium dense to dense, fine to medium grained	SPT-9	45.0 - 46.5	1.3	18-13-16	10	
			SPT-10	50.0 - 51.5	1.5	4-6-15	--	
		-silty clay with gravel lense from 56.0 to 56.4 ft	SPT-11	55.0 - 56.5	1.2	6-13-19	15	
		-silty clay with gravel lense from 61.0 to 61.5 ft	SPT-12	60.0 - 61.0	1.0	20-39-50/0.0	--	
			SPT-13	65.0 - 66.5	1.5	13-20-17	11	
			SPT-14	70.0 - 71.5	1.3	3-10-22	--	

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281720.32, E 1148307.02		
Project Name	Vermilion Power Station	Boring No.	**S-30**	Total Depth	90.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SILTY, CLAYEY SAND with Gravel (SM-SC), brown to black, dry to moist, medium dense to dense, fine to medium grained *(Continued)*		SPT-15	75.0 - 76.5	1.5	14-20-19	20	
		-silty clay with gravel lense from 80.0 to 81.5 ft		SPT-16	80.0 - 81.5	1.5	6-6-13	--	
				SPT-17	85.0 - 86.5	1.5	4-7-15	14	
517.0	89.0								
515.5	90.5	SHALE, light gray, weathered		SPT-18	89.0 - 90.5	1.3	12-26-44	--	

Auger Refusal /
Bottom of Hole

Top of Rock = 89.0
Elevation (517.0)

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281699.11, E 1148347.09
Project Name	Vermilion Power Station	Boring No.	**S-31** Total Depth 51.5 ft
County	Vermilion	Surface Elevation	593.6 ft
Project Type	Geotechnical Exploration	Date Started	7/8/17 Completed 7/9/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 7/9/17
Logged By	T. Caudill	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
593.6	0.0	Top of Hole						
		LEAN CLAY with Sand (CL) (FILL), brown, dry to moist, stiff to very stiff	SPT-1	0.0 - 1.5	1.3	2-5-6	15	
			SPT-2	1.5 - 3.0	1.5	4-8-11	13	
			SPT-3	3.0 - 4.5	1.5	10-11-16	8	
			SPT-4	4.5 - 6.0	1.5	8-9-12	17	
			SPT-5	6.0 - 7.5	1.5	12-21-22	10	
			SPT-6	7.5 - 9.0	1.5	15-11-6	13	
			SPT-7	9.0 - 10.5	1.4	6-7-6	16	
582.7	10.9	SILTY SAND (SM), brown, moist, loose to medium dense, fine to coarse grained	SPT-8	10.5 - 12.0	1.5	2-5-7	16	
			SPT-9	12.0 - 13.5	1.5	16-14-13	--	
			SPT-10	13.5 - 15.0	0.7	6-3-2	14	
			SPT-11	15.0 - 16.5	1.5	1-1-2	--	
			SPT-12	16.5 - 18.0	1.5	10-8-4	21	
			SPT-13	18.0 - 19.5	1.1	8-9-11	--	
573.4	20.2	SANDY SILTY CLAY (CL-ML), gray, moist, medium stiff to stiff	SPT-14	19.5 - 21.0	1.0	3-2-4	13	
			SPT-15	21.0 - 22.5	0.7	4-4-4	13	
			SPT-16	25.0 - 26.5	1.1	5-5-7	17	Vibrating-wire piezometer installed at a depth of 25.0 ft.
564.3	29.3	SILTY SAND (SM), gray, moist, medium dense, fine to medium grained	SPT-17	30.0 - 31.5	0.8	3-5-8	17	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1281699.11, E 1148347.09
Project Name	Vermilion Power Station	Boring No.	**S-31** Total Depth 51.5 ft

Lithology Elevation	Depth	Description	Overburden Rock Core	Sample # RQD	Depth Run	Rec. Ft. Rec. Ft.	Blows Rec. %	Mois.Cont. % Run Depth	Remarks
557.6	36.0			SPT-18	35.0 - 36.5	1.5	5-9-16	--	
		SILTY CLAY with Sand (CL-ML), gray, moist, very stiff							
				SPT-19	40.0 - 41.5	1.5	7-19-22	12	
				SPT-20	45.0 - 46.5	1.5	7-11-18	--	
542.1	51.5			SPT-21	50.0 - 51.5	1.3	4-8-11	15	
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282431.73, E 1148075.65
Project Name	Vermilion Power Station	Boring No.	**S-32** Total Depth 111.5 ft
County	Vermilion	Surface Elevation	605.7 ft
Project Type	Geotechnical Exploration	Date Started	6/26/17 Completed 6/27/17
Supervisor	T. Ward Driller S. Bradford	Depth to Water	25.0 ft Date/Time 6/26/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
605.7	0.0	Top of Hole							
605.5	0.2	CRUSHED LIMESTONE		SPT-1	0.0 - 1.5	1.2	6-11-9	10	
		LEAN CLAY with Gravel (CL) (FILL), brown to dark gray, dry to moist, stiff to very stiff							
		-dark gray and black at 5.5 ft		SPT-2	5.0 - 6.5	1.5	3-7-9	13	
				ST-1	10.0 - 12.0	0.6	1100 psi	--	
		-some fine grained sand at 15.0 ft -gravel lense from 15.5 to 15.7 ft		SPT-3	15.0 - 16.5	1.5	16-7-8	13	
		-trace wood fragments at 21.0 ft		SPT-4	20.0 - 21.5	1.5	3-7-7	20	
580.7	25.0								
		GRAVELLY SAND (SP-SM), brown, moist, medium dense, medium to coarse grained -rock fragment at 26.5 ft		SPT-5	25.0 - 26.5	0.5	7-11-12	19	

Project Number	175667038	Location	N 1282431.73, E 1148075.65
Project Name	Vermilion Power Station	Boring No.	**S-32** Total Depth 111.5 ft

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		GRAVELLY SAND (SP-SM), brown, moist, medium dense, medium to coarse grained *(Continued)*	SPT-6	30.0 - 31.5	1.5	12-12-6	11	Gravel=31.1%, Sand=57.7%, Fines=11.2%
569.7	36.0		SPT-7	35.0 - 36.5	1.5	4-7-7	--	Added drilling fluid at 36.0 ft.
		LEAN CLAY (CL), gray, moist, medium stiff to very stiff, some sand, some gravel						
			SPT-8	40.0 - 41.5	1.5	1-2-5	14	
			ST-2	45.0 - 46.5	0.5	700 psi	--	
			SPT-9	50.0 - 51.5	1.5	5-6-7	15	
			SPT-10	55.0 - 56.5	1.5	4-6-6	13	
			SPT-11	60.0 - 61.5	1.5	4-4-5	17	

Project Number	175667038	Location	N 1282431.73, E 1148075.65
Project Name	Vermilion Power Station	Boring No.	**S-32** Total Depth 111.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		LEAN CLAY (CL), gray, moist, medium stiff to very stiff, some sand, some gravel *(Continued)*		SPT-12	65.0 - 66.5	1.5	4-7-14	17	
				ST-3	70.0 - 72.0	2.0	1300 psi	--	LL=28, PI=8, DD=111.6 pcf, MC=20%, Gs=2.68 DD=111.9 pcf, MC=18% DD=112.7 pcf, MC=17%
529.7	76.0			SPT-13	75.0 - 76.5	1.5	6-7-8	--	
		SILTY, CLAYEY SAND (SM-SC), dark gray, moist to wet, medium dense, fine grained		SPT-14	80.0 - 81.5	1.5	7-8-15	25	
				SPT-15	85.0 - 86.5	1.5	5-5-6	--	
				ST-4	90.0 - 92.0	2.0	1200 psi	--	
510.7	95.0								
		SILTY SAND with Gravel (SM), moist, very dense, coarse grained		SPT-16	95.0 - 96.3	1.3	12-26-50/0.3	26	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282431.73, E 1148075.65
Project Name	Vermilion Power Station	Boring No.	**S-32** Total Depth 111.5 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SILTY SAND with Gravel (SM), moist, very dense, coarse grained *(Continued)*						
			SPT-17	100.0 - 101.4	1.4	14-33-50/0.4	--	Gravel=13.8%, Sand=73.3%, Fines=12.9%
			SPT-18	105.0 - 105.9	0.9	21-50/0.4	13	
495.7	110.0							
494.2	111.5	SHALE, light gray	SPT-19	110.0 - 111.3	1.3	16-62-50/0.3	--	

Auger Refusal / Bottom of Hole

Top of Rock = 110.0 Elevation (495.7)

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1282188.69, E 1148202.80
Project Name	Vermilion Power Station	Boring No.	**S-33** Total Depth 105.7 ft
County	Vermilion	Surface Elevation	605.6 ft
Project Type	Geotechnical Exploration	Date Started	6/19/17 Completed 6/19/17
Supervisor	T. Ward Driller S. Bradford	Depth to Water	20.0 ft Date/Time 6/19/17
Logged By	J. Stepina	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
605.6	0.0	Top of Hole						
605.3	0.3	CRUSHED LIMESTONE	SPT-1	0.0 - 1.5	0.7	4-8-8	8	
		LEAN CLAY with Gravel (CL) (FILL), brownish gray, dry to moist, medium stiff to very stiff	SPT-2	5.0 - 6.5	1.2	5-3-3	--	
			ST-1	10.0 - 12.0	1.7	975 psi	14	DD=116.4 pcf
			SPT-3	15.0 - 16.5	1.5	3-4-7	15	
585.1	20.5	BOTTOM ASH with Clay (CCR), black, moist, loose, angular	SPT-4	20.0 - 21.5	1.3	3-6-3	15	
580.6	25.0	SILTY CLAY (CL-ML), gray, moist, medium stiff	SPT-5	25.0 - 26.5	1.5	2-3-4	32	
575.6	30.0	GRAVELLY SAND (SP), brown, moist, loose, layers of fine grained sand and medium to coarse grained sandy gravel	SPT-6	30.0 - 31.5	1.1	WOR-WOR-5	--	

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282188.69, E 1148202.80
Project Name	Vermilion Power Station	Boring No.	**S-33**
Total Depth	105.7 ft		

Lithology: Elevation	Lithology: Depth	Description	Overburden: Sample # / Rock Core: RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
569.6	36.0		SPT-7	35.0 - 36.5	1.5	2-4-6	15	
		SILTY CLAY with Gravel (CL-ML), gray, moist, stiff to very stiff, occasional lenses of 0.4 ft thick fine grained sand and gravel						
			SPT-8	40.0 - 41.5	1.5	1-3-11	--	
			SPT-9	45.0 - 46.5	1.5	2-3-7	13	
			SPT-10	50.0 - 51.5	1.5	4-7-10	--	
			SPT-11	55.0 - 56.5	1.5	4-12-19	11	
			ST-2	60.0 - 62.0	0.9	1500 psi	24	
			SPT-12	65.0 - 66.5	1.5	8-7-5	--	
			SPT-13	70.0 - 71.5	1.5	5-14-19	15	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282188.69, E 1148202.80
Project Name	Vermilion Power Station	Boring No.	**S-33** Total Depth 105.7 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SILTY CLAY with Gravel (CL-ML), gray, moist, stiff to very stiff, occasional lenses of 0.4 ft thick fine grained sand and gravel *(Continued)*		SPT-14	75.0 - 76.5	1.5	6-9-11	--	
523.6	82.0			ST-3	80.0 - 82.0	2.0	9000 psi	27	DD=104.7 pcf
		LEAN CLAY (CL), gray, moist to wet, medium stiff to very stiff		SPT-15	85.0 - 86.5	1.5	1-3-3	27	
				SPT-16	90.0 - 91.5	1.5	7-8-9	--	
				SPT-17	95.0 - 96.5	1.5	16-17-15	32	
504.1	101.5			SPT-18	100.0 - 101.5	1.5	9-14-27	--	
499.9	105.7	SHALE, light gray, slightly weathered		SPT-19	105.0 - 105.7	0.7	43-50/0.2	--	

Auger Refusal /
Bottom of Hole

Top of Rock = 105.0
Elevation (500.6)

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282149.17, E 1148531.24
Project Name	Vermilion Power Station	Boring No.	**S-34** Total Depth 94.5 ft
County	Vermilion	Surface Elevation	596.2 ft
Project Type	Geotechnical Exploration	Date Started	7/9/17 Completed 7/9/17
Supervisor	T. Ward Driller S. Bradford	Depth to Water	Dry Date/Time 7/9/17
Logged By	J. Stepina	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
596.2	0.0	Top of Hole							
596.0	0.2	CRUSHED LIMESTONE							
		LEAN CLAY with Sand (CL) (FILL), brownish gray, dry to moist, stiff, trace fly ash, some gravel		SPT-1	0.0 - 1.5	1.1	6-8-7	13	
				SPT-2	1.5 - 3.0	1.2	6-6-5	15	
				SPT-3	3.0 - 4.5	0.6	1-3-4	21	
				SPT-4	4.5 - 6.0	1.5	10-12-13	16	
				SPT-5	6.0 - 7.5	1.5	10-12-15	13	
				SPT-6	7.5 - 9.0	1.5	9-8-7	13	LL=25, PI=9, DD=118.3 pcf, MC=13%, Gs=2.65
				ST-1	9.0 - 11.0	1.7	900 psi	--	DD=117.5 pcf, MC=15%
584.7	11.5	LEAN CLAY (CL) (FILL), dark gray, moist to wet, soft to stiff, trace gravel		SPT-7	11.0 - 12.5	1.5	3-3-4	22	
				SPT-8	12.5 - 14.0	1.5	1-2-3	19	
				SPT-9	14.0 - 15.5	1.5	4-7-8	17	
				SPT-10	15.5 - 17.0	1.5	1-3-4	14	
				SPT-11	17.5 - 19.0	1.5	2-2-3	24	
				SPT-12	19.0 - 20.5	1.5	1-1-3	28	

Project Number	175667038	Location	N 1282149.17, E 1148531.24
Project Name	Vermilion Power Station	Boring No.	**S-34** Total Depth 94.5 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
574.7	21.5	-some wood debris and organic material at 20 ft		SPT-13	20.5 - 22.0	1.5	1-2-4	--	
		SILTY SAND (SM), brown, dry, dense to very dense, fine to medium grained, some gravel		SPT-14	22.0 - 23.5	1.5	5-11-31	11	
				SPT-15	23.5 - 25.0	1.2	4-32-33	--	
				SPT-16	25.0 - 26.5	0.0	16-29-25	--	No recovery, apparent boulder.
569.2	27.0								
		LEAN CLAY with Gravel (CL), gray, moist, stiff to very stiff, lenses of light brown sand throughout, some gravel		SPT-17	26.5 - 28.0	0.3	10-17-7	14	
				SPT-18	28.0 - 29.5	0.7	23-11-6	14	
				SPT-19	29.5 - 31.0	1.2	3-5-4	17	
				SPT-20	31.0 - 32.5	1.5	5-7-9	13	
				ST-2	32.5 - 34.5	1.2	900 psi	15	LL=18, PI=9, DD=126.5 pcf, Gs=2.70
				SPT-21	34.5 - 36.0	0.0	11-15-13	--	
				SPT-22	36.0 - 37.5	1.5	11-13-21	12	
				SPT-23	37.5 - 39.0	1.5	8-11-24	12	
				SPT-24	39.0 - 40.5	1.5	16-14-23	15	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1282149.17, E 1148531.24
Project Name	Vermilion Power Station	Boring No.	**S-34** Total Depth 94.5 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		LEAN CLAY with Gravel (CL), gray, moist, stiff to very stiff, lenses of light brown sand throughout, some gravel *(Continued)*							
				SPT-25	45.0 - 46.5	1.5	18-18-19	11	
				SPT-26	50.0 - 51.5	1.5	5-8-10	13	
				SPT-27	55.0 - 56.5	1.5	10-17-14	12	
				SPT-28	60.0 - 61.5	1.5	8-8-14	12	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1282149.17, E 1148531.24
Project Name	Vermilion Power Station	Boring No.	**S-34**
		Total Depth	94.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		LEAN CLAY with Gravel (CL), gray, moist, stiff to very stiff, lenses of light brown sand throughout, some gravel *(Continued)*		ST-3	65.0 - 67.0	1.3	900 psi	--	
				SPT-29	70.0 - 71.5	1.5	4-7-13	27	
				SPT-30	75.0 - 76.5	1.5	3-4-5	18	
516.2	80.0	SILTY SAND (SM), light brown, moist, medium dense, medium to coarse grained, some gravel		SPT-31	80.0 - 81.5	1.5	5-14-9	16	
513.4	82.8	SHALE, gray, weathered, thinly bedded		SPT-32	82.5 - 83.9	1.3	1-42-50/0.4	--	Began Core
				0	1.7	1.0	59	84.5	

Project Number	175667038	Location	N 1282149.17, E 1148531.24
Project Name	Vermilion Power Station	Boring No.	**S-34**
		Total Depth	94.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
506.7	89.5	SHALE, gray, weathered, thinly bedded *(Continued)*		16	5.0	1.0	20	89.5	
501.7	94.5	BITUMINOUS COAL, black, slightly weathered to fresh, some vertical fractures		30	5.0	5.0	100	94.5	
		Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282073.98, E 1148551.67
Project Name	Vermilion Power Station	Boring No.	**S-35** Total Depth 51.5 ft
County	Vermilion	Surface Elevation	591.7 ft
Project Type	Geotechnical Exploration	Date Started	7/2/17 Completed 7/2/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	11.4 ft Date/Time 7/2/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden Rock Core Sample # RQD	Depth Run	Rec. Ft. Rec. Ft.	Blows Rec. %	Mois.Cont. % Run Depth	Remarks
591.7	0.0	Top of Hole						
587.4	4.3	LEAN CLAY with Sand (CL) (FILL), grayish brown, moist, medium stiff to stiff, trace gravel, some roots, lenses of sand throughout	SPT-1	0.0 - 1.5	1.2	2-2-4	19	
			SPT-2	1.5 - 3.0	1.3	4-4-4	15	
			SPT-3	3.0 - 4.5	1.5	2-3-6	13	
585.2	6.5	SILTY, CLAYEY SAND (SM-SC) (FILL), gray, moist, medium dense	SPT-4	4.5 - 6.0	1.5	4-9-11	11	
583.4	8.3	LEAN CLAY (CL) (FILL), brown, moist, medium stiff	ST-1	6.0 - 8.0	1.6	700 psi	14	LL=29, PI=13, DD=119.4 pcf, Gs=2.67
580.3	11.4	SILTY SAND (SM), tan and brown, dry, loose, medium to coarse grained	SPT-5	8.0 - 9.5	1.5	2-3-6	8	
			SPT-6	9.5 - 11.0	1.5	2-2-2	--	
577.1	14.6	GRAVELLY SAND (SP), light brown, wet, loose, medium to coarse grained	SPT-7	11.0 - 12.5	1.1	2-2-2	19	
			SPT-8	12.5 - 14.0	0.9	1-3-5	--	
576.1	15.6	SANDY LEAN CLAY (CL), gray, moist, stiff	SPT-9	14.0 - 15.5	0.5	6-6-7	17	Added drilling fluid at 15.0 ft.
561.1	30.6	LEAN CLAY (CL), gray, moist, stiff	SPT-10	15.5 - 17.0	1.5	5-7-8	13	
			ST-2	17.0 - 19.0	0.8	450 psi	13	LL=20, PI=9, DD=128.1 pcf, Gs=2.71
			SPT-11	19.0 - 20.5	0.8	4-5-5	16	
		-some sand at 21.0 ft	SPT-12	20.5 - 22.0	0.6	4-5-8	15	
			SPT-13	25.0 - 26.5	1.3	1-3-6	13	Vibrating-wire piezometer installed at a depth of 25.0 ft.
		SILTY SAND (SM), gray with brown, wet, medium dense to dense, fine to medium grained	SPT-14	30.0 - 31.5	1.4	1-3-8	--	

Project Number	175667038	Location	N 1282073.98, E 1148551.67
Project Name	Vermilion Power Station	Boring No.	**S-35** Total Depth 51.5 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		SILTY SAND (SM), gray with brown, wet, medium dense to dense, fine to medium grained *(Continued)* -medium to coarse grained at 36.0 ft		SPT-15	35.0 - 36.5	1.5	4-5-9	13	Gravel=3.0%, Sand=68.9%, Fines=28.1%, Gs=2.70
		-some gravel at 40.7 ft		SPT-16	40.0 - 41.5	1.5	7-19-25	--	
		-clay seam from 45.8 to 46.2 ft		SPT-17	45.0 - 46.5	1.5	9-14-23	14	
540.2	51.5			SPT-18	50.0 - 51.5	1.5	13-19-25	--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282412.51, E 1148579.26
Project Name	Vermilion Power Station	Boring No.	**S-36** Total Depth 96.4 ft
County	Vermilion	Surface Elevation	595.5 ft
Project Type	Geotechnical Exploration	Date Started	6/30/17 Completed 7/8/17
Supervisor	T. Ward Driller S. Bradford	Depth to Water	15.0 ft Date/Time 6/30/17
Logged By	J. Stepina	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
595.5	0.0	Top of Hole							
595.3	0.2	CRUSHED LIMESTONE		SPT-1	0.0 - 1.5	1.5	6-6-7	12	
		LEAN CLAY (CL) (FILL), brown, moist, stiff, trace gravel, some sand							
				SPT-2	5.0 - 6.5	1.5	1-3-5	14	
				ST-1	10.0 - 12.0	2.0	800 psi	--	LL=23, PI=8, DD=110.6 pcf, MC=14%, Gs=2.67 DD=120.2 pcf, MC=14%
580.5	15.0	SANDY LEAN CLAY (CL) (FILL), light brown, moist, stiff, some gravelly seams		SPT-3	15.0 - 16.5	1.5	3-6-9	19	Added drilling fluid at 15.0 ft.
575.0	20.5			SPT-4	20.0 - 21.5	1.5	6-9-11	16	
574.0	21.5	SILTY SAND (SM), brown, moist, medium dense, medium to coarse grained, some gravel							
		SILTY CLAY (CL-ML), gray, moist, stiff, some gravel, some sand		SPT-5	25.0 - 26.5	1.2	3-6-7	13	
				SPT-6	30.0 - 31.5	1.5	3-5-8	13	

Project Number	175667038	Location	N 1282412.51, E 1148579.26
Project Name	Vermilion Power Station	Boring No.	**S-36** Total Depth 96.4 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SILTY CLAY (CL-ML), gray, moist, stiff, some gravel, some sand *(Continued)*		SPT-7	35.0 - 36.5	1.5	3-6-3	14	
				ST-2	40.0 - 42.0	0.6	900 psi	--	
549.9	45.6								
		SAND, light brown with gray, moist, medium dense		SPT-8	45.0 - 46.5	1.5	3-4-8	14	
547.0	48.5								
		LEAN CLAY (CL), gray, moist to wet, stiff to very stiff, trace gravel		SPT-9	50.0 - 51.5	1.5	5-8-10	13	
		-sand lense from 55.6 to 56.4 ft		SPT-10	55.0 - 56.5	1.5	4-8-7	17	
				SPT-11	60.0 - 61.5	1.5	6-6-10	14	
				ST-3	65.0 - 67.0	1.6	975 psi	--	LL=30, PI=9, DD=81.1 pcf, MC=39%, Gs=2.70 DD=93.3 pcf, MC=33% DD=101.4 pcf, MC=24%
				SPT-12	70.0 - 71.5	1.5	7-6-8	26	

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282412.51, E 1148579.26
Project Name	Vermilion Power Station	Boring No.	**S-36**
		Total Depth	96.4 ft

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
520.5	75.0	SILTY CLAY with Sand (CL-ML), gray to greenish gray, moist, stiff	SPT-13	75.0 - 76.5	1.5	3-4-6	19	
515.0	80.5	SANDY LEAN CLAY (CL), gray to greenish gray, moist, very stiff	SPT-14	80.0 - 81.5	1.5	7-14-20	20	
512.0	83.5	SHALE, gray to light gray, slightly weathered to fresh, thinly bedded	SPT-15	83.5 - 84.0	0.2	50/0.5	--	Began Core
			76	1.7	1.5	88	86.4	
			68	5.0	4.8	96	91.4	
499.1	96.4		78	5.0	5.0	100	96.4	

Bottom of Hole

Top of Rock = 83.5
Elevation (512.0)

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282577.35, E 1148255.43
Project Name	Vermilion Power Station	Boring No.	**S-37** — Total Depth 106.0 ft
County	Vermilion	Surface Elevation	595.6 ft
Project Type	Geotechnical Exploration	Date Started	6/28/17 — Completed 6/28/17
Supervisor	T. Ward — Driller S. Bradford	Depth to Water	18.0 ft — Date/Time 6/28/17
Logged By	T. Ward	Depth to Water	N/A — Date/Time N/A

Lithology: Elevation	Lithology: Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
595.6	0.0	Top of Hole						
595.4	0.2	CRUSHED LIMESTONE	SPT-1	0.0 - 1.5	1.5	11-7-7	11	
		SANDY LEAN CLAY (CL) (FILL), brown to dark gray, dry to moist, stiff to very stiff, some gravel						
		-wood fragments at 6.0 ft	SPT-2	5.0 - 6.5	1.0	2-4-5	12	
			ST-1	10.0 - 12.0	1.6	700 psi	13	LL=23, PI=9, DD=120.3 pcf, Gs=2.65
579.6	16.0	SANDY GRAVEL (GP), brown, moist, loose, medium to coarse grained	SPT-3	15.0 - 16.5	0.9	3-9-19	15	
575.1	20.5	SILTY CLAY (CL-ML), gray, moist to wet, stiff to very stiff, some gravel	SPT-4	20.0 - 21.5	1.5	3-4-6	13	Added drilling fluid at 20.0 ft.
			SPT-5	25.0 - 26.5	1.2	2-3-7	12	
			SPT-6	30.0 - 31.5	1.3	4-5-8	13	

Project Number	175667038	Location	N 1282577.35, E 1148255.43
Project Name	Vermilion Power Station	Boring No.	**S-37** Total Depth 106.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SILTY CLAY (CL-ML), gray, moist to wet, stiff to very stiff, some gravel *(Continued)*		ST-2	35.0 - 37.0	1.0	1000 psi	13	LL=17, PI=5, DD=127.7 pcf, Gs=2.70
				SPT-7	40.0 - 41.5	1.5	5-6-7	13	
				SPT-8	45.0 - 46.5	1.5	4-7-8	14	
				SPT-9	50.0 - 51.5	1.5	4-9-6	14	
				SPT-10	55.0 - 56.5	1.5	4-8-12	29	
534.6	61.0			SPT-11	60.0 - 61.5	0.6	10-12-16	18	
		SILTY SAND (SM), dark gray, moist, loose to medium dense, some clay, fine grained							
				SPT-12	65.0 - 66.5	1.5	5-5-3	24	
				ST-3	70.0 - 72.0	1.8	900 psi	--	

SUBSURFACE LOG (DRAFT)

Stantec

Project Number	175667038	Location	N 1282577.35, E 1148255.43
Project Name	Vermilion Power Station	Boring No.	**S-37** Total Depth 106.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SILTY SAND (SM), dark gray, moist, loose to medium dense, some clay, fine grained *(Continued)*	SPT-13	75.0 - 76.5	1.5	1-4-6	--	
515.6	80.0							
		SAND with Gravel and Silt (SP-SM), brown, moist, dense to very dense, medium to coarse grained	SPT-14	80.0 - 81.5	1.5	11-19-21	23	
			SPT-15	85.0 - 86.5	1.2	5-12-28	--	
								Gravel=7.8%, Sand=84.4%, Fines=7.8%
			SPT-16	90.0 - 90.9	0.9	38-50/0.4	15	
500.8	94.8		SPT-17	94.0 - 94.8	0.8	34-50/0.3	--	Began Core
		SHALE, gray, slightly weathered	0	1.2	1.2	100	96.0	
495.6	100.0							
		ANTHRACITE COAL with Quartz Veins, highly fractured/weathered, moderately strong to strong	66	5.0	5.0	100	101.0	
489.6	106.0		44	5.0	5.0	100	106.0	
		Bottom of Hole						

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1280440.10, E 1149422.90
Project Name	Vermilion Power Station	Boring No.	**S-38** Total Depth 41.5 ft
County	Vermilion	Surface Elevation	644.0 ft
Project Type	Geotechnical Exploration	Date Started	6/27/17 Completed 6/27/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 6/27/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core: Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
644.0	0.0	Top of Hole						
		SANDY SILTY CLAY (CL-ML) (FILL), dry to moist, stiff to very stiff, gravel, boulders	SPT-1	0.0 - 1.5	1.5	4-7-7	9	
			SPT-2	5.0 - 6.5	1.5	5-8-9	11	
			SPT-3	10.0 - 11.5	1.5	14-21-30	11	
630.5	13.5							
		FLY ASH with Bottom Ash (CCR), gray, moist to saturated, soft to stiff	SPT-4	15.0 - 16.5	1.5	7-9-11	19	
			SPT-5	20.0 - 21.5	1.5	3-3-4	--	
			SPT-6	25.0 - 26.5	1.5	1-1-1	33	
		-sand and gravel lense from 31.0 to 31.5 ft	SPT-7	30.0 - 31.5	1.5	3-7-8	--	

Project Number	175667038	Location	N 1280440.10, E 1149422.90
Project Name	Vermilion Power Station	Boring No.	**S-38**
		Total Depth	41.5 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
605.8	38.2	FLY ASH with Bottom Ash (CCR), gray, moist to saturated, soft to stiff *(Continued)*		SPT-8	35.0 - 36.5	1.5	4-4-5	46	
602.5	41.5	SANDY LEAN CLAY (CL), brown, moist, very stiff, gravel		SPT-9	40.0 - 41.5	1.5	4-8-11	14	
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280165.23, E 1148902.53
Project Name	Vermilion Power Station	Boring No.	**S-39** Total Depth 26.5 ft
County	Vermilion	Surface Elevation	640.0 ft
Project Type	Geotechnical Exploration	Date Started	7/10/17 Completed 7/10/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 7/10/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
640.0	0.0	Top of Hole							
		FLY ASH with Bottom Ash (CCR), gray, wet, very soft to very stiff		SPT-1	0.0 - 1.5	1.5	2-2-2	35	
				SPT-2	5.0 - 6.5	1.5	4-10-10	--	
				SPT-3	10.0 - 11.5	1.5	5-4-5	34	
				SPT-4	15.0 - 16.5	1.5	3-3-3	--	
				SPT-5	20.0 - 21.5	1.5	1-1-1	37	
617.0	23.0	LEAN CLAY (CL), gray to brown, moist, medium stiff							
613.5	26.5			SPT-6	25.0 - 26.5	1.5	2-2-5	22	
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280371.29, E 1149468.06
Project Name	Vermilion Power Station	Boring No.	S-40 / Total Depth 36.5 ft
County	Vermilion	Surface Elevation	644.8 ft
Project Type	Geotechnical Exploration	Date Started	7/10/17 / Completed 7/10/17
Supervisor	T. Ward / Driller T. Caudill	Depth to Water	Dry / Date/Time 7/10/17
Logged By	D. Clements	Depth to Water	N/A / Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
644.8	0.0	Top of Hole						
		SANDY LEAN CLAY (CL) (FILL), brown to gray, dry to moist, stiff to very stiff, gravel	SPT-1	0.0 - 1.5	1.2	3-5-8	8	
			SPT-2	5.0 - 6.5	1.5	9-9-8	--	
			SPT-3	10.0 - 11.5	1.5	6-6-8	18	
628.7	16.1		SPT-4	15.0 - 16.5	1.2	3-2-2	--	
		SANDY SILTY CLAY (CL-ML), gray, moist, soft, wood fragments						
624.8	20.0							
		SILTY CLAY (CL-ML), gray, moist, medium stiff to very stiff	SPT-5	20.0 - 21.5	1.5	3-3-4	12	
			SPT-6	25.0 - 26.5	1.3	8-12-13	--	

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280371.29, E 1149468.06
Project Name	Vermilion Power Station	Boring No.	**S-40** Total Depth 36.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SILTY CLAY (CL-ML), gray, moist, medium stiff to very stiff *(Continued)*		SPT-7	30.0 - 31.5	0.5	9-11-15	13	
608.3	36.5			SPT-8	35.0 - 36.5	1.2	24-15-16	--	
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282309.38, E 1147614.05
Project Name	Vermilion Power Station	Boring No.	**ST-1** Total Depth 8.5 ft
County	Vermilion	Surface Elevation	596.3 ft
Project Type	Geotechnical Exploration	Date Started	6/30/17 Completed 6/30/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	0.5 ft Date/Time 6/30/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
596.3	0.0	Top of Hole							
		FLY ASH (CCR), gray, saturated							No recovery from 0.0-7.0 ft.
587.8	8.5			BAG-1	7.0 - 8.5			--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282309.27, E 1147813.97
Project Name	Vermilion Power Station	Boring No.	**ST-2** Total Depth 10.0 ft
County	Vermilion	Surface Elevation	596.7 ft
Project Type	Geotechnical Exploration	Date Started	6/30/17 Completed 6/30/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	0.3 ft Date/Time 6/30/17
Logged By	B. Herries	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden Rock Core	Sample # RQD	Depth Run	Rec. Ft. Rec. Ft.	Blows Rec. %	Mois.Cont. % Run Depth	Remarks
596.7	0.0	Top of Hole							
		FLY ASH (CCR), gray, saturated		BAG-1	4.0 - 10.0			--	
586.7	10.0								
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282309.27, E 1148013.96
Project Name	Vermilion Power Station	Boring No.	**ST-3** Total Depth 8.5 ft
County	Vermilion	Surface Elevation	596.1 ft
Project Type	Geotechnical Exploration	Date Started	6/30/17 Completed 6/30/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	0.3 ft Date/Time 6/30/17
Logged By	B. Herries	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
596.1	0.0	Top of Hole							
587.6	8.5	FLY ASH (CCR), gray, saturated		BAG-1	4.0 - 8.5			--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282109.31, E 1147613.99
Project Name	Vermilion Power Station	Boring No.	**ST-4** Total Depth 7.0 ft
County	Vermilion	Surface Elevation	600.1 ft
Project Type	Geotechnical Exploration	Date Started	6/30/17 Completed 6/30/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	4.0 ft Date/Time 6/30/17
Logged By	B. Herries	Depth to Water	N/A Date/Time N/A

Lithology		Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
Elevation	Depth								
600.1	0.0	Top of Hole							
593.1	7.0	FLY ASH with Bottom Ash (CCR), gray, wet -clay seam from 4.5 to 5.0 ft		BAG-1	4.0 - 7.0			--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282109.19, E 1147814.09
Project Name	Vermilion Power Station	Boring No.	**ST-5** Total Depth 7.0 ft
County	Vermilion	Surface Elevation	599.2 ft
Project Type	Geotechnical Exploration	Date Started	6/30/17 Completed 6/30/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	3.4 ft Date/Time 6/30/17
Logged By	B. Herries	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
599.2	0.0	Top of Hole							
592.2	7.0	FLY ASH with Bottom Ash (CCR), grayish brown to gray, wet		BAG-1	4.0 - 7.0			--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282109.25, E 1148014.06
Project Name	Vermilion Power Station	Boring No.	**ST-6** Total Depth 7.0 ft
County	Vermilion	Surface Elevation	597.7 ft
Project Type	Geotechnical Exploration	Date Started	6/30/17 Completed 7/1/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	0.9 ft Date/Time 7/1/17
Logged By	B. Herries	Depth to Water	N/A Date/Time N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
597.7	0.0	Top of Hole							
590.7	7.0	FLY ASH (CCR), gray, saturated		BAG-1	4.0 - 7.0			--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1282109.31, E 1148213.99
Project Name	Vermilion Power Station	Boring No.	**ST-7**
		Total Depth	8.5 ft
County	Vermilion	Surface Elevation	597.9 ft
Project Type	Geotechnical Exploration	Date Started	7/1/17
		Completed	7/1/17
Supervisor	T. Ward	Driller	T. Caudill
Depth to Water	1.0 ft	Date/Time	7/1/17
Logged By	B. Herries	Depth to Water	N/A
		Date/Time	N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
597.9	0.0	Top of Hole							
589.4	8.5	FLY ASH with Bottom Ash (CCR), gray to brownish gray, wet		BAG-1	4.0 - 8.5			--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281908.81, E 1147411.56
Project Name	Vermilion Power Station	Boring No.	**ST-8** Total Depth 36.5 ft
County	Vermilion	Surface Elevation	602.5 ft
Project Type	Geotechnical Exploration	Date Started	6/29/17 Completed 6/29/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	1.0 ft Date/Time 6/29/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
602.5	0.0	Top of Hole						
		FLY ASH with Bottom Ash (CCR), gray, wet, soft						
			BAG-1	5.0 - 11.0			--	
		-sand zone from 16.0 to 16.5 ft	BAG-2	14.0 - 20.0			--	

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281908.81, E 1147411.56
Project Name	Vermilion Power Station	Boring No.	**ST-8**
		Total Depth	36.5 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		FLY ASH with Bottom Ash (CCR), gray, wet, soft *(Continued)*		SPT-1	25.0 - 26.5	1.0	1-2-2	24	
573.0	29.5								
572.0	30.5	SILTY SAND (SM), gray, wet, coarse grained		SPT-2	30.0 - 31.5	1.5	1-2-3	13	
		SILTY CLAY (CL-ML), gray, medium stiff to stiff							
				SPT-3	35.0 - 36.5	1.5	4-4-7	13	
566.0	36.5								
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281909.04, E 1147614.11
Project Name	Vermilion Power Station	Boring No.	**ST-9** Total Depth 21.0 ft
County	Vermilion	Surface Elevation	601.3 ft
Project Type	Geotechnical Exploration	Date Started	6/20/17 Completed 6/20/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	1.0 ft Date/Time 6/20/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
601.3	0.0	Top of Hole							
		FLY ASH with Bottom Ash (CCR), gray, wet		BAG-1	8.0 - 14.0			--	
				BAG-2	17.0 - 21.0			--	
580.8	20.5	SILTY SAND (SM), brown, wet, coarse grained							
580.3	21.0	No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281909.09, E 1147814.83
Project Name	Vermilion Power Station	Boring No.	**ST-10** Total Depth 21.5 ft
County	Vermilion	Surface Elevation	601.0 ft
Project Type	Geotechnical Exploration	Date Started	6/20/17 Completed 6/20/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	1.0 ft Date/Time 6/20/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
601.0	0.0	Top of Hole						
		FLY ASH with Bottom Ash (CCR), gray, very wet	BAG-1	8.0 - 14.0			--	
588.5	12.5							
		FLY ASH (CCR), gray, wet, coal fragments	BAG-2	16.0 - 20.0			--	
581.3	19.7							
579.5	21.5	SILTY SAND (SM), brown, wet, medium dense	SPT-1	20.0 - 21.5	1.0	4-6-9	--	
		No Refusal / Bottom of Hole						

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281910.55, E 1148015.20
Project Name	Vermilion Power Station	Boring No.	**ST-11** Total Depth 20.0 ft
County	Vermilion	Surface Elevation	601.1 ft
Project Type	Geotechnical Exploration	Date Started	6/20/17 Completed 6/20/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	1.0 ft Date/Time 6/20/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
601.1	0.0	Top of Hole						
		FLY ASH with Bottom Ash (CCR), gray, wet	BAG-1	5.0 - 11.0			--	
			BAG-2	14.0 - 20.0			--	
582.1	19.0							Two samples obtained.
581.1	20.0	SANDY LEAN CLAY (CL), brown, moist						
		No Refusal / Bottom of Hole						

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

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SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281909.29, E 1148213.67
Project Name	Vermilion Power Station	Boring No.	ST-12 — Total Depth 20.0 ft
County	Vermilion	Surface Elevation	600.7 ft
Project Type	Geotechnical Exploration	Date Started	6/20/17 — Completed 6/20/17
Supervisor	T. Ward — Driller T. Caudill	Depth to Water	1.0 ft — Date/Time 6/20/17
Logged By	D. Clements	Depth to Water	N/A — Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
600.7	0.0	Top of Hole							
		FLY ASH with Bottom Ash (CCR), gray, wet		BAG-1	4.0 - 10.0			--	
				BAG-2	12.0 - 18.0			--	
582.2	18.5								
580.7	20.0	SILTY SAND (SM), brown, wet							
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1279507.91, E 1150492.70
Project Name	Vermilion Power Station	Boring No.	**ST-13** Total Depth 20.0 ft
County	Vermilion	Surface Elevation	604.0 ft
Project Type	Geotechnical Exploration	Date Started	6/29/17 Completed 6/29/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	1.0 ft Date/Time 6/29/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
604.0	0.0	Top of Hole							
		FLY ASH with Bottom Ash (CCR), gray, wet							
				BAG-1	4.0 - 10.0			--	
				BAG-2	14.0 - 20.0			--	
584.0	20.0								
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281706.22, E 1147616.14
Project Name	Vermilion Power Station	Boring No.	**ST-14** Total Depth 23.0 ft
County	Vermilion	Surface Elevation	605.6 ft
Project Type	Geotechnical Exploration	Date Started	6/19/17 Completed 6/20/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	1.0 ft Date/Time 6/20/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
605.6	0.0	Top of Hole							
		FLY ASH with Bottom Ash (CCR), gray, wet							
				BAG-1	8.0 - 14.0			--	
				BAG-2	17.0 - 23.0			--	
582.6	23.0								
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281707.54, E 1147813.58
Project Name	Vermilion Power Station	Boring No.	**ST-15** Total Depth 23.0 ft
County	Vermilion	Surface Elevation	604.4 ft
Project Type	Geotechnical Exploration	Date Started	6/19/17 Completed 6/19/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	1.0 ft Date/Time 6/19/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
604.4	0.0	Top of Hole							
		FLY ASH with Bottom Ash (CCR), gray, wet							
				BAG-1	8.0 - 14.0			--	
				BAG-2	17.0 - 22.0			--	
581.4	23.0								
		No Refusal / Bottom of Hole							

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9/5/17

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SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281713.33, E 1148023.92
Project Name	Vermilion Power Station	Boring No.	**ST-16** Total Depth 26.5 ft
County	Vermilion	Surface Elevation	603.3 ft
Project Type	Geotechnical Exploration	Date Started	6/19/17 Completed 6/19/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	1.0 ft Date/Time 6/19/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
603.3	0.0	Top of Hole							
		FLY ASH with Bottom Ash (CCR), gray, wet		BAG-1	7.0 - 13.0			--	
				BAG-2	16.0 - 22.0			--	
579.3	24.0								
576.8	26.5	SILTY SAND (SM), light brown, wet, medium dense, coarse grained		SPT-1	25.0 - 26.5	1.5	6-6-8	14	Gravel=0.9%, Sand=79.6%, Fines=19.5%
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

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Project Number	175667038	Location	N 1281711.87, E 1148212.82
Project Name	Vermilion Power Station	Boring No.	**ST-17** Total Depth 23.0 ft
County	Vermilion	Surface Elevation	603.0 ft
Project Type	Geotechnical Exploration	Date Started	6/19/17 Completed 6/19/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	1.0 ft Date/Time 6/19/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
603.0	0.0	Top of Hole						
		FLY ASH with Bottom Ash (CCR), gray, wet						
			BAG-1	8.0 - 14.0			--	
			BAG-2	17.0 - 22.0			--	
581.0	22.0							
580.0	23.0	SILTY SAND (SM), brown, wet						
		No Refusal / Bottom of Hole						

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

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SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281507.51, E 1147611.47
Project Name	Vermilion Power Station	Boring No.	**ST-18** Total Depth 26.5 ft
County	Vermilion	Surface Elevation	604.3 ft
Project Type	Geotechnical Exploration	Date Started	6/18/17 Completed 6/18/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	8.0 ft Date/Time 6/18/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
604.3	0.0	Top of Hole						
		FLY ASH with Bottom Ash (CCR), gray						
		-wet at 8.0 ft						
			BAG-1	8.0 - 14.0			--	
			BAG-2	17.0 - 23.0			--	
581.8	22.5	SILTY SAND (SM), brown, wet, dense, coarse grained						
577.8	26.5		SPT-1	25.0 - 26.5	1.1	14-15-15	--	
		No Refusal / Bottom of Hole						

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281505.18, E 1147815.45
Project Name	Vermilion Power Station	Boring No.	**ST-19** Total Depth 23.0 ft
County	Vermilion	Surface Elevation	613.8 ft
Project Type	Geotechnical Exploration	Date Started	6/18/17 Completed 6/18/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	8.0 ft Date/Time 6/18/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
613.8	0.0	Top of Hole							
		FLY ASH with Bottom Ash (CCR), gray							
		-wet at 8.0 ft							
				BAG-1	8.0 - 14.0			--	
				BAG-2	17.0 - 23.0			--	
590.8	23.0								
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

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SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281511.05, E 1148010.45
Project Name	Vermilion Power Station	Boring No.	**ST-20** Total Depth 26.5 ft
County	Vermilion	Surface Elevation	605.4 ft
Project Type	Geotechnical Exploration	Date Started	6/18/17 Completed 6/18/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	1.5 ft Date/Time 6/18/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
605.4	0.0	Top of Hole						
		FLY ASH with Bottom Ash (CCR), gray, wet						
			BAG-1	8.0 - 14.0			--	
			BAG-2	17.0 - 23.0			--	
580.3	25.1							
578.9	26.5	SILTY SAND (SM), brown, medium dense	SPT-1	25.0 - 26.5	1.1	3-6-12	--	
		No Refusal / Bottom of Hole						

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281306.23, E 1147816.76
Project Name	Vermilion Power Station	Boring No.	**ST-21** Total Depth 21.0 ft
County	Vermilion	Surface Elevation	612.2 ft
Project Type	Geotechnical Exploration	Date Started	6/7/17 Completed 6/7/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	12.0 ft Date/Time 6/7/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
612.2	0.0	Top of Hole							
		FLY ASH (CCR), gray, moist, with roots							
				BAG-1	8.0 - 14.0			--	
		-wet at 12.0 ft							Added drilling fluid at 12.0 ft.
				BAG-2	15.0 - 21.0			--	
591.2	21.0								
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281307.29, E 1148017.19
Project Name	Vermilion Power Station	Boring No.	**ST-22** Total Depth 31.5 ft
County	Vermilion	Surface Elevation	609.5 ft
Project Type	Geotechnical Exploration	Date Started	6/16/17 Completed 6/17/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	4.5 ft Date/Time 6/17/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
609.5	0.0	Top of Hole						
		FLY ASH with Bottom Ash (CCR), gray, wet -wet at 4.5 ft	BAG-1	8.0 - 14.0			--	
			BAG-2	17.0 - 23.0			--	
583.5	26.0		SPT-1	25.0 - 26.5	1.5	WOH-WOH-1	--	
581.0	28.5	SANDY SILTY CLAY (CL-ML), brown, wet, soft						
578.0	31.5	SILTY SAND (SM), brown to gray, moist, medium dense, coarse grained	SPT-2	30.0 - 31.5	1.0	4-6-8	--	
		No Refusal / Bottom of Hole						

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SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281309.77, E 1148210.32
Project Name	Vermilion Power Station	Boring No.	**ST-23** Total Depth 23.0 ft
County	Vermilion	Surface Elevation	607.1 ft
Project Type	Geotechnical Exploration	Date Started	6/17/17 Completed 6/17/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	1.0 ft Date/Time 6/17/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
607.1	0.0	Top of Hole							
		FLY ASH with Bottom Ash (CCR), gray, wet							
				BAG-1	8.0 - 14.0			--	
				BAG-2	17.0 - 23.0			--	
584.1	23.0								
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281111.04, E 1147808.09
Project Name	Vermilion Power Station	Boring No.	ST-24 — Total Depth 37.5 ft
County	Vermilion	Surface Elevation	606.8 ft
Project Type	Geotechnical Exploration	Date Started	6/17/17 — Completed 6/17/17
Supervisor	T. Ward — Driller T. Caudill	Depth to Water	1.0 ft — Date/Time 6/17/17
Logged By	D. Clements	Depth to Water	N/A — Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
606.8	0.0	Top of Hole							
		FLY ASH with Bottom Ash (CCR), gray, wet, very soft							
				BAG-1	8.0 - 14.0			--	
				BAG-2	17.0 - 23.0			--	
				SPT-1	25.0 - 26.5	1.5	WOH-WOH-1	42	Gravel=2.8%, Sand=39.3%, Fines=57.9%, Gs=2.04

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281111.04, E 1147808.09
Project Name	Vermilion Power Station	Boring No.	**ST-24** Total Depth 37.5 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
573.8	33.0	FLY ASH with Bottom Ash (CCR), gray, wet, very soft *(Continued)*		SPT-2	30.0 - 31.5	1.1	1-1-1	--	
569.3	37.5	SAND with Gravel and Silt (SP-SM), gray, wet, loose, boulders		SPT-3	35.0 - 36.5	0.7	3-3-4	--	
		No Refusal / Bottom of Hole							

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SUBSURFACE LOG (DRAFT)

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Project Number	175667038	Location	N 1281107.68, E 1148014.49
Project Name	Vermilion Power Station	Boring No.	**ST-25** Total Depth 21.0 ft
County	Vermilion	Surface Elevation	611.3 ft
Project Type	Geotechnical Exploration	Date Started	6/6/17 Completed 6/6/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	7.0 ft Date/Time 6/6/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology: Elevation	Lithology: Depth	Description	Overburden / Rock Core: Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
611.3	0.0	Top of Hole						
		FLY ASH (CCR), gray, moist to wet, some bottom ash						Added drilling fluid at 7.0 ft.
			BAG-1	8.0 - 14.0			--	
			BAG-2	15.0 - 21.0			--	
590.3	21.0							
		No Refusal / Bottom of Hole						

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1281111.74, E 1148214.70
Project Name	Vermilion Power Station	Boring No.	**ST-26** Total Depth 21.0 ft
County	Vermilion	Surface Elevation	608.3 ft
Project Type	Geotechnical Exploration	Date Started	6/16/17 Completed 6/16/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	4.5 ft Date/Time 6/16/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
608.3	0.0	Top of Hole							
		FLY ASH with Bottom Ash (CCR), gray		BAG-1	8.0 - 14.0			--	
				BAG-2	15.0 - 21.0			--	
587.3	21.0								
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

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SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280906.32, E 1148014.79
Project Name	Vermilion Power Station	Boring No.	**ST-27** Total Depth 26.5 ft
County	Vermilion	Surface Elevation	612.8 ft
Project Type	Geotechnical Exploration	Date Started	6/6/17 Completed 6/6/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	8.0 ft Date/Time 6/6/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
612.8	0.0	Top of Hole							
		FLY ASH (CCR), gray, moist, some bottom ash							
				BAG-1	8.0 - 14.0			--	
				BAG-2	15.0 - 21.0			--	Added drilling fluid at 17.0 ft.
587.7	25.1								
586.3	26.5	LEAN CLAY (CL), brown, moist, medium stiff		SPT-1	25.0 - 26.5	1.5	1-3-3	22	
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280909.59, E 1148419.09
Project Name	Vermilion Power Station	Boring No.	**ST-28** Total Depth 40.7 ft
County	Vermilion	Surface Elevation	623.0 ft
Project Type	Geotechnical Exploration	Date Started	6/3/17 Completed 6/3/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	32.0 ft Date/Time 6/3/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden Rock Core	Sample # RQD	Depth Run	Rec. Ft. Rec. Ft.	Blows Rec. %	Mois.Cont. % Run Depth	Remarks
623.0	0.0	Top of Hole							
620.0	3.0	LEAN CLAY (CL) (FILL), brown, moist							
		FLY ASH (CCR), gray, saturated, bottom ash lenses		BAG-1	10.0 - 16.0			--	
		-bottom ash with fly ash lense from 20.0 to 22.0 ft		BAG-2	20.0 - 26.0			--	
591.1	31.9								
		LEAN CLAY (CL), light brown, stiff							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280909.59, E 1148419.09
Project Name	Vermilion Power Station	Boring No.	**ST-28**
		Total Depth	40.7 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		LEAN CLAY (CL), light brown, stiff *(Continued)*		SPT-1	35.0 - 36.5	1.5	3-2-7	--	
582.3	40.7			SPT-2	39.2 - 40.7	0.9	3-6-9	--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280684.45, E 1148281.23
Project Name	Vermilion Power Station	Boring No.	**ST-29** Total Depth 33.0 ft
County	Vermilion	Surface Elevation	622.4 ft
Project Type	Geotechnical Exploration	Date Started	6/3/17 Completed 6/3/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	14.0 ft Date/Time 6/3/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
622.4	0.0	Top of Hole						
		LEAN CLAY (CL) (FILL), brown, moist						
617.4	5.0							
		FLY ASH (CCR), gray, saturated						
			BAG-1	15.0 - 21.0			--	
593.9	28.5							
		SANDY LEAN CLAY with Gravel (CL), light gray and brown, wet						
			BAG-2	31.0 - 33.0			--	
589.4	33.0							
		No Refusal / Bottom of Hole						

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280710.63, E 1148413.39
Project Name	Vermilion Power Station	Boring No.	ST-30
		Total Depth	41.5 ft
County	Vermilion	Surface Elevation	624.4 ft
Project Type	Geotechnical Exploration	Date Started	6/3/17
		Completed	6/3/17
Supervisor	T. Ward	Depth to Water	27.0 ft
Driller	T. Caudill	Date/Time	6/3/17
Logged By	T. Ward	Depth to Water	N/A
		Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
624.4	0.0	Top of Hole							
621.4	3.0	LEAN CLAY (CL) (FILL), brown, moist							
614.9	9.5	BOTTOM ASH (CCR), black and brown, moist							
		FLY ASH (CCR), gray, saturated		BAG-1	15.0 - 21.0			--	
				BAG-2	30.0 - 36.0			--	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1280710.63, E 1148413.39
Project Name	Vermilion Power Station	Boring No.	**ST-30**
		Total Depth	41.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
585.2	39.2	FLY ASH (CCR), gray, saturated *(Continued)*							Added drilling fluid at 35.0 ft.
582.9	41.5	LEAN CLAY (CL), light gray to brown, moist, medium stiff		SPT-1	40.0 - 41.5	1.2	2-3-4	27	
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280712.36, E 1148617.79
Project Name	Vermilion Power Station	Boring No.	**ST-31** Total Depth 37.0 ft
County	Vermilion	Surface Elevation	627.4 ft
Project Type	Geotechnical Exploration	Date Started	6/21/17 Completed 6/21/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	36.5 ft Date/Time 6/26/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
627.4	0.0	Top of Hole							
		SANDY CLAY with Gravel (CL) (FILL), brown, moist							
621.9	5.5								
		FLY ASH with Bottom Ash (CCR), gray, moist, clay, gravel, coal fragments							
				BAG-1	15.0 - 21.0			--	
599.9	27.5								
		FLY ASH with Bottom Ash (CCR), gray, moist							
				BAG-2	31.0 - 37.0			--	

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280712.36, E 1148617.79
Project Name	Vermilion Power Station	Boring No.	**ST-31** Total Depth 37.0 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
590.4	37.0	FLY ASH with Bottom Ash (CCR), gray, moist *(Continued)* -wet at 36.5 ft							
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280710.56, E 1148813.45
Project Name	Vermilion Power Station	Boring No.	**ST-32** Total Depth 37.0 ft
County	Vermilion	Surface Elevation	632.2 ft
Project Type	Geotechnical Exploration	Date Started	6/26/17 Completed 6/26/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 6/26/17
Logged By	D. Clements	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
632.2	0.0	Top of Hole							
		SANDY SILTY CLAY with Gravel (FILL), brown to gray, moist, fly ash layers							
622.7	9.5								
		FLY ASH with Bottom Ash (CCR), gray, moist							
				BAG-1	15.0 - 21.0			--	
				BAG-2	31.0 - 37.0			--	

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280710.56, E 1148813.45
Project Name	Vermilion Power Station	Boring No.	**ST-32** Total Depth 37.0 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
595.2	37.0	FLY ASH with Bottom Ash (CCR), gray, moist *(Continued)*							
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280697.49, E 1149013.19
Project Name	Vermilion Power Station	Boring No.	**ST-33** Total Depth 37.0 ft
County	Vermilion	Surface Elevation	634.8 ft
Project Type	Geotechnical Exploration	Date Started	6/4/17 Completed 6/4/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 6/4/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
634.8	0.0	Top of Hole							
634.6	0.2	TOPSOIL							
		LEAN CLAY (CL) (FILL), brown, moist, sand, gravel							
626.3	8.5	FLY ASH (CCR), gray, dry to moist, trace bottom ash							
				BAG-1	15.0 - 21.0			--	

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280697.49, E 1149013.19
Project Name	Vermilion Power Station	Boring No.	**ST-33** Total Depth 37.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
597.8	37.0	FLY ASH (CCR), gray, dry to moist, trace bottom ash *(Continued)* -cemented layers from 34.0' to 37.0'		BAG-2	31.0 - 37.0			--	
		No Refusal / Bottom of Hole							

Project Number	175667038	Location	N 1280678.45, E 1149210.89
Project Name	Vermilion Power Station	Boring No.	ST-34 Total Depth 37.0 ft
County	Vermilion	Surface Elevation	633.6 ft
Project Type	Geotechnical Exploration	Date Started	6/4/17 Completed 6/4/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 6/4/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
633.6	0.0	Top of Hole							
		LEAN CLAY (CL) (FILL), brown, moist							
628.1	5.5								
		FLY ASH (CCR), gray, moist to wet, bottom ash lenses							
				BAG-1	15.0 - 21.0			--	
				BAG-2	31.0 - 37.0			--	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1280678.45, E 1149210.89
Project Name	Vermilion Power Station	Boring No.	**ST-34**
		Total Depth	37.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
596.6	37.0								
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280516.26, E 1148412.71
Project Name	Vermilion Power Station	Boring No.	ST-35
		Total Depth	37.0 ft
County	Vermilion	Surface Elevation	627.0 ft
Project Type	Geotechnical Exploration	Date Started	6/3/17
		Completed	6/3/17
Supervisor	T. Ward	Driller	T. Caudill
Depth to Water	20.0 ft	Date/Time	6/3/17
Logged By	T. Ward		
Depth to Water	N/A	Date/Time	N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
627.0	0.0	Top of Hole							
622.5	4.5	LEAN CLAY (CL) (FILL), brown, moist							
		FLY ASH (CCR), gray, wet, bottom ash lenses							
				BAG-1	15.0 - 21.0			--	
				BAG-2	31.0 - 37.0			--	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1280516.26, E 1148412.71
Project Name	Vermilion Power Station	Boring No.	**ST-35**
		Total Depth	37.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
590.0	37.0	FLY ASH (CCR), gray, wet, bottom ash lenses *(Continued)*							
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280510.25, E 1148618.25
Project Name	Vermilion Power Station	Boring No.	**ST-36** Total Depth 51.5 ft
County	Vermilion	Surface Elevation	629.9 ft
Project Type	Geotechnical Exploration	Date Started	6/2/17 Completed 6/2/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	4.5 ft Date/Time 6/2/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden / Rock Core Sample #	RQD	Depth Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
629.9	0.0	Top of Hole							
625.4	4.5	LEAN CLAY (CL) (FILL), brown, moist, (mixture of clay, fly ash, bottom ash)							
615.9	14.0	FLY ASH (CCR), dark gray, wet, trace coal and rock fragments							
		FLY ASH (CCR), dark gray, wet, very soft to stiff, zones of bottom ash, coal fragments	BAG-1		15.0 - 19.0			--	
			BAG-2		31.0 - 36.0			--	

Project Number	175667038	Location	N 1280510.25, E 1148618.25
Project Name	Vermilion Power Station	Boring No.	**ST-36**
		Total Depth	51.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		FLY ASH (CCR), dark gray, wet, very soft to stiff, zones of bottom ash, coal fragments *(Continued)*							
				SPT-1	40.0 - 41.5	1.5	1-1-1	49	Gravel=0.6%, Sand=22.8%, Fines=76.6%, Gs=2.02
				SPT-2	45.0 - 46.5	1.5	7-8-9	--	
581.9	48.0								
		LEAN CLAY (CL), grayish brown, moist, medium stiff							
578.4	51.5			SPT-3	50.0 - 51.5	1.5	4-4-5	--	
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280510.27, E 1148818.23
Project Name	Vermilion Power Station	Boring No.	**ST-37** Total Depth 35.0 ft
County	Vermilion	Surface Elevation	633.9 ft
Project Type	Geotechnical Exploration	Date Started	6/2/17 Completed 6/2/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 6/2/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
633.9	0.0	Top of Hole						
		LEAN CLAY (CL) (FILL), brown, moist						
626.1	7.8							
		FLY ASH (CCR), gray, moist, very stiff						
			SPT-1	10.0 - 11.5	1.5	6-7-11	--	
			BAG-1	15.0 - 19.5			--	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280510.27, E 1148818.23
Project Name	Vermilion Power Station	Boring No.	**ST-37**
		Total Depth	35.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
598.9	35.0	FLY ASH (CCR), gray, moist, very stiff *(Continued)*		BAG-2	31.0 - 35.0			--	
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280511.11, E 1149014.44
Project Name	Vermilion Power Station	Boring No.	**ST-38** Total Depth 34.5 ft
County	Vermilion	Surface Elevation	639.5 ft
Project Type	Geotechnical Exploration	Date Started	6/2/17 Completed 6/2/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 6/2/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
639.5	0.0	Top of Hole						
		SANDY SILTY CLAY with Gravel (CL-ML) (FILL), dark to light brown with gray, moist, very stiff, trace gravel -apparent boulder at 4.5 ft						
			SPT-1	5.0 - 6.5	1.5	2-7-10	14	Gravel=9.4%, Sand=40.3%, Fines=50.3, LL=23, PI=5, Gs=2.77
628.1	11.4		SPT-2	10.0 - 11.5	1.5	4-5-6	--	
		FLY ASH (CCR), light gray, dry, trace bottom ash						
			BAG-1	15.0 - 19.0			--	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

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SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280511.11, E 1149014.44
Project Name	Vermilion Power Station	Boring No.	**ST-38** Total Depth 34.5 ft

Lithology: Elevation	Lithology: Depth	Description	Overburden / Rock Core: Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		FLY ASH (CCR), light gray, dry, trace bottom ash *(Continued)*	BAG-2	31.0 - 33.0			--	
605.0	34.5		BAG-3	33.0 - 34.5			--	
		No Refusal / Bottom of Hole						

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280506.77, E 1149216.56
Project Name	Vermilion Power Station	Boring No.	**ST-39** Total Depth 36.5 ft
County	Vermilion	Surface Elevation	644.2 ft
Project Type	Geotechnical Exploration	Date Started	6/1/17 Completed 6/1/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 6/1/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
644.2	0.0	Top of Hole							
644.0	0.2	TOPSOIL							
		SANDY SILTY CLAY (CL-ML) (FILL), brown, moist, gravel							
632.7	11.5	SILTY CLAY (CL-ML) (FILL), gray, moist, wood fragments							
628.0	16.2	FLY ASH (CCR), gray, moist		BAG-1	15.0 - 19.0			--	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1280506.77, E 1149216.56
Project Name	Vermilion Power Station	Boring No.	**ST-39** Total Depth 36.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		FLY ASH (CCR), gray, moist *(Continued)*		BAG-2	31.0 - 36.5			--	
607.7	36.5								
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280512.60, E 1149413.93
Project Name	Vermilion Power Station	Boring No.	**ST-40** Total Depth 61.5 ft
County	Vermilion	Surface Elevation	639.0 ft
Project Type	Geotechnical Exploration	Date Started	6/1/17 Completed 6/1/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	14.0 ft Date/Time 6/1/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
639.0	0.0	Top of Hole							
638.7	0.3	TOPSOIL							
631.5	7.5	SANDY SILTY CLAY with Gravel (CL-ML) (FILL), brown, moist							
627.0	12.0	SILTY, CLAYEY SAND with Gravel (SM-SC) (FILL), brown to gray, moist							
		FLY ASH (CCR), gray, wet		BAG-1	15.0 - 17.0			--	
				BAG-2	25.0 - 29.0			--	

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280512.60, E 1149413.93
Project Name	Vermilion Power Station	Boring No.	**ST-40** Total Depth 61.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
602.0	37.0	FLY ASH (CCR), gray, wet *(Continued)*		BAG-3	35.0 - 39.0			--	
		LEAN CLAY (CL), brown, moist, soft to very stiff		SPT-1	40.0 - 41.5		3-3-3	57	
				SPT-2	45.0 - 46.5		1-2-3	--	
				SPT-3	50.0 - 51.5		1-2-2	52	
				SPT-4	55.0 - 56.5		3-4-7	--	
577.5	61.5			SPT-5	60.0 - 61.5		5-11-17	11	
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280340.23, E 1149016.48
Project Name	Vermilion Power Station	Boring No.	ST-41
		Total Depth	15.0 ft
County	Vermilion	Surface Elevation	641.3 ft
Project Type	Geotechnical Exploration	Date Started	6/1/17
		Completed	6/1/17
Supervisor	T. Ward	Driller	T. Caudill
Depth to Water	Dry	Date/Time	6/1/17
Logged By	T. Ward		
Depth to Water	N/A	Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
641.3	0.0	Top of Hole							
641.1	0.2	TOPSOIL							
636.8	4.5	LEAN CLAY with Gravel (CL) (FILL), brown, moist							
631.8	9.5	SILTY CLAY with Gravel (CL-ML) (FILL), gray, moist							
626.3	15.0	SANDY LEAN CLAY with Gravel (CL) (FILL), gray, moist							
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280311.30, E 1149217.80
Project Name	Vermilion Power Station	Boring No.	ST-42
		Total Depth	15.0 ft
County	Vermilion	Surface Elevation	645.2 ft
Project Type	Geotechnical Exploration	Date Started	5/31/17
		Completed	5/31/17
Supervisor	T. Ward	Depth to Water	Dry
Driller	T. Caudill	Date/Time	5/31/17
Logged By	T. Ward	Depth to Water	N/A
		Date/Time	N/A

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
645.2	0.0	Top of Hole							
644.9	0.3	TOPSOIL							
638.7	6.5	SANDY SILTY CLAY (CL-ML) (FILL), brown, moist to wet -apparent boulder from 3.0 to 4.0 ft							
634.2	11.0	SILTY CLAY (CL-ML) (FILL), gray, moist, with wood fragments							
630.2	15.0	SILTY SAND (SM), gray to brown, moist							
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280308.36, E 1149407.23		
Project Name	Vermilion Power Station	Boring No.	**ST-43**	Total Depth	15.0 ft
County	Vermilion	Surface Elevation	649.8 ft		
Project Type	Geotechnical Exploration	Date Started	5/31/17	Completed	5/31/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry	Date/Time	5/31/17
Logged By	T. Ward	Depth to Water	N/A	Date/Time	N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
649.8	0.0	Top of Hole							
649.6	0.2	Topsoil							
		SILTY CLAY (CL-ML) (FILL), brown to gray, moist, sand, gravel							
634.8	15.0								
		No Refusal / Bottom of Hole							

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280311.86, E 1149609.80
Project Name	Vermilion Power Station	Boring No.	ST-44
		Total Depth	15.0 ft
County	Vermilion	Surface Elevation	637.0 ft
Project Type	Geotechnical Exploration	Date Started	5/31/17
		Completed	5/31/17
Supervisor	T. Ward	Depth to Water	Dry
Driller	T. Caudill	Date/Time	5/31/17
Logged By	T. Ward	Depth to Water	N/A
		Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
637.0	0.0	Top of Hole						
636.8	0.2	TOPSOIL						
624.5	12.5	SILTY CLAY (CL-ML) (FILL), gray, moist						
622.0	15.0	SILTY, CLAYEY SAND (SM-SC), gray, wet						
		No Refusal / Bottom of Hole						

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Stantec

Project Number	175667038	Location	N 1280107.07, E 1149414.07
Project Name	Vermilion Power Station	Boring No.	**ST-45**
		Total Depth	15.0 ft
County	Vermilion	Surface Elevation	640.2 ft
Project Type	Geotechnical Exploration	Date Started	5/31/17
		Completed	5/31/17
Supervisor	T. Ward	Depth to Water	9.0 ft
Driller	T. Caudill	Date/Time	5/31/17
Logged By	T. Ward	Depth to Water	N/A
		Date/Time	N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
640.2	0.0	Top of Hole							
639.9	0.3	TOPSOIL							
		SILTY CLAY (CL-ML), brown to gray, moist							
		-apparent boulder from 12.0 to 12.5 ft							
625.2	15.0								
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280114.59, E 1149612.65
Project Name	Vermilion Power Station	Boring No.	**ST-46**
		Total Depth	15.0 ft
County	Vermilion	Surface Elevation	638.9 ft
Project Type	Geotechnical Exploration	Date Started	5/31/17
		Completed	5/31/17
Supervisor	T. Ward	Depth to Water	5.5 ft
Driller	T. Caudill	Date/Time	5/31/17
Logged By	T. Ward	Depth to Water	N/A
		Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
638.9	0.0	Top of Hole							
638.7	0.2	Topsoil							
		SANDY SILTY CLAY with Gravel (CL-ML), brown, moist, small cobbles							
633.4	5.5	SANDY SILTY CLAY (CL-ML), gray, saturated							
623.9	15.0	No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280106.25, E 1149810.28
Project Name	Vermilion Power Station	Boring No.	ST-47
		Total Depth	15.0 ft
County	Vermilion	Surface Elevation	636.9 ft
Project Type	Geotechnical Exploration	Date Started	5/31/17
		Completed	5/31/17
Supervisor	T. Ward	Depth to Water	3.5 ft
Driller	T. Caudill	Date/Time	5/31/17
Logged By	T. Ward	Depth to Water	N/A
		Date/Time	N/A

Lithology: Elevation	Lithology: Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
636.9	0.0	Top of Hole							
636.7	0.2	Topsoil							
633.4	3.5	LEAN CLAY (CL), brown to gray, moist							
624.9	12.0	SANDY SILTY CLAY with Gravel (CL-ML), brown, wet							
621.9	15.0	SHALE, weathered							
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1279906.19, E 1149414.73
Project Name	Vermilion Power Station	Boring No.	**ST-48**
		Total Depth	15.0 ft
County	Vermilion	Surface Elevation	656.8 ft
Project Type	Geotechnical Exploration	Date Started	5/31/17
		Completed	5/31/17
Supervisor	T. Ward	Driller	T. Caudill
Depth to Water	Dry	Date/Time	5/31/17
Logged By	T. Ward		
Depth to Water	N/A	Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
656.8	0.0	Top of Hole							
656.5	0.3	TOPSOIL							
		SILTY CLAY (CL-ML), brown, moist							
642.8	14.0	-gray at 13.5 ft							
641.8	15.0	SANDY SILTY CLAY (CL-ML), brown, moist							
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1279909.51, E 1149615.30
Project Name	Vermilion Power Station	Boring No.	**ST-49**
		Total Depth	15.0 ft
County	Vermilion	Surface Elevation	656.2 ft
Project Type	Geotechnical Exploration	Date Started	5/31/17
		Completed	5/31/17
Supervisor	T. Ward	Driller	T. Caudill
Depth to Water	Dry	Date/Time	5/31/17
Logged By	T. Ward		
Depth to Water	N/A	Date/Time	N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
656.2	0.0	Top of Hole							
655.9	0.3	TOPSOIL							
		SILTY CLAY (CL-ML), gray, moist							
645.2	11.0								
		SANDY SILTY CLAY (CL-ML), moist							
641.2	15.0								
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1279908.88, E 1149814.58
Project Name	Vermilion Power Station	Boring No.	**ST-50** Total Depth 15.0 ft
County	Vermilion	Surface Elevation	657.0 ft
Project Type	Geotechnical Exploration	Date Started	5/31/17 Completed 5/31/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 5/31/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
657.0	0.0	Top of Hole							
656.7	0.3	TOPSOIL							
		SILTY CLAY, brown, moist							
		-sandy from 11.5 to 13.5 ft							
642.0	15.0								
		No Refusal / Bottom of Hole							

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SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280369.17, E 1149116.83
Project Name	Vermilion Power Station	Boring No.	ST-51
		Total Depth	63.0 ft
County	Vermilion	Surface Elevation	642.7 ft
Project Type	Geotechnical Exploration	Date Started	6/4/17
		Completed	6/4/17
Supervisor	T. Ward	Depth to Water	55.0 ft
Driller	T. Caudill	Date/Time	6/4/17
Logged By	T. Ward	Depth to Water	N/A
		Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
642.7	0.0	Top of Hole						
		SANDY LEAN CLAY with Gravel (CL) (FILL), brown to gray, dry, stiff to very stiff, clayey sand lenses						
			SPT-1	5.0 - 6.5	1.4	8-11-9	--	
		-fly ash lense from 8.2 to 9.2 ft						
			SPT-2	10.0 - 11.5	1.5	4-6-8	14	
629.2	13.5	FLY ASH (CCR), gray to black, dry, soft, bottom ash lenses						
			SPT-3	15.0 - 16.5	1.3	2-1-3	--	
		-brown clay seam from 17.5 to 18.5 ft						
			BAG-1	17.0 - 23.0			--	
620.7	22.0	LEAN CLAY (CL) (FILL), brown and gray, moist, soft, some gravel						
617.2	25.5	FLY ASH (CCR), gray, moist to wet, soft to stiff, clay lenses						
			SPT-4	25.0 - 26.5	1.5	1-1-3	--	
			BAG-2	26.5 - 33.5			--	

Project Number	175667038	Location	N 1280369.17, E 1149116.83
Project Name	Vermilion Power Station	Boring No.	**ST-51** Total Depth 63.0 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		FLY ASH (CCR), gray, moist to wet, soft to stiff, clay lenses *(Continued)*							
				SPT-5	40.0 - 41.5	1.5	6-6-9	51	
				SPT-6	45.0 - 46.5	1.5	2-2-3	--	
				SPT-7	50.0 - 51.5	1.5	5-3-3	64	Gravel=5.4%, Sand=50.0%, Fines=44.6%
				SPT-8	55.0 - 56.5	1.5	9-11-4	--	
582.0	60.7								
		LEAN CLAY (CL), gray, moist, medium stiff to stiff		SPT-9	60.0 - 61.5	1.5	2-2-5	27	
579.7	63.0			SPT-10	61.5 - 63.0	1.3	3-5-9	--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1280349.56, E 1149017.01
Project Name	Vermilion Power Station	Boring No.	ST-52 Total Depth 41.0 ft
County	Vermilion	Surface Elevation	641.4 ft
Project Type	Geotechnical Exploration	Date Started	6/5/17 Completed 6/5/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	Dry Date/Time 6/5/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
641.4	0.0	Top of Hole							
		SANDY SILTY CLAY (CL-ML) (FILL), brown, moist							
633.9	7.5								
		FLY ASH (CCR), gray, moist							
				BAG-1	20.0 - 26.0			--	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Project Number	175667038	Location	N 1280349.56, E 1149017.01		
Project Name	Vermilion Power Station	Boring No.	**ST-52**	Total Depth	41.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
600.4	41.0	FLY ASH (CCR), gray, moist *(Continued)*		BAG-2	35.0 - 41.0			--	
		No Refusal / Bottom of Hole							

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280322.91, E 1149220.07
Project Name	Vermilion Power Station	Boring No.	ST-53
		Total Depth	51.0 ft
County	Vermilion	Surface Elevation	645.0 ft
Project Type	Geotechnical Exploration	Date Started	6/5/17
		Completed	6/5/17
Supervisor	T. Ward	Depth to Water	50.0 ft
Driller	T. Caudill	Date/Time	6/5/17
Logged By	T. Ward	Depth to Water	N/A
		Date/Time	N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
645.0	0.0	Top of Hole						
640.5	4.5	SANDY SILTY CLAY (CL-ML) (FILL), brown, moist, gravel						
625.5	19.5	LEAN CLAY (CL) (FILL), gray, fly ash, wood, gravel, silt and sand throughout						
		SANDY SILTY CLAY with Gravel (CL-ML) (FILL), moist	BAG-1	20.0 - 22.0			--	
			BAG-2	25.0 - 27.0			--	
616.0	29.0							
		FLY ASH (CCR), gray, moist, stiff	SPT-1	30.0 - 31.5	1.5	5-6-7	23	
			BAG-3	31.5 - 37.5			--	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280322.91, E 1149220.07
Project Name	Vermilion Power Station	Boring No.	**ST-53**
Total Depth	51.0 ft		

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		FLY ASH (CCR), gray, moist, stiff *(Continued)*							
				BAG-4	45.0 - 51.0			--	
594.0	51.0								
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

Stantec

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280299.68, E 1149405.80
Project Name	Vermilion Power Station	Boring No.	**ST-54** Total Depth 50.0 ft
County	Vermilion	Surface Elevation	650.2 ft
Project Type	Geotechnical Exploration	Date Started	6/5/17 Completed 6/5/17
Supervisor	T. Ward Driller T. Caudill	Depth to Water	20.5 ft Date/Time 6/5/17
Logged By	T. Ward	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
650.2	0.0	Top of Hole						
		SANDY LEAN CLAY with Gravel (CL-ML) (FILL), brown, moist, stiff to very stiff						
			SPT-1	5.0 - 6.5	1.3	2-4-8	13	
			SPT-2	10.0 - 11.5	0.7	20-15-15	--	
636.7	13.5	LEAN CLAY with Gravel (CL), brown to gray, moist, stiff, some gravel						
			SPT-3	15.0 - 16.5	1.5	6-6-8	16	
629.7	20.5	SAND with Gravel and Silt (SP-SM), brown, wet, medium dense, coarse grained						
			SPT-4	20.0 - 21.5	1.5	7-8-7	--	
628.2	22.0	LEAN CLAY (CL), gray with brown, dry to moist, very stiff, gravel						
			SPT-5	25.0 - 26.5	1.5	8-10-8	11	
		-gray at 30.0 ft	SPT-6	30.0 - 31.5	1.4	6-8-13	--	

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG (DRAFT)

Project Number	175667038	Location	N 1280299.68, E 1149405.80		
Project Name	Vermilion Power Station	Boring No.	**ST-54**	Total Depth	50.0 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		LEAN CLAY (CL), gray with brown, dry to moist, very stiff, gravel *(Continued)*							
			SPT-7		38.5 - 40.0	1.5	10-13-16	10	
600.2	50.0		SPT-8		48.5 - 50.0	1.5	8-15-16	--	
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY 175667038_DATABASE.GPJ FMSM-GRAPHIC LOG.GDT 9/5/17

SUBSURFACE LOG

Project Number	175657154	Location	N 1282584.36, E 1147687.59
Project Name	Vermilion Power Station	Boring No.	**S-101** Total Depth 118.5 ft
County	Vermilion, Illinois	Surface Elevation	606.0 ft
Project Type	Geotechnical Exploration	Date Started	11/16/18 Completed 11/17/18
Supervisor	P. Cichocki Driller K. Hayslip	Depth to Water	21.0 ft Date/Time 11/16/18
Logged By	P. Cichocki	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Sample # / RQD	Depth / Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
606.0	0.0	Top of Hole						
601.5	4.5	SANDY LEAN CLAY (CL), brown, trace organics,and silt, damp, stiff to very stiff	SPT-1	0.0 - 1.5	1.5	3-6-9	15	Gravel=2.4%, Sand=31.5%, Fines=66.1%, LL=28, PI=13
			SPT-2	1.5 - 3.0	1.5	5-8-8	13	
			SPT-3	3.0 - 4.5	1.5	4-7-9	14	
589.5	16.5	CLAYEY SAND (SC), gray, some silt, damp, loose to medium dense	SPT-4	4.5 - 6.0	1.5	4-6-7	16	- wood fragments in sample - granular layer near 6.8 ft - increase fine sand Gravel=0.5%, Sand=52.9%, Fines=46.6%, LL=21, PI=9 - brown and gray mottled - increased silt at 14.7 ft
			SPT-5	6.0 - 7.5	1.5	5-5-6	15	
			SPT-6	7.5 - 9.0	1.5	2-4-7	14	
			SPT-7	9.0 - 10.5	1.5	4-4-9	13	
			SPT-8	10.5 - 12.0	1.5	5-7-8	14	
			SPT-9	12.0 - 13.5	1.5	5-7-7	15	
			SPT-10	13.5 - 15.0	1.5	4-4-7	17	
			SPT-11	15.0 - 16.5	1.5	4-6-11	20	
585.0	21.0	SANDY LEAN CLAY (CL), gray, and silt, damp, medium stiff to very stiff	SPT-12	16.5 - 18.0	1.5	4-6-6	17	- increased moisture content Gravel=0.6%, Sand=24.8%, Fines=74.6%, LL=25, PI=10
			SPT-13	18.0 - 19.5	1.5	1-3-4	23	
			SPT-14	19.5 - 21.0	1.5	3-3-6	19	
584.5	21.5	SAND AND GRAVEL (SP), brown, coarse grained, little clay, wet, very loose	SPT-15	21.0 - 22.5	1.5	3-2-2	22	- bulk sample taken Gravel=0.3%, Sand=32.2%, Fines=67.5%, LL=30, PI=15
583.5	22.5	SANDY LEAN CLAY (CL), brown, little gravel, wet, soft	SPT-16	22.5 - 25.0	1.0	2-1-2	19	
576.0	30.0	GRAVEL with Stone fragments, Sand, Clay, and Silt (GP-GC), brown, coarse grained, wet, very loose to medium dense	SPT-17	24.0 - 26.5	0.9	6-6-11	10	Gravel=53.3%, Sand=36.7%, Fines=10.0% Possible cobble present
		SANDY LEAN CLAY (CL) (FILL), reddish gray, little to some silt, damp to moist, stiff to very stiff	SPT-18	30.0 - 31.5	1.5	5-6-8	13	
			SPT-19	35.0 - 36.5	1.5	5-5-8	13	

STANTEC/FMSM_LEGACY VISTRA NORTH ASH POND PHASE 1.GPJ FMSM-GRAPHIC LOG.GDT 1/24/19

Project Number	175657154	Location	N 1282584.36, E 1147687.59
Project Name	Vermilion Power Station	Boring No.	**S-101** Total Depth 118.5 ft

Lithology Elevation	Lithology Depth	Description	Sample # / RQD	Depth / Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SANDY LEAN CLAY (CL) (FILL), reddish gray, little to some silt, damp to moist, stiff to very stiff *(Continued)*	ST-1	38.0 - 40.0	1.6		--	
			SPT-20	40.0 - 41.5	1.5	5-5-6	13	Gravel=3.9%, Sand=42.5%, Fines=53.6%, LL=20, PI=9
			SPT-21	45.0 - 46.5	1.5	6-6-10	13	
			SPT-22	50.0 - 51.5	1.5	7-7-11	18	- increase in silt content - coarse sand in bottom of sample
			SPT-23	55.0 - 56.5	1.5	5-6-13	16	
			SPT-24	60.0 - 61.5	1.5	8-10-17	18	Gravel=4.4%, Sand=18.6%, Fines=77.0%, LL=25, PI=9
			SPT-25	65.0 - 66.5	1.5	4-6-7	20	
535.5	70.5							
		SANDY SILT (ML), gray, very fine grained, trace to little clay, wet, very stiff	SPT-26	70.0 - 71.5	1.5	5-10-15	24	Sand=33.0%, Fines=67.0%, LL=NP, PI=NP
531.0	75.0							
		SAND (SP-SM), brown, fine to medium grained, trace to little clay, damp to moist, medium dense	SPT-27	75.0 - 76.5	1.5	5-5-10	30	- clay in bottom of sample
526.0	80.0							

STANTEC/FMSM_LEGACY VISTRA NORTH ASH POND PHASE 1.GPJ FMSM-GRAPHIC LOG.GDT 1/24/19

SUBSURFACE LOG

Project Number	175657154	Location	N 1282584.36, E 1147687.59
Project Name	Vermilion Power Station	Boring No.	**S-101** Total Depth 118.5 ft

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
521.0	85.0	SANDY LEAN CLAY (CL), gray, trace organics, little to some silt, damp to wet, stiff *(Continued)*		SPT-28	80.0 - 81.5	1.5	4-5-7	25	- wood fragments in sample
516.0	90.0	SANDY SILTY CLAY (CL-ML), gray, very fine grained, damp to moist, stiff		SPT-29	85.0 - 86.5	1.5	4-6-7	25	
				ST-2	88.0 - 90.0	1.8		--	DP = 700 - 800 psi REC. = 1.8 ft
515.2	90.8	SAND (SP-SM), brown, coarse grained, some silt and clay, wet, loose		SPT-30	90.0 - 91.5	1.5	5-5-5	23	
511.0	95.0	SANDY SILTY CLAY (CL-ML), gray, fine grained, moist, medium stiff							
501.0	105.0	SANDY LEAN CLAY (CL), gray, trace gravel, and silt, damp to wet, stiff to very stiff		SPT-31	95.0 - 96.5	1.5	5-6-8	23	Sand=16.9%, Fines=83.1%, LL=28, PI=12
				SPT-32	100.0 - 101.5	1.5	5-6-10	20	
498.0	108.0	GRAVEL and Stone Fragments with Sand (GM-GC), brown, coarse grained, trace silt and clay, wet, Dense		SPT-33	105.0 - 106.5	1.5	8-15-23	15	Gravel=31.4%, Sand=58.8%, Fines=21.8%
				SPT-34	108.0 - 108.3	0.3	50/3.6"	36	Began Core
492.5	113.5	Moderately weathered, COAL, black, soft, very fine grained, thin bedded, flat bedding, highly fractured, pyritic		15	5.0	4.6	92	113.5	
487.5	118.5	Moderately to highly weathered, SHALE, gray, soft to moderately hard, very fine grained, thin bedded, flat bedding, moderately fractured		88	5.0	5.0	100	118.5	

Bottom of Hole

Top of Rock = 108.0
Elevation (498.0)

Stantec

SUBSURFACE LOG

Project Number	175657154	Location	N 1281585.79, E 1147395.92
Project Name	Vermilion Power Station	Boring No.	**S-105A** Total Depth 25.5 ft
County	Vermilion, Illinois	Surface Elevation	608.8 ft
Project Type	Geotechnical Exploration	Date Started	11/16/18 Completed 11/16/18
Supervisor	E. Holcombe Driller D. Jessie	Depth to Water	9.0 ft Date/Time 11/16/18
Logged By	E. Holcombe	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth Run	Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
608.8	0.0	Top of Hole						
		SILT WITH SAND (ML), dark gray, little clay, trace gravel, damp to moist, very loose	SPT-1	0.0 - 1.5	1.5	2-1-1	34	Gravel=0.6%, Sand=20.1%, Fines=79.3%, LL=NP, PI=NP
			SPT-2	1.5 - 3.0	1.5	2-1-1	43	
604.3	4.5		SPT-3	3.0 - 4.5	0.7	1-1-1	33	
		SANDY SILT (ML), brown gray mottled, some sand, trace gravel, damp, stiff to very stiff	SPT-4	4.5 - 6.0	1.0	3-8-10	12	Gravel=2.8%, Sand=29.4%, Fines=67.8%, LL=25, PI=3
			SPT-5	6.0 - 7.5	1.5	3-6-6	24	
599.8	9.0		SPT-6	7.5 - 9.0	0.9	4-9-9	16	
		FLY ASH (CCR), dark gray to black, wet, very loose	SPT-7	9.0 - 10.5	0.8	1-1-1	53	
			SPT-8	10.5 - 12.0	1.1	WOH-1-1	44	
			SPT-9	12.0 - 13.5	0.9	WOH	38	
			SPT-10	13.5 - 15.0	0.8	WOH	31	
			SPT-11	15.0 - 16.5	0.7	WOH	35	Gravel=0.1%, Sand=5.9%, Fines=93.0%
			SPT-12	16.5 - 18.0	0.6	WOH	43	
			SPT-13	18.0 - 19.5	0.0	WOR	--	
			SPT-14	19.5 - 21.0	0.0	WOR	--	
			SPT-15	21.0 - 22.5	1.5	WOR	38	
584.8	24.0		SPT-16	22.5 - 24.0	0.5	WOH	43	
583.3	25.5	SAND (SM-SC), brown and gray, fine sand, little silt, moist to wet, medium dense	SPT-17	24.0 - 25.5	1.5	4-5-7	17	Sand=74.6%, Fines=25.4%, LL=NP, PI=NP
		No Refusal / Bottom of Hole						Boring Terminated at 25.5'

SUBSURFACE LOG

Project Number	175657154	Location	N 1281580.83, E 1147399.55
Project Name	Vermilion Power Station	Boring No.	**S-105B** Total Depth 100.6 ft
County	Vermilion, Illinois	Surface Elevation	608.3 ft
Project Type	Geotechnical Exploration	Date Started	11/17/18 Completed 11/17/18
Supervisor	E. Holcombe Driller D. Jessie	Depth to Water	Dry Date/Time 11/17/18
Logged By	E. Holcombe	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
608.3	0.0	Top of Hole						
		No sampling from Top of Hole to depth of 30.0 ft						
578.3	30.0							
		SAND (SM-SC), brown and gray, fine to coarse grained, little silt, wet, loose to medium dense	SPT-1	30.0 - 31.5	0.9	4-2-3	21	- clay seam at 30.0 ft to 30.4 ft and 35.0 ft to 35.2 ft Sand=75.4%, Fines=24.6%, LL=NP, PI=NP
			SPT-2	35.0 - 36.5	0.8	3-15-50/4.8"	12	- stone fragment in bottom of sample

STANTEC/FMSM_LEGACY VISTRA NORTH ASH POND PHASE 1.GPJ FMSM-GRAPHIC LOG.GDT 1/24/19

Project Number	175657154	Location	N 1281580.83, E 1147399.55
Project Name	Vermilion Power Station	Boring No.	**S-105B** Total Depth 100.6 ft

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SAND (SM-SC), brown and gray, fine to coarse grained, little silt, wet, loose to medium dense *(Continued)*		SPT-3	40.0 - 41.5	1.5	6-4-7	12	
563.3	45.0								
		LEAN CLAY (CL) (TILL), gray, little sand and gravel, damp to moist, stiff		SPT-4	45.0 - 46.5	0.9	10-8-5	12	
558.1	50.2			ST-1	50.0 - 50.2	0.2		--	DP = 1000 psi REC. = 0.2 ft
		SAND (SM-SC), brown and gray, fine to coarse grained, trace silt, trace cobble and gravel, wet, medium dense		SPT-5	50.2 - 51.7	0.9	7-9-8	12	Gravel=3.2%, Sand=60.6%, Fines=36.2% - fine sand seam at 51.4 ft to 51.7 ft
553.3	55.0								
		SAND (SP), light brown, fine grained, wet, very dense		SPT-6	55.0 - 56.5	1.2	13-24-27	22	- clay seam in bottom of sample - stone fragments in sample
548.3	60.0								
		LEAN CLAY (CL) (TILL), gray, trace gravel, little sand, damp, very stiff		SPT-7	60.0 - 61.5	1.5	14-12-14	11	
				SPT-8	65.0 - 66.5	0.2	11-11-15	23	- soft seam
				SPT-9	70.0 - 71.5	1.5	9-11-14	18	Gravel=0.1%, Sand=19.0%, Fines=70.9%, LL=26, PI=9
				SPT-10	75.0 - 76.5	1.5	8-10-11	18	
									- soft seam

SUBSURFACE LOG

Project Number	175657154	Location	N 1281580.83, E 1147399.55
Project Name	Vermilion Power Station	Boring No.	**S-105B** Total Depth 100.6 ft

Lithology: Elevation	Lithology: Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
523.1	85.2	LEAN CLAY (CL) (TILL), gray, trace gravel, little sand, damp, very stiff *(Continued)*		SPT-11	80.0 - 81.5	1.5	4-1-1	20	
518.2	90.1	SAND (SM-SC), gray, fine grained, trace silt, wet, dense		SPT-12	85.0 - 86.5	1.5	10-14-26	22	
512.2	96.1	CLAYEY SILT (CL-ML), gray, trace fine sand, moist to wet, very stiff		SPT-13	90.0 - 91.5	1.5	11-9-10	24	Sand=17.1%, Fines=82.9%, LL=27, PI=9
				SPT-14	95.0 - 96.5	0.6	7-4-2	20	
509.3	99.0	LEAN CLAY (CL), gray, trace silt and sand, moist, medium stiff							
507.7	100.6	SAND with Gravel (SP-SM), gray and brown, fine and coarse grained, little clay, some stone fragments, wet, very dense		SPT-15	100.0 - 100.6	0.4	15-50/1.2"	15	

No Refusal / Bottom of Hole

STANTEC/FMSM_LEGACY VISTRA NORTH ASH POND PHASE 1.GPJ FMSM-GRAPHIC LOG.GDT 1/24/19

Stantec

SUBSURFACE LOG

Project Number	175657154	Location	N 1281469.58, E 1147823.06
Project Name	Vermilion Power Station	Boring No.	**S-106** Total Depth 131.5 ft
County	Vermilion, Illinois	Surface Elevation	613.0 ft
Project Type	Geotechnical Exploration	Date Started	11/13/18 Completed 11/14/18
Supervisor	E. Holcombe Driller D. Jessie	Depth to Water	14.8 ft Date/Time 11/13/18
Logged By	E. Holcombe	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
613.0	0.0	Top of Hole							
		FLY ASH (CCR), gray, damp, very loose to dense		SPT-1	0.0 - 1.5	1.3	6-6-5	22	
				SPT-2	1.5 - 3.0	1.1	7-9-19	27	
				SPT-3	3.0 - 4.5	1.0	41-50	26	
				SPT-4	4.5 - 6.0	1.5	14-21-14	23	
				SPT-5	6.0 - 7.5	1.5	7-11-14	28	
				SPT-6	7.5 - 9.0	1.5	12-10-13	26	Sand=26.8%, Fines=73.2%, LL=NP, PI=NP
				SPT-7	9.0 - 10.5	1.5	2-1-1	37	
				ST-1	10.5 - 12.5	1.8		--	DP = 750 psi REC. = 1.8 ft
				SPT-8	12.5 - 14.0	1.5	2-1-1	30	- some black staining in sample
				SPT-9	14.0 - 15.5	0.8	2-1-1	44	
				SPT-10	15.5 - 17.0	1.5	WOH	33	
				SPT-11	17.0 - 18.5	1.5	1-1-1	39	
				SPT-12	18.5 - 20.0	1.5	1-1-1	40	
				SPT-13	20.0 - 21.5	1.5	2-1-1	45	
				SPT-14	21.5 - 23.0	1.5	WOH-1-1	44	
				SPT-15	23.0 - 24.5	1.5	WOH	41	
				SPT-16	24.5 - 26.0	1.5	WOH	41	
				SPT-17	31.0 - 32.5	1.5	WOH	48	
576.4	36.6								
				SPT-18	36.0 - 37.5	1.5	7-8-6	19	

STANTEC/FMSM_LEGACY VISTRA NORTH ASH POND PHASE 1.GPJ FMSM-GRAPHIC LOG.GDT 1/24/19

Project Number	175657154	Location	N 1281469.58, E 1147823.06		
Project Name	Vermilion Power Station	Boring No.	**S-106**	Total Depth	131.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
		SAND (SP-SM), gray, some gravel, wet, medium dense *(Continued)*							
				SPT-19	41.0 - 42.5	1.5	8-11-10	16	Gravel=22.9%, Sand=62.8%, Fines=13.3%
				SPT-20	45.0 - 46.5	1.1	8-7-9	13	
561.5	51.5			SPT-21	50.0 - 51.5	1.5	14-5-15	13	
556.5	56.5	SILTY CLAYEY SAND (SC-SM), gray, fine to coarse grained, some gravel, moist, medium dense		SPT-22	55.0 - 56.5	1.1	7-6-14	13	Gravel=28.8%, Sand=47.6%, Fines=23.6%, LL=18, PI=7 - fine sand lense at 56.2 ft to 56.5 ft
		LEAN CLAY (CL) (TILL), gray, trace silt, little gravel, some sand, moist to wet, very stiff to hard		SPT-23	60.0 - 61.5	0.6	9-23-42	13	
				SPT-24	65.0 - 66.5	0.5	12-11-14	11	Very Dense Fine Sand Lenses from 52.0 ft to 71.0 ft - large cobble at 66.2 ft
542.0	71.0			SPT-25	70.0 - 71.5	1.5	7-16-38	10	
536.0	77.0	SILTY CLAYEY SAND (SM-SC), gray, fine grained, little gravel, wet, very dense		SPT-26	75.0 - 76.5	1.5	12-18-40	11	Gravel=8.9%, Sand=79.6%, Fines=11.6
		SANDY SILTY CLAY (CL-ML), gray, moist, stiff to very stiff							

SUBSURFACE LOG

Project Number	175657154	Location	N 1281469.58, E 1147823.06
Project Name	Vermilion Power Station	Boring No.	**S-106** Total Depth 131.5 ft

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SANDY SILTY CLAY (CL-ML), gray, moist, stiff to very stiff *(Continued)*		SPT-27	80.0 - 81.5	1.1	6-6-15	20	
				SPT-28	85.0 - 86.5	1.5	4-6-12	21	
				SPT-29	90.0 - 91.5	1.5	7-5-9	22	Sand=9.6%, Fines=90.4%, LL=27, PI=9
				SPT-30	95.0 - 96.5	1.5	WOH	22	
513.0	100.0								
		SAND (SM-SC), gray, fine grained, wet, dense to very dense		SPT-31	100.0 - 101.5	1.1	13-28-43	17	Gravel=0.5%, Sand=86.3%, Fines=13.2%
				SPT-32	105.0 - 106.5	1.5	27-31-50/1.2"	17	
				SPT-33	110.0 - 111.5	1.5	19-23-48	18	- white stone fragments in sample
498.0	115.0								
		Slightly to moderately weathered, COAL, black, moderately hard, very fine grained, thin bedded, flat bedding, pyrtic		SPT-34	115.0 - 115.5	0.2	50/2.4"	26	Began Core
				0	1.0	0.2	20	116.5	
493.5	119.5								
		Highly weathered, SHALE, gray, soft, very fine grained, thin bedded		36	5.0	4.4	88	121.5	

SUBSURFACE LOG

Project Number	175657154	Location	N 1281469.58, E 1147823.06		
Project Name	Vermilion Power Station	Boring No.	**S-106**	Total Depth	131.5 ft

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
486.5	126.5	Highly weathered, SHALE, gray, soft, very fine grained, thin bedded *(Continued)*		82	5.0	5.0	100	126.5	
481.5	131.5	Moderately weathered, SHALE, gray, soft to moderately hard, very fine grained, thin bedded, slightly fractured, flat bedding, smooth		78	5.0	5.0	100	131.5	
		Bottom of Hole Top of Rock = 115.0 Elevation (498.0)							

SUBSURFACE LOG

Project Number	175657154	Location	N 1281202.42, E 1147707.76
Project Name	Vermilion Power Station	Boring No.	**S-107A** Total Depth 111.0 ft
County	Vermilion, Illinois	Surface Elevation	611.1 ft
Project Type	Geotechnical Exploration	Date Started	11/15/18 Completed 11/16/18
Supervisor	E. Holcombe Driller D. Jessie	Depth to Water	9.3 ft Date/Time 11/15/18
Logged By	E. Holcombe	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
611.1	0.0	Top of Hole						
		SILTY SAND (SM-SC), dark brown, trace clay, moist, very loose	SPT-1	0.0 - 1.5	1.4	1-1-2	27	
608.8	2.3		SPT-2	1.5 - 3.0	1.5	2-2-3	14	- organic material at 2.0 ft
		SILTY CLAY (CL-ML), brown gray mottled, trace sand and gravel, damp to moist, stiff	SPT-3	3.0 - 4.5	1.4	8-6-7	14	
			SPT-4	4.5 - 6.0	1.1	WOH-5-6	12	
			SPT-5	6.0 - 7.5	1.5	5-6-8	12	- trace stone fragments
			SPT-6	7.5 - 9.0	1.5	4-6-6	13	Gravel=8.1%, Sand=28.1%, Fines=63.8%, LL=24, PI=10
601.8	9.3	SILTY SAND (SM-SC), dark gray, trace clay, wet, very loose	SPT-7	9.0 - 10.5	1.5	3-1-1	31	
			SPT-8	10.5 - 12.0	0.5	WOH-WOH-1	27	Gravel=7.0%, Sand=34.4%, Fines=58.6%, LL=NP, PI=NP
			SPT-9	12.0 - 13.5	1.4	1-1-1	28	
597.6	13.5	FLY ASH (CCR), gray, trace clay, moist, very loose	SPT-10	13.5 - 15.0	0.9	WOH-WOH-WOH	34	
			SPT-11	15.0 - 16.5	1.5	WOH-1-2	54	
			SPT-12	16.5 - 18.0	1.5	2-2-2	41	
593.1	18.0	FLY ASH (CCR), dark gray, trace clay, wet, very loose to loose	SPT-13	18.0 - 19.5	1.0	3-4-4	37	
			SPT-14	19.5 - 21.0	0.8	WOH-WOH-3	43	
			SPT-15	21.0 - 22.5	1.5	1-2-3	51	
			SPT-16	22.5 - 24.0	0.7	1-2-4	42	
			SPT-17	24.0 - 25.5	1.2	WOR-WOR-WOH	45	
			SPT-18	30.0 - 31.5	1.5	WOH	40	
			SPT-19	35.0 - 36.5	1.1	2-7-10	25	

STANTEC/FMSM_LEGACY VISTRA NORTH ASH POND PHASE 1.GPJ FMSM-GRAPHIC LOG.GDT 1/24/19

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SUBSURFACE LOG

Project Number	175657154	Location	N 1281202.42, E 1147707.76
Project Name	Vermilion Power Station	Boring No.	**S-107A** Total Depth 111.0 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
571.1	40.0								
		LEAN CLAY (CL) (TILL), gray, trace silt, little sand, damp to moist, stiff to hard		SPT-20	40.0 - 41.5	1.5	8-8-6	14	
				SPT-21	45.0 - 46.5	0.7	20-11-12	19	- sand and gravel seam at 45.0 ft
				SPT-22	50.0 - 51.5	1.5	4-6-8	12	Gravel=2.5%, Sand=46.5%, Fines=51.0%, LL=21, PI=11
				ST-1	55.0 - 56.0	0.8		--	DP = 750 psi REC. = 1.0 ft
				SPT-23	60.0 - 61.5	1.5	14-16-17	11	
				SPT-24	65.0 - 66.5	1.4	11-6-7	13	
				SPT-25	70.0 - 71.5	1.4	7-6-8	13	- sand seam at 71.0 ft
				SPT-26	75.0 - 76.5	1.5	6-7-7	14	
530.5	80.6								Gravel=0.6%,

STANTEC/FMSM_LEGACY VISTRA NORTH ASH POND PHASE 1.GPJ FMSM-GRAPHIC LOG.GDT 1/24/19

SUBSURFACE LOG

Project Number	175657154	Location	N 1281202.42, E 1147707.76
Project Name	Vermilion Power Station	Boring No.	**S-107A** Total Depth 111.0 ft

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
		SILTY SAND (SM-SC), gray, fine grained, wet, medium dense		SPT-27	80.0 - 81.5	1.1	8-11-15	29	Sand=68.7%, Fines=30.7%, LL=NP, PI=NP
525.1	86.0			SPT-28	85.0 - 86.5	1.5	46-15-19	19	
		SILTY CLAY (CL-ML), gray, trace sand, damp, stiff to very stiff		SPT-29	90.0 - 91.5	1.5	8-9-11	25	
				SPT-30	95.0 - 96.5	1.5	4-8-4	24	Sand=6.7%, Fines=93.3%, LL=30, PI=12
510.4	100.7			SPT-31	100.0 - 101.5	1.5	9-24-14	24	
		SILTY CLAY (CL-ML), gray, some fine grained sand, moist to wet, hard		SPT-32	105.0 - 106.5	1.5	7-22-32	23	
501.1	110.0								
500.1	111.0	SAND (SM-SC), gray, coarse and fine grained, little gravel, wet, very dense		SPT-33	110.0 - 111.0	1.0	20-50/6"	17	Gravel=13.7%, Sand=77.6%, Fines=8.7%
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY VISTRA NORTH ASH POND PHASE 1.GPJ FMSM-GRAPHIC LOG.GDT 1/24/19

Stantec

SUBSURFACE LOG

Project Number	175657154	Location	N 1281206.60, E 1147704.30
Project Name	Vermilion Power Station	Boring No.	**S-107B** Total Depth 15.0 ft
County	Vermilion, Illinois	Surface Elevation	611.2 ft
Project Type	Geotechnical Exploration	Date Started	11/16/18 Completed 11/16/18
Supervisor	E. Holcombe Driller D. Jessie	Depth to Water	Dry Date/Time 11/16/18
Logged By	E. Holcombe	Depth to Water	N/A Date/Time N/A

Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
611.2	0.0	Top of Hole							
596.2	15.0	Attempted to Mud Rotary to Rock, Boring Terminated at 15.0 ft							

No Refusal /
Bottom of Hole

STANTEC/FMSM_LEGACY VISTRA NORTH ASH POND PHASE 1.GPJ FMSM-GRAPHIC LOG.GDT 1/24/19

SUBSURFACE LOG

Project Number	175657154	Location	N 1280882.07, E 1148238.17
Project Name	Vermilion Power Station	Boring No.	**S-109** Total Depth 101.0 ft
County	Vermilion, Illinois	Surface Elevation	617.8 ft
Project Type	Geotechnical Exploration	Date Started	11/15/18 Completed 11/15/18
Supervisor	P. Cichocki Driller K. Hayslip	Depth to Water	15.5 ft Date/Time 11/15/18
Logged By	P. Cichocki	Depth to Water	N/A Date/Time N/A

Lithology Elevation	Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
617.8	0.0	Top of Hole						
616.3	1.5	LEAN CLAY (CL), brown gray mottled, trace silt, moist, medium stiff	SPT-1	0.0 - 1.5	1.2	3-3-3	30	
615.8	2.0	GRAVEL and Sand (GP-GM), gray, little to some clay, wet, loose	SPT-2	1.5 - 3.0	1.5	2-3-6	19	
614.8	3.0	LEAN CLAY (CL), brown orange mottled, damp, medium stiff	SPT-3	3.0 - 4.5	1.5	4-6-8	17	
614.1	3.7	GRAVEL and Sand (GP-GM) , gray, little to some clay, wet, loose	SPT-4	4.5 - 6.0	1.5	4-4-7	20	- gravel layer at 4.5 ft to 4.8 ft
		SANDY LEAN CLAY (CL), brown gray mottled, trace to little stone fragments, damp, medium stiff to stiff	SPT-5	6.0 - 7.5	1.5	3-3-3	20	
			SPT-6	7.5 - 9.0	1.4	2-2-4	20	- Possible cobbles present
			SPT-7	9.0 - 10.5	1.5	2-3-3	19	- coal fragments in sample
			ST-1	10.5 - 12.5	1.7		--	Gravel=1.7%, Sand=23.4%, Fines=74.9%, LL=34, PI=18 DP = 600 psi REC. = 1.7 ft
604.3	13.5	FLY ASH (CCR), gray, very fine grained, dry to damp, loose to medium dense	SPT-8	12.5 - 14.0	1.5	3-4-11	20	
			SPT-9	14.0 - 15.5	1.5	6-8-10	46	- trace coal fragments Sand=34.0%, Fines=66.0%, LL=NP, PI=NP
			SPT-10	15.5 - 17.0	1.5	3-3-4	47	- wet
			SPT-11	17.0 - 18.5	1.5	2-3-4	45	
			SPT-12	18.5 - 20.0	1.5	3-3-4	55	
			SPT-13	20.0 - 21.5	1.5	2-1-3	83	
595.3	22.5	LEAN CLAY (CL), brown gray mottled, trace stone fragments, damp to moist, very soft	SPT-14	21.5 - 23.0	1.5	1-WOH-1	75	- higher silt content
			SPT-15	23.0 - 24.5	1.5	WOH	26	- trace organics
593.3	24.5	LEAN CLAY (CL)(TILL), brown gray mottled, little stone fragments, damp to moist, medium stiff to stiff	SPT-16	24.5 - 26.0	1.5	3-4-5	22	
			SPT-17	30.0 - 31.5	1.5	2-3-4	25	Gravel=0.4%, Sand=17.3%, Fines=82.3%, LL=37, PI=21
582.8	35.0	SILTY SAND (SM), brown and gray, medium to coarse grained, wet, loose	SPT-18	35.0 - 36.5	1.5	3-4-4	23	

STANTEC/FMSM_LEGACY VISTRA NORTH ASH POND PHASE 1.GPJ FMSM-GRAPHIC LOG.GDT 1/24/19

Stantec

SUBSURFACE LOG

Project Number	175657154	Location	N 1280882.07, E 1148238.17
Project Name	Vermilion Power Station	Boring No.	**S-109** Total Depth 101.0 ft

Lithology Elevation	Depth	Description	Overburden / Rock Core Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
577.8	40.0	GRAVEL with Sand (GP), orange brown, coarse grained, wet, medium dense	SPT-19	40.0 - 41.5	1.3	6-6-14	9	Gravel=41.8%, Sand=48.8%, Fines=9.4%
572.8	45.0	SANDY LEAN CLAY (CL) (TILL), gray, damp to moist, stiff	SPT-20	45.0 - 46.5	1.5	3-5-7	13	- Possible cobbles present
			SPT-21	50.0 - 51.5	1.5	3-5-16	13	
566.8	51.0	SILTY SAND (SM), medium to coarse grained, wet, medium dense						
562.8	55.0	SANDY LEAN CLAY (CL), gray, damp to moist, stiff	SPT-22	55.0 - 56.5	1.5	5-5-8	14	
557.8	60.0	SAND (SM-SC), gray, coarse grained, trace silt, some gravel, wet, dense	SPT-23	60.0 - 61.5	1.0	15-16-21	14	Gravel=16.4%, Sand=74.1%, Fines=9.5%
			SPT-24	65.0 - 66.5	1.3	12-12-10	14	
551.8	66.0	SANDY LEAN CLAY (CL), gray, damp to moist, stiff						
547.8	70.0	GRAVELLY SAND (SP), gray and brown, coarse grained, wet, medium dense	SPT-25	70.0 - 71.5	1.1	8-7-8	17	Gravel=13.2%, Sand=79.3%, Fines=7.5%
542.8	75.0	SILTY SAND (SM), gray, fine to medium grained, trace gravel, wet, medium dense to dense	SPT-26	75.0 - 76.5	1.4	8-10-12	17	Gravel=2.8%,

STANTEC/FMSM_LEGACY VISTRA NORTH ASH POND PHASE 1.GPJ FMSM-GRAPHIC LOG.GDT 1/24/19

Project Number	175657154	Location	N 1280882.07, E 1148238.17
Project Name	Vermilion Power Station	Boring No.	**S-109** Total Depth 101.0 ft

Lithology Elevation	Lithology Depth	Description	Overburden Sample # / Rock Core RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
532.8	85.0	SILTY SAND (SM), gray, fine to medium grained, trace gravel, wet, medium dense to dense *(Continued)*	SPT-27	80.0 - 81.5	1.5	9-11-10	19	Sand=27.5%, Fines=69.7%
527.6	90.2	SANDY LEAN CLAY (CL), gray, trace stone fragments and silt, damp to moist, very stiff	SPT-28	85.0 - 86.5	1.5	5-7-15	23	
			SPT-29	90.0 - 90.9	0.8	42-50/4.8"	10	Began Core
516.8	101.0	Moderately to highly Weathered, SHALE, soft, very fine grained, thin bedded, argillaceous	77	10.0	9.4	94	101.0	

Bottom of Hole

Top of Rock = 90.2
Elevation (527.6)

SUBSURFACE LOG

Project Number	175657154	Location	N 1280718.58, E 1148017.18
Project Name	Vermilion Power Station	Boring No.	**S-110** Total Depth 114.5 ft
County	Vermilion, Illinois	Surface Elevation	619.3 ft
Project Type	Geotechnical Exploration	Date Started	11/13/18 Completed 11/14/18
Supervisor	P. Cichocki Driller K. Hayslip	Depth to Water	10.5 ft Date/Time 11/13/18
Logged By	P. Cichocki	Depth to Water	N/A Date/Time N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
619.3	0.0	Top of Hole							
616.3	3.0	FLY ASH (CCR), gray, little sand, some clay, damp, very loose to loose		SPT-1	0.0 - 1.5	1.2	1-3-5	22	
				SPT-2	1.5 - 3.0	1.1	3-2-1	24	
611.8	7.5	SILTY CLAY (CL-ML), brown gray mottled, trace sand, dry to damp, stiff to very stiff		SPT-3	3.0 - 4.5	1.0	6-12-14	10	
				SPT-4	4.5 - 6.0	1.2	8-10-11	11	
				SPT-5	6.0 - 7.5	1.3	4-5-8	12	
601.3	18.0	SANDY LEAN CLAY (CL), gray and brown, damp to wet, soft to stiff		SPT-6	7.5 - 9.0	1.2	6-8-6	10	
				SPT-7	9.0 - 10.5	0.5	5-2-2	12	
				SPT-8	10.5 - 12.0	0.4	1-1-1	19	
				SPT-9	12.0 - 13.5	0.1	WOH-WOH-2	18	
				SPT-10	13.5 - 15.0	0.7	1-2-2	16	
				SPT-11	15.0 - 16.5	1.4	1-1-2	24	
				SPT-12	16.5 - 18.0	1.5	2-2-2	23	
584.3	35.0	SILTY CLAY (CL-ML), brown and gray, very fine grained, little sand, moist, soft to stiff		SPT-13	18.0 - 19.5	1.5	WOH-2-2	24	
				SPT-14	19.5 - 21.0	1.5	2-3-7	17	- stone fragments in sample
				ST-1	21.0 - 22.0	0.5		--	Gravel=2.8%, Sand=32.5%, Fines=64.7%, LL=29, PI=13 DP = 900 - 1000 psi
				SPT-15	22.0 - 23.5	0.3	2-2-5	20	
				SPT-16	23.5 - 25.0	1.5	1-2-3	20	
				ST-2	25.0 - 27.0	2.0		--	Shelby Tube Attempted (Damaged) Gravel=2.6%, Sand=33.4%, Fines=64.0%, LL=29, PI=14 DP = 500 - 850 psi REC. = 2.0
				SPT-17	30.0 - 31.5	1.5	3-2-2	19	
				SPT-18	35.0 - 36.5	1.5	3-1-3	24	

STANTEC/FMSM_LEGACY VISTRA NORTH ASH POND PHASE 1.GPJ FMSM-GRAPHIC LOG.GDT 1/24/19

SUBSURFACE LOG

Project Number	175657154	Location	N 1280718.58, E 1148017.18
Project Name	Vermilion Power Station	Boring No.	**S-110** Total Depth 114.5 ft

Lithology Elevation	Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
579.3	40.0	CLAYEY SAND (SC), brown, coarse grained, trace to little gravel, wet, loose *(Continued)*		SPT-19	40.0 - 41.5	0.9	3-5-5	13	Cobble present Gravel=34.8%, Sand=49.2%, Fines=16.0%
573.8	45.5	SAND (SM-SC), gray and brown, coarse grained, trace to little clay, some gravel and stone fragments, wet, loose to medium dense		SPT-20	44.0 - 45.5	1.5	3-9-10	13	
		LEAN CLAY (CL) (TILL), gray, trace sand, trace stone fragments, damp to moist, very stiff		SPT-21	49.0 - 50.5	1.5	7-9-11	13	- very stiff clay
564.3	55.0			SPT-22	54.0 - 55.5	1.5	10-17-30	12	
		SILTY CLAYEY SAND (SM-SC), brown, coarse grained, wet, very dense		SPT-23	59.0 - 60.5	1.4	32-33-34	10	Gravel=21.2%, Sand=65.4%, Fines=13.4%
555.3	64.0	SILTY SAND (SM), brown and gray, very fine grained, moist to damp, dense		SPT-24	64.0 - 65.5	0.4	50/4.8"	11	
550.3	69.0	SAND (SM), brown, coarse grained, wet, very dense		SPT-25	69.0 - 70.5	0.4	50/4.8"	21	
				SPT-26	74.0 - 75.5	0.4	50/4.8"	11	
539.8	79.5			SPT-27	79.0 - 80.5	1.3	36-46-	10	

STANTEC/FMSM_LEGACY VISTRA NORTH ASH POND PHASE 1.GPJ FMSM-GRAPHIC LOG.GDT 1/24/19

Project Number	175657154	Location	N 1280718.58, E 1148017.18
Project Name	Vermilion Power Station	Boring No.	**S-110** Total Depth 114.5 ft

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		LEAN CLAY (CL), gray, trace sand and stone fragments, damp to moist, hard *(Continued)*					50/3.6"		- vertical sand seams throughout sample - very dense coarse sand lenses at 79.5 ft to 89.0 ft Gravel=2.8%, Sand=64.0%, Fines=33.2%, LL=NP, PI=NP
530.3	89.0			SPT-28	84.0 - 85.5	1.5	28-27-30	14	
525.3	94.0	SANDY SILTY CLAY (CL-ML), gray, moist to wet, very stiff		SPT-29	89.0 - 90.5	1.5	6-9-12	23	Gravel=1.1%, Sand=40.7%, Fines=58.2%, LL=22, PI=7
520.3	99.0	SANDY LEAN CLAY (CL), gray brown mottled, trace silt, damp to moist, hard		SPT-30	94.0 - 95.5	1.5	6-16-19	18	
515.3	104.0	SANDY SILTY CLAY (CL-ML), gray, wet, hard		SPT-31	99.0 - 100.5	1.5	13-19-29	21	
				SPT-32	104.0 - 104.5	0.4	50/4.8"	13	Began Core
504.8	114.5	Moderately to highly weathered SHALE, gray, soft to moderately hard, very fine grained, thin bedded, argillaceous		92	10.0	9.8	98	114.5	

Bottom of Hole

Top of Rock = 104.0
Elevation (515.3)

KEY TO BORING LOGS

Graphic Symbol	Description	USCS Classification
GRAVEL		
	GRAVEL with little or no fines	GP or GW
	Silty GRAVEL	GM
	Clayey GRAVEL	GC
	SAND and GRAVEL	SP/GP
SAND		
	SAND poorly graded	SP
	SAND well graded	SW
	Silty SAND	SM
	Clayey SAND	SC
LOW PLASTIC SILTS AND CLAYS		
	Inorganic low plastic SILT	ML
	Inorganic low plastic CLAY	CL
	Sandy SILT	ML
	Sandy CLAY	CL
	Gravelly CLAY	CL
	Organic low plastic SILT or CLAY	OL
HIGH PLASTIC SILTS AND CLAYS		
	Inorganic high plastic SILT	MH
	Inorganic high plastic CLAY	CH
	Sandy Inorganic high plastic CLAY	CH
	Organic high plastic SILT or CLAY	OH
	Peat and other highly organic soils	PT
ROCKS		
	LIMESTONE	
	SHALE	
	SANDSTONE	
	SILTSTONE	
SURFACE MATERIALS		
	FLY ASH/BOTTOM ASH	
	FILL	
	Topsoil	

TERMS DESCRIBING DENSITY OR CONSISTENCY

Coarse grained soils (major portion retained on No. 200 sieve) include gravels and sands. Density is based on the Standard Penetration Test (SPT).

Density	SPT blows per foot
Very loose	0 – 5
Loose	5 – 10
Medium dense	10 – 30
Dense	30 – 50
Very dense	Greater than 50

Fine grained soils (major portion passing No. 200 sieve) include clays and silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

Descriptive Term	SPT blows per foot	Estimated undrained shear strength (ksf)	Hand Test
Very soft	0–2	< 0.25	Extrudes between fingers
Soft	2–4	0.25–0.5	Molded by slight pressure
Medium stiff	4–8	0.5–1.0	Molded by strong pressure
Stiff	8–15	1.0–2.0	Indented by thumb
Very stiff	15–30	2.0–4.0	Indented by thumbnail
Hard	> 30	> 4.0	Difficult to indent

LEGEND AND NOMENCLATURE

- Standard penetration test sample
- Grab sample
- Continuous sample
- Undisturbed shelby tube sample
- California modified sample
- NX core.

PP Su	Pocket penetrometer undrained shear strength
TV Su	Torvane undrained shear strength
NMC	Natural Moisture Content, %
LL	Liquid Limit
PI	Plasticity Index
NP	Non–plastic
–#200	(% pass #200 sieve)
SA(%)	Sieve analysis (% passing #200)
LV Su	Lab vane undrained shear strength
UUC Qu	Unconfined undrained compression strength
TXUU Su	Unconsolidated undrained triaxial compression shear strength
CONS	Consolidation test
DSS	Direct simple shear test
RC	Resonant column test
CyTXCIU	Cyclic isotropically consolidated undrained triaxial compression test
CyDSSCKoU	Cyclic Ko–consolidated undrained direct simple shear test
RQD	Rock quality designation
∇	Depth Groundwater enters at time of drilling.
▼	Groundwater Level at some specified time after drilling

SAMPLING RESISTANCE

P	Sample pushed by hydraulic rig action.
3 6 9	Numbers indicate blows per 6 in. of sampler penetration. Standard penetration test sampler, (2–in O.D.) and oversize penetration sample (3–in O.D.) are driven by a 140 lb hammer falling freely 30–in
50/2	Number of blows (50) used to drive a penetration sampler a certain number of inches (2)
WOH	Weight of hammer

ABBREVIATIONS USED UNDER "FIELD NOTES"

HSA = Hollow Stem Auger
CFA = Continuous Flight Auger
ATD = At Time of Drilling
AD = After Drilling
ST = Static

URS

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KEY TO BORING LOGS

Graphic Symbol	Description	USCS Classification
GRAVEL		
	GRAVEL with little or no fines	GP or GW
	Silty GRAVEL	GM
	Clayey GRAVEL	GC
	SAND and GRAVEL	SP/GP
SAND		
	SAND poorly graded	SP
	SAND well graded	SW
	Silty SAND	SM
	Clayey SAND	SC
LOW PLASTIC SILTS AND CLAYS		
	Inorganic low plastic SILT	ML
	Inorganic low plastic CLAY	CL
	Sandy SILT	ML
	Sandy CLAY	CL
	Gravelly CLAY	CL
	Organic low plastic SILT or CLAY	OL
HIGH PLASTIC SILTS AND CLAYS		
	Inorganic high plastic SILT	MH
	Inorganic high plastic CLAY	CH
	Sandy Inorganic high plastic CLAY	CH
	Organic high plastic SILT or CLAY	OH
	Peat and other highly organic soils	PT
ROCKS		
	LIMESTONE	
	SHALE	
	SANDSTONE	
	SILTSTONE	
SURFACE MATERIALS		
	FLY ASH/BOTTOM ASH	
	FILL	
	Topsoil	

TERMS DESCRIBING DENSITY OR CONSISTENCY

Coarse grained soils (major portion retained on No. 200 sieve) include gravels and sands. Density is based on the Standard Penetration Test (SPT).

Density	SPT blows per foot
Very loose	0 – 5
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Dense	30 – 50
Very dense	Greater than 50

Fine grained soils (major portion passing No. 200 sieve) include clays and silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

Descriptive Term	SPT blows per foot	Estimated undrained shear strength (ksf)	Hand Test
Very soft	0–2	< 0.25	Extrudes between fingers
Soft	2–4	0.25–0.5	Molded by slight pressure
Medium stiff	4–8	0.5–1.0	Molded by strong pressure
Stiff	8–15	1.0–2.0	Indented by thumb
Very stiff	15–30	2.0–4.0	Indented by thumbnail
Hard	> 30	> 4.0	Difficult to indent

LEGEND AND NOMENCLATURE

Standard penetration test sample

Grab sample

Continuous sample

Undisturbed shelby tube sample

California modified sample

NX core.

PP Su	Pocket penetrometer undrained shear strength
TV Su	Torvane undrained shear strength
NMC	Natural Moisture Content, %
LL	Liquid Limit
PI	Plasticity Index
NP	Non–plastic
–#200	(% pass #200 sieve)
SA(%)	Sieve analysis (% passing #200)
LV Su	Lab vane undrained shear strength
UUC Qu	Unconfined undrained compression strength
TXUU Su	Unconsolidated undrained triaxial compression shear strength
CONS	Consolidation test
DSS	Direct simple shear test
RC	Resonant column test
CyTXCIU	Cyclic isotropically consolidated undrained triaxial compression test
CyDSSCKoU	Cyclic Ko–consolidated undrained direct simple shear test
RQD	Rock quality designation
▽	Depth Groundwater enters at time of drilling.
▼	Groundwater Level at some specified time after drilling

SAMPLING RESISTANCE

P	Sample pushed by hydraulic rig action.
3 6 9	Numbers indicate blows per 6 in. of sampler penetration. Standard penetration test sampler, (2–in O.D.) and oversize penetration sample (3–in O.D.) are driven by a 140 lb hammer falling freely 30–in
50/2	Number of blows (50) used to drive a penetration sampler a certain number of inches (2)
WOH	Weight of hammer

ABBREVIATIONS USED UNDER "FIELD NOTES"

HSA = Hollow Stem Auger
CFA = Continuous Flight Auger
ATD = At Time of Drilling
AD = After Drilling
ST = Static

URS

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LOG of BORING No. B-13-1

STARTED 8/8/13
COMPLETED 8/8/13
LOCATION Danville, IL
SURFACE EL., FT 606.4
EL. DATUM NAVD 88
NORTHING 1281636.51
EASTING 1147839.71
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0				Very loose, dry, light gray FLY ASH, trace fine bottom ash.										
		1 1 1	100											
5		1 1 1	100	Becomes moist.										
		1 0 0	100	▽										
				Becomes wet.										
10		1 0 0	100											
15		1 0 1	100	Fly ash - 90% coarse to fine bottom ash - 10%			39							15' : Fines content (%)=97.7
20		0 0 0	100	Saturated										

Completion Depth: 51.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 8 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

11/21/13 URS GEOTECH TEMPLATE (LAB STRENGTH-TXUU) Y:\GINT\PROJECTS\DYNERG-VERMILLION_21562906.GPJ URS_STL.GLB

URS

LOG of BORING No. B-13-1

STARTED 8/8/13
COMPLETED 8/8/13
LOCATION Danville, IL
SURFACE EL., FT 606.4
EL. DATUM NAVD 88
NORTHING 1281636.51
EASTING 1147839.71
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25		5 6 7	100											
				Medium dense, wet, light brown, coarse to fine silty SAND (SM). [ALLUVIAL]	580.4 26.0									
30		9 7 8	0											
				Becomes poorly graded, medium to fine sand.										
35		6 11 10	100				12				>4.5 2.5			
				Very stiff, moist, gray, low plastic CLAY (CL), trace medium sand. [TILL]	570.9 35.5									
40		4 5 8	100	Becomes stiff, trace coarse to medium sand.			12		24	12	4.0			
45		16 9 11	89	Becomes very stiff.							4.5			
					556.4									

Completion Depth: 51.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.

Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 8 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

URS

LOG of BORING No. B-13-1

STARTED 8/8/13
COMPLETED 8/8/13
LOCATION Danville, IL
SURFACE EL., FT 606.4
EL. DATUM NAVD 88
NORTHING 1281636.51
EASTING 1147839.71
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
50		12 18 18	100	Medium dense, wet, light brown, medium to fine, silty SAND (SM). [OUTWASH]	50.0 / 555.4 51.0									
				Hard, moist, gray, low plastic CLAY (CL), trace coarse to medium sand. [TILL]	554.9 51.5									
				Bottom of boring at 51.5'										
55														
60														
65														
70														

Completion Depth: 51.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.

Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 8 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-2

STARTED 8/6/13
COMPLETED 8/6/13
LOCATION Danville, IL
SURFACE EL., FT 603.1
EL. DATUM NAVD 88
NORTHING 1281700.74
EASTING 1148264.03
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0		2 1 1	78	Very loose, moist, gray fly ash. [FILL]										
		1 1 1	100											
5		P	100				35 49 40 31	102 96 98						5.4' : Fines content (%)=87.2 5.4' :TX CD C'= 0 ; phi'=36.8 5.95' :Consol test: Cc=0.277 Cr=0.033
		4 6 6	100		595.1		14		22	6	2.0			
				Stiff, moist, light brown, low plastic, fine sandy CLAY (CL). [FILL]	8.0									
10		5 6 8	100		592.1									
				Medium dense, moist, gray, FLYASH, trace fine bottom ash. [FILL]	11.0									
15		9 22 26	100	Becomes very dense, trace fine sand, no bottom ash.	585.1									
				Very loose, wet, light brown, fine silty SAND (SM). [ALLUVIAL]	18.0									
20		1 1 2			582.1		18							20' : Fines content (%)=36.1
				Soft, moist, light brown, low plastic, silty CLAY (CL). [ALLUVIAL]	21.0									
				▽	579.1									
				Loose, wet, light brown, medium to fine silty SAND (SM). [ALLUVIAL]	24.0									

Completion Depth: 46.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.

Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 24 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-2

STARTED 8/6/13
COMPLETED 8/6/13
LOCATION Danville, IL
SURFACE EL., FT 603.1
EL. DATUM NAVD 88
NORTHING 1281700.74
EASTING 1148264.03
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25		P	33											Sample put in jar.
				Soft, moist, gray, low plastic, silty CLAY (CL), trace medium to fine sand. [ALLUVIAL]	576.6 / 26.5									
30				Dense, wet, light brown, poorly graded, coarse to fine silty SAND (SM). [ALLUVIAL]	573.1 / 30.0									
35		9 11 13	100				11				4.5			35' : Fines content (%)=28.8
				Medium dense, wet, gray, sandy SILT (ML). [TILL]	567.1 / 36.0									
40				Dense, wet, coarse to fine SAND (SP), trace silt. [OUTWASH]	563.1 / 40.0									
45		9 17 26	100				10							
				Hard, moist, gray, medium plastic CLAY (CL), trace coarse to fine sand. [TILL]	557.6 / 45.5									
				Bottom of boring at 46.5'	556.6 / 46.5									

Completion Depth: 46.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 24 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

URS

LOG of BORING No. B-13-3

STARTED 8/6/13
COMPLETED 8/6/13
LOCATION Danville, IL
SURFACE EL., FT 605.9
EL. DATUM NAVD 88
NORTHING 1281688.64
EASTING 1148286.59
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0				3/4" minus crushed limestone rock. [FILL]										
				Very stiff, moist, light brown, low plastic CLAY (CL). [FILL]	604.9 / 1.0									
		6 7 9	89				16		38	22				
5		4 5 4	100											
				Loose, moist, drak gray, FLYASH, trace clay. [FILL]	600.4 / 5.5									
		7 7 7	100	Becomes medium dense.										
10		P	24	With medium to fine gravel										Bent tube. Put in jar
15		8 10 13	100	Trace medium to fine sand, no gravel.										
				Medium dense, moist, light brown to gray, medium to fine silty SAND (SM). [ALLUVIAL]	587.9 / 18.0									
20		10 11 10	100											

Completion Depth: 51.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 26 ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.
Logged by: Tim Hicks

URS

LOG of BORING No. B-13-3

STARTED: 8/6/13
COMPLETED: 8/6/13
LOCATION: Danville, IL
SURFACE EL., FT: 605.9
EL. DATUM: NAVD 88
NORTHING: 1281688.64
EASTING: 1148286.59
N, E DATUM: IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25		5 2 3	100	Becomes loose, wet.			17							25' : Fines content (%)=25.4
30		3 3 5	67	Loose, wet, light brown, poorly graded, coarse to fine SAND (SP-SM), with silt. [ALLUVIAL]	575.9 30.0		17							30' : Fines content (%)=6.38
35		3 5 10	89				11		23	11				
				Stiff, moist, gray, medium plastic CLAY (CL), trace coarse to fine sand. [TILL]	569.9 36.0									
40		14 23 34	89	Becomes very stiff.							4.5			
				Very dense, wet, light brown, medium to fine, silty SAND (SM). [OUTWASH]	564.9 41.0									
45														

Completion Depth: 51.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 26 ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-3

STARTED 8/6/13
COMPLETED 8/6/13
LOCATION Danville, IL
SURFACE EL., FT 605.9
EL. DATUM NAVD 88
NORTHING 1281688.64
EASTING 1148286.59
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
50		10 21 35	89	Becomes coarse to fine sand.	554.6 51.3									
				Limestone in sample spoon shoe. Bottom of boring at 51.5'										
55														
60														
65														
70														

Completion Depth: 51.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 26 ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-4

STARTED 7/23/13
COMPLETED 7/23/13
LOCATION Danville, IL
SURFACE EL., FT 593.3
EL. DATUM NAVD 88
NORTHING 1281668.92
EASTING 1148334.20
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0		6 10 10	50	Soft, dry, black, TOPSOIL.	592.3 / 1.0									
		11 12 16	83	Very stiff, dry, light brown, clayey SILT (ML), trace fine sand. [FILL]			8							
5		9 10 12	83	Very stiff, moist, light brown, fine sandy and silty CLAY (CL). [FILL]	588.3 / 5.0		14				3.5 >4.5			
		9 15 19	83		585.3 / 8.0						3.3			
				Dense, moist, light gray, fine, silty SAND (SM), trace clay. [ALLUVIAL]										
10		4 3 2	92	Becomes loose.	582.3 / 11.0		17							10' : Fines content (%)=40.3
				Increase in clay content										
15		P	38		577.8 / 15.5									
				Soft, wet, gray, sandy CLAY (CL), trace silt. [ALLUVIAL] ▽										
					573.8 / 19.5									
20		3 4 5	100	Stiff, wet, gray, silty CLAY (CL), trace poorly graded sand. [ALLUVIAL]			12		24	12				20' : Fines content (%)=93.41

Completion Depth: 42.0 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 16 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

11/21/13 URS GEOTECH TEMPLATE (LAB STRENGTH-TXUU) Y:\GINT\PROJECTS\DYNERG-VERMILLION_21562906.GPJ URS_STL.GLB

URS

LOG of BORING No. B-13-4

STARTED 7/23/13
COMPLETED 7/23/13
LOCATION Danville, IL
SURFACE EL., FT 593.3
EL. DATUM NAVD 88
NORTHING 1281668.92
EASTING 1148334.20
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25		4 7 8	100	Becomes stiff.							2.0 4.0			
				1/2" Poorly graded sand seam.	566.3 / 27.0									
				Stiff, wet, gray, silty CLAY (CL), trace poorly graded sand. [ALLUVIAL]	564.3 / 29.0									
				Loose, wet, light brown, poorly graded, silty SAND (SM). [ALLUVIAL]										
30		9 14 10	100		562.3 / 31.0									
				6" : Stiff, wet, gray, silty CLAY (CL), trace sand.	561.8 / 31.5									
				Loose, wet, light brown, poorly graded silty SAND (SM). [ALLUVIAL]										
35		P	0											10 ft of blow back. Added water. No sample spoon collected
40		14 20 28	100				13							40' : Fines content (%)=15.2
					551.3 / 42.0									
				Bottom of boring at 42'										Auger refusal at 42.0'. SHALE in spoon shoe.
45														

Completion Depth: 42.0 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 16 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

URS

LOG of BORING No. B-13-5

STARTED 8/7/13
COMPLETED 8/7/13
LOCATION Danville, IL
SURFACE EL., FT 608.0
EL. DATUM NAVD 88
NORTHING 1281208.71
EASTING 1148299.28
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0		2 4 1	89	Loose, moist, gray, FLYASH, trace fine bottom ash and clay. [FILL]										
		2 2 2	100	Becomes wet.										
5		2 2 3	78		602.5 / 5.5		17		35	18	1.0			
				Medium stiff, moist, gray, medium plastic CLAY (CL). [FILL]										
		2 4 6	89	Becomes stiff, tace medium to fine sand.			18				3.0 3.25			
10		4 2 4	44				19				2.3			
15		P	83		592.0 / 16.0		18 18 17	132 134 135 134	36	20				
				Very stiff to stiff, moist, gray, medium plastic CLAY (CL). [FILL]										16.5' :TX CD C'=0 ; phi'=40.1
20		6 7 8	78				17				4.5			20.5' : Limestone fragments in split spoon shoe.
					583.0									

Completion Depth: 51.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 30 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-5

STARTED 8/7/13
COMPLETED 8/7/13
LOCATION Danville, IL
SURFACE EL., FT 608.0
EL. DATUM NAVD 88
NORTHING 1281208.71
EASTING 1148299.28
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25		2 7 9	78	Very stiff to stiff, moist, gray,low plastic, silty CLAY (CL). [FILL]	25.0		20				2.5			26.5' : Chunk of wood in shoe.
30		5 3 2	11	Loose, wet, dark gray, silty, medium to fine SAND (SP), trace silt. [ALLUVIAL]	578.0 / 30.0									31.5' : Limestone fragments wedged in spoon shoe
				Medium stiff, moist, dark gray, low plastic, silty CLAY (CL). [ALLUVIAL]	574.5 / 33.5									
35		5 5 4	89								1.0			
				Loose, wet, dark gray, medium to fine silty SAND (SM). [ALLUVIAL]	572.0 / 36.0									
40		2 1 0	67				12		22	11	1.0			
				Very soft, wet, gray, low plastic, sandy CLAY (CL). [ALLUVIAL]	567.5 / 40.5									
45														
				Medium dense, wet, light brown, fine SAND (SP), trace silt (SP). [ALLUVIAL]	562.0 / 46.0									

Completion Depth: 51.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 30 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-5

STARTED 8/7/13
COMPLETED 8/7/13
LOCATION Danville, IL
SURFACE EL., FT 608.0
EL. DATUM NAVD 88
NORTHING 1281208.71
EASTING 1148299.28
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
50		6 3 7	67	Becomes poorly graded, coarse to fine sand.	557.0 / 51.0									
				Bottom of boring at 51.5'										
55														
60														
65														
70														

Completion Depth: 51.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.

Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 30 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

URS

LOG of BORING No. B-13-6

STARTED 8/7/13
COMPLETED 8/7/13
LOCATION Danville, IL
SURFACE EL., FT 605.9
EL. DATUM NAVD 88
NORTHING 1281218.93
EASTING 1148322.85
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0		4 6 7	78	Stiff, dry, brown, low plastic CLAY (CL), trace 3/4" minus rock. [FILL]										
		5 7 10	89	Becomes very stiff			14				3.0 +4.5			
5		4 3 4	67	Becomes medium stiff, trace medium to fine sand.			16		32	16	3.5			
		4 7 8	89	Becomes very stiff			19				3.5 2.5 4			
10		2 3 4	78	Becomes medium stiff, moist.			18				3.0 +4 1.5			
15		P	94				16 19 21 20 18	130 134 132 132	36	20				16.5' : TX CU C'=0; phi=37.3; phi'=31.7
20		5 6 8	89	Becomes stiff.							3.5			

Completion Depth: 50.3 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 35.5 ft., After ATD hrs.; 27 ft., After 1 hrs.; ft., After hrs.
Logged by: Tim Hicks

11/21/13 URS GEOTECH TEMPLATE (LAB STRENGTH-TXUU) Y:\GINT\PROJECTS\DYNERG-VERMILLION_21562906.GPJ URS_STL.GLB

URS

LOG of BORING No. B-13-6

STARTED 8/7/13
COMPLETED 8/7/13
LOCATION Danville, IL
SURFACE EL., FT 605.9
EL. DATUM NAVD 88
NORTHING 1281218.93
EASTING 1148322.85
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	NMC, %	γt, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25	3 4 5	0	With coarse gravel to fine cobbles.									
30	6 4 6	56			18							
35	6 8 9	0										
			Medium dense, wet, medium to fine silty SAND (SM). [ALLUVIAL]	570.4 / 35.5								
			Stiff, moist, gray, low plastic, CLAY (CL), trace medium sand. [TILL]	566.9 / 39.0								
40	4 5 7	78	1" medium to fine, silty sand lens.		11				2.0 3.0			
45												
			Dense, wet, gray medium to fine, silty sand (SM). [OUTWASH]	559.9 / 46.0								

Completion Depth: 50.3 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.

Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 35.5 ft., After ATD hrs.
27 ft., After 1 hrs.
ft., After hrs.
Logged by: Tim Hicks

URS

LOG of BORING No. B-13-6

STARTED 8/7/13
COMPLETED 8/7/13
LOCATION Danville, IL
SURFACE EL., FT 605.9
EL. DATUM NAVD 88
NORTHING 1281218.93
EASTING 1148322.85
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
50		50/3"		LIMESTONE: Weathered.	555.6 50.3									50.25' : Auger refusal.
				Bottom of boring at 50.25'										
55														
60														
65														
70														

Completion Depth: 50.3 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.

Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 35.5 ft., After ATD hrs.
27 ft., After 1 hrs.
ft., After hrs.

Logged by: Tim Hicks

URS

LOG of BORING No. B-13-7

STARTED 7/24/13
COMPLETED 7/24/13
LOCATION Danville, IL
SURFACE EL., FT 590.6
EL. DATUM NAVD 88
NORTHING 1281238.89
EASTING 1148378.49
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0		3 4 5	83	3" soft, dry, black, silty CLAY (CL). [TOPSOIL]	590.4 / 0.3						4.0			
				Stiff, dry, tan, silty CLAY (CL). [FILL]										
		P	75				16 14 10	126 131 129 130	28	14				
				Stiff, moist, gray, fine sandy CLAY (CL). [FILL]	587.1 / 3.5									3.5' : TX CIU C=99; phi=49.4 ; C'=382 psf; phi'=23.7
5		8 7 9	83				12							
				3" medium dense, brown, fine silty sand seam.	584.9 / 5.8									
				Very stiff, moist, dark gray, poorly graded, sandy clay (CL). [ALLUVIAL]										
		P	50				17 17	118 126	27	12			0.68	
				Medium stiff, moist, dark gray, silty CLAY (CL), trace fine sand. [ALLUVIAL]	581.1 / 9.5									
10		2 3 3	100				27				2.0 2.5			
15		1 2 3	94				23				2.0			15' : Fines content (%)=42.8
				Loose, wet , dark gray, fine, silty SAND (SM), trace clay. [ALLUVIAL]	574.6 / 16.0									
				LIMESTONE: weathered, fractured, with chert fine sand lenses.	571.1 / 19.5									
20		25 17 8	44											20' : Auger refusal.
				Bottom of boring at 21.5'	569.1 / 21.5									

Completion Depth: 21.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 16 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-8

STARTED 8/2/13
COMPLETED 8/2/13
LOCATION Danville, IL
SURFACE EL., FT 623.8
EL. DATUM NAVD 88
NORTHING 1280859.34
EASTING 1148569.02
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0	3 5 5	78	Stiff, dry, light brown, low plastic CLAY (CL), trace fine sand. [FILL]						2.5			
	6 6 5	78							2.5			
			Medium dense, moist, brown, medium to fine SAND (SP), trace silt. [FILL]	620.3 / 3.5								
5	3 1 1	100										
			Very loose, wet, gray FLY ASH. [FILL]	618.3 / 5.5								
	P	75			26 35 29 28	109 107 114						8.65' : Fines content (%)=78.9 8.65' : TX CD C'=0 ; phi'=37.6
10	1 1 1	100										
			Soft, moist, light brown, low plastic CLAY (CL), with fly ash. [FILL]	612.8 / 11.0								
			Loose, moist, gray FLY ASH. [FILL]	610.3 / 13.5								
15	2 3 5	100			22		39	20				
			Medium stiff, moist, gray to brown, low plastic CLAY (CL), trace fly ash. [FILL]	608.3 / 15.5								
20	3 4 5	100							1.5			
			Loose, wet, gray to light brown, FLY ASH, trace fine bottom ash. [FILL]	600.3 / 23.5								

Completion Depth: 47.0 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.

Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 45.5 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

URS

LOG of BORING No. B-13-8

STARTED 8/2/13
COMPLETED 8/2/13
LOCATION Danville, IL
SURFACE EL., FT 623.8
EL. DATUM NAVD 88
NORTHING 1280859.34
EASTING 1148569.02
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25		2 1 3	89											
30		P	75	Loose to medium dense, moist, gray, FLY ASH, trace fine bottom ash. [FILL]	593.8 30.0		47 48 44	104 102 103					1.07	30.95' : Fines content (%)=97.5 30.95' : Consol test Cc=0.275 Cr=0.008
35		3 5 7	100											
40		2 7 10	100	Very stiff, moist, light brown to gray, low plastic CLAY (CL), mottled, trace fine sand. [ALLUVIAL]	583.3 40.5		17				3.0 2.5			
45		1 6 11	100	Very stiff, wet, light brown, coarse to fine sandy CLAY (CL). [ALLUVIAL]	578.3 45.5		13							
				Medium dense, wet, light brown, coarse to fine, silty SAND (SM), trace coarse gravel to fine cobbles. [ALLUVIAL]	577.3 46.5									
				Bottom of boring at 47'	576.8 47.0									47: Auger refusal

Completion Depth: 47.0 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.

Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 45.5 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

URS

LOG of BORING No. B-13-9

STARTED 8/1/13
COMPLETED 8/1/13
LOCATION Danville, IL
SURFACE EL., FT 626.8
EL. DATUM NAVD 88
NORTHING 1280889.90
EASTING 1148585.00
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0		4 5 6	83	Stiff, dry, light brown, low plastic CLAY (CL), trace coarse to medium sand. [FILL]							2.0			
		8 8 10	89	Becomes very stiff.			10				4.0			
5		P	75				18 20 20	129 133 132	33	17				6.15' : Fines content (%)=93.6 6.15' : TX CIU C=0; phi=51; C'= 0; phi'=30.3
		2 3 4	89	Becomes medium stiff to stiff, moist, trace fly ash.			22				1.5 1.75 2.25			
10		3 5 9	100	Becomes stiff.							2.5			
				Medium dense, dry, gray, FLY ASH. [FILL]	615.8 11.0									
15		3 6 8	100				23				2.5 2.0 2.25			
				Stiff, moist, brown, low plastic CLAY (CL), trace medium gravel to fine sand. [FILL]	611.3 15.5									
20		3 4 5	83	Trace fly ash.			12				2.5 +4.0			

Completion Depth: 80.0 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 50 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-9

STARTED 8/1/13
COMPLETED 8/1/13
LOCATION Danville, IL
SURFACE EL., FT 626.8
EL. DATUM NAVD 88
NORTHING 1280889.90
EASTING 1148585.00
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25		P	63				40 44	99 104					1.10	25.7' : Fines content (%)=98.9
				Medium dense, moist, gray, FLY ASH and BOTTOM ASH. [FILL]	600.8 26.0									Based on auger cuttings
30		3 3 4	100	Becomes loose, 90% fly ash, 10% bottom ash.										
35		10 5 2	100	Becomes 100% fly ash, trace fine bottom ash.										
40		2 6 5	100	Becomes medium dense, wet.										
				Medium stiff, moist, gray, low plastic CLAY (CL), trace fine sand. [ALLUVIAL]	584.3 42.5									
45		2 3 3	100				21				1.0 1.5			
				Medium stiff,, wet, gray, sandy CLAY (CL). [ALLUVIAL]	580.8 46.0									

Completion Depth: 80.0 feet	Drilling Equipment: D-50 ATV	Water Depth: 50 ft., After ATD hrs.	
Project No.: 21562906	Drilling Method: HSA (3.25" ID, 7.00" OD)	ft., After hrs.	
Project Name: Dynergy- Vermilion	Hammer Type: Automatic	ft., After hrs.	
Drilling Contractor: MET, Inc.	Driller's Name: Zack Wilcoxen	Logged by: Tim Hicks	

LOG of BORING No. B-13-9

STARTED 8/1/13
COMPLETED 8/1/13
LOCATION Danville, IL
SURFACE EL., FT 626.8
EL. DATUM NAVD 88
NORTHING 1280889.90
EASTING 1148585.00
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
50		14 23 24	89											
				Dense, wet, brown, coarse to fine sandy GRAVEL (GP). [OUTWASH]	576.3 50.5									
55														
				Dense, wet, gray, coarse to fine silty SAND (SP-SM). [OUTWASH]	569.8 57.0									
60		6 16 20	100	With clay layers.			10							60' : Fines content (%)=12.8
65				Hard, moist, gray, coarse to fine sandy CLAY (CL). [TILL]	561.8 65.0									
70		23 20 30	100				6				4.5			
				Limestone fragments.										

Completion Depth: 80.0 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 50 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-9

STARTED 8/1/13
COMPLETED 8/1/13
LOCATION Danville, IL
SURFACE EL., FT 626.8
EL. DATUM NAVD 88
NORTHING 1280889.90
EASTING 1148585.00
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
75				Increasing gravel/ limestone fragments.										
80				Bottom of boring at 80'	546.8 80.0									
85														
90														
95														

Completion Depth: 80.0 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.

Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 50 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

URS

LOG of BORING No. B-13-10

STARTED 7/24/13
COMPLETED 7/24/13
LOCATION Danville, IL
SURFACE EL., FT 592.6
EL. DATUM NAVD 88
NORTHING 1281038.83
EASTING 1148540.89
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0		4 5 5	89	Stiff, dry, tan, silty CLAY(CL). [FILL]	591.6 / 1.0						4.0			
				Stiff, dry, dark gray, silty CLAY (CL). [ALLUVIAL]										
		P	13				12							
				Trace coarse to fine gravel.										
5		21 19 15	0	Becomes hard.										
		5 7 9	94	Becomes stiff, trace medium to fine sand, no coarse to fine gravel.			19		42	21	4.0			
10		P	4	Trace coarse to fine gravel, coarse to fine sand.	580.6 / 12.0		18							
		2 1 1	100	Very loose, wet, tan, poorly graded, medium to fine silty SAND (SM). ▽			21							12.5' : Fines content (%)=35.7
15		11 16 19	56	LIMESTONE: Fractured, weathered.	576.6 / 16.0									15.5' : Auger refusal.
				Bottom of boring at 15.5'										
20														

Completion Depth: 15.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 12.5 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

11/21/13 URS GEOTECH TEMPLATE (LAB STRENGTH-TXUU) Y:\GINT\PROJECTS\DYNERG-VERMILLION_21562906.GPJ URS_STL.GLB

URS

LOG of BORING No. B-13-11

STARTED 7/24/13
COMPLETED 7/25/13
LOCATION Danville, IL
SURFACE EL., FT 634.4
EL. DATUM NAVD 88
N, E DATUM IL CS, East Zone
NORTHING 1280560.90
EASTING 1148856.98

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0		3 4 7	100	Stiff, dry, tan, low plastic,silty CLAY (CL). [FILL]							>4			
		5 9 9	89	Becomes very stiff.			14				4.0			
				Trace coarse sand to fine gravel.										
5		P	0											Bent tube. No recovery.
		P	0		626.4 8.0									
				Gravel layer.	625.4 9.0									
				Dense, black, 50% FLY ASH and 50% BOTTOM ASH.										
10		P	21											
				Some slag.										
					619.9 14.5									
				Very dense, moist, black, 50% BOTTOM ASH, 25% slag, 25% fly ash.										
15		37 41 44	89				4							15' : Fines content (%)=13.7
20		15 8 8	100		613.9 20.5									
				Medium dense, moist, gray, 95% FLY ASH, 5% bottom ash.										
					610.4 24.0									
				Medium dense, moist, dark gray, 75% BOTTOM ASH, 20% fly ash, 5% unburnt coal and slag.										

Completion Depth: 58.9 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 50.5 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-11

STARTED 7/24/13
COMPLETED 7/25/13
LOCATION Danville, IL
SURFACE EL., FT 634.4
EL. DATUM NAVD 88
NORTHING 1280560.90
EASTING 1148856.98
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25		9 10 11	100											
30		11 19 23	100	Dense, moist, dark gray, FLY ASH, trace bottom ash.	604.4 30.0									
35		7 16 14	100				53							35' : Fines content (%)=81.8
				Becomes dry.										
40		P	60											Only able to push 10". Piston sampler not in yet. Put in jar.
				Becomes moist.										
45		14 8 13	100	Becomes medium dense, 5% to 10% bottom ash.										

Completion Depth: 58.9 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 50.5 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-11

STARTED 7/24/13
COMPLETED 7/25/13
LOCATION Danville, IL
SURFACE EL., FT 634.4
EL. DATUM NAVD 88
NORTHING 1280560.90
EASTING 1148856.98
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
50		1 1 3	100	Becomes very loose, wet, no bottom ash. ▽			34							50' : Fines content (%)=90.4
				Very stiff, moist, gray, silty CLAY (CL), trace fine sand. [ALLUVIAL]	581.4 / 53.0									
55		7 9 11	100				23				4.5 >4.0			
				Dense, wet, gray to brown, poorly graded SAND (SP), trace silt. [ALLUVIAL]	576.9 / 57.5									
		50/5"		Weathered limestone/chert.	575.5 / 58.9									58.5' : Auger refusal.
				Bottom of boring at 58.9'										
60														
65														
70														

Completion Depth: 58.9 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.

Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 50.5 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-12

STARTED 8/5/13
COMPLETED 8/5/13
LOCATION Danville, IL
SURFACE EL., FT 632.3
EL. DATUM NAVD 88
NORTHING 1280716.74
EASTING 1148877.46
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0		3 5 12	67	Very stiff, dry, light brown, low plastic CLAY (CL). [FILL]										
		6 9 11	89				13				>4.0			
5		7 8 12	94				17				>4.0			
		7 16 14	39											
				Dense, dry, dark gray, coarse to fine BOTTOM ASH, trace fly ash. [FILL]	624.3 8.0									
10		8 8 8	89				7							10' : Fines content (%)=17.9
				Stiff, moist, light brown, low plastic CLAY (CL), trace sand. [FILL]	619.3 13.0									
15		P	100											
		18 40 42	100	Very dense, moist, dark gray, coarse to fine BOTTOM ASH, trace fly ash. [FILL]	616.8 15.5									
20		6 9 9	100											
				Medium dense, moist, gray, FLY ASH, trace clay. [FILL]	611.8 20.5									

Completion Depth: 60.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 55.5 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-12

STARTED 8/5/13
COMPLETED 8/5/13
LOCATION Danville, IL
SURFACE EL., FT 632.3
EL. DATUM NAVD 88
NORTHING 1280716.74
EASTING 1148877.46
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25		7 14 7	89											
30		8 18 41	100	Very dense, dry, gray, FLY ASH, trace medium to fine bottom ash. [FILL]	602.3 30.0									
35		3 6 11	100	Becomes medium dense. Becomes wet.										
40		3 2 5	100	Becomes loose.			65							40' : Fines content (%)=89.5
45		8 8 8	100	Becomes medium dense. Becomes wet.										
				Stiff, moist, light brown to gray, low plastic	582.8 49.5									

Completion Depth: 60.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 55.5 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

URS

LOG of BORING No. B-13-12

STARTED 8/5/13
COMPLETED 8/5/13
LOCATION Danville, IL
SURFACE EL., FT 632.3
EL. DATUM NAVD 88
NORTHING 1280716.74
EASTING 1148877.46
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
50		6 6 7	100	CLAY (CL), trace silt.			20				2.5 1.75 2.25			
55		10 10 12	100	Medium dense, wet, light brown, coarse to fine SAND (SP), trace silt.	576.8 55.5									
60		50/6"	0	Very dense, wet, coarse SAND to coarse GRAVEL (SP-GP).	572.3 60.0									
				Bottom of boring at 60.5'	571.8 60.5									
65														
70														

Completion Depth: 60.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 55.5 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-13

STARTED: 8/5/13
COMPLETED: 8/5/13
LOCATION: Danville, IL
SURFACE EL., FT: 633.3
EL. DATUM: NAVD 88
NORTHING: 1280751.58
EASTING: 1148882.38
N, E DATUM: IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0		4 4 7	89	Stiff, dry, light brown, low plastic CLAY (CL), trace medium to fine sand. [FILL]							3.0			
		11 13 15	100	Becomes very stiff.			7		24	10	3.5			
5		7 9 10	89	Trace fly ash.			13				3.0 >4.0			
		16 20 32	0	Becomes hard.										7.5' to 12' : Driving through limestone gravel.
10		6 11 14	28	Becomes very stiff.			10							
				Dense, dry, dark gray, BOTTOM ASH and FLYASH, with limestone gravel. [FILL]	620.3 13.0									
15		19 19 24	56				6							15' : Fines content (%)=17.9
20		11 10 12	0											
				Medium dense, moist, gray, FLY ASH, trace fine bottom ash. [FILL]	610.3 23.0									

Completion Depth: 71.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 56 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-13

STARTED 8/5/13
COMPLETED 8/5/13
LOCATION Danville, IL
SURFACE EL., FT 633.3 EL. DATUM NAVD 88 N, E DATUM IL CS, East Zone
NORTHING 1280751.58
EASTING 1148882.38

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25		5 5 6	94				41							25' : Fines content (%)=79.3
30		18 22 10	100	Becomes dense.										
				Becomes medium dense, wet.										
35		2 3 6	100	Becomes loose.										
40		2 4 5	94	Becomes moist, trace coarse to fine bottom ash.										
45		5 6 3	100											

Completion Depth: 71.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 56 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-13

STARTED 8/5/13
COMPLETED 8/5/13
LOCATION Danville, IL
SURFACE EL., FT 633.3
EL. DATUM NAVD 88
NORTHING 1280751.58
EASTING 1148882.38
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
50		3 4 5	100		582.8		19				2.5 2.0			
				Medium stiff, moist, gray, low plastic, silty CLAY (CL). [ALLUVIAL]	50.5									
55					577.3									
				Dense, wet, light brown, poorly graded, coarse to fine SAND (SP). [ALLUVIAL]	56.0									
60		14 17 40	100		572.3									
				Hard, moist, light gray, SILT (ML), trace fine sand. [OUTWASH]	61.0									
65					568.3									
				Very stiff, moist, light gray, medium plastic CLAY (CL), trace coarse to medium sand. [TILL]	65.0									
70		35 50/6"			563.3									
				Very dense, wet, light gray, gravelly, silty, fine SAND (SM), trace clay.	70.0		11							70' : Fines content (%)=23.6
					561.8									
				Bottom of boring at 71.5'	71.5									70' : Auger refusal.

Completion Depth: 71.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 56 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-14

STARTED 7/24/13
COMPLETED 7/24/13
LOCATION Danville, IL
SURFACE EL., FT 592.6
EL. DATUM NAVD 88
NORTHING 1280854.70
EASTING 1148991.34
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0		4 4 5	100	Medium stiff to stif, dry, silty CLAY (CL). [FILL]							2.0			
		2 4 4	89		589.6 / 3.0		17				2.0 4.0			
				Medium stiff to stiff, moist, silty CLAY (CL), trace medium to fine sand.										
5		3 6 6	100				15				3.0 >4.0			
				Becomes stiff, dark gray. [ALLUVIAL]										
		4 4 4	100		584.6 / 8.0									
				Loose, light brown, moist, fine, silty SAND (SM). [ALLUVIAL]										
10		2 7 6	100	Medium dense, moist, brown, fine sandy SILT (ML). [ALLUVIAL]	582.6 / 10.0									
				Medium dense, moist, brown, poorly graded, medium to fine, silty SAND (SM). [ALLUVIAL] ▽	581.6 / 11.0									
15		7 17 9	67		577.1 / 15.5		9							15' : Fines content (%)=8.5
				Medium dense, wet, brown, poorly graded, coarse to fine SAND with SILT (SP-SM).										
				Stiff, wet, gray, low plastic CLAY (CL), coarse to fine sand trace. [ALLUVIAL]	574.1 / 18.5									
20		4 6 7	100				11		23	11				
				Hard, moist, gray, coarse to fine sandy CLAY (CL). [TILL]	569.6 / 23.0									

Completion Depth: 42.0 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 13 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-14

STARTED 7/24/13
COMPLETED 7/24/13
LOCATION Danville, IL
SURFACE EL., FT 592.6
EL. DATUM NAVD 88
NORTHING 1280854.70
EASTING 1148991.34
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25		14 13 22	100				10				>4.0			
30		3 7 10	100	Becomes very stiff.			11		24	11				
35		7 13 16	100											
				Dense, wet, light brown, poorly graded, medium to fine SAND (SP), trace silt. [OUTWASH]	556.6 36.0									
40		22 20 24		Hard, moist, gray, high plastic CLAY (CH). [TILL]	552.6 40.0		19				>4.0			
				Bottom of boring at 42'	550.6 42.0									42' : Auger refusal in shale.
45														

Completion Depth: 42.0 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.

Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 13 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

URS

LOG of BORING No. B-13-15

STARTED 7/29/13
COMPLETED 7/29/13
LOCATION Danville, IL
SURFACE EL., FT 635.0
EL. DATUM NAVD 88
NORTHING 1280663.39
EASTING 1149166.89
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0		4 6 17	72	Very stiff, dry, brown to gray, low plastic, silty CLAY (CL), trace fine gravel. [FILL]							4.0			
		5 6 5	89	Becomes stiff.			16				4.0			0-5' : cap
5		P	83					124						
				Medium dense, dry, gray, FLY ASH. [FILL]	629.0 6.0		15	133	33	17				6.15' : TX CID C'=0; phi'=42
		6 8 8	100											
10		2 1 2	100	Becomes very loose			38							10' : Fines content (%)=96.7
15		P	100				35 27 31	89 105 106						15.6' : TX CID C'=39 psf; phi'=35.3 15.9' : Fines content (%)=94.0
20		2 2 2	100	Becomes loose, 1" coarse to fine bottom ash seams.										
				Loose, moist, gray, 75 % FLY ASH, 25% coarse to fine bottom ash. [FILL]	611.5 23.5									

Completion Depth: 86.0 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 43.5 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

11/21/13 URS GEOTECH TEMPLATE (LAB STRENGTH-TXUU) Y:\GINT\PROJECTS\DYNERG-VERMILLION_21562906.GPJ URS_STL.GLB

URS

STARTED 7/29/13
COMPLETED 7/29/13
LOCATION Danville, IL

LOG of BORING No. B-13-15

NORTHING 1280663.39
EASTING 1149166.89
SURFACE EL., FT 635.0 EL. DATUM NAVD 88 N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25		2 3 2	100											
30		7 10 9	100	Becomes medium dense. 75% to 80% fly ash 25% to 20% bottom ash			33							30' : Fines content (%)=71.6
35		3 8 8	100	Trace medium to fine bottom ash .										
40		4 11 12	100	2" wet zone.										41' : Perched water level.
				Becomes wet, very loose. ▽										
45		1 0 1	100											

Completion Depth: 86.0 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.

Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 43.5 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

URS

LOG of BORING No. B-13-15

STARTED 7/29/13
COMPLETED 7/29/13
LOCATION Danville, IL
SURFACE EL., FT 635.0
EL. DATUM NAVD 88
NORTHING 1280663.39
EASTING 1149166.89
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
50		2 2 2	100	Very loose to loose.			78							50' : Fines content (%)=93.4
				Stiff, moist, mottled brown to gray, medium plastic CLAY (CL), trace silt. [ALLUVIUM]	582.0 53.0									
55		4 6 6	100				22				4 2.5 3.5			
60		7 7 15	100	Stiff to very stiff, moist, medium plastic CLAY (CL), trace medium to fine sand. [TILL] 2" coarse sand to medium gravel layer.	575.0 60.0						4.0			
				Medium dense, wet, gray, fine to medium SAND (SP), trace silt. [OUTWASH]	573.5 61.5									
				Very stiff, moist, gray, medium plastic CLAY (CL), trace silt and medium to coarse sand. [TILL]	572.0 63.0									
65		7 11 14	100								4.5			
70														

Completion Depth: 86.0 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 43.5 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

URS

LOG of BORING No. B-13-15

STARTED 7/29/13
COMPLETED 7/29/13
LOCATION Danville, IL
SURFACE EL., FT 635.0
EL. DATUM NAVD 88
NORTHING 1280663.39
EASTING 1149166.89
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
75		8 10 14	89				11				4.5			
80														
85		11 50	83	SHALE: Weathered, gray.	549.0 86.0									
				Bottom of boring at 86'										86' : Auger refusal.
90														
95														

Completion Depth: 86.0 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 43.5 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-16

STARTED 7/30/13
COMPLETED 7/31/13
LOCATION Danville, IL
SURFACE EL., FT 634.6
EL. DATUM NAVD 88
NORTHING 1280698.03
EASTING 1149169.68
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0		4 6 7	89	Stiff, dry, light brown, low plastic CLAY (CL), trace coarse to fine sand. [FILL]							3.5			
		7 9 9	89				10				3.0			
5		4 2 3	78	Becomes medium stiff, moist.			15				1.5			
		4 5 3	100	Loose, moist, gray FLY ASH, trace bottom ash. [FILL]	626.6 / 8.0									
10		1 0 0	100	Becomes very loose, wet.										
15		P	13	Trace clay.										Sample put in jar.
20		P	33	No trace clay.										
		1 0 0	100	Becomes saturated.										23' : Perched water

Completion Depth: 81.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 60 ft., After ATD hrs.
56.4 ft., After 1 hr. hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-16

STARTED 7/30/13
COMPLETED 7/31/13
LOCATION Danville, IL
SURFACE EL., FT 634.6 EL. DATUM NAVD 88 N, E DATUM IL CS, East Zone
NORTHING 1280698.03
EASTING 1149169.68

DEPTH, ft.	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25	1 1 0	100										
30	5 6 11	100	Medium dense, moist, dark gray, 75% FLY ASH; 25% medium to fine bottom ash. [FILL]	604.6 / 30.0								
35	4 12 5	100	90% fly ash; 10% medium to fine bottom ash.		51							35' : Fines content (%)=96.1
			Dense, dry, dark gray FLY ASH, trace fine bottom ash. [FILL]	595.6 / 39.0								
40	29 19 15	100										
			Becomes medium dense, moist with wet seams.									
45	1 4 6	100										

Completion Depth: 81.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen
Water Depth: 60 ft., After ATD hrs.
56.4 ft., After 1 hr. hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-16

STARTED 7/30/13
COMPLETED 7/31/13
LOCATION Danville, IL
SURFACE EL., FT 634.6
EL. DATUM NAVD 88
NORTHING 1280698.03
EASTING 1149169.68
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
50		3 3 7	100								2.0			
				Medium stiff, moist, gray, low plastic CLAY (CL). [ALLUVIAL]	583.6 / 51.0									
				Becomes loose, mottled, light gray to brown.										
55		3 3 3	100				17		29	12	2.0 1.0			
60		1 0 0	56	Very loose, saturated, coarse to fine sandy SILT (ML).	574.6 / 60.0		29							60' : Fines content (%)=17.4 Added water into the augers.
65														
				Becomes medium dense.										
70		9 18 13	89											
				Hard, moist, gray low plastic CLAY (CL), trace coarse to fine sand. [TILL]	563.1 / 71.5									

Completion Depth: 81.5 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.
Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 60 ft., After ATD hrs.
56.4 ft., After 1 hr. hrs.
ft., After hrs.
Logged by: Tim Hicks

URS

LOG of BORING No. B-13-16

STARTED: 7/30/13
COMPLETED: 7/31/13
LOCATION: Danville, IL
SURFACE EL., FT: 634.6
EL. DATUM: NAVD 88
NORTHING: 1280698.03
EASTING: 1149169.68
N, E DATUM: IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
75														
80		36 44 30	0	Bottom of boring at 81.5'	553.1 81.5									80' : Auger refusal. 80.5' : Dark gray, weathered shale in SPT shoe.
85														
90														
95														

Completion Depth: 81.5 feet	Drilling Equipment: D-50 ATV	Water Depth: 60 ft., After ATD hrs.
Project No.: 21562906	Drilling Method: HSA (3.25" ID, 7.00" OD)	56.4 ft., After 1 hr. hrs.
Project Name: Dynergy- Vermilion	Hammer Type: Automatic	ft., After hrs.
Drilling Contractor: MET, Inc.	Driller's Name: Zack Wilcoxen	Logged by: Tim Hicks

LOG of BORING No. B-13-17

STARTED 7/29/13
COMPLETED 7/29/13
LOCATION Danville, IL
SURFACE EL., FT 590.0
EL. DATUM NAVD 88
NORTHING 1280850.61
EASTING 1149176.76
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
0		2 2 2	67	Soft, moist, light brown, low plastic, silty CLAY (CL). [FILL]										
				Soft, moist, gray to light brown, low plastic, sIlty CLAY (CL), trace medium to fine sand. [ALLUVIUM]	588.5 / 1.5									
		P	83				27 37 37 37	95 108 93 98	44	9	1.0			6.15' : TX CD C=0; phi=41.3
5		2 3 3	78	Becomes medium dense.			19				1.0			
		5 5 4	100											
				Loose, moist, brown, fine, clayey SAND (SC), trace silt. [ALLUVIAL]	582.0 / 8.0									
10		4 3 3	100				18							10' : Fines content (%)=17.2
				Loose, wet, brown, medium to fine, silty SAND ▽ (SM).	579.5 / 10.5									
15		4 7 9	94	Stiff to very stiff, moist, dark gray, silty CLAY (CL), trace medium sand. [TILL]	575.0 / 15.0		10				4.0 >4.0			
20		8 11 11	100	1" thick coarse to medium sand seam. Becomes very stiff.			10				>4.5 >4.0			

Completion Depth: 40.7 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.

Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 11 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

LOG of BORING No. B-13-17

STARTED 7/29/13
COMPLETED 7/29/13
LOCATION Danville, IL
SURFACE EL., FT 590.0
EL. DATUM NAVD 88
NORTHING 1280850.61
EASTING 1149176.76
N, E DATUM IL CS, East Zone

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	NMC, %	γ_t, PCF	LL	PI	PP Su, KSF	TV Su, KSF	TXUU Su, KSF	NOTES
25		16 21 21	0	Becomes hard.										
30		6 9 11	100	Coarse to fine sand.			11				4.0 >4.0			
35		8 15 20	89	Dense, wet, dark gray, medium to fine clayey SAND (SC). [TILL]	554.8 35.3									
40		32 50/2.5"	82	Very dense, wet, brown, medium to fine, silty SAND (SM). [OUTWASH]	549.5 40.5									40.5' : Auger refusal.
				Gray SHALE.	549.3 40.7									
				Bottom of boring at 40.7'										
45														

Completion Depth: 40.7 feet
Project No.: 21562906
Project Name: Dynergy- Vermilion
Drilling Contractor: MET, Inc.

Drilling Equipment: D-50 ATV
Drilling Method: HSA (3.25" ID, 7.00" OD)
Hammer Type: Automatic
Driller's Name: Zack Wilcoxen

Water Depth: 11 ft., After ATD hrs.
ft., After hrs.
ft., After hrs.
Logged by: Tim Hicks

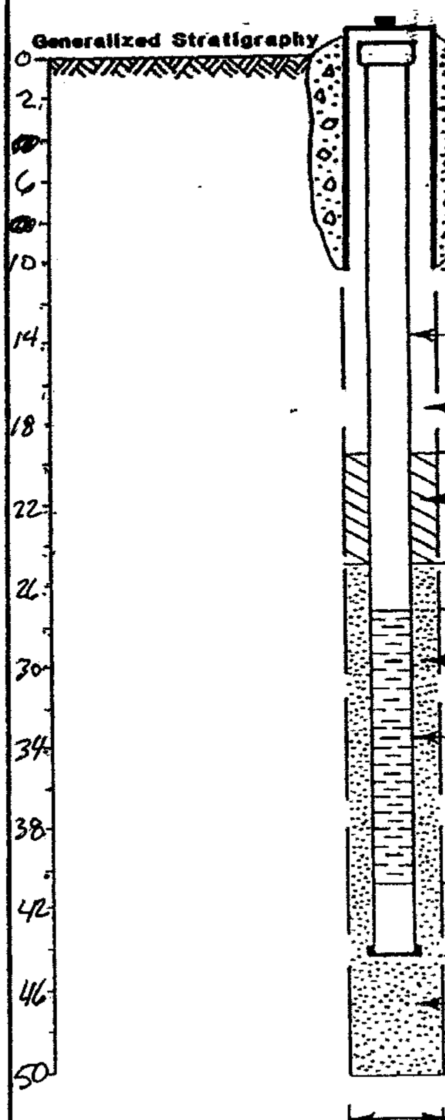
URS

GROUND WATER OBSERVATION WELL REPORT

Project Name DYNEGY VERMILLION
Location DANVILLE, IL
Installed by ZACH WILCOXEN (MET)
Inspected by TIM HICKS
Method of Installation HSA BOREHOLE
Remarks

Piez./Well No. B-13-3
Project No. 21562906
Date 8-6-13
Time 1440

Generalized Stratigraphy



Ground Elevation 0

I.D./Type of surface casing —

Type of surface seal —

Depth of surface seal —

I.D./Type of riser pipe —

Type of backfill

Elev./Depth of top of seal —

Type of seal BENTONITE PLUG

Elev./Depth of top of filter pack 20ft

Elev./Depth of top of screen —

Type of filter pack SAND

I.D./Type of screen —

Screen slot size —

Elev./Depth of bottom of ~~screen~~ PIEZO 42ft

Elev./Depth of bottom of plugged blank section —

Type of backfill below observation well SAND

Elev./Depth of bottom of boring 50ft

Diameter of boring 7 3/4"

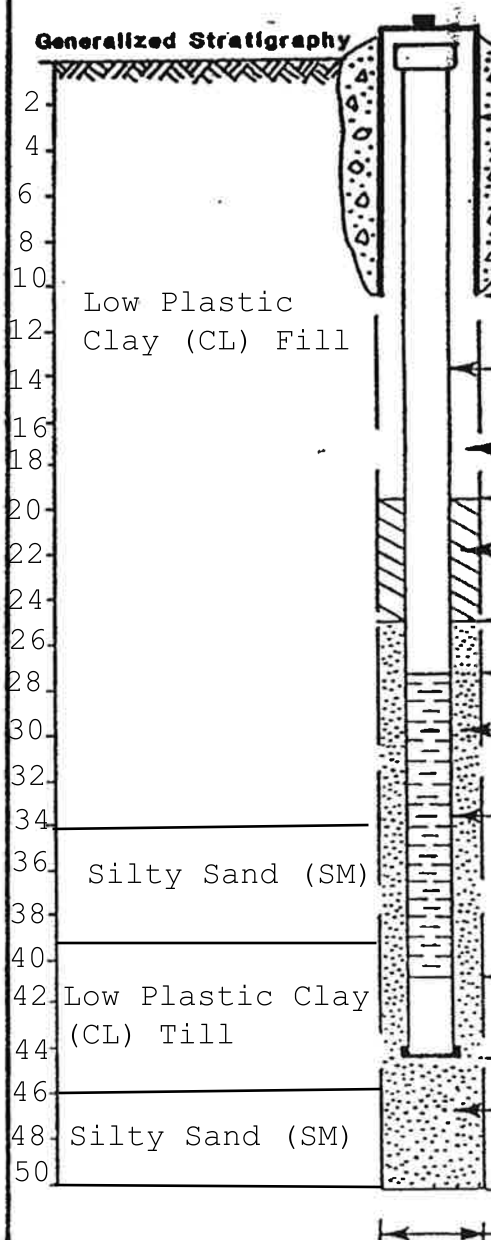
Woodward-Clyde Consultants

Fig.

GROUND WATER OBSERVATION WELL REPORT

Project Name: Dynegy - Vermillion
Location: Danville, IL
Installed by: Zach Wilcoxen (MET)
Inspected by: Tim Hicks (URS)
Method of Installation: HSA Borehole
Remarks: Vibrating Wire Piezometer

Piez./Well No.: B-13-06
Project No.: 21562906
Date: 8/7/2013
Time: 1332 to 1350



Ground Elevation: 0
I.D./Type of surface casing: ----
Type of surface seal: Grout
Depth of surface seal: ----
I.D./Type of riser pipe: ----
Type of backfill: Grout
Elev./Depth of top of seal: 10ft
Type of seal: Bentonite
Elev./Depth of top of filter pack: 20 ft
Elev./Depth of top of screen: ----
Type of filter pack: Sand
I.D./Type of screen: ----
Screen slot size: ----
Elev./Depth of bottom of ~~screen~~ - Piezo.: 40 ft
Elev./Depth of bottom of plugged blank section: ----
Type of backfill below observation well: Sand
Elev./Depth of bottom of boring: 50.25ft
Diameter of boring: 7 3/4 in

Woodward-Clyde Consultants

Fig. ______

GROUND WATER OBSERVATION WELL REPORT

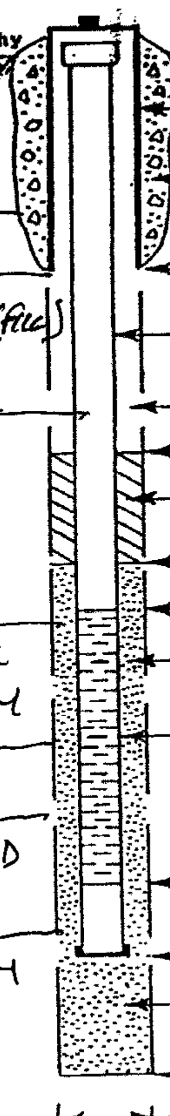
Project Name: DYNEGY - VERMILLION	Piez./Well No. B-13-9
Location: DANVILLE, IL	Project No. 21562906
Installed by: ZACH WILCAKEN (MET)	Date: 8-1-13
Inspected by: TIM HICKS (URS)	Time: 1345 TO 1600 HRS

Method of Installation: HSA BOREHOLE

Remarks: VIBRATING WIRE PIEZOMETER

Generalized Stratigraphy

Depth	Stratigraphy
3	low Plastic CLAY (CL) (FILL)
9	
15	Fly ASH
21	low Plastic CLAY (CL) (fill)
27	Fly ASH
33	
39	
45	low PLASTIC SANDY CLAY (CL)
51	
57	C-F SAND
63	clayey SAND (SP/SC)
69	Sand CLAY (CL)
75	80ft



Item	Value
Ground Elevation	0
I.D./Type of surface casing	—
Type of surface seal	GROUT
Depth of surface seal	~~GROUT~~
I.D./Type of riser pipe	—
Type of backfill	GROUT
Elev./Depth of top of seal	40ft
Type of seal	BENTONITE
Elev./Depth of top of filter pack	50ft
Elev./Depth of top of screen	—
Type of filter pack	SAND
I.D./Type of screen	—
Screen slot size	—
Elev./Depth of bottom ~~of screen~~ OF PIEZO	70ft
Elev./Depth of bottom of plugged blank section	—
Type of backfill below observation well	SAND
Elev./Depth of bottom of boring	80ft
Diameter of boring	7 3/4"

Woodward-Clyde Consultants

Fig.

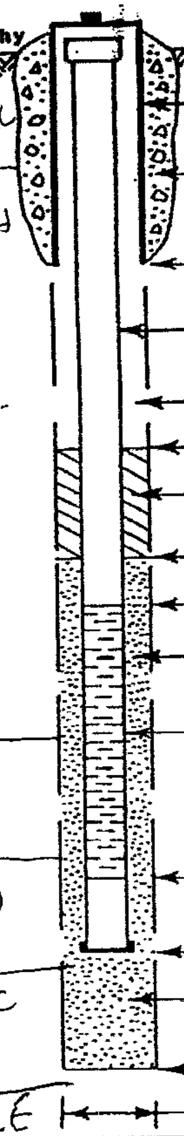
GROUND WATER OBSERVATION WELL REPORT

Project Name: DYNEGY VERMILLION
Location: DANVILLE, IL
Installed by: Z. WILCOXEN (MET)
Inspected by: TIM HICKS
Method of Installation: VIBRATING WIRE PIEZOMETER
Remarks:

Piez./Well No. B-13-16
Project No. 21562906
Date 7/31/13
Time 10:00 AM – 6:40 pm

Generalized Stratigraphy

Depth	Stratigraphy
3	low Plastic CLAY (CL) FILL
9	Fly ASH BOTTOM ASH
15	
21	
27	
33	
39	
45	
51	low PLASTIC CLAY (CL)
57	
63	SAND (SP)
69	low PLASTIC CLAY
75	
80	SHALE



Ground Elevation ____
I.D./Type of surface casing ____
Type of surface seal ____
Depth of surface seal 0
I.D./Type of riser pipe ____
Type of backfill QUICK-GROUT
Elev./Depth of top of seal 37.0 FT
Type of seal BENTONITE PELLETS
Elev./Depth of top of filter pack 45.0 FT
Elev./Depth of top of screen ____
Type of filter pack SAND
I.D./Type of screen ____
Screen slot size ____
Elev./Depth of bottom of screen ____
Elev./Depth of bottom of ~~plugged blank section~~ PIEZOMETER 68.2 Ft
Type of backfill below observation well SAND
Elev./Depth of bottom of boring 80.0 Ft
Diameter of boring 7 3/4"

Woodward-Clyde Consultants

Fig. ____

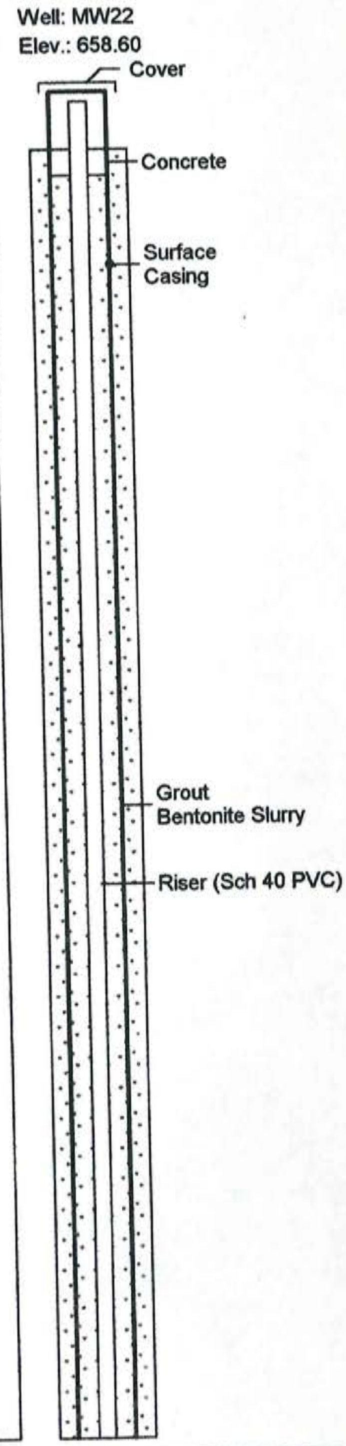
KELRON Environmental	LOG OF BORING MW22 (Page 1 of 2)

East Ash Pond Hydrogeologic Investigation
Vermilion Power Station
Dynegy Midwest Generation, Inc.

Location: Twp 20N, Rng 12W, 20 SW/NE/SE

Date Completed	: 11/30/2001	Driller	: Dusty Jackson
Hole Diameter	: 4 1/2; 2 1/2 inches	Geologist	: Eric Kovatch (NRT)
Drilling Method	: Rotary	Land Surface Elevation	: 655.6
Sampling Method	: HQ Core (2.5 inch)	Top of Casing Elevation	: 658.60
Drilling Company	: Mid-America Drilling, Inc.	X,Y Coordinates	: 1150083,1279669

Depth in Feet	DESCRIPTION	Surf. Elev. 655.6	Samples	Recovery inches	Blow Count	Qp TSF	USCS	GRAPHIC
0		655						
5	Blind Drill to 70.5 feet - see log of Well MW10	650						
10	Surface Casing = 4.3 I.D. / 4.5 inch O.D. Installed to 70 feet below ground	645						
15		640						
20		635						
25		630						
30		625						
35		620						
40		615						
45		610						
50								



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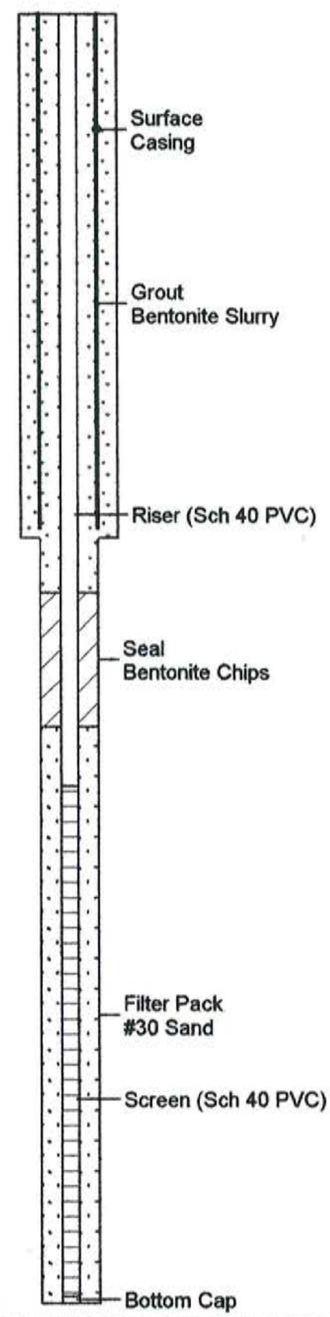
KELRON Environmental	LOG OF BORING MW22 (Page 2 of 2)

East Ash Pond Hydrogeologic Investigation Vermilion Power Station Dynegy Midwest Generation, Inc. Location: Twp 20N, Rng 12W, 20 SW/NE/SE				
	Date Completed	: 11/30/2001	Driller	: Dusty Jackson
	Hole Diameter	: 4 1/2; 2 1/2 inches	Geologist	: Eric Kovatch (NRT)
	Drilling Method	: Rotary	Land Surface Elevation	: 655.6
	Sampling Method	: HQ Core (2.5 inch)	Top of Casing Elevation	: 658.60
	Drilling Company	: Mid-America Drilling, Inc.	X,Y Coordinates	: 1150083,1279669

Depth in Feet	DESCRIPTION	Surf. Elev. 655.6	Samples	Recovery inches	Blow Count	Qp TSF	USCS	GRAPHIC
50		605						
55		600						
60		595						
65		590						
70	SHALE, bedrock	585						
	HQ Core 1 (70.5-80: 9.5 ft recovery) - weathered, blocky, fissile, soft, dark gray							
75		580	1	114				
	- competent, hard, dark gray; laminated with clay/ silt seams/lenses, <1 to 4 mm, light gray							
80	- seams/lenses of light gray clay/silt from <1 to 11mm	575						
	HQ Core 2 (80-90: 10 ft recovery) - same as above with occasional blue tint, blocky when sheared							
85		570	2	120			SH	
90	- seams/lenses of light gray clay/silt from <1 to 2 cm	565						
	HQ Core 3 (90-100: 10 ft recovery)							
95		560	3	120				
	END BOREHOLE AT 100 FEET BLS							
100								

Well: MW22
Elev.: 658.60



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LOG OF BORING JMA-1

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 654.3 Feet
Date Drilled: 10/29/82
Drilling Contractor: John Mathes & Associates, Inc.
Drilling Method: HA & Rotary Wash
Logged By: John Mathes & Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0			CL	*Gray Silty CLAY with Sand, Trace Gravel*				*10-29-82 at 8:00 a.m., no water in augers.*
650 / 5	4 10 13	31/36						*For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.*
645 / 10				*-Silt Seam 9.0-9.5'*				
	4 7 11	30/36	ML	*Gray SILT with Clay, Trace Sand, Gravel*				
640 / 15			CL	*Gray Silty CLAY with Sand, Trace Gravel*				
	9 12 12	36/36		*-Silt Seam 15.4-16.0'*				
635 / 20		30/36	SM	*Brown Silty Medium SAND with Clay, Trace Gravel*				
630 / 25			SP-SM	*Brown Medium SAND, Trace Silt, Gravel*				
	8 10 8	28/36						
625 / 30								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates, Inc. presented in a report dated April 11, 1983.

GROUNDWATER

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.
Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING JMA-1 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 654.3 Feet

Date Drilled: 10/29/82
Drilling Contractor: John Mathes & Associates, Inc.
Drilling Method: HA & Rotary Wash
Logged By: John Mathes & Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30	9 10 7	28/36		*Brown Medium SAND, Trace Silt, Gravel (continued)*				*For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.*
620 / 35	13 18 15	26/36						*Perched water level in augers at 37.5' with augers at 39.5'.*
615 / 40	3 9 12	32/36	*SP*	*Gray Gravelly SAND*				
610 / 45	28 40 33	4/36	*CL*	*Gray-Brown Silty CLAY with Sand, Trace Gravel*				
605 / 50	12 20 30	36/36						
600 / 55	9 33 41	26/36						
595 / 60								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates, Inc. presented in a report dated April 11, 1983.

GROUNDWATER

Piezometer Installed: No

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A Division of Environmental Operations, Inc.
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LOG OF BORING JMA-1 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 654.3 Feet

Date Drilled: 10/29/82
Drilling Contractor: John Mathes & Associates, Inc.
Drilling Method: HA & Rotary Wash
Logged By: John Mathes & Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
60	13 25 39	32/36		*Gray-Brown Silty CLAY with Sand, Trace Gravel (continued)*				*For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.*
590 / 65	13 28 33	32/36	*ML*	*Gray SILT with Clay, Trace Sand*				
			CL	*Gray Silty CLAY with Sand, Trace Gravel*				
585 / 70	4 13 18	36/36						
580 / 75	4 7 10	36/36						
575 / 80	6 10 13	30/36						
570 / 85	4 7 8	36/36						
565 / 90								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates, Inc. presented in a report dated April 11, 1983.

GROUNDWATER ∇ ▼

Piezometer Installed: No

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LOG OF BORING JMA-1 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 654.3 Feet

Date Drilled: 10/29/82
Drilling Contractor: John Mathes & Associates, Inc.
Drilling Method: HA & Rotary Wash
Logged By: John Mathes & Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
90	6 4 6	36/36		*Gray Silty CLAY with Sand, Trace Gravel (continued)*				*Blow counts are for the first 3 - 6" increments.*
560 / 95	5 5 8	36/36		*-Silt Seam 95.5-96.0'*			*11*	*LL = 22 PL = 11 PI = 11 LL = 17 PL = 11 PI = 6*
555			*SP*	*Gray Fine-Medium SAND, Trace Gravel*				
100	22 50 100/4"	16/16	*SW-SM*	*Gray Medium SAND with Gravel, Trace Silt*				
			CL	*Gray Silty CLAY with Sand, Trace Gravel*				
550 / 105	33 66 100/4"	16/16					*11*	
545 / 110								
540 / 115								
535 / 120				*TD - 119.5 Feet*				

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates, Inc. presented in a report dated April 11, 1983.

GROUNDWATER ∇ ▼

Piezometer Installed: No

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RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeologic Study, Vermilion Power Plant
JOB NO. 82-1292

BORING: JMA-1
SHEET 1 OF 4

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System: Unified; Surface Elevation: 654.3'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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)
0					Gray Silty CLAY w/Sand Trace Gravel, CL			
5	1	SS	36/31	1		4-10-13		
					-Silt Seam 9.0-9.5'			
10	2	SS	36/30	1	Gray SILT w/Clay Trace Sand, Gravel, ML	4-7-11		
					Gray Silty CLAY w/Sand Trace Gravel, CL			
15	3	SS	36/36	1	-Silt Seam 15.4-16.0'	9-12-12		
20	4	SS	36/30	1	Brown Silty Medium SAND w/Clay Trace Gravel, SM			
					Brown Medium SAND Trace Silt, Gravel, SP-SM			
25	5	SS	36/23	1		8-10-8		
30	6	SS	36/28	1		9-10-7		
35	7	SS	36/26	1		13-13-15		

DRILLING METHOD: HA & Rotary Wash
DATE DRILLED: 10-28, 29-82
DRILLED BY: Roberts
LOGGED BY: Maxeiner
PIEZOMETER: Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeologic Study Vermilion Power Plant
JOB NO.: 82-1292
BORING: JMA-1
SHEET 2 OF 4

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System: Unified; Surface Elevation: 654.3'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	Shear Strength, tsf / PL NMC LL / Rock Quality Designation
	7	SS	36/26	1 3	Brown Medium SAND Trace Silt, Gravel, SP-SM	13-18-15		
40	8	SS	36/32	1	Gray Gravelly SAND, SP	3-9-12		
45	9	SS	30/4	2	Gray-Brown Silt CLAY w/Sand Trace Gravel, CL	28-40-33		
50	10	SS	36/36	1		12-20-30		
55	11	SS	36/26	1		9-33-41		
60	12	SS	36/32	1		13-25-39		
65					Gray SILT w/Clay Trace Sand, ML			
	13	SS	36/32	1	Gray Silty CLAY w/Sand Trace Gravel, CL	13-28-33		
70	14	SS	36/36	1		4-13-18		

DRILLING METHOD: HA & Rotary Wash
DATE DRILLED: 10-28, 29-82
DRILLED BY: Roberts
LOGGED BY: Maxeiner
PIEZOMETER: Yes

GROUNDWATER LEVELS

Encountered at - Feet
____ Hours after completion ____ 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.

mathes

John Mathes & Associates, Inc.

RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeologic Study, Vermilion Power Plant
JOB NO.: 82-1292
BORING: JMA-1
SHEET 3 OF 4

Soil Classification System: Unified
Surface Elevation: 654.3'

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	Shear Strength, tsf (SV△, QP/2□, QU/2○); PL, NMC, LL; Rock Quality Designation
	14	SS	36/36	1	Gray Silty CLAY w/Sand Trace Gravel, CL	4-13-18		
75	15	SS	36/36	1		4-7-10		
80	16	SS	30/30	1		6-10-13		
85	17	SS	36/36	4 1		4-7-8		
90	18	SS	36/36	1		6-4-6		
95	19	SS	36/36	1	-Silt Seam 95.5-96.0'	5-5-8		
					Gr Fi-Med SAND Tr Gvl, SP			
100	20	SS	16/16		Gray Medium SAND w/Gravel Trace Silt, SW-SM	22-50-100/4		
					Gray Silty CLAY w/Sand Trace Gravel, CL			
105	21	SS	16/16			33-66-100/4		

DRILLING METHOD: HA & Rotary Wash
DATE DRILLED: 10-28, 29-82
DRILLED BY: Roberts
LOGGED BY: Maxeiner
PIEZOMETER: Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeologic Study, Vermilion Power Plant
BORING: JMA-1
SHEET 4 OF 4
JOB NO. 82-1292

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System: Unified; Surface Elevation: 654.3'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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)
					Gray Silty CLAY w/Sand Trace Gravel, CL			
110								
115								
120					TOB			

REMARKS:
1. Sample Was Driven 36". Blow Counts Are For The First 3-6" Increments.
2. Sample Was Driven 30". Blow Counts Are For The First 3-6" Increments.
3. Perched Water Level In Augers @ 37.5' w/Augers @ 39.5'.
4. 10-29-82 @ 8:00 a.m., No Water In Augers.

DRILLING METHOD: HA & Rotary Wash
DATE DRILLED: 10-28, 29-82
DRILLED BY: Roberts
LOGGED BY: Maxeiner
PIEZOMETER: Yes

GROUNDWATER LEVELS

Encountered at - Feet
____ Hours after completion ____ 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.

mathes

John Mathes & Associates, Inc.

LOG OF BORING JMA-2

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 590.3 Feet
Date Drilled: 11/03/82
Drilling Contractor: John Mathes & Associates, Inc.
Drilling Method: Hollow Auger
Logged By: John Mathes & Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
590 / 0			CL	Brown Silty CLAY				
			ML	Brown Sandy SILT with Clay				
585 / 5	8 14 13	33/36	ML	Brown Clayey SILT with Sand			10	For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.
580 / 10		18/36	SP	Brown Medium SAND with Gravel -Cobbles 12.0-14.0'			11	
575 / 15			SP-SM	Brown Fine-Medium SAND with Silt, Trace Gravel				
	6 13 20	36/36	CL	Gray Silty CLAY with Sand, Sand Seams, Trace Gravel			11	
570 / 20	11 20 27	21/36						
565 / 25	15 20 28	35/36					10	
			SP	Gray Fine-Medium SAND				
30								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates, Inc. presented in a report dated April 11, 1983.

GROUNDWATER

Piezometer Installed: No

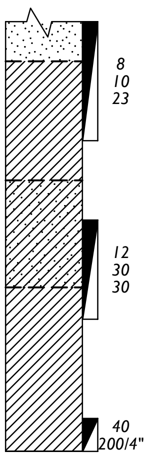
Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING JMA-2 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 590.3 Feet

Date Drilled: 11/03/82
Drilling Contractor: John Mathes & Associates, Inc.
Drilling Method: Hollow Auger
Logged By: John Mathes & Associates, Inc.



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
560 / 30				*Gray Fine-Medium SAND (continued)*				
	8 10 23	34/36	CL	*Gray Silty CLAY with Sand, Trace Gravel*				*For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.*
555 / 35			CL	*Gray Sandy CLAY with Silt, Sand Seams, Trace Gravel*				
	12 30 30	30/30		*-Sand Seam 36.2-36.7'*			10	
			CL	*Gray Silty CLAY with Sand, Trace Gravel*				
550 / 40	40 200/4"	8/10		*-Silt Seam below 40.5'*			20	
				TD - 40.8 Feet				
545 / 45								
540 / 50								
535 / 55								
60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates, Inc. presented in a report dated April 11, 1983.

GROUNDWATER

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study
Vermilion Power Plant
JOB NO. 82-1292

BORING JMA-2
SHEET 1 OF 2

Soil Classification System: Unified
Surface Elevation: 590.3'

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL, Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
0					Brown Silty CLAY, CL		
					Brown Sandy SILT w/Clay, ML		
5	1	SS	36/33	1	Brown Clayey SILT w/Sand, ML	8-14-13	
10					Brown Medium SAND w/Gravel, SP		
	2	SS	36/18	1	-Cobbles 12.0 - 14.0'		
15					Br Fi-Med SAND w/Si Tr Gvl, SP-SM		
	3	SS	36/36	1	Gray Silty CLAY w/Sand, Sand Seams Trace Gravel, CL	6-13-20	
20	4	SS	36/21	1		11-20-27	
25	5	SS	36/35	1		15-20-28	
					Gray Fine-Medium SAND, SP		
30	6	SS	36/34	1	Gray Silty CLAY w/Sand Trace Gravel, CL	8-10-23	
35	7	SS	30/30	2	Gray Sandy CLAY w/Silt, Sand Seams, Trace Gravel, CL	12-30-30	

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 11-3-82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at ____ Feet
____ Hours after completion ____ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeology Study
Vermilion Power Plant
JOB NO. 82-1292

BORING JMA-2
SHEET 2 OF 2

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified; Surface Elevation 590.3'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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
					Gr Sa CL w/Si, SA Seams Tr, Gvl, CL-Sand Seam 36.2-36.7			
	7	SS	30/30	2	Gray Silty CLAY w/Sand Trace Gravel, CL	12-30-30		
40	8	SS	10/8		-Silt Seam Below 40.5'	40-200/4"		
					TOB			
45								

REMARKS:
1. Sample Was Driven 36". Blow Counts Are For The First 3-6" Increments.
2. Sample Was Driven 30". Blow Counts Are For The First 3-6" Increments.

DRILLING METHOD Hollow Auger
DATE DRILLED 11-3-82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at ______ Feet
____ Hours after completion ____ 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.

LOG OF BORING VAMW-3R

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 587.8 Feet

Date Drilled: 12/07/93
Drilling Contractor: Whitney & Associates
Drilling Method: Hollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0–10			SM	*Grayish Brown to Brown Fine SAND and SILT, Loose, Dry to Moist by 4'* *-Becoming Wet*				*Blow counts are for 12" intervals unless otherwise noted.*
10–16	0	14/24	SP	*Grayish Brown Fine SAND, Very Loose, Saturated, No Odor, No Visible Contaminants*				
15–18	7 23	14/24	GP	*Gravel and SAND Mix*				
18–20			CH	*CLAY*				
20–28	18 6/6"	19/24	ML	*Gray to Light Grayish Brown SILT, Stiff, Grades to Silty Clay in Parts, Very Thin Sand Interbeds*				
25	19 19	17/24						
28–29			SP	*SAND and GRAVEL, Small Sulfur Pocket at 28'*				
29–30			CH					

Elevation scale: 585, 580, 575, 570, 565, 560. Depth scale: 0, 5, 10, 15, 20, 25, 30.

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1994.

GROUNDWATER

▽ First Observed During Drilling - 5.2 Feet
▼

Piezometer Installed: No

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A Division of Environmental Operations, Inc.

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Illinois (618) 398-1414

LOG OF BORING VAMW-3R (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 587.8 Feet

Date Drilled: 12/07/93
Drilling Contractor: Whitney & Associates
Drilling Method: Hollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30				*CLAY* *CLAY (continued)*				
555			*SP*	*Fine SAND and GRAVEL*				
35								
				TD - 36.5 Feet				
550								
40								
545								
45								
540								
50								
535								
55								
530								
60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1994.

GROUNDWATER

∇ First Observed During Drilling - 5.2 Feet

▼

Piezometer Installed: No

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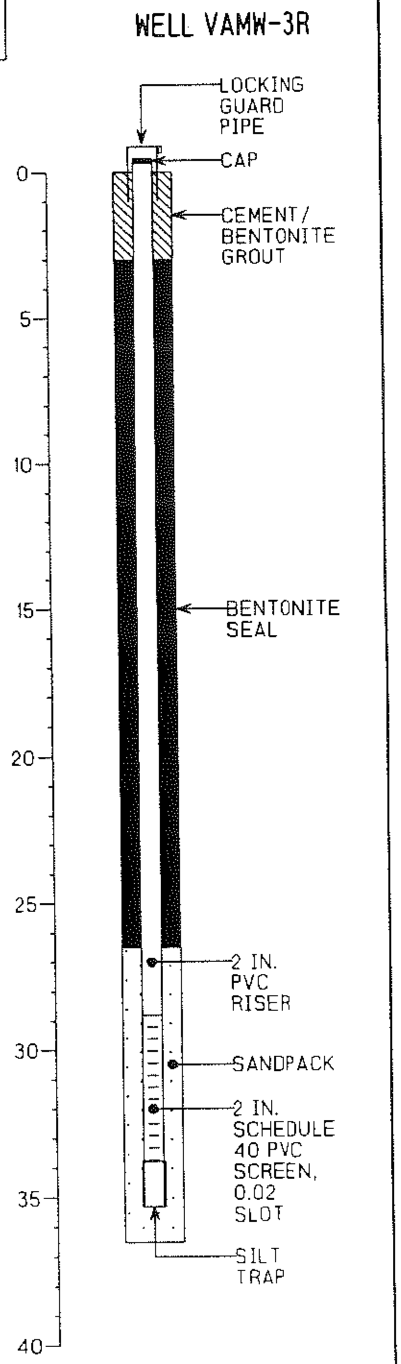
BORING VAMW-3R

PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/7/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: PAUL MAYWOOD
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 5.2 FEET
DATUM: MSL
LOCATION: STATION E

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION color, density, SOIL,admixture, moisture, other notes, ORIGIN	MOISTURE CONTENT (DRY / MOIST / WET)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)
			Grayish brown to brown fine SAND and SILT, loose, dry to moist by 4				
			becoming wet				
10-12	0	60	Grayish brown fine SAND, very loose, saturated, no odor, no visible contaminants.				
15-17	?,23	60	GRAVEL and SAND mix.				
			CLAY.				
20-22	18,6 (6")	80	Gray to light grayish brown SILT, stiff, grades to silty clay in parts, very thin sand interbeds.				
25-27	19,19	70					
			SAND and GRAVEL, small sulfur pocket at 28				
			CLAY				
			Fine SAND and GRAVEL				
			TD 36.5				

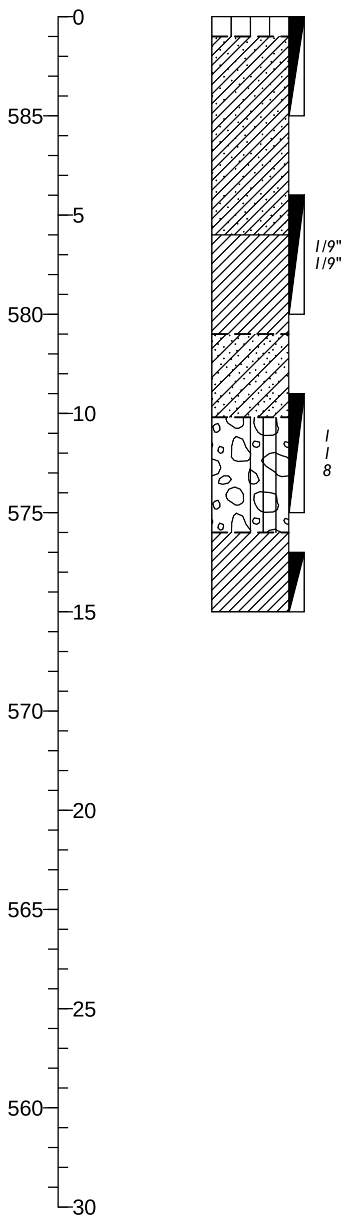
WELL CONSTRUCTION



LOG OF BORING JMA-4

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 587.5 Feet

Date Drilled: 11/04/82
Drilling Contractor: John Mathes & Associates, Inc.
Drilling Method: Hollow Auger
Logged By: John Mathes & Associates, Inc.



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
			ML	*Dark Gray Clayey SILT with Sand*				
		30/30	CL	*Red-Brown Sandy CLAY with Silt*			*15*	*Split spoon pushed from 0 to 2.5 feet.*
							23	
		32/36	CL	*Gray-Brown Silty CLAY with Sand*			*24*	*For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments. Gravelly drilling 8.0 to 9.0 feet.*
			SC	*Brown Fine SAND with Gravel, Trace Clay*				
		20/36	GP-GM	*Brown Sandy GRAVEL Trace Silt*				
				-Gravelly at 12.5'				
		12/18	CL	*Gray Silty CLAY with Sand Trace Gravel*			*12*	
				TD - 15.0 Feet				

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates, Inc. presented in a report dated April 11, 1983.

GROUNDWATER

Piezometer Installed: No

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RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeologic Study, Vermilion Power Plant
JOB NO.: 82-1292

BORING: JMA-4
SHEET 1 OF 1

Soil Classification System: Unified
Surface Elevation: 587.5'

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					~~Dark Gray Clayey SILT w/Sand, ML~~	Pushed	
	1	SS	30/30	1	Red-Brown Sandy CLAY w/Silt, CL		
5					Gray-Brown Silty CLAY w/Sand, CL	1/9"-1/9"	
	2	SS	36/32	2			
				3	Brown Fine SAND w/Gravel, Trace Clay, SC		
10					Brown Sandy GRAVEL Trace Silt, GP-GM	1-1-8	
	3	SS	36/20	2			
					Gray Silty CLAY w/Sand Trace Gravel, CL		
	4	SS	18/12		TOB		
15							
20							
25							
30							
35							

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)

REMARKS:
1. Sample Was Driven 30". Blow Counts Are For The First 3-6" Increments.
2. Sample Was Driven 36". Blow Counts Are For The First 3-6" Increments.
3. Gravelly Drilling 8.0-9.0'

DRILLING METHOD: Hollow Auger
DATE DRILLED: 11-4-82
DRILLED BY: Roberts
LOGGED BY: Maxeiner
PIEZOMETER: Yes

GROUNDWATER LEVELS
Encountered at ____
____ Hours after completion ____
____ after completion ____
____ after completion ____

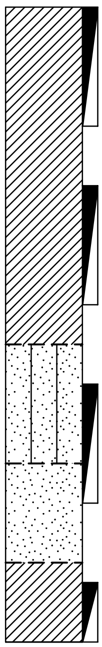
NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.

John Mathes & Associates, Inc.

LOG OF BORING JMA-5

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 592.3 Feet

Date Drilled: 11/04/82
Drilling Contractor: John Mathes & Associates, Inc.
Drilling Method: Hollow Auger
Logged By: John Mathes & Associates, Inc.



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
592.3 / 0		32/36	CL	*Dark Gray Silty CLAY with Sand*			15	*Split spoon pushed from 0 to 3.0 feet.*
5	4, 6, 8	32/36					20	*For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.*
			SM	*Brown Fine SAND Trace Silt*				
10	WH, 1, 2	24/36					22	
			SP	*Brown Fine-Medium SAND* *-Gravelly at 12.5'*				
			CL	*Gray Silty CLAY with Sand, Trace Gravel*				
15	1, 6, 11	11/18					12	
				TD - 16.0 Feet				

Elevation scale: 590, 585, 580, 575, 570, 565; Depth scale: 0, 5, 10, 15, 20, 25, 30

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates, Inc. presented in a report dated April 11, 1983.

GROUNDWATER

Piezometer Installed: No

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RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeologic Study, Vermilion Power Plant
BORING: JMA-5
SHEET 1 OF 1
JOB NO.: 82-1292

Soil Classification System: Unified
Surface Elevation: 592.3'

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
	1	SS	36/32	1	Dark Gray Silty CLAY w/Sand, CL	Pushed	
5	2	SS	36/32	1		4-6-8	
					Brown Fine SAND Trace Silt, SM		
10	3	SS	36/24	1, 2	Brown Fine-Medium SAND, SP	WH-1-2	
15	4	SS	18/11		Gray Silty CLAY w/Sand Trace Gravel, CL	1-6-11	
					TOB		
20							
25							
30							
35							

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)

REMARKS:
1. Sample Was Driven 36". Blow Counts Are For The First 3-6" Increments.
2. Gravelly @ 12.5'

DRILLING METHOD: Hollow Auger
DATE DRILLED: 11-4-82
DRILLED BY: Roberts
LOGGED BY: Maxeiner
PIEZOMETER: Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ 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.

mathes

John Mathes & Associates, Inc.

LOG OF BORING JMA-6

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 589.5 Feet

Date Drilled: 11/10/82
Drilling Contractor: John Mathes & Associates, Inc.
Drilling Method: Hollow Auger
Logged By: John Mathes & Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0		27/36	CL	Dark Gray-Brown Silty CLAY with Sand -Roots to 0.6' -Root Holes to 1.7'			24	Split spoon pushed from 0 to 3.0 feet.
585 / 5	2 3 2	25/36	ML	Brown Sandy SILT, Trace Clay			20	For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.
	3 6 12	29/36	SM	Gray-Brown Medium SAND with Gravel, Silt				
580 / 10	6 12 17	27/36						
	4 11 18	22/30	GP-GM	Gray Sandy GRAVEL Trace Silt				
575 / 15	10 18 13	2/30	CL	Gray Silty CLAY with Sand, Gravel				
		25/30	SP-SM	Gray-Brown Fine-Medium SAND with Gravel, Trace Silt				
570 / 20	7 5 8	27/30						
	3 6 9	20/30						
565 / 25	7 7 9	22/30		-Silt Seam 27.8-28.7'				
	2 7 10	22/30						
560 / 30			CL	Gray Silty CLAY with Sand, Trace Gravel				

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates, Inc. presented in a report dated April 11, 1983.

GROUNDWATER

Piezometer Installed: No

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LOG OF BORING JMA-6 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 589.5 Feet

Date Drilled: 11/10/82
Drilling Contractor: John Mathes & Associates, Inc.
Drilling Method: Hollow Auger
Logged By: John Mathes & Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30	2 6 8	24/30		*Gray Silty CLAY with Sand, Trace Gravel (continued)*			12	
		41/42					12	
555 / 35								
		63/60						
550 / 40								
		60/60		*-Silt Seam 42.8-43.4'*			21	
				-Organics at 45.0'				
545 / 45								
			SM	*Gray Silty Fine SAND*				
		24/30					17	
			SC	*Gray Fine SAND with Clay*				
			ML	*Gray SILT Trace Clay, Sand*				
540 / 50	14 20 29	36					13	
	14 23 28	26/36					15	
535 / 55				*TD - 54.0 Feet*				
530 / 60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates, Inc. presented in a report dated April 11, 1983.

GROUNDWATER

Piezometer Installed: No

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RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study
Vermilion Power Plant
JOB NO. 82-1292

BORING JMA-6
SHEET 1 OF 2

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified; Surface Elevation 589.5'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
	1	SS	36/27	1	Dark Gray-Brown Silty CLAY w/Sand, CL - Roots to 0.6' - Root Holes to 1.7'	Pushed	
5	2	SS	36/25	1	Brown Sandy SILT Trace Clay, ML	2-3-2	
	3	SS	36/29	1	Gray-brown Medium SAND w/Gravel, Silt, SM	3-6-12	
10	4	SS	36/27	1		6-12-17	
	5	SS	30/22	2	Gray Sandy GRAVEL Trace Silt, GP-GM	4-11-18	
15	6	SS	30/2	2	Gray Silty CLAY w/Sand, Gravel, CL	10-18-13	
	7	SS	30/25	2	Gray-Brown Fine-Medium SAND w/Gravel Trace Silt, SP-SM		
20	8	SS	30/27	2		7-5-8	
	9	SS	30/20	2		3-6-9	
25	10	SS	30/22	2	-Silt Seam 27.8-28.7'	7-7-9	
	11	SS	30/22	2	Gray Silty CLAY w/Sand Trace Gravel, CL	2-7-10	
30	12	SS	30/24	2		2-6-8	
	13	3T	42/41				
35							

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 11-9, 10-82
DRILLED BY Bignall
LOGGED BY Maxeiner
PIEZOMETER None

GROUNDWATER LEVELS

Encountered at - Feet
Hours after completion 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeology Study Vermilion Power Plant
JOB NO. 82-1292

BORING JMA-6
SHEET 2 OF 2

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified; Surface Elevation 589.5'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
	14	3T	60/63		Gray Silty CLAY w/Sand Trace Gravel, CL		
40							
	15	3T	60/60		-Silt Seam 42.8-43.4'		
45					-Organics @ 45.0'		
	16	SS	30/24		Gray Silty Fine SAND, SM		
					~~Gray Fine SAND w/Clay, SC~~		
50	17	SS	36/30	1	Gray SILT Trace Clay, Sand, ML	14-20-29	
	18	SS	36/26	1		14-23-28	
55					TOB		

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)

REMARKS:
1. Sample Was Driven 36". Blow Counts Are For The First 3-6" Increments.
2. Sample Was Driven 30". Blow Counts Are For The First 3-6" Increments.

DRILLING METHOD Hollow Auger
DATE DRILLED 11-9, 10-82
DRILLED BY Bignall
LOGGED BY Maxeiner
PIEZOMETER None

GROUNDWATER LEVELS
Encountered at ____ Feet
____ Hours after completion ____ Feet
____ after completion ____ Feet
____ after completion ____ Feet

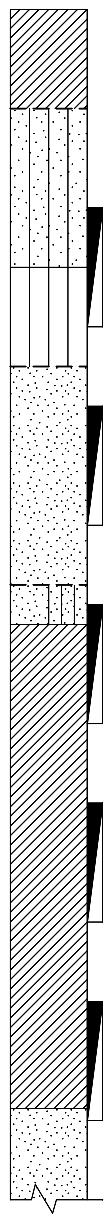
NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.

John Mathes & Associates, Inc.

LOG OF BORING JMA-2

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 590.3 Feet

Date Drilled: 11/03/82
Drilling Contractor: John Mathes & Associates, Inc.
Drilling Method: Hollow Auger
Logged By: John Mathes & Associates, Inc.



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
590 / 0			CL	*Brown Silty CLAY*				
			ML	*Brown Sandy SILT with Clay*				
585 / 5	8, 14, 13	33/36	ML	*Brown Clayey SILT with Sand*			10	*For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.*
580 / 10		18/36	SP	*Brown Medium SAND with Gravel* *-Cobbles 12.0-14.0'*			11	
575 / 15			SP-SM	*Brown Fine-Medium SAND with Silt, Trace Gravel*				
	6, 13, 20	36/36	CL	*Gray Silty CLAY with Sand, Sand Seams, Trace Gravel*			11	
570 / 20	11, 20, 27	21/36						
565 / 25	15, 20, 28	35/36					10	
			SP	*Gray Fine-Medium SAND*				
30								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates, Inc. presented in a report dated April 11, 1983.

GROUNDWATER

Piezometer Installed: No

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A Division of Environmental Operations, Inc.

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LOG OF BORING JMA-2 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 590.3 Feet

Date Drilled: 11/03/82
Drilling Contractor: John Mathes & Associates, Inc.
Drilling Method: Hollow Auger
Logged By: John Mathes & Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
560 / 30				*Gray Fine-Medium SAND (continued)*				
	8 10 23	34/36	CL	*Gray Silty CLAY with Sand, Trace Gravel*				*For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.*
555 / 35			CL	*Gray Sandy CLAY with Silt, Sand Seams, Trace Gravel*				
	12 30 30	30/30		*-Sand Seam 36.2-36.7'*			10	
			CL	*Gray Silty CLAY with Sand, Trace Gravel*				
550 / 40	40 200/4"	8/10		*-Silt Seam below 40.5'*			20	
				TD - 40.8 Feet				
545 / 45								
540 / 50								
535 / 55								
60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates, Inc. presented in a report dated April 11, 1983.

GROUNDWATER

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

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RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study
Vermilion Power Plant
JOB NO. 82-1292

BORING JMA-2
SHEET 1 OF 2

Soil Classification System: Unified
Surface Elevation: 590.3'

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)

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
0					Brown Silty CLAY, CL		
					Brown Sandy SILT w/Clay, ML		
5	1	SS	36/33	1	Brown Clayey SILT w/Sand, ML	8-14-13	
					Brown Medium SAND w/Gravel, SP		
10	2	SS	36/18	1	-Cobbles 12.0 - 14.0'		
					Br Fi-Med SAND w/Si Tr Gvl, SP-SM		
15	3	SS	36/36	1	Gray Silty CLAY w/Sand, Sand Seams Trace Gravel, CL	6-13-20	
20	4	SS	36/21	1		11-20-27	
25	5	SS	36/35	1		15-20-28	
					Gray Fine-Medium SAND, SP		
30	6	SS	36/34	1	Gray Silty CLAY w/Sand Trace Gravel, CL	8-10-23	
35	7	SS	30/30	2	Gray Sandy CLAY w/Silt, Sand Seams, Trace Gravel, CL	12-30-30	

DRILLING METHOD Hollow Auger
DATE DRILLED 11-3-82
DRILLED BY Roberts
LOGGED BY Maxeiner
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at ______ Feet
____ Hours after completion ____ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeology Study, Vermilion Power Plant
JOB NO.: 82-1292

BORING: JMA-2
SHEET: 2 OF 2

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System: Unified; Surface Elevation: 590.3'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	Shear Strength, tsf / PL NMC LL / Rock Quality Designation
	7	SS	30/30	2	Gr Sa CL w/Si, SA Seams Tr, Gvl, CL-Sand Seam 36.2-36.7; Gray Silty CLAY w/Sand Trace Gravel, CL	12-30-30		
40	8	SS	10/8		-Silt Seam Below 40.5'	40-200/4"		
					TOB			
45								

REMARKS:
1. Sample Was Driven 36". Blow Counts Are For The First 3-6" Increments.
2. Sample Was Driven 30". Blow Counts Are For The First 3-6" Increments.

DRILLING METHOD: Hollow Auger
DATE DRILLED: 11-3-82
DRILLED BY: Roberts
LOGGED BY: Maxeiner
PIEZOMETER: Yes

GROUNDWATER LEVELS

Encountered at ____ Feet
____ Hours after completion ____ 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.

LOG OF BORING VAMW-8R

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 588.0 Feet
Date Drilled: 12/06/93
Drilling Contractor: Whitney & Associates
Drilling Method: Hollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
588 / 0			SM	*Grayish Brown to Brown Fine SAND and SILT, Loose, Dry to Moist by 4'* *-Becoming Wet*				*Blow counts are for 12" intervals unless otherwise noted.*
578 / 10	0	14/24	SP	*Grayish Brown Fine SAND, Very Loose, Saturated, No Odor, No Visible Contaminants*				
573 / 15	7 23	14/24						
572 / 16			GP	*GRAVEL and SAND Mix*				
570 / 18				*TD - 18.0 Feet*				

Elevation scale: 585, 580, 575, 570, 565, 560; Depth scale: 0, 5, 10, 15, 20, 25, 30

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1994.

GROUNDWATER
▽ First Observed During Drilling - 10.3 Feet
▼

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

BORING VAMW-8R

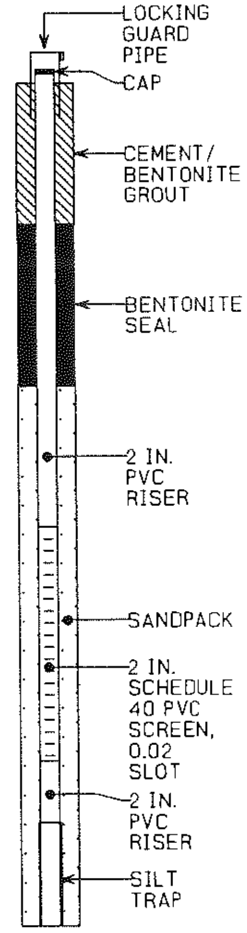
PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/6/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: PAUL MAYWOOD
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 10.3 FEET
DATUM: MSL
LOCATION: STATION E

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION (color, density, SOIL, admixture, moisture, other notes, ORIGIN)	MOISTURE CONTENT (DRY / MOIST / WET)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)
			Grayish brown to brown fine SAND and SILT, loose, dry to moist by 4	DRY			0
				MOIST			5
			becoming wet	WET			
10-12	0	60	Grayish brown fine SAND, very loose, saturated, no odor, no visible contaminants	WET			10
15-17	?,23	60	GRAVEL and SAND mix	WET			15
			TD 18				20
							25

WELL CONSTRUCTION

WELL VAMW-8R



LOG OF BORING JMA-6

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 589.5 Feet

Date Drilled: 11/10/82
Drilling Contractor: John Mathes & Associates, Inc.
Drilling Method: Hollow Auger
Logged By: John Mathes & Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0		27/36	CL	Dark Gray-Brown Silty CLAY with Sand -Roots to 0.6' -Root Holes to 1.7'			24	Split spoon pushed from 0 to 3.0 feet.
585 / 5	2 3 2	25/36	ML	Brown Sandy SILT, Trace Clay			20	For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.
	3 6 12	29/36	SM	Gray-Brown Medium SAND with Gravel, Silt				
580 / 10	6 12 17	27/36						
575	4 11 18	22/30	GP-GM	Gray Sandy GRAVEL Trace Silt				
15	10 18 13	2/30	CL	Gray Silty CLAY with Sand, Gravel				
		25/30	SP-SM	Gray-Brown Fine-Medium SAND with Gravel, Trace Silt				
570 / 20	7 5 8	27/30						
	3 6 9	20/30						
565 / 25	7 7 9	22/30		-Silt Seam 27.8-28.7'				
	2 7 10	22/30						
560 / 30			CL	Gray Silty CLAY with Sand, Trace Gravel				

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates, Inc. presented in a report dated April 11, 1983.

GROUNDWATER

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING JMA-6 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 589.5 Feet

Date Drilled: 11/10/82
Drilling Contractor: John Mathes & Associates, Inc.
Drilling Method: Hollow Auger
Logged By: John Mathes & Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30	2 6 8	24/30		*Gray Silty CLAY with Sand, Trace Gravel (continued)*			12	
555 / 35		41/42					12	
		63/60						
550 / 40		60/60		*-Silt Seam 42.8-43.4'*			21	
545 / 45				*-Organics at 45.0'*				
		24/30	SM	*Gray Silty Fine SAND*			17	
			SC	*Gray Fine SAND with Clay*				
			ML	*Gray SILT Trace Clay, Sand*				
540 / 50	14 20 29	36					13	
	14 23 28	26/36					15	
535 / 55				*TD - 54.0 Feet*				
530 / 60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates, Inc. presented in a report dated April 11, 1983.

GROUNDWATER

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.
Missouri (314) 241-0900
Illinois (618) 398-1414

RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeologic Study, Vermilion Power Plant
JOB NO.: 82-1292
BORING: JMA-6
SHEET 1 OF 2

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System: Unified; Surface Elevation: 589.5'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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)
	1	SS	36/27	1	Dark Gray-Brown Silty CLAY w/Sand, CL - Roots to 0.6' - Root Holes to 1.7'	Pushed		
5	2	SS	36/25	1	Brown Sandy SILT Trace Clay, ML	2-3-2		
	3	SS	36/29	1	Gray-brown Medium SAND w/Gravel, Silt, SM	3-6-12		
10	4	SS	36/27	1		6-12-17		
	5	SS	30/22	2	Gray Sandy GRAVEL Trace Silt, GP-GM	4-11-18		
15	6	SS	30/2	2	Gray Silty CLAY w/Sand, Gravel, CL	10-18-13		
	7	SS	30/25	2	Gray-Brown Fine-Medium SAND w/Gravel Trace Silt, SP-SM			
20	8	SS	30/27	2		7-5-8		
	9	SS	30/20	2		3-6-9		
25	10	SS	30/22	2	-Silt Seam 27.8-28.7'	7-7-9		
	11	SS	30/22	2	Gray Silty CLAY w/Sand Trace Gravel, CL	2-7-10		
30	12	SS	30/24	2		2-6-8		
	13	3T	42/41					
35								

DRILLING METHOD: Hollow Auger
DATE DRILLED: 11-9, 10-82
DRILLED BY: Bignall
LOGGED BY: Maxeiner
PIEZOMETER: None

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ 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.

mathes

John Mathes & Associates, Inc.

RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeology Study
Vermilion Power Plant
JOB NO. 82-1292

BORING: JMA-6
SHEET 2 OF 2

Soil Classification System: Unified
Surface Elevation: 589.5'

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)

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Gray Silty CLAY w/Sand Trace Gravel, CL		
	14	3T	60/63				
40							
	15	3T	60/60		-Silt Seam 42.8-43.4'		
45					-Organics @ 45.0'		
	16	SS	30/24		Gray Silty Fine SAND, SM		
					~~Gray Fine SAND w/Clay, SC~~		
50	17	SS	36/30	1	Gray SILT Trace Clay, Sand, ML	14-20-29	
	18	SS	36/26	1		14-23-28	
					TOB		
55							

REMARKS:
1. Sample Was Driven 36". Blow Counts Are For The First 3-6" Increments.
2. Sample Was Driven 30". Blow Counts Are For The First 3-6" Increments.

DRILLING METHOD: Hollow Auger
DATE DRILLED: 11-9, 10-82
DRILLED BY: Bignall
LOGGED BY: Maxeiner
PIEZOMETER: None

GROUNDWATER LEVELS

Encountered at ____ Feet
____ Hours after completion ____ 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.

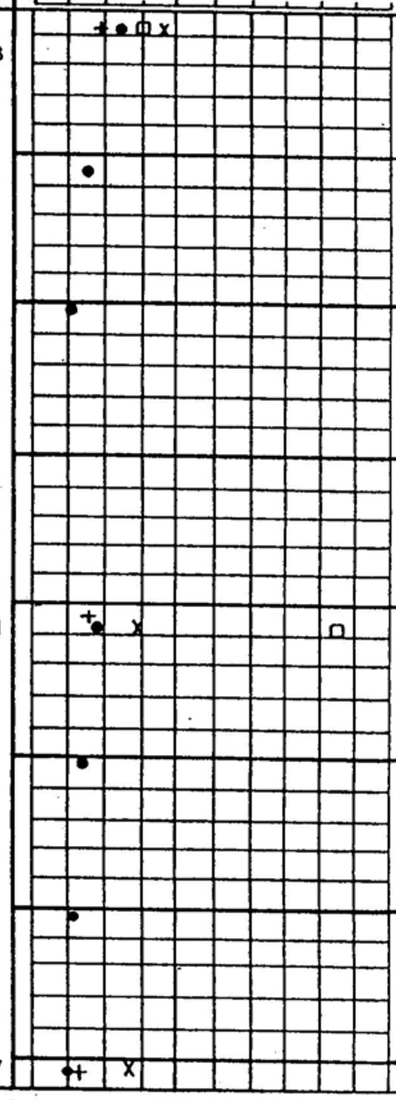
RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-10
SHEET 1 OF 3

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System: Unified; Surface Elevation: 656.2'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Yellow-Brown Silty CLAY Trace Roots, CL		
	1	HST	60/36		Brown CLAY w/Silt, Roots, CH		103
5					Olive-Brown Silty CLAY, TILL, CL		
	2	HST	60/12		-w/Gravel 6.0-8.0'		
10					-w/Gravel 10.0-12.5', & 18.0-21.0'		
	3	HST	60/6				
15							
	4	HST	60/10		-w/Cobbles @ 17.0'		
20					-Brown 20.0-30.0'		
	5	HST	60/24				111
25					-w/Sand, Gravel Seam @ 25.0'		
	6	HST	60/6				
30					-Gray Below 30.0'		
	7	HST	30/6				
					-Gravel Seam @ 32.5'		
35	8	SS	24/24	1		17-25-23-24	127

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 & Mud Rotary
DATE DRILLED: 4/28-29/87
DRILLED BY: Schaffer
LOGGED BY: Shively/Jacobi
PIEZOMETER: Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ Feet
___ after completion ___ Feet
___ after completion ___ Feet

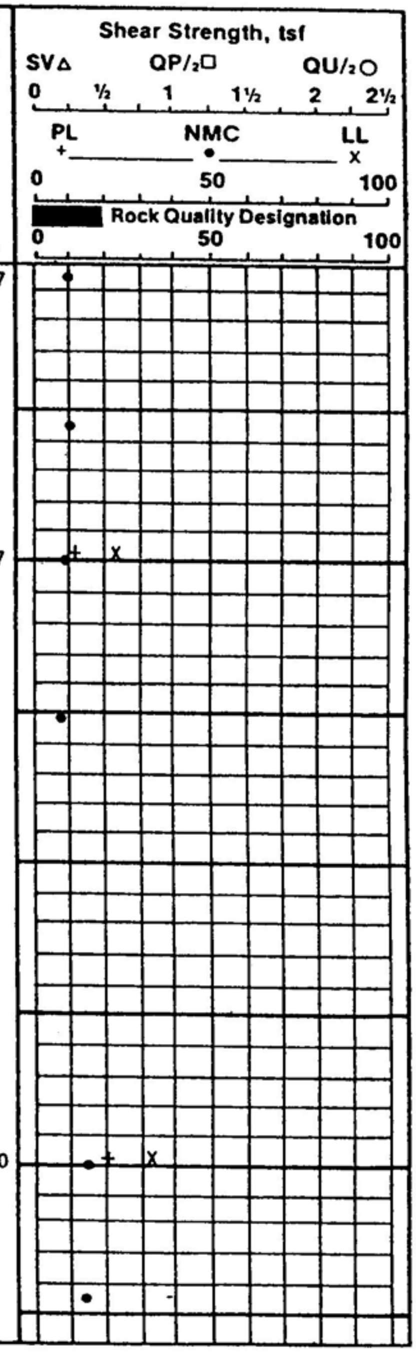
NOTE: Refer to the attached GENERAL NOTES and NOTATION USED ON RECORDS OF SUBSURFACE EXPLORATION for abbreviations, explanations, and qualifications relative to this log.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-10
SHEET 2 OF 3

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified; Surface Elevation 656.2'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
	8	HST	24/24		Gray Silty CLAY Trace Sand, Gravel, TILL, CL	17-25-23-24	127
40	9	SS	24/24			11-15-30-39	
					-Gray-Brown Below 43.0'		
45	10	SS	22/18			18-24-40-50/4"	127
					-w/Gravel Seams 49.0-59.0'		
50	11	SS	18/18			23-34-50	
55	12	SS	9/9			48-50/3"	
	13	~~AS~~					
60	14	~~SS~~	5/0			~~50/5"~~	
65	15	SS	17/15			26-30-50/5"	120
70	16	SS	12/12			24-50/6"	



DRILLING METHOD Hollow Auger & Mud Rotary
DATE DRILLED 4/28-29/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-10
SHEET 3 OF 3

DEPTH (ft)	SAMPLE NUMBER	SAMPLE INTERVAL AND TYPE	SAMPLE ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified Surface Elevation 656.2'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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
					Gray Silty CLAY Trace Sand, Gravel, TILL, CL			
75	17	SS	3/3		Gray Clayey SHALE TOB	50/3"		
80								

DRILLING METHOD Hollow Auger & Mud Rotary
DATE DRILLED 4/28-29/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO.: 11872803

BORING: B-13A
SHEET 1 OF 2

Soil Classification System: Unified
Surface Elevation: 581.9'

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
0					Brown Silty CLAY w/Sand, CL		
	1	HST	60/60				
5							116
	2	HST	60/18		Brown Fine SAND Trace Silt, SP		
					-w/Gravel Below 9.5'		
10					Gray SHALE		
	3	HST	60/36		-Oark Gray Below 13.5'		
15							
	4	HST	60/0				
20	5	SS	2/2	1		50/2"	
25	6	SS	2/0			50/2"	
30	7	SS	2/0			50/2"	
35	8	SS	1/1			50/1"	

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: 4/27/87
DRILLED BY: Schaffer
LOGGED BY: Shively/Jacobi
PIEZOMETER: Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-13A
SHEET 2 OF 2

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL, Classification) Soil Classification System Unified Surface Elevation 581.9'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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
					Dark Gray SHALE			
40	9	SS	2/1		TOB	50/2"		
					Remark:			
					1. Mud Rotary Techniques Used Below 20.0'			
45								

DRILLING METHOD Hollow Auger
DATE DRILLED 4/27/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-13B
SHEET 1 OF 1

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified Surface Elevation 581.9'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	Shear Strength, tsf SV△ QP/2□ QU/2○; PL + NMC • LL x; Rock Quality Designation
					Brown Silty CLAY w/Sand, CL			
5								
	1	SS	24/17		Brown Fine-Medium SAND w/Gravel Trace Silt, SP-SM	3-2-4-3		
10	2	SS	22/8		Brown Silty CLAY w/Sand, CL	6-6-12-50/4"		
					Gray SHALE			
					TOB			
15								
20								
25								
30								
35								

DRILLING METHOD Hollow Auger
DATE DRILLED 3/27/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT: Hydrogeologic Study Number One, Vermilion Power Plant
BORING: B-13B
SHEET 1 OF 1
JOB NO. 11872803

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL, Classification) Soil Classification System: Unified; Surface Elevation: 581.9'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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)
					Brown Silty CLAY w/Sand, CL			
5								
	1	SS	24/17		Brown Fine-Medium SAND w/Gravel Trace Silt, SP-SM	3-2-4-3		
10	2	SS	22/8		Brown Silty CLAY w/Sand, CL	6-6-12-50/4"		
					Gray SHALE			
					TOB			
15								
20								
25								
30								
35								

DRILLING METHOD: Hollow Auger
DATE DRILLED: 3/27/87
DRILLED BY: Schaffer
LOGGED BY: Shively/Jacobi
PIEZOMETER: Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-16A
SHEET 1 OF 2

Soil Classification System: Unified
Surface Elevation: 578.5'

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification)	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
0					Dark Brown Sandy SILT w/Clay, ML		
	1	HST	60/20				
5					Brown Medium SAND w/Fine Trace Clay, SW-SC		
	2	HST	60/10				
10					Brown Gravelly SAND Trace Clay, SP		
	3	HST	30/3				
					Dark Gray SHALE		
15	4	SS	4/4			50/4"	
20	5	SS	3.5/3.5	1		50/3.5"	
25	6	SS	3/3			50/3"	
30	7	SS	3/1			50/3"	
35	8	SS	2/2			50/2"	

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 & Mud Rotary
DATE DRILLED 4/28/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at 8.5 Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-16A
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) Soil Classification System Unified; Surface Elevation 578.5'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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
					Dark Gray SHALE			
					-Rock Seam 37.0-37.5'			
40								
	9	SS	2/0		TOB	40/2"		
45								
					Remarks:			
					1. Mud Rotary Techniques Used Below 19.5'			

DRILLING METHOD Hollow Auger & Mud Rotary
DATE DRILLED 4/28/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at 8.5 Feet
___ Hours after completion ___ 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-16B
SHEET 1 OF 1

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL, Classification) Soil Classification System Unified Surface Elevation 578.5'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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
					Gray-Brown Silty CLAY, CL			
5								
	1	SS	24/20		Gray Fine-Medium SAND Trace Silt, SM	2-5-4-6		
	2	SS	24/14		Brown Fine Sand w/Clay, Gravel, SC	2-2-3-9		
10					-Becoming Coarser w/Depth			
	3	SS	17/14			10-29-50/5"		
				1	TOB			
					Remark:			
15					1. Hit Shale @ 11.5'±			
20								
25								
30								
35								

DRILLING METHOD Hollow Auger
DATE DRILLED 4/28/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS
Encountered at - Feet
___ Hours after completion ___ 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.

LOG OF BORING VAMW-17

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 619.6 Feet

Date Drilled: 12/06/93
Drilling Contractor: Whitney & Associates
Drilling Method: Hollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
619.6 / 0				*Coarse, Dry, ASH and FILL*				*Blow counts are for 12" intervals unless otherwise noted.*
615 / 5				*Gray Fine ASH, Wet*				
610 / 10								
605 / 15	14 18	5/24		*Orange-Brown FILL, Wet, Poorly Sorted, Fine to Coarse Sand*				
600 / 20	22	20/24		*Black ASH, Moist, Fine to Medium Grained, Layered*				
595 / 25	8 10	16/24	ML	*Brown SILT, Well Sorted, Structureless, Few Small Pebbles*				
590 / 30				*(continued)*				

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1994.

GROUNDWATER

First Observed During Drilling - 37.2 Feet

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

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Illinois (618) 398-1414

LOG OF BORING VAMW-17 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 619.6 Feet

Date Drilled: 12/06/93
Drilling Contractor: Whitney & Associates
Drilling Method: Hollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30	8 9	21/24	CL	*Brown Silty CLAY, Structureless* *-Grading to Silty SAND*				*Blow counts are for 12" intervals unless otherwise noted.*
585 / 35	7 9	21/24	ML	*Brown to Orange Sandy SILT, Mottled* *-2" Sand and Gravel Layer with 1/4" Pebbles, Moist*				
580 / 40	6 21	24/24	SW	*Brown Fine SAND, Wet, Well Sorted*				
			ML	*Sandy SILT*				
			SP	*Medium to Coarse SAND, with Small Pebbles, Poorly Sorted*				
575 / 45	48 35	19/24	SP	*Brown Medium to Coarse SAND and GRAVEL, Wet, Poorly Sorted*				
			SM	*Gray Silty SAND with 3/4" Pebbles, Well Sorted*				
570 / 50	19	0/24						
565 / 55	17	0/12	SP	*Gray Medium SAND, Wet*				
560 / 60								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1994.

GROUNDWATER

First Observed During Drilling - 37.2 Feet

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

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Illinois (618) 398-1414

LOG OF BORING VAMW-17 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 619.6 Feet

Date Drilled: 12/06/93
Drilling Contractor: Whitney & Associates
Drilling Method: Hollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
60	78 100/2"	20/24		*Gray Medium SAND, Wet (continued)*				*Blow counts are for 12" intervals unless otherwise noted.*
			CL-ML	*Gray Silty and Sandy CLAY, with 3/4" Pebbles, Very Hard*				
555 – 65	110/9"	7/9		*-Thin Layer of Gray Medium SAND, Well Sorted*				
			SP	*Fine SAND, with 1" Pebbles, Well Sorted*				
550 – 70	120/9"	9/24	CL	*Olive Green Sandy CLAY, with 1/4" Pebbles, Hard*				
				TD - 72.0 Feet				
545 – 75								
540 – 80								
535 – 85								
530 – 90								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1994.

GROUNDWATER

∇ First Observed During Drilling - 37.2 Feet

▼

Piezometer Installed: No

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A Division of Environmental Operations, Inc.

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BORING VAMW-17

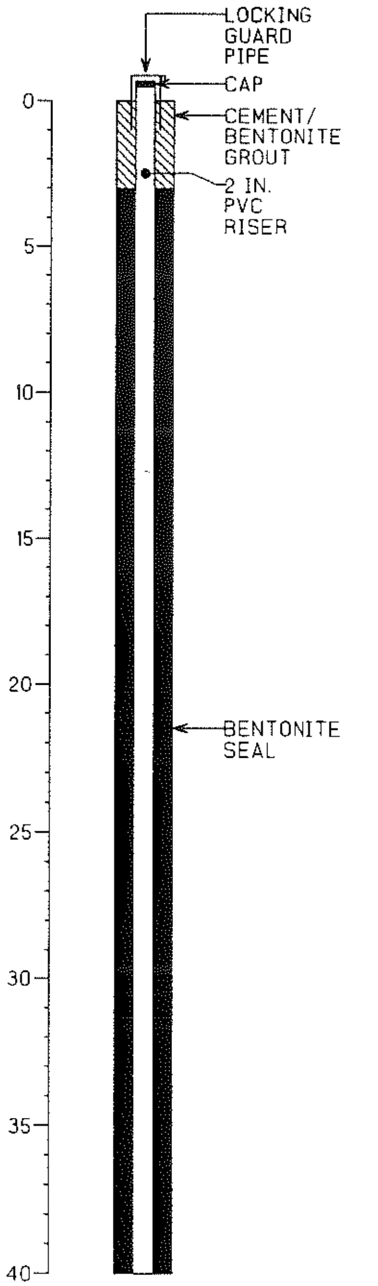
PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/6/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: BRUCE HENSEL
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 37.2 FEET
DATUM: MSL
LOCATION: STATION A

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION (color, density, SOIL, admixture, moisture, other notes, ORIGIN)
			Coarse, dry, ASH and FILL.
			Gray fine ASH, wet.
15-17	14,18	21	Orange-brown FILL, wet, poorly sorted, fine to coarse sand.
20-22	22	83	Black ASH, moist, fine to medium grained, layered.
25-27	8,10	67	Brown SILT, well sorted, structureless, few small pebbles.
30-32	8,9	88	Brown silty CLAY, structureless. Grading to silty SAND.
35-37	7,9	88	Brown to orange sandy SILT, mottled. 2" SAND and GRAVEL layer with 1/4" pebbles, moist.

MOISTURE CONTENT: DRY / MOIST / WET — SAMPLE ANALYSIS — LITHOLOGY — DEPTH (FT.)

WELL CONSTRUCTION



BORING VAMW-17

PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/6/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

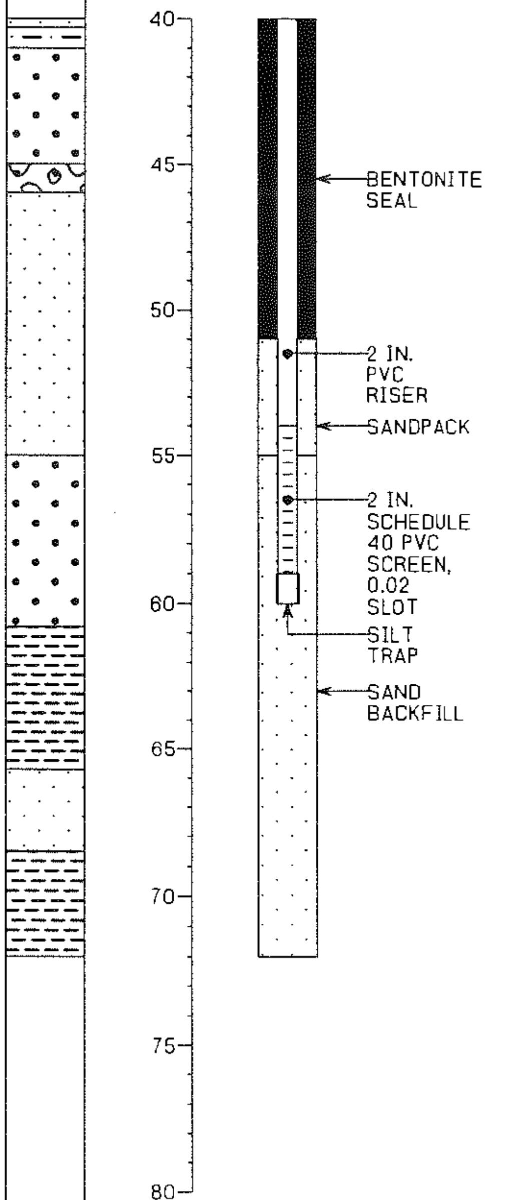
INSPECTOR: BRUCE HENSEL
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 37.2 FEET
DATUM: MSL
LOCATION: STATION A

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION: color, density, SOIL, admixture, moisture, other notes, ORIGIN
40-42	6,21	100	Brown fine SAND, wet, well sorted. Sandy SILT. Medium to coarse SAND with small pebbles, poorly sorted.
45-47	48,35	79	Brown medium to coarse SAND and GRAVEL, wet, poorly sorted. Gray silty SAND with 3/4" pebbles, well sorted.
50-52	19	0	
55-56	17	0	Gray medium SAND, wet.
60-62	78 100 (2")	83	Gray silty and sandy CLAY with 3/4" pebbles, very hard.
65-66	110 (9")	75	Thin layer of gray medium SAND, well sorted. Fine SAND with 1" pebbles, well sorted. Olive green sandy CLAY with 1/4" pebbles, hard.
70-72	120 (9")	38	TD 72

MOISTURE CONTENT: DRY / MOIST / WET — SAMPLE ANALYSIS — LITHOLOGY — DEPTH (FT.)

WELL CONSTRUCTION

WELL VAMW-17



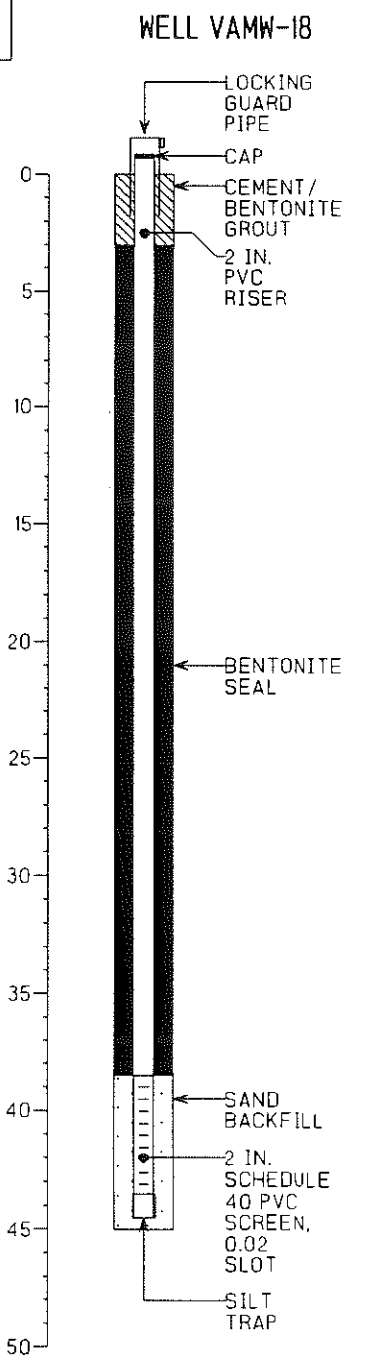
BORING VAMW-18

PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/8/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: BRUCE HENSEL
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 20.5 FEET
DATUM: MSL
LOCATION: STATION A

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION (color, density, SOIL, admixture, moisture, other notes, ORIGIN)	MOISTURE CONTENT	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)
			Coarse, dry, ASH and FILL.	DRY			0
			Gray fine ASH, wet.	WET			5
15-17	14,18	21	Orange-brown FILL, wet, poorly sorted, fine to coarse sand.	WET			15
20-22	22	83	Black ASH, moist, fine to medium grained, layered.	MOIST			20
25-27	8,10	67	Brown SILT, well sorted, structureless, few small pebbles.	MOIST			25
30-32	8,9	88	Brown silty CLAY, structureless.	MOIST			30
			Grading to silty SAND.	MOIST			
35-37	7,9	88	Brown to orange sandy SILT, mottled.	MOIST			35
			2" SAND and GRAVEL layer with 1/4" pebbles, moist.	MOIST			
40-42	6,21	100	Brown fine SAND, wet, well sorted.	WET			40
			Sandy SILT.	WET			
			Medium to coarse SAND with small pebbles, poorly sorted.	WET			
			TD 45				45

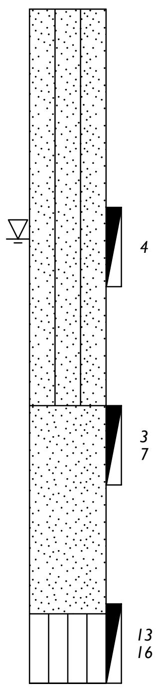
WELL CONSTRUCTION



LOG OF BORING VAMW-19

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 593.1 Feet

Date Drilled: 12/10/93
Drilling Contractor: Whitney & Associates
Drilling Method: Hollow Stem Auger
Logged By: Atlantic Environmental, Inc.



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0 – 10 (593.1)	4	18/24	SM	*Light Brown to Yellowish Brown Fine to Very Fine SAND, Very Silty, Soft, Loose, Wet at 6'*				*Blow counts are for 12" intervals unless otherwise noted.*
10 – 15	3 7	18/24	SP	*Brown to Varied color Medium SAND, Medium to Poorly Sorted, Saturated, Very Loose, Silty in Parts*				
15 – 17	13 16	24/24	ML	*Gray SILT, Very Stiff, Some Pebbles*				
				TD - 17.0 Feet				

Depth scale: 0, 5, 10, 15, 20, 25, 30; Elevation scale: 590, 585, 580, 575, 570, 565

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1994.

GROUNDWATER

∇ First Observed During Drilling - 5.8 Feet
▼

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.
Missouri (314) 241-0900
Illinois (618) 398-1414

BORING VAMW-19

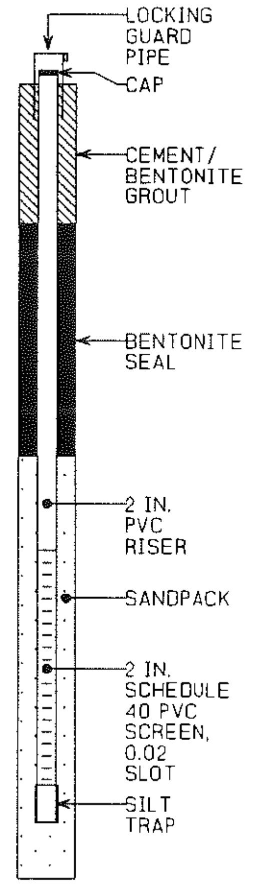
PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/10/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: PAUL MAYWOOD
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 5.8 FEET
DATUM: MSL
LOCATION: STATION C

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION: color, density, SOIL, admixture, moisture, other notes, ORIGIN	MOISTURE CONTENT (DRY / MOIST / WET)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)
			Light brown to yellowish brown fine to very fine SAND, very silty, soft, loose, wet at 6.				0
5-7	4	75					5
10-12	3,7	75	Brown to varied color medium SAND, medium to poorly sorted, saturated, very loose, silty in parts.				10
•							
15-17	13,16	100	Gray SILT, very stiff, some pebbles.				15
			TD 17				
							20
							25

WELL CONSTRUCTION

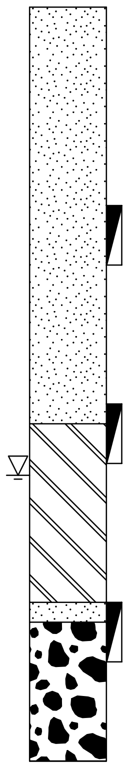
WELL VAMW-19



LOG OF BORING VAMW-20

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 590.2 Feet

Date Drilled: 12/08/93
Drilling Contractor: Whitney & Associates
Drilling Method: Hollow Stem Auger
Logged By: Atlantic Environmental, Inc.



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
590 – 0			SP	*Fine Silty SAND, Well Sorted, Soft, Loose, Slightly Moist, No Odor*				*Blow counts are for 18" intervals.*
585 – 5	5	*13/18*						
580 – 10	5	*18/18*		*-Grading to Coarser, Very Loose Sand*				
			CL/CH	*Light Olive to Light Olive Brown CLAY, Soft, Slightly Plastic, Wet, Sticky, Silty in Parts*				
575 – 15	52	*10/18*	SP	*Light Yellowish Brown Fine to Medium SAND, Loose, Wet*				
			GW	*Gray GRAVEL, Hard, Well Rounded, Poorly Sorted, Saturated, Fine to Coarse Sand Matrix*				
				TD - 19.0 Feet				
570 – 20								
565 – 25								
– 30								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1994.

GROUNDWATER

First Observed During Drilling - 11.8 Feet

Piezometer Installed: No

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BORING VAMW-20

PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/8/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

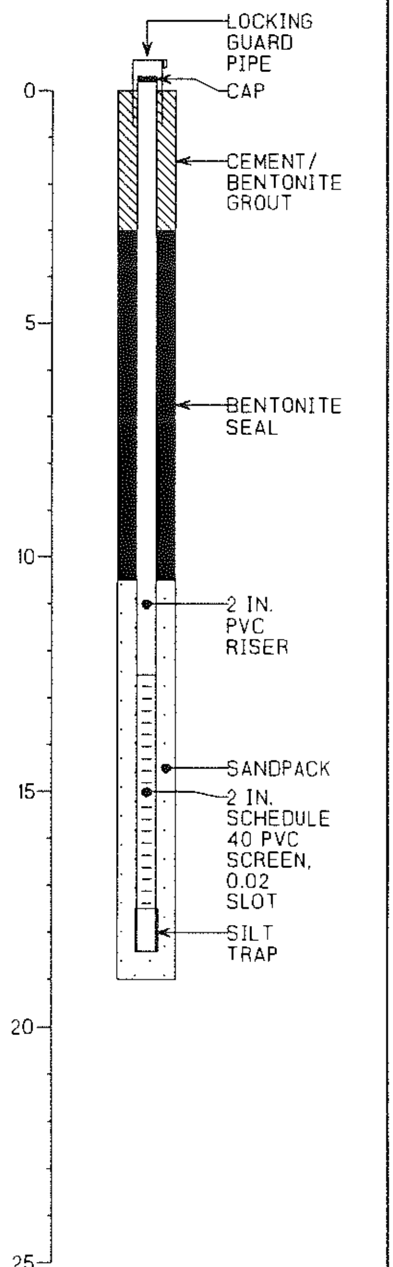
INSPECTOR: PAUL MAYWOOD
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 11.8 FEET
DATUM: MSL
LOCATION: STATION D

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 18"	PERCENT RECOVERY	SOIL DESCRIPTION (color, density, SOIL,admixture, moisture, other notes, ORIGIN)
			Fine silty SAND, well sorted, soft, loose, slightly moist, no odor.
5-6.5	5	73	
10-11.5	5	100	Grading to coarser, very loose SAND.
			Light olive to light olive brown CLAY, soft, slightly plastic, wet, sticky, silty in parts.
15-16.5	52	53	Light yellowish brown fine to medium SAND, loose, wet.
			Gray GRAVEL, hard, well rounded, poorly sorted, saturated, fine to coarse sand matrix.
			TD 19

MOISTURE CONTENT: DRY | MOIST | WET — SAMPLE ANALYSIS — LITHOLOGY — DEPTH (FT.)

WELL CONSTRUCTION

WELL VAMW-20



LOG OF BORING VAMW-21

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 670.4 Feet

Date Drilled: 12/08/93
Drilling Contractor: Whitney & Associates
Drilling Method: Hollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
670 / 0			ML	*TOPSOIL, Dark Brown SILT, with Organic Material*				*Blow counts are for 12" intervals unless otherwise noted.*
665 / 5	5 8	24/24	ML	*Gray to Orange Mottled SILT, Grading to Silty CLAY, Soft, Organics, Moist*				
660 / 10	5 10	16/24	CL	*Brown to Gray Silty CLAY, with 3/4" Pebbles, Mottled, Soft, Moist*				
655 / 15	29 35	11/24	CL	*Gray Silty CLAY, with Pebbles, Wet, Medium Stiff*				
650 / 20	10 23	18/24						
645 / 25	12 23	22/24	CL	*Gray Silty CLAY, with 1/2" Pebbles, Wet, Stiff*				
30								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1994.

GROUNDWATER ∇ First Observed During Drilling - 87.1 Feet

Piezometer Installed: No

Shively Geotechnical
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Illinois (618) 398-1414

LOG OF BORING VAMW-21 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 670.4 Feet

Date Drilled: 12/08/93
Drilling Contractor: Whitney & Associates
Drilling Method: Hollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
640 / 30	28 46	12/24		*Gray Silty CLAY, with 1/2" Pebbles, Wet, Stiff (continued)*				
			SP-SM	*Brown Medium SAND with Silt and Clay*				
635 / 35	32 70	13/24	SW	*Brown Medium to Coarse SAND, with Gravel, Loose, Poorly Sorted*				
630 / 40	53 58	13/24		*-Some Clasts over 1"*				
625 / 45	60 58	14/24						
620 / 50	25 29	20/24		*-Grading to Brown Fine to Medium SAND, Loose, Poorly Sorted*				
615 / 55	8 15	24/24	SP	*Brown Medium SAND, Some Gravel, Loose, Well Sorted*				
60				*(continued)*				

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1994.

GROUNDWATER

∇ First Observed During Drilling - 87.1 Feet

▼

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.
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Illinois (618) 398-1414

LOG OF BORING VAMW-21 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 670.4 Feet

Date Drilled: 12/08/93
Drilling Contractor: Whitney & Associates
Drilling Method: Hollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
610 / 60		0/24	SP	*SAND and GRAVEL*				
64			CH	*CLAY*				
605 / 65	50	21/24	CL	*Gray Sandy CLAY, with Pebbles, Very Stiff, Massive*				
600 / 70	45	22/24	CL	*Olive Green Sandy CLAY, with Pebbles, Very Stiff, Massive, 1/4" Sand Inclusions*				
595 / 75	53	21/24						
590 / 80	77	24/24						
585 / 85								
90								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1994.

GROUNDWATER

∇ First Observed During Drilling - 87.1 Feet

▼

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

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Illinois (618) 398-1414

LOG OF BORING VAMW-21 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 670.4 Feet

Date Drilled: 12/08/93
Drilling Contractor: Whitney & Associates
Drilling Method: Hollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
580 / 90	20 67	19/24		*Olive Green Sandy CLAY, with Pebbles, Very Stiff, Massive, 1/4" Sand Inclusions (continued)*				
575 / 95	28 50	24/24	CL	*Olive Green Silty CLAY, with 3/4: Angular to Subangular Limestone Pebbles, Stiff to Medium Stiff*				
570 / 100	38 68	20/24						
			CL	*Olive Green Sandy and Silty CLAY, with Pebbles, Very Stiff, Massive, Some Fine to Medium Sand Seams*				
565 / 105	46 115	19/24	SC	*Olive Green Fine SAND and Silty CLAY, with Pebbles*				
560 / 110	38 100/10"	20/24	SM	*Oive Green Silty Very Fine SAND, with Pebbles, Well Sorted*				
				TD - 112.0 Feet				
555 / 115								
120								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1994.

GROUNDWATER ∇ First Observed During Drilling - 87.1 Feet

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

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Illinois (618) 398-1414

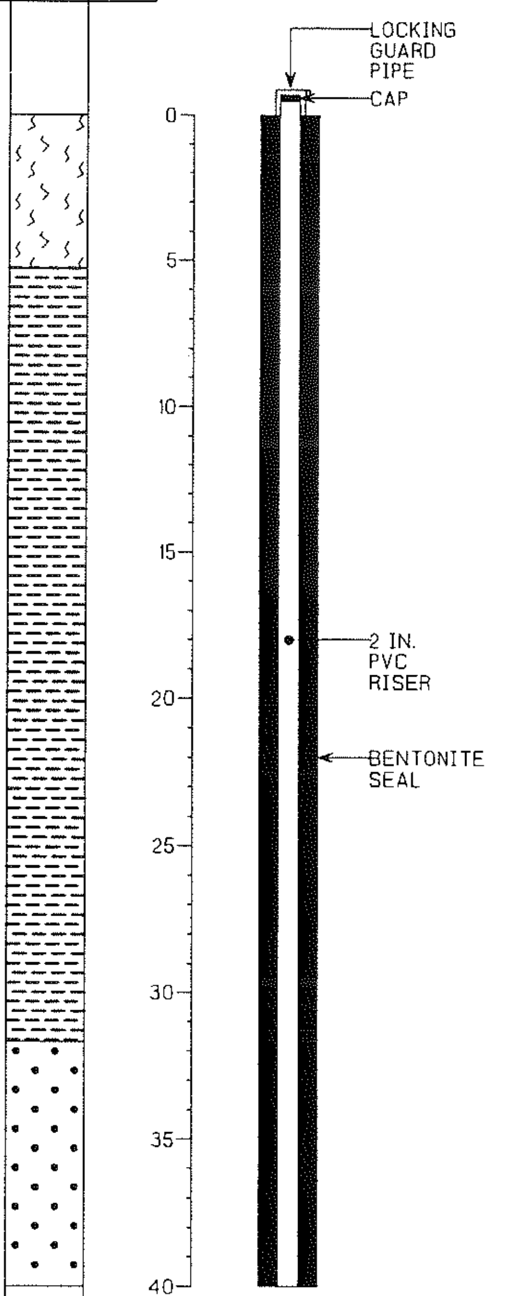
BORING VAMW-21

PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1308-07-02
DATE: 12/8/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: BRUCE HENSEL
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 87.1 FEET
DATUM: MSL
LOCATION: STATION H

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION (color, density, SOIL, admixture, moisture, other notes, ORIGIN)
			TOPSOIL, dark brown silt with organic material.
5-7	5,8	100	Gray to orange mottled SILT grading to silty CLAY, soft, organics, moist.
10-12	5,10	67	Brown to gray silty CLAY with 3/4" pebbles, mottled, soft, moist.
15-17	29,35	46	Gray silty CLAY with pebbles, wet, medium stiff.
20-22	10,23	75	
25-27	12,23	92	Gray silty CLAY with 1/2" pebbles, wet, stiff.
30-32	28,46	50	
			Brown medium SAND with silt and clay.
35-37	32,70	54	Brown medium to coarse SAND with gravel, loose, poorly sorted.

MOISTURE CONTENT: DRY / MOIST / WET — SAMPLE ANALYSIS — LITHOLOGY — DEPTH (FT.) — WELL CONSTRUCTION



BORING VAMW-21

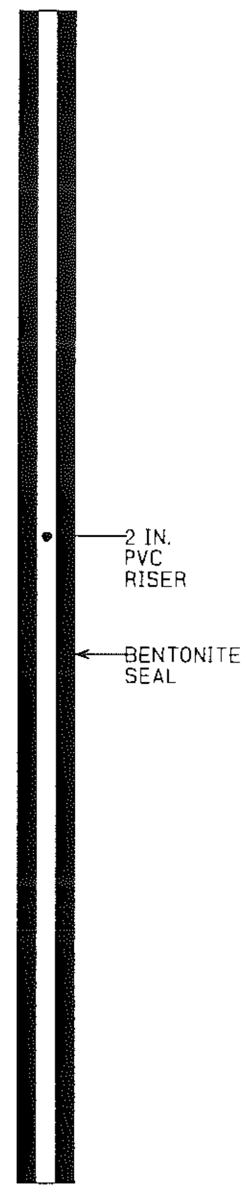
PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/8/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: BRUCE HENSEL
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 87.1 FEET
DATUM: MSL
LOCATION: STATION H

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION: color, density, SOIL, admixture, moisture, other notes, ORIGIN	MOISTURE CONTENT (DRY / MOIST / WET)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)
40-42	53,58	54	Some clasts over 1".	WET			40
45-47	60,58	58		WET			45
50-52	25,29	83	Grading to brown fine to medium SAND, loose, poorly sorted.	WET			50
55-57	8,15	100	Brown medium SAND, some gravel, loose, well sorted.	WET			55
60-62	--	0	SAND and GRAVEL.	WET			60
			CLAY.	WET			
65-67	50	88	Gray Sandy CLAY with pebbles, very stiff, massive.	WET			65
70-72	45	92	Olive green sandy CLAY with pebbles, very stiff, massive, 1/4" sand inclusions.	WET			70
75-77	53	88		WET			75
							80

WELL CONSTRUCTION

WELL VAMW-21



BORING VAMW-21

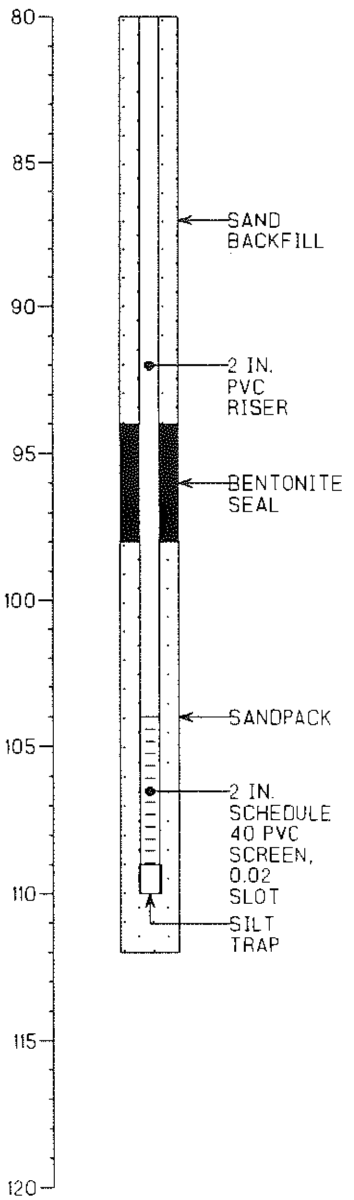
PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/8/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: BRUCE HENSEL
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 87.1 FEET
DATUM: MSL
LOCATION: STATION H

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION: color, density, SOIL, admixture, moisture, other notes, ORIGIN	MOISTURE CONTENT: DRY	MOIST	WET	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)
80-82	77	100							80
									85
90-92	20,67	79							90
95-97	28,50	100	Olive green silty CLAY with 3/4" angular to subangular limestone pebbles, stiff to medium stiff.						95
100-102	38,68	83	Olive green sandy and silty CLAY with pebbles, very stiff, massive, some fine to medium sand seams.						100
105-107	46,115	79	Olive green fine SAND and silty CLAY with pebbles.						105
110-112	38 100 (10")	83	Olive green silty very fine SAND with pebbles, well sorted.						110
			TD 112						115
									120

WELL CONSTRUCTION

WELL VAMW-21



LOG OF BORING MW22

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 655.6 Feet

Date Drilled: 11/30/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0 / 655			CL	*Yellow-Brown Silty CLAY, Trace Roots*				*Blind drilled to 70.5 feet. Descriptions taken from Boring MW-10 drilled on 11/29/87.*
			CH	*Brown CLAY with Silt, Roots*				
5 / 650			CL	*Olive-Brown Silty CLAY, TILL*				
				-with Gravel 6.0-8.0'				
10 / 645				*-with Gravel 10.0-12.5' & 18.0-21.0'*				
15 / 640								
				-with Cobbles at 17.0'				
20 / 635				*-Brown 20.0-30.0'*				
25 / 630				*-with Sand, Gravel Seam at 25.0'*				
30								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER ∇ ▼

Piezometer Installed: No

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LOG OF BORING MW22 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 655.6 Feet

Date Drilled: 11/30/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
625 / 30				*Olive-Brown Silty CLAY, TILL (continued)* *-Gray below 30.0'*				*Blind drilled to 70.5 feet. Descriptions taken from Boring MW-10 drilled on 11/29/87.*
				-Gravel Seam at 32.5'				
620 / 35								
615 / 40								
				-Gray-Brown bleow 43.0'				
610 / 45								
				-with Gravel Seams 49.0-59.0'				
605 / 50								
600 / 55								
60								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER

Piezometer Installed: No

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LOG OF BORING MW22 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 655.6 Feet

Date Drilled: 11/30/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
595 / 60				*Olive-Brown Silty CLAY, TILL (continued)*				*Blind drilled to 70.5 feet. Descriptions taken from Boring MW-10 drilled on 11/29/87.*
590 / 65								
585 / 70				*SHALE, Bedrock*				
580 / 75		*114/114*		*Gray Clayey SHALE* *-Weathered, Blocky, Fissile, Soft, Dark Gray* *-Competent, Hard, Dark Gray; Laminated with Clay/Silt Seams/Lenses, <1 to 4 mm, Light Gray*				
575 / 80				*-Seams/Lenses of Light Gray Clay/Silt from <1 to 11 mm* *-with Occasional Blue Tine, Blocky When Sheared*				
570 / 85		*120/120*						
90								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER ∇ ▼

Piezometer Installed: No

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LOG OF BORING MW22 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 655.6 Feet

Date Drilled: 11/30/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
565 / 90 – 555 / 100		120/120		*Gray Clayey SHALE (continued)* *-Seams/Lenses of Light Gray Clay/Silt from <1 to 2 cm*				
555 / 100 – 535 / 120				*TD - 100.0 Feet*				

Elevation scale: 565, 560, 555, 550, 545, 540. Depth scale: 90, 95, 100, 105, 110, 115, 120.

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER ∇ ▼

Piezometer Installed: No

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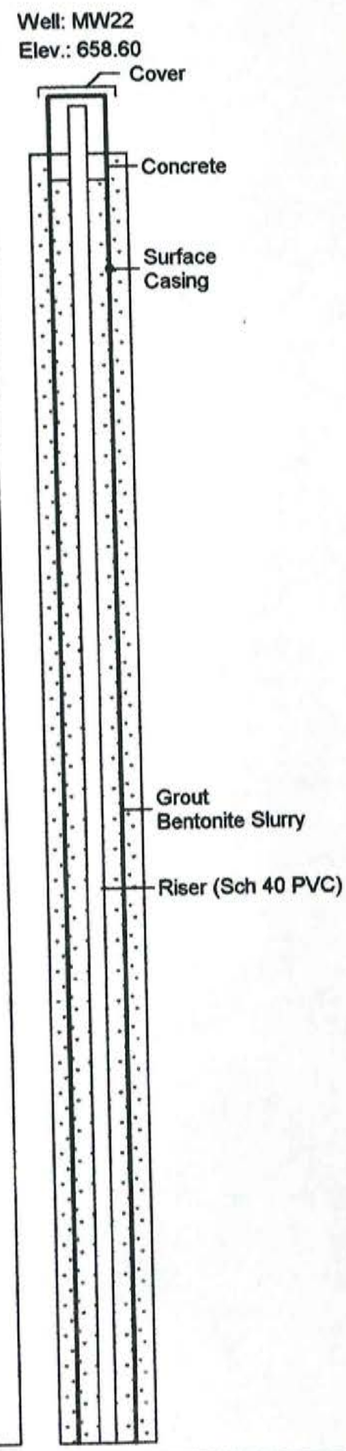
KELRON Environmental	LOG OF BORING MW22 (Page 1 of 2)

East Ash Pond Hydrogeologic Investigation Vermilion Power Station Dynegy Midwest Generation, Inc. Location: Twp 20N, Rng 12W, 20 SW/NE/SE	Date Completed : 11/30/2001 Hole Diameter : 4 1/2; 2 1/2 inches Drilling Method : Rotary Sampling Method : HQ Core (2.5 inch) Drilling Company : Mid-America Drilling, Inc.	Driller : Dusty Jackson Geologist : Eric Kovatch (NRT) Land Surface Elevation : 655.6 Top of Casing Elevation: 658.60 X,Y Coordinates : 1150083,1279669

Depth in Feet	DESCRIPTION	Surf. Elev. 655.6	Samples	Recovery inches	Blow Count	Qp TSF	USCS	GRAPHIC
0		655						
5	Blind Drill to 70.5 feet - see log of Well MW10	650						
10	Surface Casing = 4.3 I.D. / 4.5 inch O.D. Installed to 70 feet below ground	645						
15		640						
20		635						
25		630						
30		625						
35		620						
40		615						
45		610						
50								



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KELRON Environmental

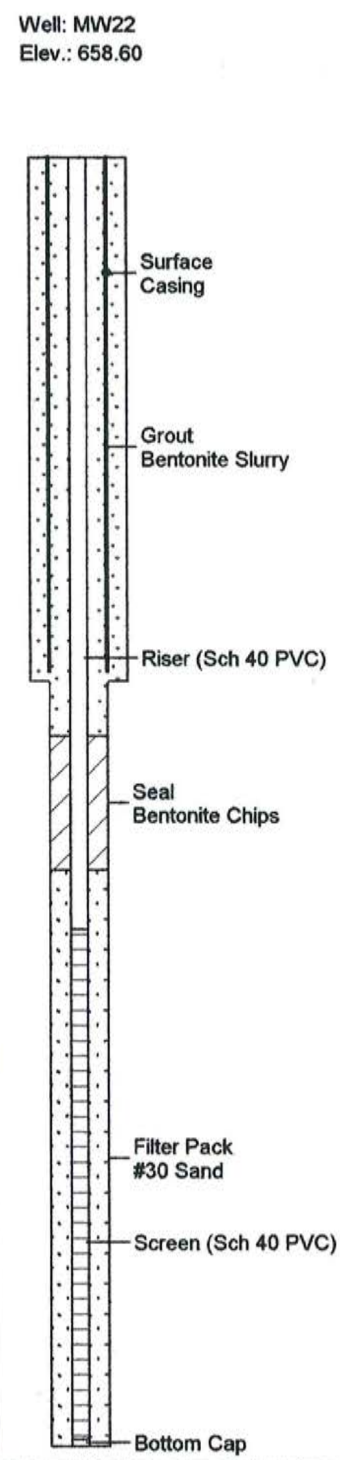
LOG OF BORING MW22

East Ash Pond Hydrogeologic Investigation
Vermilion Power Station
Dynegy Midwest Generation, Inc.

Location: Twp 20N, Rng 12W, 20 SW/NE/SE

Date Completed	: 11/30/2001	Driller	: Dusty Jackson
Hole Diameter	: 4 1/2; 2 1/2 inches	Geologist	: Eric Kovatch (NRT)
Drilling Method	: Rotary	Land Surface Elevation	: 655.6
Sampling Method	: HQ Core (2.5 inch)	Top of Casing Elevation	: 658.60
Drilling Company	: Mid-America Drilling, Inc.	X,Y Coordinates	: 1150083,1279669

Depth in Feet	DESCRIPTION	Surf. Elev. 655.6	Samples	Recovery inches	Blow Count	Qp TSF	USCS	GRAPHIC
50		605						
55		600						
60		595						
65		590						
70	SHALE, bedrock	585						
	HQ Core 1 (70.5-80: 9.5 ft recovery) - weathered, blocky, fissile, soft, dark gray							
75		580	1	114				
	- competent, hard, dark gray; laminated with clay/ silt seams/lenses, <1 to 4 mm, light gray							
80	- seams/lenses of light gray clay/silt from <1 to 11mm	575						
	HQ Core 2 (80-90: 10 ft recovery) - same as above with occasional blue tint, blocky when sheared							
85		570	2	120			SH	
90	- seams/lenses of light gray clay/silt from <1 to 2 cm	565						
	HQ Core 3 (90-100: 10 ft recovery)							
95		560	3	120				
	END BOREHOLE AT 100 FEET BLS							
100								



KELRON Environmental

LOG OF BORING MW23

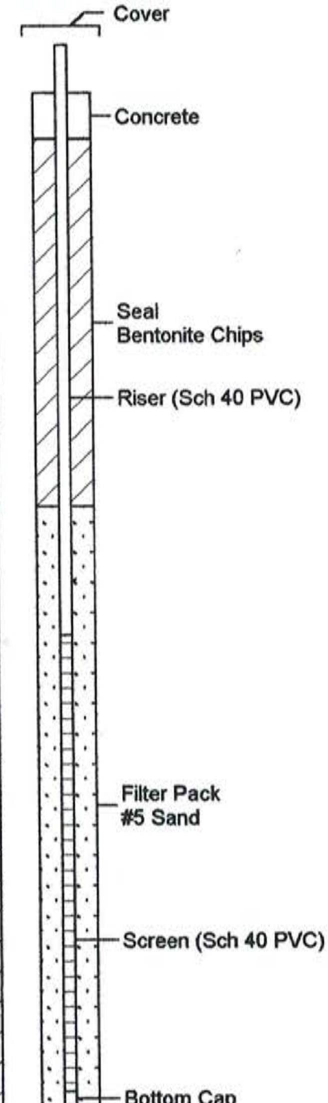
East Ash Pond Hydrogeologic Investigation
Vermilion Power Station
Dynegy Midwest Generation, Inc.

Location: Twp 20N, Rng 12W, 20 NE/NE/SE

Date Completed	: 12/03/2001	Driller	: Dusty Jackson
Hole Diameter	: 5 7/8 inch	Geologist	: Rebecca Caudill (NRT)
Drilling Method	: Hollow-stem	Land Surface Elevation	: 599.2
Sampling Method	: Split-Spoon	Top of Casing Elevation	: 601.89
Drilling Company	: Mid-America Drilling, Inc.	X,Y Coordinates	: 1150788, 1280399

Depth in Feet	DESCRIPTION	Surf. Elev. 599.19	Samples	Recovery inches	Blow Count	Qp TSF	USCS
0	SAND (fine-med) with silt, poorly graded, trace fine gravel, reddish-yellow, very moist	599					SP-SM
2		597	1	15	9 5 4 3		
4		595	2	13	9 5 6 8		
	Silty SAND (fine-crse) with gravel (fine-crse), dark brown (15% clay), slightly moist						SM
6		593	3	16	5 12 17 27		
	GRAVEL (fine-crse), angular limestone and dolomite						GP
8	Silty GRAVEL (fine) with sand (med-crse) and trace clay, poorly graded, slightly moist	591	4	7	23 24 28 28		GM
10	SILT with sand (fine), yellow with dark brown and black mottling, laminated	589	5	16	18 22 22 23	1.5	ML
12	- alternating layers (< 2 inches) of silt with sand and coarse sand with trace silt and fine gravel - grades to silt with gravel, yellow brown, hard, slightly moist	587	6	18	23 33 27 50	1.0	
14	Sandy CLAY with gravel; lean clay, fine-med sand, fine gravel; very hard, olive, slightly moist	585	7	15	23 29 39 41	>4.5	CL
16	- grades to sandy lean clay with trace gravel	583	8	15	28 49 50	>4.5	
18		581	9	18	22 35 36 50	>4.5	
20	- with fine sand, trace gravel, slightly moist	579	10	11	12 20 29	>4.5	
22	Weathered SHALE Bedrock, lean clay with silt, dark bluish gray grading to greenish gray and deeper green, hard, low-med plasticity, moist to very moist	577	11	18	17 27 41 68	3.5	SH
24		575	12	13	33 49 50	>4.5	
26		573	13	6	37 50	>4.5	
28	END BOREHOLE AT 28 FEET BLS						

Well: MW23
Elev.: 601.89



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KELRON Environmental

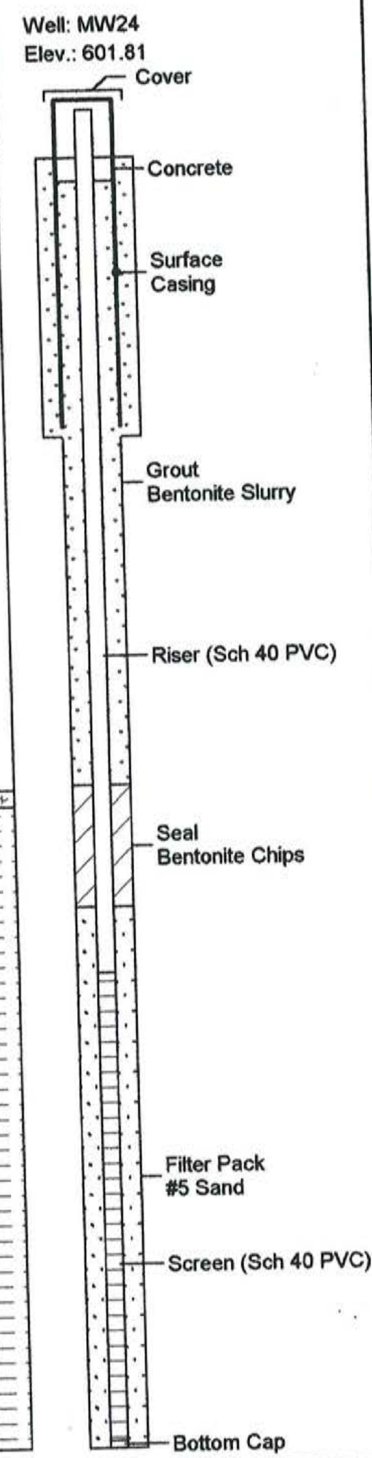
LOG OF BORING MW24

East Ash Pond Hydrogeologic Investigation
Vermilion Power Station
Dynegy Midwest Generation, Inc.

Location: Twp 20N, Rng 12W, 20 NE/NE/SE

Date Completed	: 12/03/2001
Hole Diameter	: 5 7/8, 4 1/2; 2 1/2 inches
Drilling Method	: Hollow-Stem / Rotary
Sampling Method	: HQ Core (2.5 inch)
Drilling Company	: Mid-America Drilling, Inc.
Driller	: Dusty Jackson
Geologist	: Rebecca Caudill (NRT)
Land Surface Elevation	: 598.8
Top of Casing Elevation	: 601.81
X,Y Coordinates	: 1150783, 1280404

Depth in Feet	DESCRIPTION	Surf. Elev. 598.8	Samples	Recovery inches	Blow Count	Qp TSF	USCS	GRAPHIC
0		598						
5	Blind Drill to 27 feet - see log of Well MW23	593						
10	Surface Casing = 4.3 I.D. / 4.5 inch O.D. Installed to 11.5 feet below ground	588						
15		583						
20		578						
25		573						
	Weathered SHALE bedrock, lean clay with silt, greenish gray to dark gray; with occasional light gray seams/lenses of laminated clay/silt from <1 to 4 mm						SH	
30	SHALE bedrock, competent, hard	568	1	92.5				
	HQ Core 1 (27-35: 7.7 ft recovery)							
35	- light gray seams/lenses of clay/silt from <1 to 10 mm	563						
40	HQ Core 2 (35-45: 9.9 ft recovery)	558	2	119			SH	
45	- light gray seams/lenses of clay/silt are <1 to 2 mm	553						
50	HQ Core 3 (45-55: 9.8 ft recovery)	548	3	118				
55	END BOREHOLE AT 55 FEET BLS							



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KELRON Environmental	LOG OF BORING MW25
	(Page 1 of 1)

East Ash Pond Hydrogeologic Investigation
Vermilion Power Station
Dynegy Midwest Generation, Inc.

Location: Twp 20N, Rng 12W, 29 NW/NW/NW

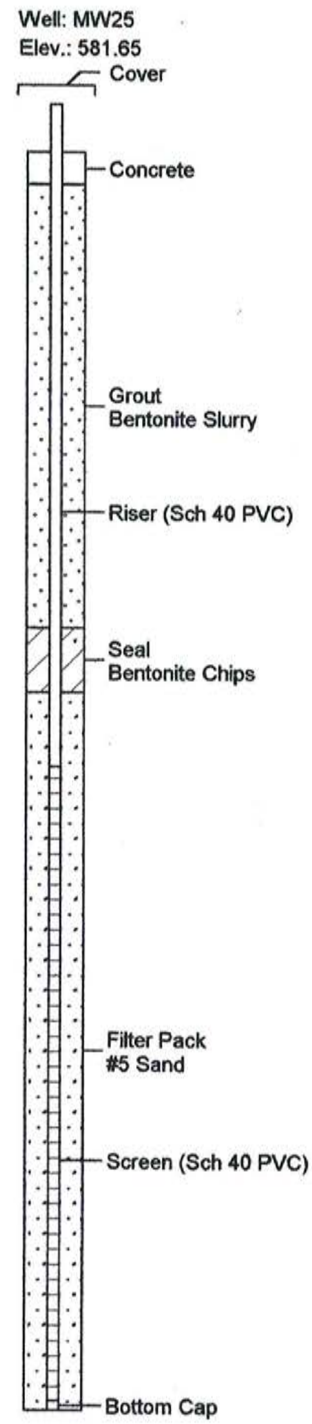
Date Completed	: 12/04/2001	Driller	: Dusty Jackson
Hole Diameter	: 5 7/8; 4 1/2; 2 1/2 inches	Geologist	: Rebecca Caudill
Drilling Method	: Hollow-stem / Rotary	Land Surface Elevation	: 578.8
Sampling Method	: Split-Spoon / HQ Core (2.5 inch)	Top of Casing Elevation	: 581.65
Drilling Company	: Mid-America Drilling, Inc.	X,Y Coordinates	: 1150916, 1278027

Depth in Feet	DESCRIPTION	Surf. Elev. 578.8	Samples	Recovery inches	USCS
0	CLAY lean, medium plasticity, firm, light brown-gray with 20% strong brown mottling, moist	578			
			1	6	CL
5	- greenish gray w 30% mottling	573	2	18	
	SAND grading to Clayey SAND (medium, rounded), wet		3	22	SC
	SAND with clay and gravel (fine subangular gravel)				SP
	Weathered SHALE bedrock,lean clay with silt, greenish gray		4	9	SH
10	SHALE, bedrock, competent, very hard, dark gray; with thin light gray laminations (seams and lenses) of clay/silt <1 to 6 mm	568			
15	HQ Core 1 (9-19: 9.8 ft recovery) (2.25 inch diameter)	563	5	118	
20	- seams of light gray clay/silt (laminations) range from 1mm to 3 cm	558			
25	HQ Core 2 (19-29: 9.9 ft recovery)	553	6	119	SH
30	- seams of light gray laminations less than 1 mm	548			
35	HQ Core 3 (29-39: 9.9 ft recovery)	543	7	119	
	END BOREHOLE AT 39 FEET BLS				
40					

Blow Count: 6 7 7 3 5 7 11 15 5 6 8 11 10 75

Qp TSF

GRAPHIC



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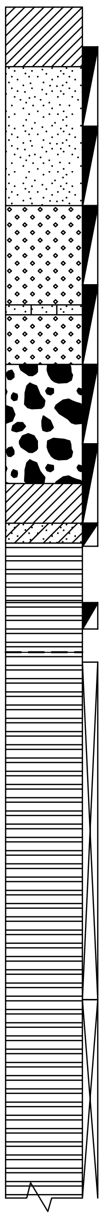
LOG OF BORING MW26/MW27

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 580.4 Feet

Date Drilled: 11/26/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: Hollow Stem
Logged By: Kelron Environmental, Inc.



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
580 — 0			CL	*Silty and Sandy CLAY, with Roots, Dark Brown, Moist*				
	3 3 3 4	20/24	SP	*SAND (Fine), well sorted, Light Yellow-Brown, Moist*		1.75 Qp		
	3 4 4 4	20/24						
575 — 5	4 5 4 4	14/24	SW	*SAND (Fine-Medium) with Shell Fragments, Poorly Sorted, Light Brown, Moist*				
	3 5 7 10	18/24		*-Wet*				
			SM	*Clayey and Silty SAND (Fine), Dark Brown*				
			SW	*SAND (Fine-Coarse) with Trace Fine Gravel (Angular-Subrounded), Poorly Sorted*				
570 — 10	7 8 12 17	6/24	GW	*SAND (Fine-Coarse) and GRAVEL (Fine, Subangular-Subrounded), Poorly Sorted*				
	7 15 18 29	8/24						
			CL	*Silty CLAY, Olive-Gray; Alluvial*				
	25 50	7/7	SC	*SAND (Medium-Coarse) with Silty Clay, Olive-Gray; Alluvial, Wet*				
565 — 15	35 50	8/8		*Weathered SHALE Bedrock Lean Clay with Silt, Uniform, Medium Greenish Gray, Moist*				
				SHALE Bedrock, Hard, Fissile with Horizontal Parting, Greenish Gray				
				SHALE Bedrock, Competent with Yellow-Brown Very Fine Sand/Silt Seams and Lenses (<1 mm to 2 cm), Light Gray to Olive Gray				
560 — 20		102/102						
555 — 25				*-Gray to Dark Gray; with Thin Laminations (Seams/Lenses) of Clay/Silt/Very Fine Sand (<1 to 4 mm), Light Gray*				
30								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER ∇ ▼

Piezometer Installed: No

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LOG OF BORING MW26/MW27 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 580.4 Feet

Date Drilled: 11/26/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: Hollow Stem
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
550 / 30		120/120		*SHALE Bedrock, Competent with Yellow-Brown Very Fine Sand/Silt Seams and Lenses (<1 mm to 2 cm), Light Gray to Olive Gray (continued)*				
545 / 35								
540 / 40		108/108						
535 / 45				*TD - 44.0 Feet*				
530 / 50								
525 / 55								
60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER ∇ ▼

Piezometer Installed: No

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A Division of Environmental Operations, Inc.

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Illinois (618) 398-1414

LOG OF BORING MW30

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 645.7 Feet

Date Drilled: 11/21/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: HA & Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0 / 645			CL	*Silty CLAY Till with Trace Fine-Medium Sand, Olive, Moist*				
5 / 640	9 7 12 17	20/24		*-with Light Gray Mottling Grading to Brown, Trace Fine Gravel*		4.5 Qp		
			ML	*SILT with Fine Sand Grading to Silty SAND, Olive, Dry*				
10 / 635	7 9 14 20	20/24		*-Very Moist*		>4.5 Qp		
			CL	*Silty CLAY TILL with Trace Sand and Gravel, Dry*				
15 / 630	16 25 34 48	24/24		*-Medium Gray*		>4.5 Qp		
20 / 625	27 47 50	17/17		*-Moist* *-with Sand and Gravel, Medium Brown*		>4.5 Qp		
			SW	*SAND ans GRAVEL, Fine-Coarse Sand, Fine Gravel, Light Brown, Dry*				
			CL	*Silty CLAY Till with Sand and Gravel (Fine)*				
25 / 620	11 25 37 50	17/17	SW	*SAND (Medium-Coarse) with Fine Gravel, Poorly Sorted, Wet*		>4.5 Qp		
			CL	*Silty CLAY Till with Fine Sand and Gravel, Dry*				
30	33 50	13/13	SP					

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER

Piezometer Installed: No

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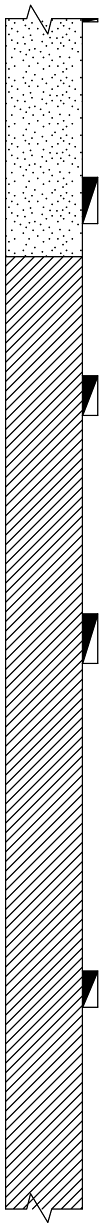
LOG OF BORING MW30 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 645.7 Feet

Date Drilled: 11/21/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: HA & Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
615 / 30	50			*SAND (Fine), Well Sorted, Light Brown, Moist (continued)*				
35	49 50	14/14						
610			CL	*Silty CLAY Till with Sand and Gravel, Medium Gray, Dry*				
40	36 107	12/12				>4.5 Qp		
605 / 45	29 45 50	15/15				>4.5 Qp		
600 / 50								
595 / 55	62 112	11/11				>4.5 Qp		
590 / 60								



(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING MW30 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 645.7 Feet

Date Drilled: 11/21/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: HA & Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
585 / 60				*Silty CLAY Till with Sand and Gravel, Medium Gray, Dry (continued)*				
580 / 65	27 37 50	15/18				>4.5 Qp		
575 / 70								
570 / 75		12/12	ML	*SILT, Medium Gray, Slightly Moist*				
			CL	*Silty CLAY Till with Trace Sand and Gravel, Medium Gray*				
565 / 80								
560 / 85	66 78	10/10	SM	*Silty SAND (Fine), Well Sorted, Medium Gray, Wet*				
			CL	*Silty CLAY Till with Trace Sand and Gravel, Medium Gray, Moist*				
90								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER

Piezometer Installed: No

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A Division of Environmental Operations, Inc.
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LOG OF BORING MW30 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 645.7 Feet

Date Drilled: 11/21/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: HA & Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
555 / 90				*Silty CLAY Till with Trace Sand and Gravel, Medium Gray, Moist (continued)*				
550 / 95	33 28 52 54	22/22				>4.5 Qp		
545 / 100								
540 / 105	26 34 40 46	20/24		*-Dark Brown with 2x6 mm Piece of Wood, Trace Sand, Plastic, Olive Gray* *-Layer of Clay with Silt, Plastic (Thickness Unkown)*		>4.5 Qp		
535 / 110								
530 / 115	32 47 50	17/17						
	135	6/6		*SHALE, Bedrock, Very Hard, Light Gray, Dry, Fissile*				
120								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER

Piezometer Installed: No

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A Division of Environmental Operations, Inc.

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BORING LOG W/OUT B DESIGNATION 6451 GINT LOGS.GPJ IL_DOT.GDT 7/13/11

LOG OF BORING MW30 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 645.7 Feet

Date Drilled: 11/21/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: HA & Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
525 / 120				*SHALE, Bedrock, Very Hard, Light Gray, Dry, Fissile (continued)*				
		118/120						
520 / 125								
515 / 130								
		120/120						
510 / 135								
505 / 140								
		108/108						
500 / 145				*COAL with Vertical, Calcite Filled Fractures, Black, Slightly Moist*				
				TD - 148.0 Feet				
150								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes & Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER ∇ ▼

Piezometer Installed: No

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A Division of Environmental Operations, Inc.

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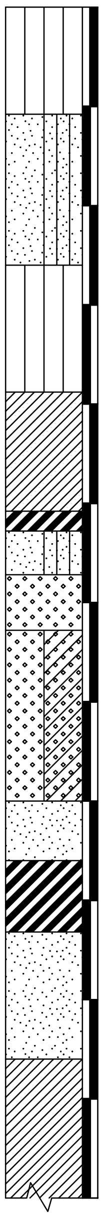
Illinois (618) 398-1414

LOG OF BORING MW34

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 590.0 Feet

Date Drilled: 10/20/10
Drilling Contractor: PSC
Drilling Method: Hollow Stem
Logged By: Kelron Environmental, Inc.

Graphic Log Sampler Symbols and SPT Blows:



Elevation/ Depth (feet)	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
590—0	47/60	ML	*Sandy SILT, Trace Clay, Brownish-Yellow (10YR-6/6), Moist*				
		SP-SM	*SAND (Fine) with Silt, Poorly Graded, Dry* *-Moist* *-Trace Coarse Sand*				
585—5	41/60	ML	*Sandy SILT, Trace Clay*				
580—10	48/60	CL	*Silty CLAY, Very Soft, Non-Plastic, Light Gray(Gley1-7/N) with Yellow-Brown Mottling (50%), Moist* *-Trace Fine Sand, Medium Soft, Reddish-Brown Mottling (25%)* *-2-Inch Seam Sand (Fine-Coarse), Trace Gravel*				
		CH	*CLAY, Very Soft, High Plasticity*				
		SP-SM	*SAND (Fine) with Silt, Poorly Graded, Gray (Gley 1-6/N), wet*				
575—15		SW	*SAND, Fine-Coarse, Trace Gravel, Well Graded, Trace Shells-Loose, Dar Gray (Gley1-4/N)*				
	22/60	SW-SC	*SAND (Fine-Coarse) with Clay, Well Graded, Dense, Trace Shells*				
570—20		SP	*SAND (Fine), Poorly Graded, Loose, Dark Gray (Gley 1-5/N)*				
	42/60	CH	*CLAY with Sand (Fine-Coarse), Trace Gravel, Stiff, Trace Shells, Moist to Wet*				
565—25		SP	*SAND (Fine, Trace Coarse), Poorly Graded, Medium Dense, Trace Shells, Gray (Gley 1-6/N), Wet*				
	43/60	CL	*Silty CLAY, Little Sand (Fine-Coase), Trace Gravel, Stiff-Very Stiff, Low Plasticity, Gray, Moist* *-Medium to High Plasticity*				
560—30							

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental presented in a report dated October 2011.

GROUNDWATER

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING MW34 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 590.0 Feet

Date Drilled: 10/20/10
Drilling Contractor: PSC
Drilling Method: Hollow Stem
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
560—30				*Silty CLAY, Little Sand (Fine-Coase), Trace Gravel, Stiff-Very Stiff, Low Plasticity, Gray, Moist (continued)*				
		49/60		*-1-Inch Sand Seam (Fine-Medium)*				
555—35			SP	*SAND (Fine, Trace Medium), Poorly Graded, Wet*				
			ML	*SILT*				
		48/60	CL	*Silty CLAY, Very Stiff, Non Plastic, Moist*				
			SP	*SAND (Fine), Poorly Graded, Wet*				
			SW	*SAND (Fine-Coarse) with Gravel (Fine-Coarse), Well Graded*				
550—40			CL	*Silty CLAY, Few Sand (Fine-Coarse), Trace Gravel, Very Stiff, Non Plastic, Greenish Gray (Gley1-5/10Y), Moist*				
			ML	*SILT with Little Sand (Fine), Gray (Gley 1-6/N), Wet*				
			CL	*Silty CLAY, few Sand (fine-Medium), Stiff, Medium Plasticity, Moist*				
		45/60	SW	*SAND (Fine-Coarse), Trace Gravel (Fine), Well Graded, Dense, Wet*				
			SP	*SAND (Fine), Poorly Graded*				
545—45			SW	*SAND (Fine-Coarse), Trace Gravel, Well Graded*				
			SP	*SAND (Fine), Trace Medium-Coarse, Poorly Graded, Loose, Gray*				
			SW	*SAND with GRAVEL, Fine-Coarse, Well Graded*				
		45/60	SP	*SAND (Fine), Trace Medium-Coarse, Poorly Graded, Loose, Gray (Gley 1-6/N)* *-Dense, Greenish-Gray (Gley 1-6/1)*				
540—50								
		51/60						
			SW	*SAND (Medium-Coarse), Well Graded, Wet*				
535—55			CH	*Silty CLAY, Trace Sand and Gravel, Soft to Very Soft, High Plasticity, Dark Greenish-Gray, moist (Gley 1-4/1)*				
		55/60						
530—60								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental presented in a report dated October 2011.

GROUNDWATER

Piezometer Installed: No

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A Division of Environmental Operations, Inc.
Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING MW34 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 590.0 Feet

Date Drilled: 10/20/10
Drilling Contractor: PSC
Drilling Method: Hollow Stem
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
530 — 60			ML	SILT, Moist (continued)				
		46/60	CH	Silty CLAY, Medium Stiff, High Plasticity, Moist				
525 — 65			CL	CLAY, Stiff				
		54/60	CL	Silty CLAY, Medium Stiff, Non-Plastic, Very Dark Greenish-Gray (Gley 1-3/1), Moist -Medium to High Plasticity				
			CL	CLAY, Few Sand (Fine), Very Stiff to Hard, Medium to High Plasticity, Very Dark Greenish-Gray, Dry				
520 — 70				TD - 70.0 Feet				
515 — 75								
510 — 80								
505 — 85								
500 — 90								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental presented in a report dated October 2011.

GROUNDWATER ∇ ▼

Piezometer Installed: No

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Illinois (618) 398-1414

KELRON Environmental

LOG OF BORING MW32

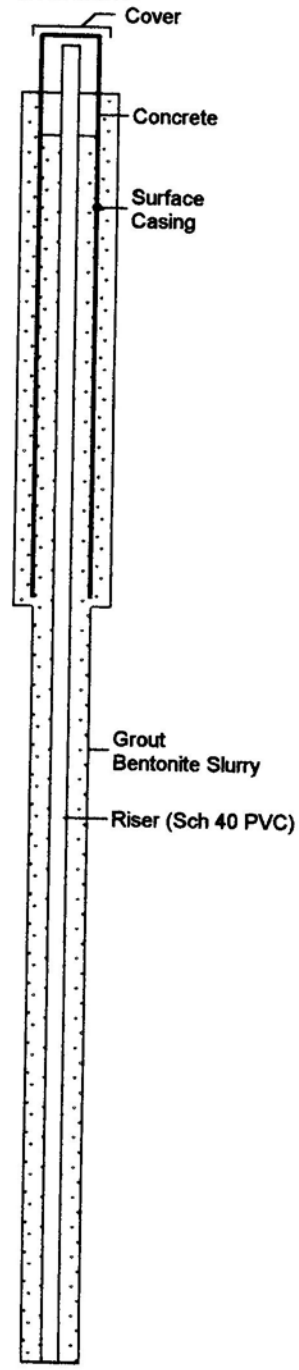
East Ash Pond Hydrogeologic Investigation
Vermilion Power Station
Dynegy Midwest Generation, Inc.

Location: Twp 20N, Rng 12W, 21 NW/NW/SW

Date Completed	: 12/04/2001
Hole Diameter	: 5 7/8, 4 1/2; 2 1/2 inches
Drilling Method	: Hollow-Stem / Rotary
Sampling Method	: HQ Core (2.5 inch)
Drilling Company	: Mid-America Drilling, Inc.
Driller	: Dusty Jackson
Geologist	: Rebecca Caudill (NRT)
Land Surface Elevation	: 581.9
Top of Casing Elevation	: 585.00
X,Y Coordinates	: 1151312, 1279850

Depth in Feet	DESCRIPTION	Surf. Elev. 581.9	Samples	Recovery inches	Blow Count	Qp TSF	USCS	GRAPHIC
0	Clayey SAND, fine, rounded, well sorted, dark reddish brown, slightly moist	581						
	Surface Casing = 4.3 I.D. / 4.5 inch O.D. Installed to 11.96 feet (143.5 inches below ground)		1	21	4 5 5 7		SC	
5			2	2	5 5 6 6			
	CLAY with Sand (fine), lean, firm, plastic, light yellowish brown with strong brown mottling, very moist; grades to sand at 7 feet	576	3	22	5 6 7 8		CL	
	SAND, medium, rounded, well sorted, with trace silt, brown, slightly moist - same as above with 10% crse sand, trace gravel		4	23	5 5 5 6		SP	
10	Weathered SHALE bedrock, gray; upper 2 inches very moist		5	6	14 67		SH	
	SHALE bedrock, competent, hard; medium to dark gray; with fine laminations from seams/lenses of light gray clay/silt, some with cross-bedding, <1 mm to 4 cm	571						
15	HQ Core 1 (11.5-21.5: 9.75 ft recovery)	566	6	117				
20	- light gray seams/lenses range from <1 to 4 mm	561					SH	
25	HQ Core 2 (21.5-31.5: 9.9 ft recovery)	556	7	119				
30								

Well: MW32
Elev.: 585.00



KELRON
Environmental

LOG OF BORING MW32

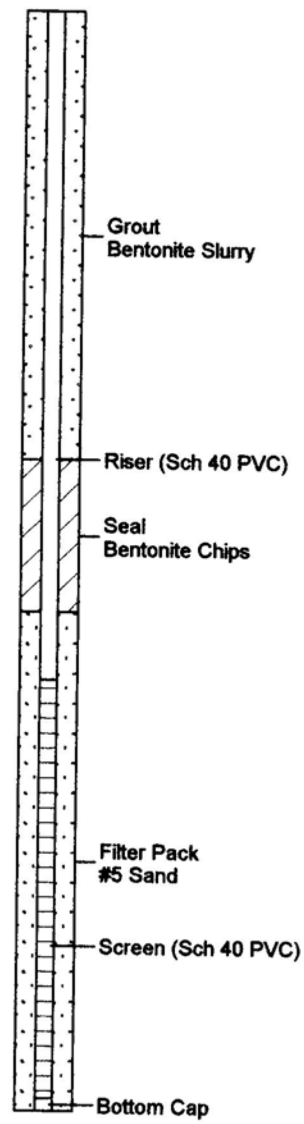
East Ash Pond Hydrogeologic Investigation
Vermilion Power Station
Dynegy Midwest Generation, Inc.

Location: Twp 20N, Rng 12W, 21 NW/NW/SW

Date Completed	: 12/04/2001	Driller	: Dusty Jackson
Hole Diameter	: 5 7/8, 4 1/2; 2 1/2 inches	Geologist	: Rebecca Caudill (NRT)
Drilling Method	: Hollow-Stem / Rotary	Land Surface Elevation	: 581.9
Sampling Method	: HQ Core (2.5 inch)	Top of Casing Elevation	: 585.00
Drilling Company	: Mid-America Drilling, Inc.	X,Y Coordinates	: 1151312, 1279850

Depth in Feet	DESCRIPTION	Surf. Elev. 581.9	Samples	Recovery inches	Blow Count	Qp TSF	USCS	GRAPHIC
30								
	- light gray seams/lenses range from <1 to 7 mm	551	7	119				
35								
	HQ Core 3 (31.5-41.5: 10 ft recovery)	546	8	120				
40								
	- light gray seams/lenses range from <1 to 2 cm	541					SH	
45								
	HQ Core 4 (41.5-51.5: 9.9 ft recovery)	536	9	118.5				
50		531						
	HQ Core 5 (51.5-56: 4.4 ft recovery)		10	52.5				
55	END BOREHOLE AT 56 FEET BLS	526						
60								

Well: MW32
Elev.: 585.00



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NATURAL RESOURCE TECHNOLOGY

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Station		MW35D

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Bruno Williamson Ramsey Geotechnical Engineering	3/1/2017	3/3/2017	rotary/auger

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
MW35D	Feet (NAVD88)	581.25 Feet (NAVD88)	7.3 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 1,279,955.58 N, 1,151,276.17 E (E)/W
1/4 of 1/4 of Section , T N, R
Lat 40° 10' 47.14212"
Long 87° 44' 8.06652"
Local Grid Location: Feet ☐ N ☐ S, Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	IL	Danville

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 SS	24 / 16.5	2 2 3 3	0–2.5	0 - 2.5' **FILL, SILT:** ML, very dark grayish brown (10YR 3/2), 15-30% silt, trace wood and roots, cohesive, low plasticity, moist.	(FILL) ML								
2 SS	24 / 19	1 3 3 3	2.5–4.3	2.5 - 4.3' **SANDY LEAN CLAY:** s(CL), weak red (2.5YR 4/2), 5-15% fine sand, sand content increasing with depth, low plasticity, moist.	s(CL)								
3 SS	24 / 21	2 3 4 3	4.3–8	4.3 - 8' **POORLY-GRADED SAND:** SP, yellowish brown (10YR 5/6), fine sand, 15-30% clay, moist. 5.1' trace clay. 7.5' trace gravel and cobbles.	SP								Auger bringing up cobbles on flights.
4 SS	24 / 18	3 3 3 3											
5 SS	24 / 10	3 4 4 22	8–8.5	8 - 8.5' **FAT CLAY:** CH, very dark grayish brown (10YR 3/2), trace silt, high plasticity, moist.	CH			0.5					
			8.5–10	8.5 - 10' **Weathered SHALE Bedrock** BDX (SH), very dark grayish brown (10YR 3/2) to very dark greenish gray (GLEY 1 3/10Y), highly weathered, red (7.5YR 4/6) discoloration, fissile, moist.	BDX (SH)								
6 SS	15 / 15	20 34 50 for 3"	10–15.6	10 - 15.6' **Weathered SHALE Bedrock** to **SHALE:** BDX (SH), gray (GLEY 1 6/N), weak, fissile, intensely fractured, red (7.5YR 4/6) discoloration, dry.	BDX (SH)								

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

NATURAL RESOURCE TECHNOLOGY

Boring Number MW35D

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
7 SS	8 9	45 50 for 2"	13	10 - 15.6' **Weathered SHALE Bedrock** to **SHALE:** BDX (SH), gray (GLEY 1 6/N), weak, fissile, intensely fractured, red (7.5YR 4/6) discoloration, dry. *(continued)*	BDX (SH)									
8 SS	9 7	31 50 for 3"	14 15											
9 CORE	120 120		16 17 18 19 20 21 22 23 24 25	15.6 - 45.8' **SHALE:** BDX (SH), dark reddish gray (10YR 4/1) to gray (2.5Y 5/1), microcrystalline, thinly bedded to laminated, weak, slightly decomposed (very dark gray (10YR 3/1) to black (10YR 2/1) discoloration in partly healed fractures), competent, dry to moist in fractures.	BDX (SH)									Core 9, RQD = 89%. Light brown gray return water. 4" diameter outer casing set from 0-16 ft bgs.
10 CORE	131.3 120		26 27 28 29 30 31 32	25.6' partly to totally healed fractures.										Core 10, RQD = 89%. Light gray return water.

NATURAL RESOURCE TECHNOLOGY

Boring Number MW35D

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
11 CORE	111.1 120		33–45	15.6 - 45.8' **SHALE:** BDX (SH), dark reddish gray (10YR 4/1) to gray (2.5Y 5/1), microcrystalline, thinly bedded to laminated, weak, slightly decomposed (very dark gray (10YR 3/1) to black (10YR 2/1) discoloration in partly healed fractures), competent, dry to moist in fractures. *(continued)* 41.9' - 43' crossbedding.	BDX (SH)									Core 11, RQD = 93%. Gray return water.
				45.8' End of Boring.										

SOIL BORING LOG INFORMATION

NATURAL RESOURCE TECHNOLOGY

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Station		MW35S

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Bruno Williamson Ramsey Geotechnical Engineering	3/1/2017	3/1/2017	hollow stem auger

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
MW35S	Feet (NAVD88)	581.15 Feet (NAVD88)	7.3 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 1,279,958.41 N, 1,151,272.97 E Ⓔ/W
1/4 of 1/4 of Section , T N, R

Lat 40° 10 '47.17026 "
Long 87° 44 ' 8.10749"

Local Grid Location
Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	IL	Danville

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
			0	0 - 2.5' **FILL, SILT:** ML, Blind Drill. See MW35D Boring Log for Detailed Lithology.	(FILL) ML									Blind Drill.
			2.5	2.5 - 4.3' **SANDY LEAN CLAY:** s(CL).	s(CL)									
			4.3	4.3 - 8' **POORLY-GRADED SAND:** SP.	SP									
			8	8 - 8.5' **FAT CLAY:** CH.	CH									
			8.5	8.5' End of Boring.										

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

Signature	Firm
[signature]	Natural Resource Technology 234 W. Florida St., Fifth Floor, Milwaukee, WI 53204 Tel: (414) 837-3607 Fax: (414) 837-3608

Template: ILLINOIS BORING LOG - Project: 2411 GINT 2017.GPJ

LOG OF BORING TW-1

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 574.9 Feet

Date Drilled: 10/21/10
Drilling Contractor: PSC
Drilling Method: Hand Auger
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0			SP	*SAND, (Medium-Coarse) with Some Gravel, Poorly Graded, Dry to Moist*				
				TD - 3.9 Feet				
570 / 5								
565 / 10								
560 / 15								
555 / 20								
550 / 25								
545 / 30								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental presented in a report dated October 2011.

GROUNDWATER

▽

▼ At Completion - 1.5 Feet

Piezometer Installed: No

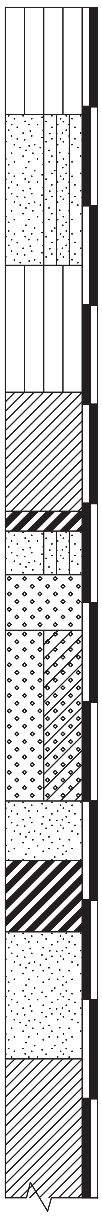
Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING MW34

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 590.0 Feet

Date Drilled: 10/20/10
Drilling Contractor: PSC
Drilling Method: Hollow Stem
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
590—0		47/60	ML	Sandy SILT, Trace Clay, Brownish-Yellow (10YR-6/6), Moist				
585—5			SP-SM	SAND (Fine) with Silt, Poorly Graded, Dry -Moist -Trace Coarse Sand				
		41/60	ML	Sandy SILT, Trace Clay				
580—10		48/60	CL	Silty CLAY, Very Soft, Non-Plastic, Light Gray(Gley1-7/N) with Yellow-Brown Mottling (50%), Moist -Trace Fine Sand, Medium Soft, Reddish-Brown Mottling (25%) -2-Inch Seam Sand (Fine-Coarse), Trace Gravel				
			CH	CLAY, Very Soft, High Plasticity				
			SP-SM	SAND (Fine) with Silt, Poorly Graded, Gray (Gley 1-6/N), wet				
575—15			SW	SAND, Fine-Coarse, Trace Gravel, Well Graded, Trace Shells-Loose, Dar Gray (Gley1-4/N)				
		22/60	SW-SC	SAND (Fine-Coarse) with Clay, Well Graded, Dense, Trace Shells				
570—20			SP	SAND (Fine), Poorly Graded, Loose, Dark Gray (Gley 1-5/N)				
		42/60	CH	CLAY with Sand (Fine-Coarse), Trace Gravel, Stiff, Trace Shells, Moist to Wet				
565—25			SP	SAND (Fine, Trace Coarse), Poorly Graded, Medium Dense, Trace Shells, Gray (Gley 1-6/N), Wet				
560—30		43/60	CL	Silty CLAY, Little Sand (Fine-Coase), Trace Gravel, Stiff-Very Stiff, Low Plasticity, Gray, Moist -Medium to High Plasticity				

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental presented in a report dated October 2011.

GROUNDWATER
▽
▼

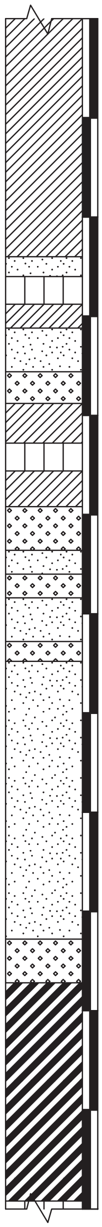
Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.
Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING MW34 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 590.0 Feet

Date Drilled: 10/20/10
Drilling Contractor: PSC
Drilling Method: Hollow Stem
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
560—30		49/60		*Silty CLAY, Little Sand (Fine-Coase), Trace Gravel, Stiff-Very Stiff, Low Plasticity, Gray, Moist (continued)* *-1-Inch Sand Seam (Fine-Medium)*				
555—35								
		48/60	SP	*SAND (Fine, Trace Medium), Poorly Graded, Wet*				
			ML	*SILT*				
			CL	*Silty CLAY, Very Stiff, Non Plastic, Moist*				
			SP	*SAND (Fine), Poorly Graded, Wet*				
550—40			SW	*SAND (Fine-Coarse) with Gravel (Fine-Coarse), Well Graded*				
			CL	*Silty CLAY, Few Sand (Fine-Coarse), Trace Gravel, Very Stiff, Non Plastic, Greenish Gray (Gley1-5/10Y), Moist*				
		45/60	ML	*SILT with Little Sand (Fine), Gray (Gley 1-6/N), Wet*				
			CL	*Silty CLAY, few Sand (fine-Medium), Stiff, Medium Plasticity, Moist*				
545—45			SW	*SAND (Fine-Coarse), Trace Gravel (Fine), Well Graded, Dense, Wet*				
			SP	*SAND (Fine), Poorly Graded*				
			SW	*SAND (Fine-Coarse), Trace Gravel, Well Graded*				
		45/60	SP	*SAND (Fine), Trace Medium-Coarse, Poorly Graded, Loose, Gray*				
540—50			SW	*SAND with GRAVEL, Fine-Coarse, Well Graded*				
		51/60	SP	*SAND (Fine), Trace Medium-Coarse, Poorly Graded, Loose, Gray (Gley 1-6/N)* *-Dense, Greenish-Gray (Gley 1-6/1)*				
			SW	*SAND (Medium-Coarse), Well Graded, Wet*				
535—55		55/60	CH	*Silty CLAY, Trace Sand and Gravel, Soft to Very Soft, High Plasticity, Dark Greenish-Gray, moist (Gley 1-4/1)*				
530—60								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental presented in a report dated October 2011.

GROUNDWATER

Piezometer Installed: No

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Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING MW34 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 590.0 Feet

Date Drilled: 10/20/10
Drilling Contractor: PSC
Drilling Method: Hollow Stem
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
530 — 60			ML	SILT, Moist (continued)				
		46/60	CH	Silty CLAY, Medium Stiff, High Plasticity, Moist				
525 — 65			CL	CLAY, Stiff				
		54/60	CL	Silty CLAY, Medium Stiff, Non-Plastic, Very Dark Greenish-Gray (Gley 1-3/1), Moist -Medium to High Plasticity				
			CL	CLAY, Few Sand (Fine), Very Stiff to Hard, Medium to High Plasticity, Very Dark Greenish-Gray, Dry				
520 — 70				TD - 70.0 Feet				
515 — 75								
510 — 80								
505 — 85								
500 — 90								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental presented in a report dated October 2011.

GROUNDWATER ∇ ▼

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING TW-1

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 574.9 Feet

Date Drilled: 10/21/10
Drilling Contractor: PSC
Drilling Method: Hand Auger
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0			SP	*SAND, (Medium-Coarse) with Some Gravel, Poorly Graded, Dry to Moist*				
				TD - 3.9 Feet				
570 — 5								
565 — 10								
560 — 15								
555 — 20								
550 — 25								
545 — 30								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental presented in a report dated October 2011.

GROUNDWATER

▽

▼ At Completion - 1.5 Feet

Piezometer Installed: No

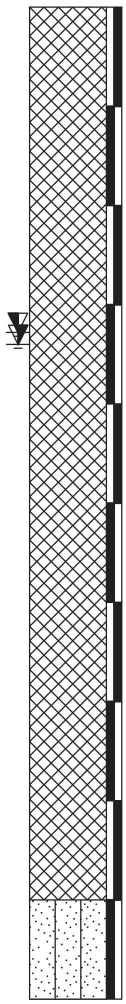
Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING VP-1

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 603.7 Feet

Date Drilled: 06/21/11
Drilling Contractor: PSC
Drilling Method: Geoprobe
Logged By: PSC



Elevation/ Depth (feet)	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
603.7 / 0	48/60		*FILL - Flyash, silty, very soft, medium to dark gray, some black lenses throughout, moist*				
5			*-wet*				
	60/60						
10	60/60		*ASH - SILT with Sand (ML); sand fine grained, very dark gray*				*Shelby Tube (ST-VP1 10-12) at 10-12 feet (18/24" recovery)*
	60/60						
22.5	60/60	SM	*SAND (fine) with Silt, poorly graded, olive-brown, wet*				
25			*TD - 25.0 Feet*				

Elevation scale: 600, 595, 590, 585, 580, 575. Depth scale: 0, 5, 10, 15, 20, 25, 30.

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental dated July 15, 2011.

GROUNDWATER

2 Days After Completion - 8.2 Feet
9 Days After Completion - 8.5 Feet

Piezometer Installed: Yes

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING VP-2

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 606.6 Feet

Date Drilled: 06/20/11
Drilling Contractor: PSC
Drilling Method: Geoprobe
Logged By: PSC

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0		60/60		*FILL - Flyash, silty to clayey, soft, medium to dark gray, moist*				
605				*-wet, very soft*				
5 / 600		60/60		*ASH - SILT (ML), trace fine sand, dark olive-brown*				*Shelby Tube (ST-VP2 5-7) at 5-7 feet (24/24" recovery)*
10 / 595		60/60						
15 / 590		60/60						
20 / 585		60/60						
25			CL	*Silty CLAY with Flyash lenses - transitional zone from Fill to native material*				
580		60/60	SM	*Silty SAND (fine grained), shells <2mm, poorly graded, loose, dark olive-brown*				
30								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental dated July 15, 2011.

GROUNDWATER

2 Days After Completion - 14.9 Feet
10 Days After Completion - 15.3 Feet
Piezometer Installed: Yes

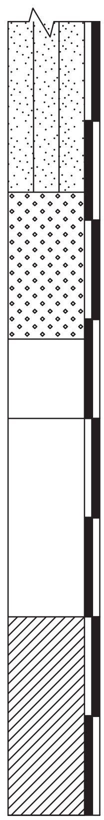
Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING VP-2 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 606.6 Feet

Date Drilled: 06/20/11
Drilling Contractor: PSC
Drilling Method: Geoprobe
Logged By: PSC



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30 / 575		42/60		*Silty SAND (fine grained), shells <2mm, poorly graded, loose, dark olive-brown (continued)* *-light gray* *-brown*				
35 / 570		44/60	SW	*Sand (fine-coarse) with gravel, well graded, gray* *-wood pieces up to 1.5"*				
				-no recovery from 38 to 40 feet; soft push at 38 feet indicating possible lithologic change - possible silt or reworked glacial				*No recovery 38-40 feet*
40 / 565		0/60		*-no sample recovery from 40 to 45 feet*				*No recovery from 40-45 feet*
45 / 560		60/60	CL	*Sandy CLAY (lean), trace fine gravel (subangular to angular), high plasticity, very stiff, dark gray-brown, moist (DIAMICTON)*				*Geotech sample (sieve/hydrometer) at 45-46 feet*
50 / 555				*TD - 50.0 Feet*				
55 / 550								
60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental dated July 15, 2011.

GROUNDWATER

2 Days After Completion - 14.9 Feet
10 Days After Completion - 15.3 Feet
Piezometer Installed: Yes

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING VP-3

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 611.2 Feet
Date Drilled: 06/21/11
Drilling Contractor: PSC
Drilling Method: Geoprobe
Logged By: PSC

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0				*FILL - Flyash, silty to clayey, soft, medium to dark gray, moist*				
610				*-wet*				
		60/60						
5 / 605		*60/60*						
10 / 600		*60/60*						
15 / 595		*60/60*						
20 / 590		*60/60*						
25 / 585		*60/60*						
30				*(continued)*				

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental dated July 15, 2011.

GROUNDWATER

2 Days After Completion - 11.5 Feet
9 Days After Completion - 11.8 Feet

Piezometer Installed: Yes

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

BORING LOG W/OUT B DESIGNATION 6451 GINT LOGS.GPJ IL_DOT.GDT 7/27/11

LOG OF BORING VP-3 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 611.2 Feet

Date Drilled: 06/21/11
Drilling Contractor: PSC
Drilling Method: Geoprobe
Logged By: PSC

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
580 / 30–35		60/60	CL/CH	*CLAY (lean to fat), high organics with roots and shells (<2mm), medium density, medium-high plasticity, very dark gray*		*1.5 Qp*		*Geotech sample (sieve/hydrometer) at 34.5-35 feet*
575 / 35–37		4/24	SM	*Silty SAND (fine grained), poorly graded, gray, wet*				*Shelby Tube (ST-VP3 35-37) at 35-37 feet (4/24" recovery)*
				TD - 37.0 Feet				

Depth scale (feet): 30, 35, 40, 45, 50, 55, 60
Elevation scale: 580, 575, 570, 565, 560, 555

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental dated July 15, 2011.

GROUNDWATER

2 Days After Completion - 11.5 Feet
9 Days After Completion - 11.8 Feet
Piezometer Installed: Yes

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING VP-4

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 627.2 Feet

Date Drilled: 06/22/11
Drilling Contractor: PSC
Drilling Method: Geoprobe
Logged By: PSC

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0				*FILL - Silt and Clay with rock, very hard, dry to moist*				
625		*36/60*						
5				*FILL - Flyash, silty and clayey, medium gray; lenses of black and brown coarser ash layers with coal fragments and cinders; generally soft, moist*				
620		*60/60*						
				ASH - SILT (ML), trace fine sand, dark gray				*Shelby Tube (ST-VP4 8-10) at 8-10 feet (24/24" recovery)*
10								
615		*50/60*						
15				*-wet*				
610		*60/60*						
				ASH - SILT with Sand (ML), dark gray				*Shelby Tube (ST-VP4 18-20) at 18-20 feet (24/24" recovery)*
20								
605		*60/60*						
25								
600		*60/60*						
30				*(continued)*				

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental dated July 15, 2011.

GROUNDWATER

1 Days After Completion - 35.65 Feet
8 Days After Completion - 35.4 Feet
Piezometer Installed: Yes

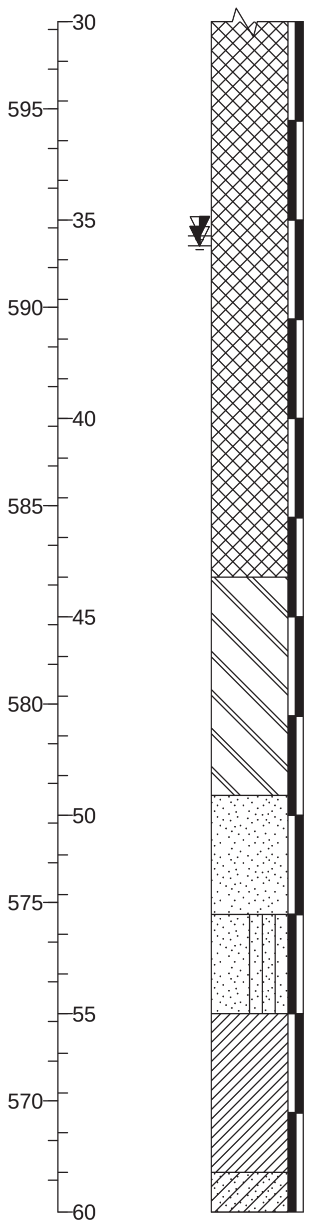
Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING VP-4 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 627.2 Feet

Date Drilled: 06/22/11
Drilling Contractor: PSC
Drilling Method: Geoprobe
Logged By: PSC



Elevation/ Depth (feet)	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30–44 (595, 590, 585)	60/60; 60/60; 60/60		*FILL - Flyash, silty and clayey, medium gray; lenses of black and brown coarser ash layers with coal fragments and cinders; generally soft, moist (continued)*				
44–49 (580)	60/60	CL/CH	*CLAY (lean to fat), trace fine sand, high organics, medium-high plasticity, gray-brown (2.5Y 4/2), moist* *-light olive-brown (2.5 4/6) with gray (2.5Y 5/1) mottling*		*4-2 Qp*		*Geotech sample (sieve/hydrometer) at 44-45 feet*
49–52 (575)	37/60	SP	*SAND (medium to coarse) with Gravel, shells <2mm, poorly graded, loose, dark gray-brown, wet* *-with fine-medium gravel, brownish-gray*				
52–55		SP-SM	*SAND (fine) with Silt, poorly graded, dark gray* *-no recovery from 53-55 feet*				*No recovery 53-55 feet*
55–59 (570)	60/60	CL	*Silty CLAY with fine gravel (subangular to angular), high plasticity, very stiff, moist (DIAMICTON)*		*>5.0 Qp*		
59–60		SC	*Clayey SAND (fine-med), tra gravel, dk gray*				*Geotech sample (sieve/hydrometer) at 59-60 feet*
60			*TD - 60.0 Feet*				

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental dated July 15, 2011.

GROUNDWATER

1 Days After Completion - 35.65 Feet
8 Days After Completion - 35.4 Feet

Piezometer Installed: Yes

Shively Geotechnical
A Division of Environmental Operations, Inc.
Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING VP-5

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 637.8 Feet
Date Drilled: 06/23/11
Drilling Contractor: PSC
Drilling Method: Geoprobe
Logged By: PSC

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0				*FILL - very hard, stiff, silty clay with sand and gravel, brown*				*Refusals at 6, 7 and 10 feet at three locations*
635		*48/60*						
5								*Offset 30 feet to northwest and began fourth probehole at 5 feet*
630		*60/60*		*FILL - Flyash, silty to clayey, dark gray, moist*				
10								
625		*60/60*		*ASH - Sandy SILT (ML), dark gray*				*Shelby Tube (ST-VP5 13-15) at 13-15 feet (24/24" recovery)*
15				*-wet*				
620		*60/60*						
20								
615		*49/60*		*-Flyash with gravel, including pyrite nodules, hard* *-no recovery at 24-25 feet*				*No recovery 24-25 feet*
25								
610		*41/60*						*Refusal of dual-tube system at 29 feet; proceed with MacroCore only*
30		*12/12*						

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental dated July 15, 2011.

GROUNDWATER

Piezometer Installed: Yes

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING VP-5 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 637.8 Feet

Date Drilled: 06/23/11
Drilling Contractor: PSC
Drilling Method: Geoprobe
Logged By: PSC

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30 – 40 (605, 600)		60/60 60/60		*FILL - very hard, stiff, silty clay with sand and gravel, brown (continued)* *-Interbedded layers of bottom ash/slag (hard) and flyash (medium to stiff) from 29-32 feet* *-Flyash with occasional thin layers of bottom ash*				
40 – 60 (595, 590, 585, 580)				*TD - 40.0 Feet*				*Refusal at 40 feet*

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Kelron Environmental dated July 15, 2011.

GROUNDWATER

Piezometer Installed: Yes

Shively Geotechnical
A Division of Environmental Operations, Inc.
Missouri (314) 241-0900
Illinois (618) 398-1414

Illinois Environmental Protection Agency Well Completion Report

SITE #: None COUNTY: Vermilion WELL #: MW-34

SITE NAME: Vermilion Power Station, Oakwood, IL (Dynegy Midwest Generation, Inc.) BOREHOLE #: same

STATE PLANE COORDINATE: X 1148079 Y 1282550 (or) LATITUDE: LONGITUDE:

SURVEYED BY: James Anderson, Chastain & Assoc., LLP ILL REGISTRATION #: 3504

DRILLING CONTRACTOR: PSC Industrial Outsourcing DRILLER: Jerry Hancock

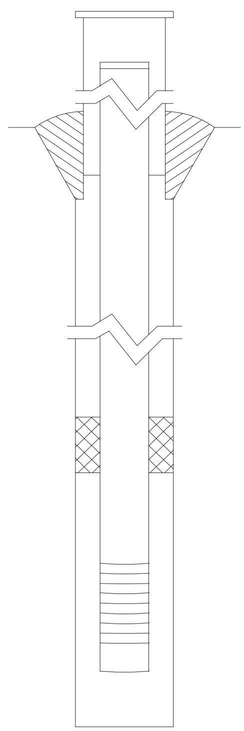
CONSULTING FIRM: Kelron Environmental, Inc. GEOLOGIST: Stuart J. Cravens

DRILLING METHOD: Hollow-Stem Auger w/ MacroCore sampler DRILLING FLUIDS (TYPE): water only

LOGGED BY: Stuart J. Cravens DATE STARTED: 10/20/10 DATE FINISHED: 10/21/10

REPORT FORM COMPLETED BY: Stuart J. Cravens DATE : 11/12/10

ANNULAR SPACE DETAILS



	ELEVATIONS (MSL) *	DEPTHS (BGS)	(.01 ft)
			TOP OF PROTECTIVE CASING
	592.52	-2.52	TOP OF RISER PIPE
TYPE OF SURFACE SEAL: Concrete	590.00	0.00	GROUND SURFACE
	589.00	1.00	TOP OF ANNULAR SEALANT
TYPE OF ANNULAR SEALANT: Bentonite-Cement Grout; INSTALLATION METHOD: Tremied; SETTING TIME: + 24 hours	577.54	12.46	STATIC WATER LEVEL (AFTER COMPLETION)
TYPE OF BENTONITE SEAL- GRANULAR, PELLET, SLURRY, CHIPS (CIRCLE ONE)	546.50	43.50	TOP OF SEAL
INSTALLATION METHOD: Poured and hydrated; SETTING TIME: ~ 30 minutes	542.80	47.20	TOP OF SANDPACK
	540.90	49.10	TOP OF SCREEN
TYPE OF SAND PACK: Quartz; GRAIN SIZE: #1 Morie Sand (crse)	535.88	54.12	BOTTOM OF SCREEN
INSTALLATION METHOD: Poured	535.66	54.34	BOTTOM OF WELL
TYPE OF BACKFILL MATERIAL: Quartz sand (IF APPLICABLE); INSTALLATION METHOD: Poured	535.66	54.34	BOTTOM OF BOREHOLE

* REFERENCED TO A NATIONAL GEODETIC VERTICAL DATUM

WELL CONSTRUCTION MATERIALS

(CIRCLE ONE)

PROTECTIVE CASING	SS304, SS316, PTFE, PVC OR OTHER: Steel
RISER PIPE ABOVE W.T.	SS304, SS316, PTFE, PVC OR OTHER:
RISER PIPE BELOW W.T.	SS304, SS316, PTFE, PVC OR OTHER:
SCREEN	SS304, SS316, PTFE, PVC OR OTHER:

CASING MEASUREMENTS

DIAMETER OF BOREHOLE (in.)	8.25
ID OF RISER PIPE (in)	2.0
PROTECTIVE CASING LENGTH (ft)	5.0
RISER PIPE LENGTH (ft)	51.62
BOTTOM OF SCREEN TO END CAP (ft)	5.02
SCREEN LENGTH (1st SLOT TO LAST SLOT) (ft)	4.62
TOTAL LENGTH OF CASING (ft)	56.86
SCREEN SLOT SIZE **	0.01

** HAND-SLOTTED WELL SCREENS ARE UNACCEPTABLE

Illinois Environmental Protection Agency Well Completion Report

SITE #: None | COUNTY: Vermilion | WELL #: TW-1

SITE NAME: Vermilion Power Station, Oakwood, IL (Dynegy Midwest Generation, Inc.) | BOREHOLE #: same

STATE PLANE COORDINATE: X 1149953 Y 1280575 (or) LATITUDE: LONGITUDE:

SURVEYED BY: James Anderson, Chastain & Assoc., LLP | ILL REGISTRATION #: 3504

DRILLING CONTRACTOR: PSC Industrial Outsourcing | DRILLER: Jerry Hancock

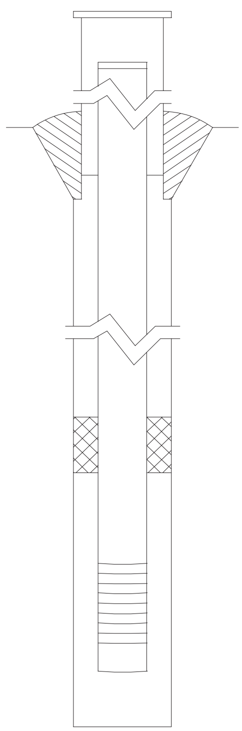
CONSULTING FIRM: Kelron Environmental, Inc. | GEOLOGIST: Stuart J. Cravens

DRILLING METHOD: Hand Auger | DRILLING FLUIDS (TYPE): water only

LOGGED BY: Stuart J. Cravens | DATE STARTED: 10/21/10 | DATE FINISHED: 10/21/10

REPORT FORM COMPLETED BY: Stuart J. Cravens | DATE : 11/12/10

ANNULAR SPACE DETAILS



TYPE OF SURFACE SEAL: Bentonite

TYPE OF ANNULAR SEALANT: none

INSTALLATION METHOD: none

SETTING TIME: none

TYPE OF BENTONITE SEAL-
GRANULAR, PELLET, SLURRY, CHIPS
(CIRCLE ONE)

INSTALLATION METHOD: Poured

SETTING TIME: ~ 30 minutes

TYPE OF SAND PACK: Quartz

GRAIN SIZE: #1 Morie Sand (crse)

INSTALLATION METHOD: Poured

TYPE OF BACKFILL MATERIAL: Quartz sand
(IF APPLICABLE)

INSTALLATION METHOD: Poured

ELEVATIONS (MSL) *	DEPTHS (BGS)	(.01 ft)
		TOP OF PROTECTIVE CASING
577.69	-2.79	TOP OF RISER PIPE
574.90	0.00	GROUND SURFACE
574.90	0.00	TOP OF ANNULAR SEALANT
573.40	1.50	STATIC WATER LEVEL (AFTER COMPLETION)
574.90	0.00	TOP OF SEAL
573.90	1.00	TOP OF SANDPACK
573.83	1.07	TOP OF SCREEN
571.00	3.90	BOTTOM OF SCREEN
571.00	3.90	BOTTOM OF WELL
570.90	4.00	BOTTOM OF BOREHOLE

* REFERENCED TO A NATIONAL GEODETIC VERTICAL DATUM

WELL CONSTRUCTION MATERIALS

(CIRCLE ONE)

PROTECTIVE CASING	SS304, SS316, PTFE, PVC OR OTHER: Steel
RISER PIPE ABOVE W.T.	SS304, SS316, PTFE, PVC OR OTHER:
RISER PIPE BELOW W.T.	SS304, SS316, PTFE, PVC OR OTHER:
SCREEN	SS304, SS316, PTFE, PVC OR OTHER:

CASING MEASUREMENTS

DIAMETER OF BOREHOLE (in.)	5.25
ID OF RISER PIPE (in)	1.5
PROTECTIVE CASING LENGTH (ft)	4.3
RISER PIPE LENGTH (ft)	3.86
BOTTOM OF SCREEN TO END CAP (ft)	2.83
SCREEN LENGTH (1st SLOT TO LAST SLOT) (ft)	2.40
TOTAL LENGTH OF CASING (ft)	6.69
SCREEN SLOT SIZE **	0.01

** HAND-SLOTTED WELL SCREENS ARE UNACCEPTABLE

KELRON ENVIRONMENTAL
INCORPORATED

LOG OF BORING VP1

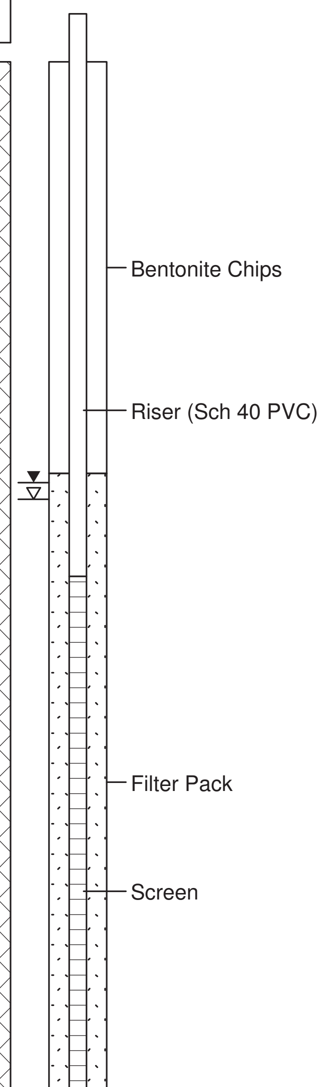
Hydrogeologic Investigation
North and Old East Ash Ponds
Vermilion Power Station
Dynegy Midwest Generation, Inc.

Date Completed	: 06/21/2011	Driller	: Fahey
Hole Diameter	: 2-inch	Geologist	: Wilder
Drilling Method	: Geoprobe 6620 DT	Land Surface Elevation	: 603.7
Sampling Method	: Dual Tube MacroCore (2")	Top of Casing Elevation	606.76
Drilling Company	: PSC	X,Y Coordinates	: 1147632, 1281798

Depth in Feet	DESCRIPTION	Surf. Elev. 603.70	Samples	Recovery inches	Qp TSF	USCS
0	FILL - Flyash, silty, very soft, medium to dark gray, some black lenses throughout, moist					
		600	1	48		
5	- wet					
	- water level on 6/23/11 = 8.2' bgs - water level on 6/30/11 = 8.5' bgs	595	2	60		
10	- Shelby Tube (ST-VP1 10-12) at 10-12 feet (18/24" recovery) ASH-SILT with Sand (ML); sand fine grained, very dark gray					FL
		590	3	60		
15						
		585	4	60		
20						
	SAND (fine) with Silt, poorly graded, olive-brown, wet		5	60		SM
		580				
25	END PROBEHOLE AT 25 FEET BLS					

GRAPHIC

Well: VPZ1
Elev.: 606.76



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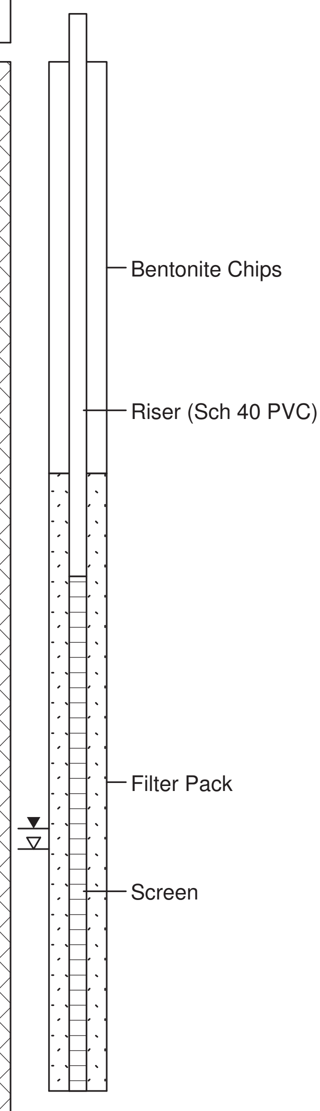
KELRON ENVIRONMENTAL INCORPORATED	LOG OF BORING VP2 (Page 1 of 2)

Hydrogeologic Investigation North and Old East Ash Ponds Vermilion Power Station Dynegy Midwest Generation, Inc.	Date Completed : 06/20/2011 Hole Diameter : 2-inch Drilling Method : Geoprobe 6620 DT Sampling Method : Dual Tube MacroCore (2") Drilling Company : PSC	Driller : Fahey Geologist : Wilder Land Surface Elevation: 606.6 Top of Casing Elevation 609.53 X,Y Coordinates : 1147914,1281509

Depth in Feet	DESCRIPTION	Surf. Elev. 606.6	Samples	Recovery inches	Qp TSF	USCS	GRAPHIC
0	FILL - Flyash, silty to clayey, soft, medium to dark gray, moist						
	- wet, very soft		1	60			
5	- Shelby Tube (ST-VP2 5-7) at 5-7 ft (24/24" recovery) ASH-SILT (ML), trace fine sand, dark olive-brown						
		600	2	60			
10							
		595	3	60		FL	
15	- water level on 6/22/11 = 14.9' bgs - water level on 6/30/11 = 15.3' bgs						
		590	4	60			
20							
		585	5	60			
25							

Well: VPZ2
Elev.: 609.53



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KELRON ENVIRONMENTAL
INCORPORATED

LOG OF BORING VP2

(Page 2 of 2)

Hydrogeologic Investigation
North and Old East Ash Ponds
Vermilion Power Station
Dynegy Midwest Generation, Inc.

Date Completed	: 06/20/2011	Driller	: Fahey
Hole Diameter	: 2-inch	Geologist	: Wilder
Drilling Method	: Geoprobe 6620 DT	Land Surface Elevation	: 606.6
Sampling Method	: Dual Tube MacroCore (2")	Top of Casing Elevation	609.53
Drilling Company	: PSC	X,Y Coordinates	: 1147914,1281509

Well: VPZ2
Elev.: 609.53

Depth in Feet	DESCRIPTION	Surf. Elev. 606.6	Samples	Recovery inches	Qp TSF	USCS	GRAPHIC
25						FL	
	Silty CLAY with Flyash lenses - transitional zone from Fill to native material					CH/FL	
	Silty SAND (fine grained), shells <2mm, poorly graded, loose, dark olive-brown		6	60			
30	- light gray					SM	
		575					
	- brown		7	42			
35	Sand (fine-crse) with gravel, well graded, gray - wood pieces up to 1.5"						
		570				SW	
			8	44			
	- no recovery from 38 to 40 feet; soft push at 38 feet indicating possible lithologic change - possibly silt or reworked glacial						
40	- no sample recovery from 40 to 45 feet						
		565					
			9	0			
45	- geotech sample (sieve/hydrometer) @ 45-46 ft Sandy CLAY (lean), trace fine gravel (subangular to angular), high plasticity, very stiff, dark gray-brown, moist (DIAMICTON)						
		560					
			10	60		CL	
	END PROBEHOLE AT 50 FEET BLS						
50							

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KELRON
ENVIRONMENTAL
INCORPORATED

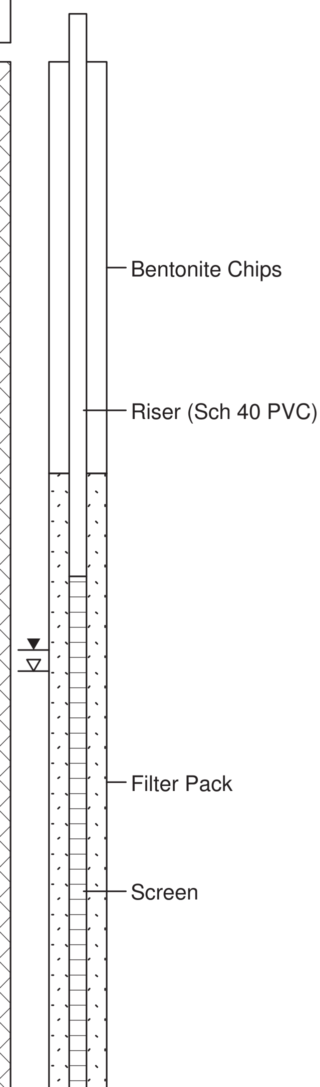
LOG OF BORING VP3

Hydrogeologic Investigation
North and Old East Ash Ponds
Vermilion Power Station
Dynegy Midwest Generation, Inc.

Date Completed	: 06/21/2011	Driller	: Fahey
Hole Diameter	: 2-inch	Geologist	: Wilder
Drilling Method	: Geoprobe 6620 DT	Land Surface Elevation	: 611.2
Sampling Method	: Dual Tube MacroCore (2")	Top of Casing Elevation	614.21
Drilling Company	: PSC	X,Y Coordinates	: 1147960, 1281139

Depth in Feet	DESCRIPTION	Surf. Elev. 611.2	Samples	Recovery inches	Qp TSF	USCS	GRAPHIC
0	FILL - Flyash, silty to clayey, soft, medium to dark gray, moist - wet	610	1	60			
5		605	2	60			
10	- water level on 6/23/11 = 11.5' bgs - water level on 6.30/11 = 11.8' bgs	600	3	60		FL	
15		595	4	60			
20		590	5	60			
25							

Well: VPZ3
Elev.: 614,21



KELRON
ENVIRONMENTAL
INCORPORATED

LOG OF BORING VP3

Hydrogeologic Investigation
North and Old East Ash Ponds
Vermilion Power Station
Dynegy Midwest Generation, Inc.

Date Completed	: 06/21/2011	Driller	: Fahey
Hole Diameter	: 2-inch	Geologist	: Wilder
Drilling Method	: Geoprobe 6620 DT	Land Surface Elevation	: 611.2
Sampling Method	: Dual Tube MacroCore (2")	Top of Casing Elevation	614.21
Drilling Company	: PSC	X,Y Coordinates	: 1147960, 1281139

Depth in Feet	DESCRIPTION	Surf. Elev. 611.2	Samples	Recovery inches	Qp TSF	USCS	GRAPHIC
25		585	6	60		FL	
30	CLAY (lean to fat), high organics with roots and shells (< 2mm), medium density, medium-high plasticity, very dark gray - geotech sample (sieve/hydrometer) @ 34.5-35 ft	580	7	60	1.5	CL/CH	
35	Silty SAND (fine grained), poorly graded, gray, wet (from Shelby Tube sample at 35 to 37 feet with 4" recovery)	575	8	4		SM	
	END PROBEHOLE AT 37 FEET BLS						
40		570					
45		565					
50							

Well: VPZ3
Elev.: 614,21

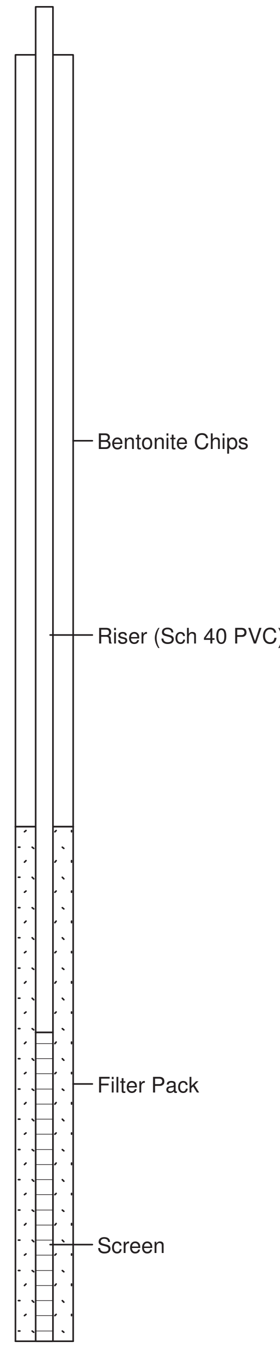
KELRON ENVIRONMENTAL INCORPORATED	LOG OF BORING VP4 (Page 1 of 3)

Hydrogeologic Investigation
North and Old East Ash Ponds
Vermilion Power Station
Dynegy Midwest Generation, Inc.

Date Completed	: 06/22/2011	Driller	: Fahey
Hole Diameter	: 2-inch	Geologist	: Wilder
Drilling Method	: Geoprobe 6620 DT	Land Surface Elevation	: 627.2
Sampling Method	: Dual Tube MacroCore (2")	Top of Casing Elevation	630.17
Drilling Company	: PSC	X,Y Coordinates	: 1148593, 1280616

Depth in Feet	DESCRIPTION	Surf. Elev. 627.2	Samples	Recovery inches	Qp TSF	USCS	GRAPHIC
0	FILL - Silt and Clay with rock, very hard, dry to moist	625	1	36		FL	
5	FILL - Flyash, silty and clayey, medium gray; lenses of black and brown coarser ash layers with coal fragments and cinders; generally soft, moist	620	2	60			
	- Shelby Tube (ST-VP4 8-10) at 8-10 feet (24/24" recovery) ASH-SILT (ML), trace fine sand, dark gray						
10		615	3	30			
15	- wet					FL	
		610	4	60			
	- Shelby Tube (ST-VP4 18-20) at 18-20 feet (24/24" recovery) ASH-SILT with Sand (ML), dark gray						
20		605	5	60			
25							

Well: VPZ4
Elev.: 630.17

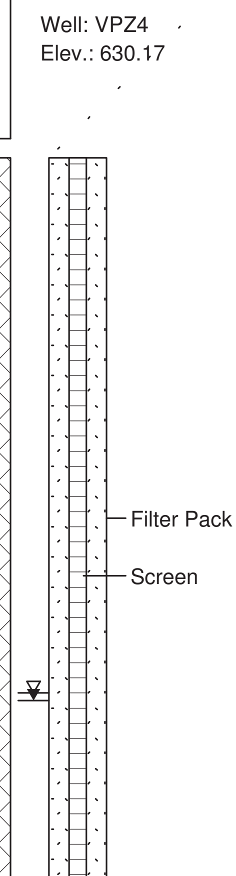


KELRON ENVIRONMENTAL INCORPORATED	LOG OF BORING VP4 (Page 2 of 3)

Hydrogeologic Investigation
North and Old East Ash Ponds
Vermilion Power Station
Dynegy Midwest Generation, Inc.

Date Completed	: 06/22/2011	Driller	: Fahey
Hole Diameter	: 2-inch	Geologist	: Wilder
Drilling Method	: Geoprobe 6620 DT	Land Surface Elevation	: 627.2
Sampling Method	: Dual Tube MacroCore (2")	Top of Casing Elevation	630.17
Drilling Company	: PSC	X,Y Coordinates	: 1148593, 1280616

Depth in Feet	DESCRIPTION	Surf. Elev. 627.2	Samples	Recovery inches	Qp TSF	USCS	GRAPHIC
25							
		600	6	60			
30							
		595	7	60			
35	- water level on 6/23/11 = 35.65' bgs - water level on 6/30/11 = 35.40' bgs					FL	
		590	8	60			
40							
		585	9	60			
45	- geotech sample (sieve/hydrometer) @44-45 ft CLAY (lean to fat), trace fine sand, high organics, medium-high plasticity, gray-brown (2.5Y 4/2), moist - light olive-brown (2.5Y 4/6) with gray (2.5Y 5/1) mottling						
		580	10	60	4-2	CL/CH	
50						SP	



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KELRON ENVIRONMENTAL INCORPORATED	LOG OF BORING VP4 (Page 3 of 3)

Hydrogeologic Investigation North and Old East Ash Ponds Vermilion Power Station Dynegy Midwest Generation, Inc.	Date Completed : 06/22/2011 Hole Diameter : 2-inch Drilling Method : Geoprobe 6620 DT Sampling Method : Dual Tube MacroCore (2") Drilling Company : PSC	Driller : Fahey Geologist : Wilder Land Surface Elevation: 627.2 Top of Casing Elevation 630.17 X,Y Coordinates : 1148593, 1280616

Well: VPZ4
Elev.: 630.17

Depth in Feet	DESCRIPTION	Surf. Elev. 627.2	Samples	Recovery inches	Qp TSF	USCS	GRAPHIC
50	SAND (medium to coarse) with Gravel, shells <2mm, poorly graded, loose, dark gray-brown, wet - with fine-medium gravel, brownish-gray	575	11	37		SP	
	SAND (fine) with Silt, poorly graded, dark gray - no recovery from 53-55 ft					SP/SM	
55	Silty CLAY with fine gravel (subangular to angular), high plasticity, very stiff, moist (DIAMICTON)	570	12	60	>5	CL	
	- geotech sample (sieve/hydrometer) @ 59-60 ft Clayey SAND (fine-medium), trace gravel, dark gray					SC	
60	END PROBEHOLE AT 60 FEET BLS	565					
65		560					
70		555					
75							

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KELRON ENVIRONMENTAL
INCORPORATED

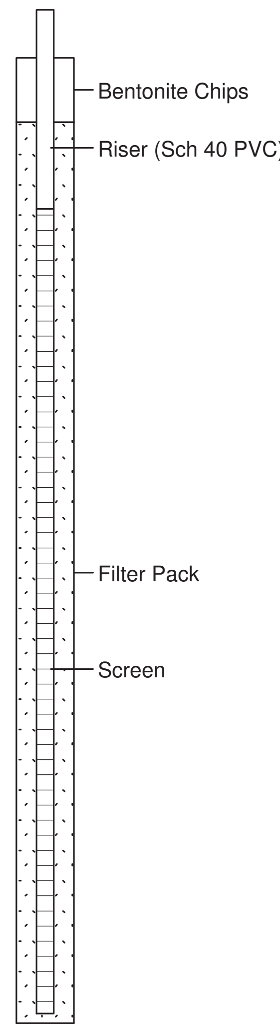
LOG OF BORING VP5

Hydrogeologic Investigation
North and Old East Ash Ponds
Vermilion Power Station
Dynegy Midwest Generation, Inc.

Date Completed	: 06/23/2011	Driller	: Fahey
Hole Diameter	: 2-inch	Geologist	: Wilder
Drilling Method	: Geoprobe 6620 DT	Land Surface Elevation	: 637.8
Sampling Method	: Dual Tube MacroCore (2")	Top of Casing Elevation	642.22
Drilling Company	: PSC	X,Y Coordinates	: 1148946, 1280488

Depth in Feet	DESCRIPTION	Surf. Elev. 637.8	Samples	Recovery inches	Qp TSF	USCS	GRAPHIC
0	FILL - Refusals at 6, 7, and 10 feet at three locations - very hard, stiff silty clay with sand and gravel, brown	635	1	0		FL	
5	- offset 30 feet to northwest and began fourth probehole at 5 feet FILL - Flyash, silty to clayey, dark gray, moist	630	2	60		FL	
10		625	3	60		FL	
15	- Shelby Tube (ST-VP5 13-15) at 13-15 feet (24/24" recovery) ASH-Sandy SILT (ML), dark gray - wet	620	4	60		FL	
20		615	5	41		FL	
25	- Flyash with gravel, including pyrite nodules, hard - no recovery at 24-25 ft	610	6	12		FL	
30	- refusal of dual-tube system at 29 ft; proceed with MacroCore only - Interbedded layers of bottom ash/slag (hard) and flyash (medium to stiff) from 29 to 32 ft - Flyash with occasional thin layers of bottom ash - water level on 6/23/11 and 6/30/11: dry (depth is greater than well depth of 29.7' bgs)	605	7	56		FL	
35	Refusal at 40 feet.	600	8	60		FL	
40	END PROBEHOLE AT 40 FEET BLS						

Well: VPZ5
Elev.: 642.22



LOG OF BORING B-1

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 615 Feet

Date Drilled: 07/01/7
Drilling Contractor: Woodward-Clyde Consultants
Drilling Method:
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
615 — 0				*SILT, Trace Fine Sand; Loose to Medium Dense, Gray-Black (Flyash)*				
610 — 5								
605 — 10								
600 — 15								
595 — 20								
590 — 25								
			CL	*Silty CLAY, Very Stiff, Slightly Plastic, Brown (Alluvium)*				
585 — 30			*SW*					

(continued)

Notes: Data presented on this log has been transcribed from information in a report pepared by Woodward-Clyde Consultants dated January 28, 1 80.

GROUNDWATER

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.
Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING B-1 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 615 Feet

Date Drilled: 07/01/7
Drilling Contractor: Woodward-Clyde Consultants
Drilling Method:
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
585—30				*Gravelly SAND (Fine-Coarse), Trace Silt, Medium Dense to Very Dense (Alluvium) (continued)*				
580—35								
575—40			CL	*Silty CLAY, Trace Sand and Fine Gravel, Hard, Slightly Plastic, Gray-Brown (Till)*				
570—45								
565—50								
				TD - 52.0 Feet				
560—55								
555—60								

Notes: Data presented on this log has been transcribed from information in a report pepared by Woodward-Clyde Consultants dated January 28, 1 80.

GROUNDWATER

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.
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LOG OF BORING B-2

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 618 Feet

Date Drilled: 07/01/7
Drilling Contractor: Woodward-Clyde Consultants
Drilling Method:
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0				*SILT, Trace Fine Sand; Loose to Medium Dense, Gray-Black (Flyash)*				
615								
5								
610								
10								
605								
15								
600								
20								
595								
25								
590								
30			*CL*	*(continued)*				

Notes: Data presented on this log has been transcribed from information in a report pepared by Woodward-Clyde Consultants dated January 28, 1 80.

GROUNDWATER ∇ ▼

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING B-2 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 618 Feet

Date Drilled: 07/01/7
Drilling Contractor: Woodward-Clyde Consultants
Drilling Method:
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30				*Silty CLAY, Very Stiff, Slightly Plastic, Brown (Alluvium) (continued)*				
585								
35			SW	*Gravelly SAND (Fine-Coarse), Trace Silt, Medium Dense to Very Dense (Alluvium)*				
580								
40								
575								
45			CL	*Silty CLAY, Trace Sand and Fine Gravel, Hard, Slightly Plastic, Gray-Brown (Till)*				
570								
50								
565				*TD - 53.0 Feet*				
55								
560								
60								

Notes: Data presented on this log has been transcribed from information in a report pepared by Woodward-Clyde Consultants dated January 28, 1 80.

GROUNDWATER ∇ ▼

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING B-3

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 620 Feet

Date Drilled: 07/01/7
Drilling Contractor: Woodward-Clyde Consultants
Drilling Method:
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
620 — 0				*SILT, Trace Fine Sand; Loose to Medium Dense, Gray-Black (Flyash)*				
615 — 5								
610 — 10								
605 — 15								
600 — 20								
595 — 25								
590 — 30				*(continued)*				

Notes: Data presented on this log has been transcribed from information in a report pepared by Woodward-Clyde Consultants dated January 28, 1 80.

GROUNDWATER ▽ ▼

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING B-3 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 620 Feet

Date Drilled: 07/01/7
Drilling Contractor: Woodward-Clyde Consultants
Drilling Method:
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
590—30				*SILT, Trace Fine Sand; Loose to Medium Dense, Gray-Black (Flyash) (continued)*				
			CL	*Silty CLAY, Very Stiff, Slightly Plastic, Brown (Alluvium)*				
585—35								
			SW	*Gravelly SAND (Fine-Coarse), Trace Silt, Medium Dense to Very Dense (Alluvium)*				
580—40								
575—45								
			CL	*Silty CLAY, Trace Sand and Fine Gravel, Hard, Slightly Plastic, Gray-Brown (Till)*				
570—50								
565—55								
560—60				*TD - 60.0 Feet*				

Notes: Data presented on this log has been transcribed from information in a report pepared by Woodward-Clyde Consultants dated January 28, 1 80.

GROUNDWATER ▽ ▼

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING B-4

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 626 Feet

Date Drilled: 07/01/7
Drilling Contractor: Woodward-Clyde Consultants
Drilling Method:
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0 (626) – 30 (596)				*SILT, Trace Fine Sand; Loose to Medium Dense, Gray-Black (Flyash)*				

Depth scale: 0, 5, 10, 15, 20, 25, 30; Elevation scale: 625, 620, 615, 610, 605, 600

(continued)

Notes: Data presented on this log has been transcribed from information in a report pepared by Woodward-Clyde Consultants dated January 28, 1 80.

GROUNDWATER

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.
Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING B-4 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 626 Feet

Date Drilled: 07/01/7
Drilling Contractor: Woodward-Clyde Consultants
Drilling Method:
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30–40 (595, 590, 585)				*SILT, Trace Fine Sand; Loose to Medium Dense, Gray-Black (Flyash) (continued)*				
40–44 (585)			CL	*Silty CLAY, Very Stiff, Slightly Plastic, Brown (Alluvium)*				
44–50 (580)			SW	*Gravelly SAND (Fine-Coarse), Trace Silt, Medium Dense to Very Dense (Alluvium)*				
50–60 (575, 570)			CL	*Silty CLAY, Trace Sand and Fine Gravel, Hard, Slightly Plastic, Gray-Brown (Till)*				
60				*TD - 60.0 Feet*				

Notes: Data presented on this log has been transcribed from information in a report pepared by Woodward-Clyde Consultants dated January 28, 1 80.

GROUNDWATER

▽

▼

Piezometer Installed: No

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LOG OF BORING B-5

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 62 .5 Feet

Date Drilled: 07/01/7
Drilling Contractor: Woodward-Clyde Consultants
Drilling Method:
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0				*SILT, Trace Fine Sand; Loose to Medium Dense, Gray-Black (Flyash)*				
625 / 5								
620 / 10								
615 / 15								
610 / 20								
605 / 25								
600 / 30								

(continued)

Notes: Data presented on this log has been transcribed from information in a report pepared by Woodward-Clyde Consultants dated January 28, 1 80.

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Piezometer Installed: No

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LOG OF BORING B-5 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 62 .5 Feet

Date Drilled: 07/01/7
Drilling Contractor: Woodward-Clyde Consultants
Drilling Method:
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30				*SILT, Trace Fine Sand; Loose to Medium Dense, Gray-Black (Flyash) (continued)*				
595 / 35								
590 / 40			CL	*Silty CLAY, Very Stiff, Slightly Plastic, Brown (Alluvium)*				
585 / 45								
			SW	*Gravelly SAND (Fine-Coarse), Trace Silt, Medium Dense to Very Dense (Alluvium)*				
580 / 50								
			CL	*Silty CLAY, Trace Sand and Fine Gravel, Hard, Slightly Plastic, Gray-Brown (Till)*				
575 / 55								
570 / 60								

(continued)

Notes: Data presented on this log has been transcribed from information in a report pepared by Woodward-Clyde Consultants dated January 28, 1 80.

GROUNDWATER

Piezometer Installed: No

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LOG OF BORING B-5 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 62 .5 Feet

Date Drilled: 07/01/7
Drilling Contractor: Woodward-Clyde Consultants
Drilling Method:
Logged By: John Mathes   Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
60				*Silty CLAY, Trace Sand and Fine Gravel, Hard, Slightly Plastic, Gray-Brown (Till) (continued)*				
				TD - 63.0 Feet				
565 / 65								
560 / 70								
555 / 75								
550 / 80								
545 / 85								
540 / 90								

Notes: Data presented on this log has been transcribed from information in a report pepared by Woodward-Clyde Consultants dated January 28, 1 80.

GROUNDWATER ▽ ▼

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LOG OF BORING JMA-1

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 654.3 Feet

Date Drilled: 10/2 /82
Drilling Contractor: John Mathes Associates, Inc.
Drilling Method: A Rotary Wash
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0			CL	*Gray Silty CLAY with Sand, Trace Gravel*				*10-29-82 at 8:00 a.m., no water in augers.*
650 / 5	*4 10 13*	*31/36*						*For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.*
				-Silt Seam 9.0-9.5'				
645 / 10	*4 7 11*	*30/36*	ML	*Gray SILT with Clay, Trace Sand, Gravel*				
640 / 15			CL	*Gray Silty CLAY with Sand, Trace Gravel*				
	9 12 12	*36/36*		*-Silt Seam 15.4-16.0'*				
635 / 20		*30/36*	SM	*Brown Silty Medium SAND with Clay, Trace Gravel*				
630 / 25			SP-SM	*Brown Medium SAND, Trace Silt, Gravel*				
	8 10 8	*28/36*						
625 / 30								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates, Inc. presented in a report dated April 11, 1 83.

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Piezometer Installed: No

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LOG OF BORING JMA-1 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 654.3 Feet

Date Drilled: 10/2 /82
Drilling Contractor: John Mathes Associates, Inc.
Drilling Method: A Rotary Wash
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30	9 10 7	28/36		*Brown Medium SAND, Trace Silt, Gravel (continued)*				*For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.*
620 / 35	13 18 15	26/36						*Perched water level in augers at 37.5' with augers at 39.5'.*
615 / 40	3 9 12	32/36	SP	*Gray Gravelly SAND*				
610 / 45	28 40 33	4/36	CL	*Gray-Brown Silty CLAY with Sand, Trace Gravel*				
605 / 50	12 20 30	36/36						
600 / 55	9 33 41	26/36						
595 / 60								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates, Inc. presented in a report dated April 11, 1 83.

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Piezometer Installed: No

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LOG OF BORING JMA-1 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 654.3 Feet

Date Drilled: 10/2 /82
Drilling Contractor: John Mathes Associates, Inc.
Drilling Method: A Rotary Wash
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
60	13 25 39	32/36		*Gray-Brown Silty CLAY with Sand, Trace Gravel (continued)*				*For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.*
590 / 65	13 28 33	32/36	*ML*	*Gray SILT with Clay, Trace Sand*				
			CL	*Gray Silty CLAY with Sand, Trace Gravel*				
585 / 70	4 13 18	36/36						
580 / 75	4 7 10	36/36						
575 / 80	6 10 13	30/36						
570 / 85	4 7 8	36/36						
565 / 90								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates, Inc. presented in a report dated April 11, 1 83.

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LOG OF BORING JMA-1 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 654.3 Feet

Date Drilled: 10/2 /82
Drilling Contractor: John Mathes Associates, Inc.
Drilling Method: A Rotary Wash
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
90	6 4 6	36/36		Gray Silty CLAY with Sand, Trace Gravel (continued)				Blow counts are for the first 3 - 6" increments.
560 / 95	5 5 8	36/36		-Silt Seam 95.5-96.0'			11	LL = 22 PL = 11 PI = 11 LL = 17 PL = 11 PI = 6
555			SP	Gray Fine-Medium SAND, Trace Gravel				
100	22 50 100/4"	16/16	SW-SM	Gray Medium SAND with Gravel, Trace Silt				
			CL	Gray Silty CLAY with Sand, Trace Gravel				
550 / 105	33 66 100/4"	16/16					11	
545 / 110								
540 / 115								
535 / 120				TD - 119.5 Feet				

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates, Inc. presented in a report dated April 11, 1 83.

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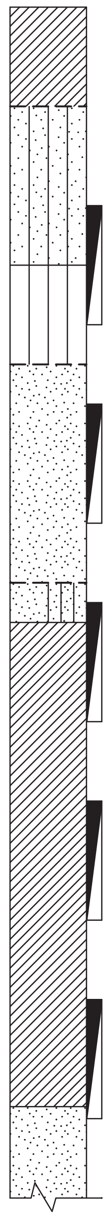
LOG OF BORING JMA-2

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 5 0.3 Feet

Date Drilled: 11/03/82
Drilling Contractor: John Mathes   Associates, Inc.
Drilling Method: ollow Auger
Logged By: John Mathes   Associates, Inc.



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
590 / 0			CL	*Brown Silty CLAY*				
			ML	*Brown Sandy SILT with Clay*				
585 / 5	8, 14, 13	33/36	ML	*Brown Clayey SILT with Sand*			10	*For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.*
580 / 10		18/36	SP	*Brown Medium SAND with Gravel* *-Cobbles 12.0-14.0'*			11	
575 / 15			SP-SM	*Brown Fine-Medium SAND with Silt, Trace Gravel*				
	6, 13, 20	36/36	CL	*Gray Silty CLAY with Sand, Sand Seams, Trace Gravel*			11	
570 / 20	11, 20, 27	21/36						
565 / 25	15, 20, 28	35/36					10	
			SP	*Gray Fine-Medium SAND*				
30								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes   Associates, Inc. presented in a report dated April 11, 1 83.

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LOG OF BORING JMA-2 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 5 0.3 Feet

Date Drilled: 11/03/82
Drilling Contractor: John Mathes   Associates, Inc.
Drilling Method: ollow Auger
Logged By: John Mathes   Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
560 / 30				*Gray Fine-Medium SAND (continued)*				
	8 10 23	34/36	CL	*Gray Silty CLAY with Sand, Trace Gravel*				*For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.*
555 / 35			CL	*Gray Sandy CLAY with Silt, Sand Seams, Trace Gravel*				
	12 30 30	30/30		*-Sand Seam 36.2-36.7'*			10	
			CL	*Gray Silty CLAY with Sand, Trace Gravel*				
550 / 40	40 200/4"	8/10		*-Silt Seam below 40.5'*			20	
				TD - 40.8 Feet				
545 / 45								
540 / 50								
535 / 55								
60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes   Associates, Inc. presented in a report dated April 11, 1 83.

GROUNDWATER

Piezometer Installed: No

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LOG OF BORING JMA-3

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 588.4 Feet

Date Drilled: 11/01/82
Drilling Contractor: John Mathes Associates, Inc.
Drilling Method: ollow Auger
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0			CL	Gray Silty CLAY				
585			SM	Gray-Brown Silty Fine SAND				
			CL	Gray Silty CLAY				
5			SM	Gray Silty SAND				
	6 8 8	34/36	CL	Gray Silty CLAY, Trace Sand			21	For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.
580, 10	WH 1 2	28/36	SP-SM	Gray Fine SAND with Medium, Trace Silt				
575			SP	Gray Medium-Coarse SAND with Gravel -Gravelly from 13.0-15.5'				
15	10 14 7	33/36	CL	Gray Silty CLAY with Sand, Trace Gravel				
570, 20	3 8 13	30/36		-Sand Seam 18.5-19.2'			12	
565			SP	Gray Fine-Medium SAND, Trace Gravel				
25	7 9 14	30/36	CL	Gray Silty CLAY with Sand, Trace Gravel				
560, 30			SP	Gray Fine SAND				

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates, Inc. presented in a report dated April 11, 1 83.

GROUNDWATER

Piezometer Installed: No

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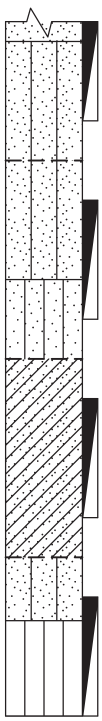
LOG OF BORING JMA-3 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 588.4 Feet

Date Drilled: 11/01/82
Drilling Contractor: John Mathes Associates, Inc.
Drilling Method: ollow Auger
Logged By: John Mathes Associates, Inc.



Elevation/ Depth (feet)	SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30	0 2 4	30/36	SM	Gray Medium SAND with Gravel, Silt				For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.
555			SM	Gray Fine-Medium SAND with Silt				
35	1 3 4	30/36					20	
			ML	Gray Sandy SILT				
550			SC	Gray Fine SAND with Clay, Trace Gravel				
40	2 3 4	36/36						
545			SM	Gray Silty SAND				
45	0 2 3	36/36	ML	Gray Clayey SILT, Trace Sand			11	
				TD - 47.5 Feet				
540								
50								
535								
55								
530								
60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates, Inc. presented in a report dated April 11, 1 83.

GROUNDWATER

Piezometer Installed: No

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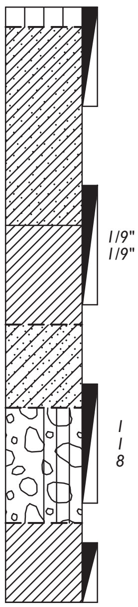
LOG OF BORING JMA-4

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 587.5 Feet

Date Drilled: 11/04/82
Drilling Contractor: John Mathes Associates, Inc.
Drilling Method: ollow Auger
Logged By: John Mathes Associates, Inc.



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0			ML	Dark Gray Clayey SILT with Sand				
		30/30	CL	Red-Brown Sandy CLAY with Silt			15	Split spoon pushed from 0 to 2.5 feet.
585								
5							23	
	1/9" 1/9"	32/36	CL	Gray-Brown Silty CLAY with Sand			24	For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments. Gravelly drilling 8.0 to 9.0 feet.
580			SC	Brown Fine SAND with Gravel, Trace Clay				
10	1 1 8	20/36	GP-GM	Brown Sandy GRAVEL Trace Silt				
575				-Gravelly at 12.5'				
		12/18	CL	Gray Silty CLAY with Sand Trace Gravel			12	
15				TD - 15.0 Feet				
570								
20								
565								
25								
560								
30								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates, Inc. presented in a report dated April 11, 1 83.

GROUNDWATER

Piezometer Installed: No

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LOG OF BORING JMA-5

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 5 2.3 Feet

Date Drilled: 11/04/82
Drilling Contractor: John Mathes Associates, Inc.
Drilling Method: ollow Auger
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0		32/36	CL	*Dark Gray Silty CLAY with Sand*			15	*Split spoon pushed from 0 to 3.0 feet.*
5	4 6 8	32/36					20	*For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.*
			SM	*Brown Fine SAND Trace Silt*				
10	WH 1 2	24/36					22	
			SP	*Brown Fine-Medium SAND* *-Gravelly at 12.5'*				
			CL	*Gray Silty CLAY with Sand, Trace Gravel*				
15	1 6 11	11/18					12	
				TD - 16.0 Feet				

Elevation scale: 590, 585, 580, 575, 570, 565; Depth scale: 0, 5, 10, 15, 20, 25, 30

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates, Inc. presented in a report dated April 11, 1 83.

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Piezometer Installed: No

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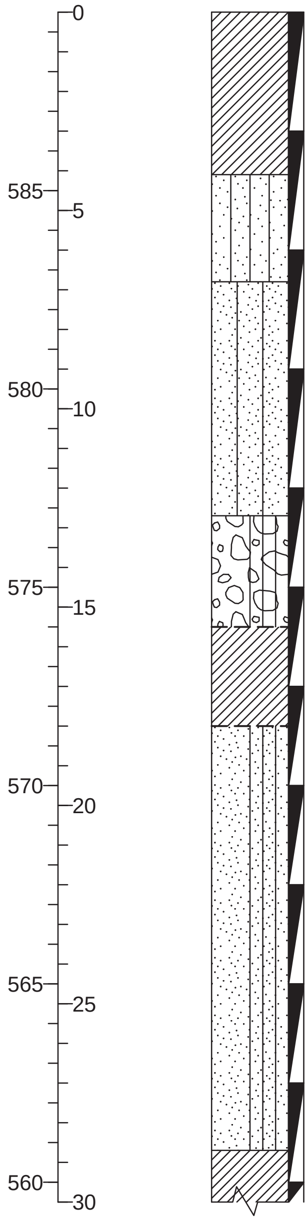
LOG OF BORING JMA-6

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 58 .5 Feet

Date Drilled: 11/10/82
Drilling Contractor: John Mathes   Associates, Inc.
Drilling Method: ollow Auger
Logged By: John Mathes   Associates, Inc.



Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
	27/36	CL	Dark Gray-Brown Silty CLAY with Sand -Roots to 0.6' -Root Holes to 1.7'			24	Split spoon pushed from 0 to 3.0 feet.
2 3 2	25/36	ML	Brown Sandy SILT, Trace Clay			20	For split spoon samples with intervals greater than 18", blow counts are for the first 3 - 6" increments.
3 6 12	29/36	SM	Gray-Brown Medium SAND with Gravel, Silt				
6 12 17	27/36						
4 11 18	22/30	GP-GM	Gray Sandy GRAVEL Trace Silt				
10 18 13	2/30	CL	Gray Silty CLAY with Sand, Gravel				
	25/30	SP-SM	Gray-Brown Fine-Medium SAND with Gravel, Trace Silt				
7 5 8	27/30						
3 6 9	20/30						
7 7 9	22/30		-Silt Seam 27.8-28.7'				
2 7 10	22/30						
		CL	Gray Silty CLAY with Sand, Trace Gravel				

(continued)

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Piezometer Installed: No

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LOG OF BORING JMA-6 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 58 .5 Feet

Date Drilled: 11/10/82
Drilling Contractor: John Mathes Associates, Inc.
Drilling Method: ollow Auger
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30	2 6 8	24/30		Gray Silty CLAY with Sand, Trace Gravel (continued)			12	
555 / 35		41/42					12	
		63/60						
550 / 40		60/60		-Silt Seam 42.8-43.4'			21	
545 / 45				-Organics at 45.0'				
		24/30	SM	Gray Silty Fine SAND			17	
			SC	Gray Fine SAND with Clay				
			ML	Gray SILT Trace Clay, Sand				
540 / 50	14 20 29	36					13	
	14 23 28	26/36					15	
535 / 55				TD - 54.0 Feet				
530 / 60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates, Inc. presented in a report dated April 11, 1 83.

GROUNDWATER

Piezometer Installed: No

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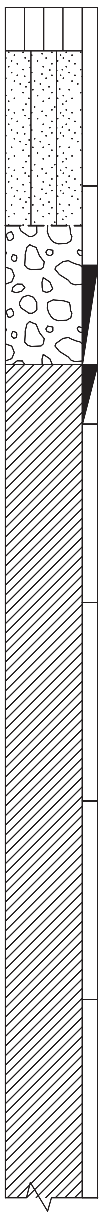
LOG OF BORING 101

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 58 .6 Feet

Date Drilled: 11/0 /82
Drilling Contractor: John Mathes   Associates, Inc.
Drilling Method: ollow Auger
Logged By: John Mathes   Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0			ML	*Dark Gray Clayey SILT with Sand, Root Holes*				
		45/54	SM	*Brown Medium SAND with Silt, Gravel*			*13*	
585 / 5		*24/24*	GP	*Brown Sandy GRAVEL*				*Blow counts are for the first 3 - 6" increments.*
	19 21 18	*8/30*						
580 / 10		*18/18*	CL	*Gray Silty CLAY with Sand, Trace Gravel*			*11*	*Split spoon pushed from 9.0 to 10.5 feet.*
		54/54					*11*	
575 / 15								
		60/60						
570 / 20								
		58/60					*14*	
565 / 25								
		60/60					*11*	*LL = 19 PL = 11 PI = 8*
560 / 30								



(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes   Associates, Inc. presented in a report dated April 1 , 1 83

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Piezometer Installed: No

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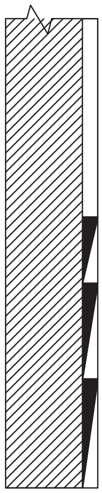
LOG OF BORING 101 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 58 .6 Feet

Date Drilled: 11/0 /82
Drilling Contractor: John Mathes Associates, Inc.
Drilling Method: ollow Auger
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30				*Gray Silty CLAY with Sand, Trace Gravel (continued)*				
		60/60					*13*	
555 / 35		*20/20*		*-Sand Seam 35.0-35.8'*				
		29/29						
550 / 40		*30/33*		*-Silt Seam 40.0-40.9'*				
				TD - 41.8 Feet				
545 / 45								
540 / 50								
535 / 55								
530 / 60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates, Inc. presented in a report dated April 1 , 1 83

GROUNDWATER ∇ ▼

Piezometer Installed: No

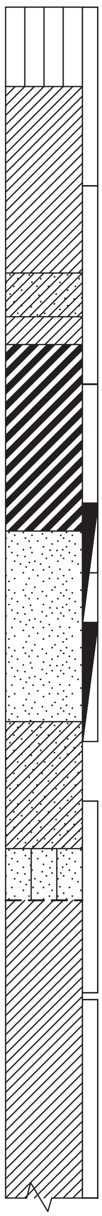
Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

LOG OF BORING 105

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 5 2.   Feet

Date Drilled: 11/08/82
Drilling Contractor: John Mathes   Associates, Inc.
Drilling Method: ollow Auger
Logged By: John Mathes   Associates, Inc.



Elevation/ Depth (feet)	SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0			ML	*Dark Gray-Brown Clayey SILT, Trace Sand, Roots, Root Holes*				
590 / 5		*54/54*	CL	*Gray-Brown Silty CLAY with Sand, Trace Gravel, Root Holes* *-Slickensides to 3.5'*			*16*	
585		*56/60*	CL	*Gray-Brown Sandy CLAY*			*25*	
10			CL	*Gray-Brown Silty CLAY with Sand, Trace Gravel*				
		53/57	CH	*Gray-Brown CLAY with Silt*			*29* *35*	
580 / 15	*1 8 7*	*21/36*	SP	*Brown Fine-Medium SAND, Trace Coarse*				*Split spoon samples were driven 36". Blow counts are for the first 3 - 6" increments.*
	3 6 9	*32/36*					*11*	
575 / 20			CL	*Gray-Brown Sandy CLAY, Trace Gravel*				
570		*55/58*	SM	*Gray Fine-Medium SAND with Silt, Trace Gravel*			*17*	
25 / 565 / 30		*63/60*	CL	*Gray Silty CLAY with Sand, Trace Gravel*			*12*	

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes   Associates, Inc. presented in a report dated April 1 , 1 83

GROUNDWATER

Piezometer Installed: No

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LOG OF BORING 105 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 5 2. Feet

Date Drilled: 11/08/82
Drilling Contractor: John Mathes Associates, Inc.
Drilling Method: ollow Auger
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30				*Gray Silty CLAY with Sand, Trace Gravel (continued)*				
560		*60/60*					*12*	
35								
555		*60/60*					*11*	
40				*TD - 40.0 Feet*				
550								
45								
545								
50								
540								
55								
535								
60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates, Inc. presented in a report dated April 1 , 1 83

GROUNDWATER ∇ ▼

Piezometer Installed: No

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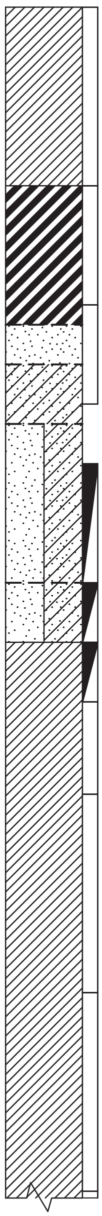
LOG OF BORING 106

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 5 3.3 Feet

Date Drilled: 11/16/82
Drilling Contractor: John Mathes Associates, Inc.
Drilling Method: ollow Auger
Logged By: John Mathes Associates, Inc.



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0		46/54	CL	Gray-Brown Silty CLAY with Sand, Root Holes -Roots to 0.9'			18	
590 / 5		32/36	CH	Brown CLAY with Silt, Slickensides, Root Holes -Sand Seam 7.5-8.0'			22	Split spoon samples were driven 36". Blow counts are for the first 3 - 6" increments.
585		22/30	SP	Brown Fine-Medium SAND with Gravel, Trace Clay				
10			SC	Brown Clayey SAND				
580	4 6 6	18/36	SP-SC	Brown Medium SAND, Trace Clay				
15	4 5 7	3/18	SP-SC	Brown Fine-Medium SAND with Gravel, Trace Clay				
	5 9 13	10/18	CL	Brown Silty CLAY with Sand, Trace Gravel				
575		0/28						
20 / 570		47/60						
25 / 565 / 30		64/60						

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates, Inc. presented in a report dated April 1 , 1 83

GROUNDWATER

Piezometer Installed: No

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LOG OF BORING 106 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 5 3.3 Feet

Date Drilled: 11/16/82
Drilling Contractor: John Mathes Associates, Inc.
Drilling Method: ollow Auger
Logged By: John Mathes Associates, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30				*Brown Silty CLAY with Sand, Trace Gravel (continued)*				
		63/60						
560								
35								
		15/60						
555								
40		*14/16*						
				TD - 41.0 Feet				
550								
45								
545								
50								
540								
55								
535								
60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates, Inc. presented in a report dated April 1 , 1 83

GROUNDWATER

Piezometer Installed: No

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RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-10
SHEET 1 OF 3

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified; Surface Elevation 656.2'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
					Yellow-Brown Silty CLAY Trace Roots, CL		
	1	HST	60/36		Brown CLAY w/Silt, Roots, CH		103
5					Olive-Brown Silty CLAY, TILL, CL		
					-w/Gravel 6.0-8.0'		
	2	HST	60/12				
10					-w/Gravel 10.0-12.5', & 18.0-21.0'		
	3	HST	60/6				
15							
	4	HST	60/10		-w/Cobbles @ 17.0'		
20					-Brown 20.0-30.0'		
	5	HST	60/24				111
25					-w/Sand, Gravel Seam @ 25.0'		
	6	HST	60/6				
30					-Gray Below 30.0'		
	7	HST	30/6				
					-Gravel Seam @ 32.5'		
35	8	SS	24/24	1		17-25-23-24	127

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 & Mud Rotary
DATE DRILLED 4/28-29/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at - Feet
___ Hours after completion ___ 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.

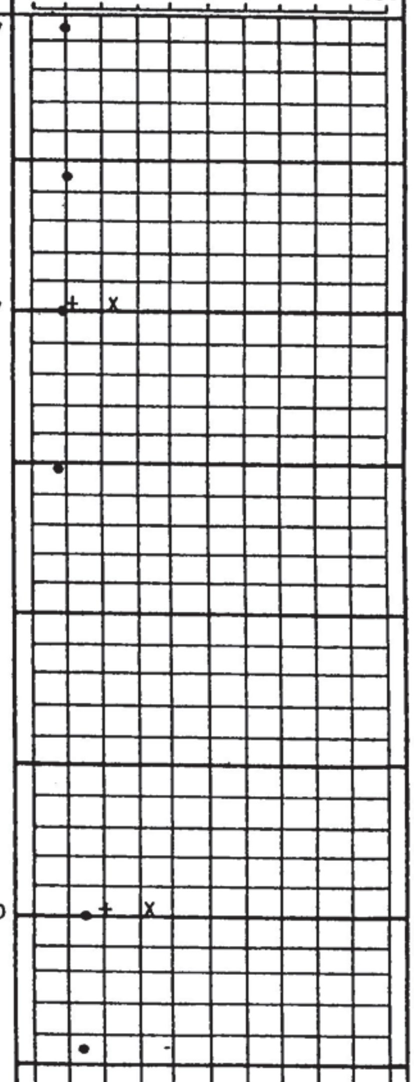
RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-10
SHEET 2 OF 3

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified; Surface Elevation 656.2'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)
	8	HST	24/24		Gray Silty CLAY Trace Sand, Gravel, TILL, CL	17-25-23-24	127
40	9	SS	24/24			11-15-30-39	
					-Gray-Brown Below 43.0'		
45	10	SS	22/18			18-24-40-50/4"	127
					-w/Gravel Seams 49.0-59.0'		
50	11	SS	18/18			23-34-50	
55	12	SS	9/9			48-50/3"	
	13	~~AS~~					
60	14	~~SS~~	5/0			~~50/5"~~	
65	15	SS	17/15			26-30-50/5"	120
70	16	SS	12/12			24-50/6"	

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 & Mud Rotary
DATE DRILLED 4/28-29/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

GROUNDWATER LEVELS

Encountered at - Feet
Hours after completion 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.

RECORD OF SUBSURFACE EXPLORATION

PROJECT Hydrogeologic Study Number One
Vermilion Power Plant
JOB NO. 11872803

BORING B-10
SHEET 3 OF 3

DEPTH (ft)	SAMPLE NUMBER	INTERVAL AND TYPE	ADVANCED / RECOVERED (in)	SEE REMARK #	DESCRIPTION OF MATERIALS (Color Modifier MATERIAL. Classification) Soil Classification System Unified; Surface Elevation 656.2'	BLOWS (per 6 in)	DRY UNIT WEIGHT (pcf)	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
					Gray Silty CLAY Trace Sand, Gravel, TILL, CL			
75	17	SS	3/3		Gray Clayey SHALE TOB	50/3"		•
80								

DRILLING METHOD Hollow Auger & Mud Rotary
DATE DRILLED 4/28-29/87
DRILLED BY Schaffer
LOGGED BY Shively/Jacobi
PIEZOMETER Yes

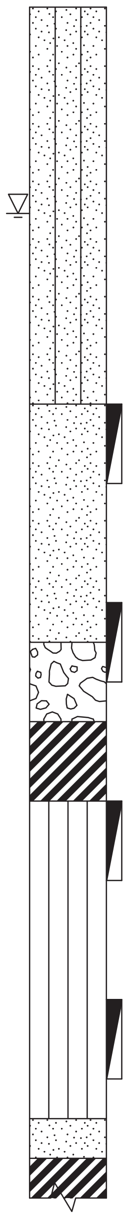
GROUNDWATER LEVELS
Encountered at - Feet
Hours after completion Feet
after completion Feet
after completion Feet

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

LOG OF BORING VAMW-3R

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 587.8 Feet

Date Drilled: 12/07/ 3
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Atlantic Environmental, Inc.



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0			SM	*Grayish Brown to Brown Fine SAND and SILT, Loose, Dry to Moist by 4'*				*Blow counts are for 12" intervals unless otherwise noted.*
585								
5								
580				*-Becoming Wet*				
10	0	14/24	SP	*Grayish Brown Fine SAND, Very Loose, Saturated, No Odor, No Visible Contaminants*				
575								
15	7 23	14/24						
			GP	*Gravel and SAND Mix*				
570			CH	*CLAY*				
20	18 6/6"	19/24	ML	*Gray to Light Grayish Brown SILT, Stiff, Grades to Silty Clay in Parts, Very Thin Sand Interbeds*				
565								
25	19 19	17/24						
560			SP	*SAND and GRAVEL, Small Sulfur Pocket at 28'*				
30			CH					

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1 4.

GROUNDWATER

First O ser ed During Drilling - 5.2 Feet

Piezometer Installed: No

Shively Geotechnical
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BORING LOG W/OUT B DESIGNATION 6451 GINT LOGS.GPJ IL_DOT.GDT 8/11/11

LOG OF BORING VAMW-3R (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 587.8 Feet

Date Drilled: 12/07/ 3
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30				*CLAY* *CLAY (continued)*				
555			SP	*Fine SAND and GRAVEL*				
35								
				TD - 36.5 Feet				
550								
40								
545								
45								
540								
50								
535								
55								
530								
60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1 4.

GROUNDWATER

⊻ First O ser ed During Drilling - 5.2 Feet

Piezometer Installed: No

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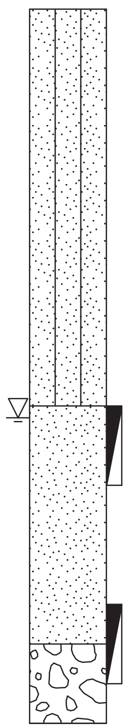
LOG OF BORING VAMW-8R

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 588.0 Feet

Date Drilled: 12/06/ 3
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Atlantic Environmental, Inc.



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0 (588)			SM	*Grayish Brown to Brown Fine SAND and SILT, Loose, Dry to Moist by 4'*				*Blow counts are for 12" intervals unless otherwise noted.*
585								
5								
580				*-Becoming Wet*				
10	0	14/24	SP	*Grayish Brown Fine SAND, Very Loose, Saturated, No Odor, No Visible Contaminants*				
575								
15	7 23	14/24	GP	*GRAVEL and SAND Mix*				
570				*TD - 18.0 Feet*				
20								
565								
25								
560								
30								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1 4.

GROUNDWATER

▽ First O ser ed During Drilling - 10.3 Feet
▼

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

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LOG OF BORING VAMW-17

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 61 .6 Feet

Date Drilled: 12/06/ 3
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0				*Coarse, Dry, ASH and FILL*				*Blow counts are for 12" intervals unless otherwise noted.*
615 / 5				*Gray Fine ASH, Wet*				
610 / 10								
605 / 15	14 18	5/24		*Orange-Brown FILL, Wet, Poorly Sorted, Fine to Coarse Sand*				
600 / 20	22	20/24		*Black ASH, Moist, Fine to Medium Grained, Layered*				
595 / 25	8 10	16/24	ML	*Brown SILT, Well Sorted, Structureless, Few Small Pebbles*				
590 / 30								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1 4.

GROUNDWATER

∑ First O ser ed During Drilling - 37.2 Feet

Piezometer Installed: No

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LOG OF BORING VAMW-17 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 61 .6 Feet

Date Drilled: 12/06/ 3
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30	8 9	21/24	CL	*Brown Silty CLAY, Structureless* *-Grading to Silty SAND*				*Blow counts are for 12" intervals unless otherwise noted.*
585 / 35	7 9	21/24	ML	*Brown to Orange Sandy SILT, Mottled* *-2" Sand and Gravel Layer with 1/4" Pebbles, Moist*				
580 / 40	6 21	24/24	SW	*Brown Fine SAND, Wet, Well Sorted*				
			ML	*Sandy SILT*				
			SP	*Medium to Coarse SAND, with Small Pebbles, Poorly Sorted*				
575 / 45	48 35	19/24	SP	*Brown Medium to Coarse SAND and GRAVEL, Wet, Poorly Sorted*				
			SM	*Gray Silty SAND with 3/4" Pebbles, Well Sorted*				
570 / 50	19	0/24						
565 / 55	17	0/12	SP	*Gray Medium SAND, Wet*				
560 / 60								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1 4.

GROUNDWATER

∇ First O ser ed During Drilling - 37.2 Feet

▼

Piezometer Installed: No

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LOG OF BORING VAMW-17 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 61 .6 Feet

Date Drilled: 12/06/ 3
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
60				*Gray Medium SAND, Wet (continued)*				
	78 100/2"	20/24	CL-ML	*Gray Silty and Sandy CLAY, with 3/4" Pebbles, Very Hard*				*Blow counts are for 12" intervals unless otherwise noted.*
555 – 65	110/9"	7/9		*-Thin Layer of Gray Medium SAND, Well Sorted*				
			SP	*Fine SAND, with 1" Pebbles, Well Sorted*				
550 – 70	120/9"	9/24	CL	*Olive Green Sandy CLAY, with 1/4" Pebbles, Hard*				
				TD - 72.0 Feet				
545 – 75								
540 – 80								
535 – 85								
530 – 90								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1 4.

GROUNDWATER

∇ First O ser ed During Drilling - 37.2 Feet

▼

Piezometer Installed: No

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A Division of Environmental Operations, Inc.

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LOG OF BORING VAMW-1

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 5 3.1 Feet

Date Drilled: 12/10/ 3
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0			SM	*Light Brown to Yellowish Brown Fine to Very Fine SAND, Very Silty, Soft, Loose, Wet at 6'*				*Blow counts are for 12" intervals unless otherwise noted.*
590 / 5	4	*18/24*						
585 / 10	3 7	*18/24*	SP	*Brown to Varied color Medium SAND, Medium to Poorly Sorted, Saturated, Very Loose, Silty in Parts*				
580 / 15	13 16	*24/24*	ML	*Gray SILT, Very Stiff, Some Pebbles*				
575 / 20				*TD - 17.0 Feet*				
570 / 25								
565 / 30								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1 4.

GROUNDWATER

∇ First O ser ed During Drilling - 5.8 Feet

▼

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

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LOG OF BORING VAMW-20

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 5 0.2 Feet

Date Drilled: 12/08/ 3
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
590 / 0			SP	*Fine Silty SAND, Well Sorted, Soft, Loose, Slightly Moist, No Odor*				*Blow counts are for 18" intervals.*
585 / 5	5	*13/18*						
580 / 10	5	*18/18*		*-Grading to Coarser, Very Loose Sand*				
			CL/CH	*Light Olive to Light Olive Brown CLAY, Soft, Slightly Plastic, Wet, Sticky, Silty in Parts*				
575 / 15	52	*10/18*	SP	*Light Yellowish Brown Fine to Medium SAND, Loose, Wet*				
			GW	*Gray GRAVEL, Hard, Well Rounded, Poorly Sorted, Saturated, Fine to Coarse Sand Matrix*				
				TD - 19.0 Feet				
570 / 20								
565 / 25								
30								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1 4.

GROUNDWATER

∇ First O ser ed During Drilling - 11.8 Feet

▼

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

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Illinois (618) 398-1414

LOG OF BORING VAMW-21

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 670.4 Feet

Date Drilled: 12/08/ 3
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
670 / 0			ML	*TOPSOIL, Dark Brown SILT, with Organic Material*				*Blow counts are for 12" intervals unless otherwise noted.*
665 / 5	5, 8	24/24	ML	*Gray to Orange Mottled SILT, Grading to Silty CLAY, Soft, Organics, Moist*				
660 / 10	5, 10	16/24	CL	*Brown to Gray Silty CLAY, with 3/4" Pebbles, Mottled, Soft, Moist*				
655 / 15	29, 35	11/24	CL	*Gray Silty CLAY, with Pebbles, Wet, Medium Stiff*				
650 / 20	10, 23	18/24						
645 / 25	12, 23	22/24	CL	*Gray Silty CLAY, with 1/2" Pebbles, Wet, Stiff*				
30								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1 4.

GROUNDWATER

∇ First O ser ed During Drilling - 87.1 Feet

▼

Piezometer Installed: No

Shively Geotechnical
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Illinois (618) 398-1414

LOG OF BORING VAMW-21 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 670.4 Feet

Date Drilled: 12/08/ 3
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
640 / 30	28 46	12/24		Gray Silty CLAY, with 1/2" Pebbles, Wet, Stiff (continued)				
			SP-SM	Brown Medium SAND with Silt and Clay				
635 / 35	32 70	13/24	SW	Brown Medium to Coarse SAND, with Gravel, Loose, Poorly Sorted				
630 / 40	53 58	13/24		-Some Clasts over 1"				
625 / 45	60 58	14/24						
620 / 50	25 29	20/24		-Grading to Brown Fine to Medium SAND, Loose, Poorly Sorted				
615 / 55	8 15	24/24	SP	Brown Medium SAND, Some Gravel, Loose, Well Sorted				
60				(continued)				

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1 4.

GROUNDWATER

First O ser ed During Drilling - 87.1 Feet

Piezometer Installed: No

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LOG OF BORING VAMW-21 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 670.4 Feet

Date Drilled: 12/08/ 3
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
610 / 60		0/24	SP	*SAND and GRAVEL*				
605 / 65			CH	*CLAY*				
	50	21/24	CL	*Gray Sandy CLAY, with Pebbles, Very Stiff, Massive*				
600 / 70	45	22/24	CL	*Olive Green Sandy CLAY, with Pebbles, Very Stiff, Massive, 1/4" Sand Inclusions*				
595 / 75	53	21/24						
590 / 80	77	24/24						
585 / 85								
90								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1 4.

GROUNDWATER

First O ser ed During Drilling - 87.1 Feet

Piezometer Installed: No

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LOG OF BORING VAMW-21 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 670.4 Feet

Date Drilled: 12/08/ 3
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Atlantic Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
580 / 90	20 67	19/24		*Olive Green Sandy CLAY, with Pebbles, Very Stiff, Massive, 1/4" Sand Inclusions (continued)*				
575 / 95	28 50	24/24	CL	*Olive Green Silty CLAY, with 3/4: Angular to Subangular Limestone Pebbles, Stiff to Medium Stiff*				
570 / 100	38 68	20/24						
			CL	*Olive Green Sandy and Silty CLAY, with Pebbles, Very Stiff, Massive, Some Fine to Medium Sand Seams*				
565 / 105	46 115	19/24	SC	*Olive Green Fine SAND and Silty CLAY, with Pebbles*				
560 / 110	38 100/10"	20/24	SM	*Oive Green Silty Very Fine SAND, with Pebbles, Well Sorted*				
				TD - 112.0 Feet				
555 / 115								
120								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by Atlantic presented in a report dated March 1 4.

GROUNDWATER

First O ser ed During Drilling - 87.1 Feet

Piezometer Installed: No

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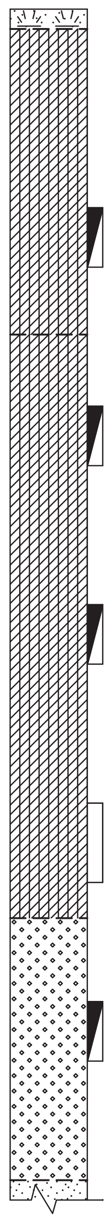
LOG OF BORING B-103

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 653. Feet

Date Drilled: 11/08/01
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Whitney



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
0				Brown SILTY CLAY LOAM, Organic Topsoil				
			CL-ML	Hard, Light Brown SILTY CLAY with Sand				
650 / 5	8, 10, 13	18				4.1 Qu	12	
645			CL-ML	Hard, Light Brown and Brown SANDY SILTY CLAY (Glacial Till)				
10	11, 19, 20	18				7.4 Qu	11	
640 / 15	8, 13, 15	18				6.9 Qu	13	
635 / 20		24						
630			SW	Dense, Light Brown, Fine-Coarse Grained SAND with Some Fine Grained Gravel				
25	9, 16, 18	18					7	
625 / 30								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER

First O ser ed During Drilling - 32.5 Feet
At Completion - 43.5 Feet

Piezometer Installed: No

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LOG OF BORING B-103 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 653. Feet

Date Drilled: 11/08/01
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Whitney

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
30	10 12 12	18	SP	*Medium-Density, Gray, Fine-Medium Grained SAND (continued)*			17	
620 / 35		24						
615 / 40	14 18 20	18	CL-ML	*Hard, Gray-Brown SANDY SILTY CLAY (Glacial Till)*		9.1 Qu	9	
610 / 45	38 50 60	18	SM	*Hard, Light Brown and Orange-Brown SILTY SAND (Glacial Till)*		4.5+ Qp	8	
605 / 50	01/10"	10	SP	*Very Dense, Light Brown, Fine-Coarse Grained SAND*			4	
600 / 55	17 19 25	18	CL	*Hard, Gray-Brown SANDY LEAN CLAY (Clacial Till)*		4.5+ Qu	13	
595 / 60			SP	*Very Dense, Gray-Brown, Fine Grained SAND and Fine Grained GRAVEL*				

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER

∇ First O ser ed During Drilling - 32.5 Feet
▼ At Completion - 43.5 Feet

Piezometer Installed: No

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LOG OF BORING B-103 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 653. Feet

Date Drilled: 11/08/01
Drilling Contractor: Whitney Associates
Drilling Method: ollow Stem Auger
Logged By: Whitney

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
60	21 37 41	18		Very Dense, Gray-Brown, Fine Grained SAND and Fine Grained GRAVEL (continued)			5	
590 / 65	31 40 52	18	CL	Hard, Gray-Brown LEAN CLAY with Sand (Glacial Till)		6.5 Qu	13	
585 / 70	101/7"	7		Hard, Gray-Brown and Gray SHALE		4.5+ Qp	12	
580 / 75	95/6"	6				4.5+ Qp	8	
				TD - 76.0 Feet				
575 / 80								
570 / 85								
565 / 90								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER

▽ First O ser ed During Drilling - 32.5 Feet
▼ At Completion - 43.5 Feet

Piezometer Installed: No

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LOG OF BORING MW22

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 655.6 Feet

Date Drilled: 11/30/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
655 / 0			CL	*Yellow-Brown Silty CLAY, Trace Roots*				*Blind drilled to 70.5 feet. Descriptions taken from Boring MW-10 drilled on 11/29/87.*
			CH	*Brown CLAY with Silt, Roots*				
650 / 5			CL	*Olive-Brown Silty CLAY, TILL*				
				-with Gravel 6.0-8.0'				
645 / 10				*-with Gravel 10.0-12.5' & 18.0-21.0'*				
640 / 15				*-with Cobbles at 17.0'*				
635 / 20				*-Brown 20.0-30.0'*				
630 / 25				*-with Sand, Gravel Seam at 25.0'*				
30								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER ▽ ▼

Piezometer Installed: No

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LOG OF BORING MW22 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 655.6 Feet

Date Drilled: 11/30/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
625 / 30				*Olive-Brown Silty CLAY, TILL (continued)* *-Gray below 30.0'*				*Blind drilled to 70.5 feet. Descriptions taken from Boring MW-10 drilled on 11/29/87.*
				-Gravel Seam at 32.5'				
620 / 35								
615 / 40								
				-Gray-Brown bleow 43.0'				
610 / 45								
				-with Gravel Seams 49.0-59.0'				
605 / 50								
600 / 55								
60								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER ▽ ▼

Piezometer Installed: No

Shively Geotechnical
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LOG OF BORING MW22 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 655.6 Feet

Date Drilled: 11/30/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
595 / 60				*Olive-Brown Silty CLAY, TILL (continued)*				*Blind drilled to 70.5 feet. Descriptions taken from Boring MW-10 drilled on 11/29/87.*
590 / 65								
585 / 70				*SHALE, Bedrock*				
580 / 75		*114/114*		*Gray Clayey SHALE* *-Weathered, Blocky, Fissile, Soft, Dark Gray* *-Competent, Hard, Dark Gray; Laminated with Clay/Silt Seams/Lenses, <1 to 4 mm, Light Gray*				
575 / 80				*-Seams/Lenses of Light Gray Clay/Silt from <1 to 11 mm* *-with Occasional Blue Tine, Blocky When Sheared*				
570 / 85		*120/120*						
90								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER

Piezometer Installed: No

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LOG OF BORING MW22 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 655.6 Feet

Date Drilled: 11/30/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
565 / 90 – 555 / 100		120/120		*Gray Clayey SHALE (continued)* *-Seams/Lenses of Light Gray Clay/Silt from <1 to 2 cm*				
555 / 100				*TD - 100.0 Feet*				

Depth scale: 90, 95, 100, 105, 110, 115, 120. Elevation scale: 565, 560, 555, 550, 545, 540.

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER

▽

▼

Piezometer Installed: No

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LOG OF BORING MW26/MW27

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 580.4 Feet

Date Drilled: 11/26/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: ollow Stem
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
580 / 0			CL	*Silty and Sandy CLAY, with Roots, Dark Brown, Moist*				
	3 3 3 4	20/24	SP	*SAND (Fine), well sorted, Light Yellow-Brown, Moist*		1.75 Qp		
	3 4 4 4	20/24						
575 / 5	4 5 4 4	14/24	SW	*SAND (Fine-Medium) with Shell Fragments, Poorly Sorted, Light Brown, Moist*				
	3 5 7 10	18/24		*-Wet*				
			SM	*Clayey and Silty SAND (Fine), Dark Brown*				
			SW					
570 / 10	7 8 12 17	6/24	GW	*SAND (Fine-Coarse) with Trace Fine Gravel (Angular-Subrounded), Poorly Sorted*				
				SAND (Fine-Coarse) and GRAVEL (Fine, Subangular-Subrounded), Poorly Sorted				
	7 15 18 29	8/24	CL	*Silty CLAY, Olive-Gray; Alluvial*				
	25 50	7/7	SC	*SAND (Medium-Coarse) with Silty Clay, Olive-Gray; Alluvial, Wet*				
565 / 15	35 50	8/8		*Weathered SHALE Bedrock Lean Clay with Silt, Uniform, Medium Greenish Gray, Moist*				
				SHALE Bedrock, Hard, Fissile with Horizontal Parting, Greenish Gray				
560 / 20		102/102		*SHALE Bedrock, Competent with Yellow-Brown Very Fine Sand/Silt Seams and Lenses (<1 mm to 2 cm), Light Gray to Olive Gray*				
555 / 25				*-Gray to Dark Gray; with Thin Laminations (Seams/Lenses) of Clay/Silt/Very Fine Sand (<1 to 4 mm), Light Gray*				
30								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER ▽ ▼

Piezometer Installed: No

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LOG OF BORING MW26/MW27 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 580.4 Feet

Date Drilled: 11/26/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: ollow Stem
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
550 / 30		*120/120*		*SHALE Bedrock, Competent with Yellow-Brown Very Fine Sand/Silt Seams and Lenses (<1 mm to 2 cm), Light Gray to Olive Gray (continued)*				
545 / 35								
540 / 40		*108/108*						
535 / 45				*TD - 44.0 Feet*				
530 / 50								
525 / 55								
60								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER ∇ ▼

Piezometer Installed: No

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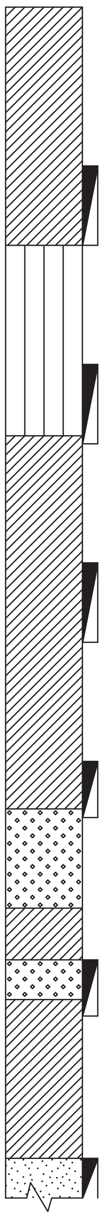
LOG OF BORING MW30

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 645.7 Feet

Date Drilled: 11/21/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: A Rotary
Logged By: Kelron Environmental, Inc.



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
645 / 0			CL	*Silty CLAY Till with Trace Fine-Medium Sand, Olive, Moist*				
640 / 5	9, 7, 12, 17	20/24		*-with Light Gray Mottling Grading to Brown, Trace Fine Gravel*		4.5 Qp		
			ML	*SILT with Fine Sand Grading to Silty SAND, Olive, Dry*				
635 / 10	7, 9, 14, 20	20/24		*-Very Moist*		>4.5 Qp		
			CL	*Silty CLAY TILL with Trace Sand and Gravel, Dry*				
630 / 15	16, 25, 34, 48	24/24		*-Medium Gray*		>4.5 Qp		
625 / 20	27, 47, 50	17/17		*-Moist* *-with Sand and Gravel, Medium Brown*		>4.5 Qp		
			SW	*SAND ans GRAVEL, Fine-Coarse Sand, Fine Gravel, Light Brown, Dry*				
			CL	*Silty CLAY Till with Sand and Gravel (Fine)*				
620 / 25	11, 25, 37, 50	17/17	SW	*SAND (Medium-Coarse) with Fine Gravel, Poorly Sorted, Wet*		>4.5 Qp		
			CL	*Silty CLAY Till with Fine Sand and Gravel, Dry*				
30	33, 50	13/13	SP					

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER

Piezometer Installed: No

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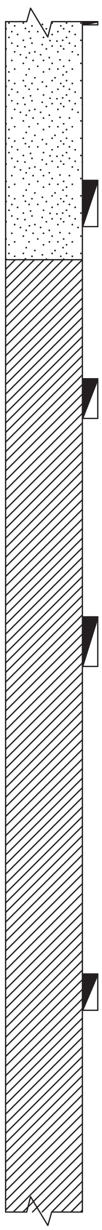
LOG OF BORING MW30 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 645.7 Feet
Date Drilled: 11/21/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: A Rotary
Logged By: Kelron Environmental, Inc.



Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
615 / 30	50			SAND (Fine), Well Sorted, Light Brown, Moist (continued)				
610 / 35	49 50	14/14						
			CL	Silty CLAY Till with Sand and Gravel, Medium Gray, Dry				
605 / 40	36 107	12/12				>4.5 Qp		
600 / 45	29 45 50	15/15				>4.5 Qp		
595 / 50								
590 / 55	62 112	11/11				>4.5 Qp		
60								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER

Piezometer Installed: No

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LOG OF BORING MW30 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 645.7 Feet

Date Drilled: 11/21/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: A Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
585 / 60				*Silty CLAY Till with Sand and Gravel, Medium Gray, Dry (continued)*				
580 / 65	27 37 50	*15/18*				*>4.5 Qp*		
575 / 70								
570 / 75		*12/12*	*ML*	*SILT, Medium Gray, Slightly Moist*				
			CL	*Silty CLAY Till with Trace Sand and Gravel, Medium Gray*				
565 / 80								
560 / 85	66 78	*10/10*	*SM*	*Silty SAND (Fine), Well Sorted, Medium Gray, Wet*				
			CL	*Silty CLAY Till with Trace Sand and Gravel, Medium Gray, Moist*				
90								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER ∇ ▼

Piezometer Installed: No

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LOG OF BORING MW30 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 645.7 Feet

Date Drilled: 11/21/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: A Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
555 / 90				*Silty CLAY Till with Trace Sand and Gravel, Medium Gray, Moist (continued)*				
550 / 95	33 28 52 54	22/22				>4.5 Qp		
545 / 100								
540 / 105	26 34 40 46	20/24		*-Dark Brown with 2x6 mm Piece of Wood, Trace Sand, Plastic, Olive Gray* *-Layer of Clay with Silt, Plastic (Thickness Unkown)*		>4.5 Qp		
535 / 110								
530 / 115	32 47 50	17/17						
				SHALE, Bedrock, Very Hard, Light Gray, Dry, Fissile				
	135	6/6						
120								

(continued)

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER

Piezometer Installed: No

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A Division of Environmental Operations, Inc.

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LOG OF BORING MW30 (Cont.)

Project Name: North and Old East Ash Ponds Study
Project Location: Vermilion Power Station
Project Number: 6451
Elevation: 645.7 Feet

Date Drilled: 11/21/01
Drilling Contractor: Mid-America Drilling, Inc.
Drilling Method: A Rotary
Logged By: Kelron Environmental, Inc.

Elevation/ Depth (feet)	Graphic Log Sampler Symbols and SPT Blows	Rec. (in./in.)	USCS	Description	DD (pcf)	UCS (tsf)	MC (%)	Remarks
525 / 120				*SHALE, Bedrock, Very Hard, Light Gray, Dry, Fissile (continued)*				
		118/120						
520 / 125								
515 / 130								
		120/120						
510 / 135								
505 / 140								
		108/108						
500 / 145				*COAL with Vertical, Calcite Filled Fractures, Black, Slightly Moist*				
				TD - 148.0 Feet				
150								

Notes: Data presented on this log has been transcribed from Boring Logs prepared by John Mathes Associates and Kelron Environmental presented in a report dated November 30, 2003.

GROUNDWATER ∇ ▼

Piezometer Installed: No

Shively Geotechnical
A Division of Environmental Operations, Inc.

Missouri (314) 241-0900
Illinois (618) 398-1414

KEY TO SYMBOLS

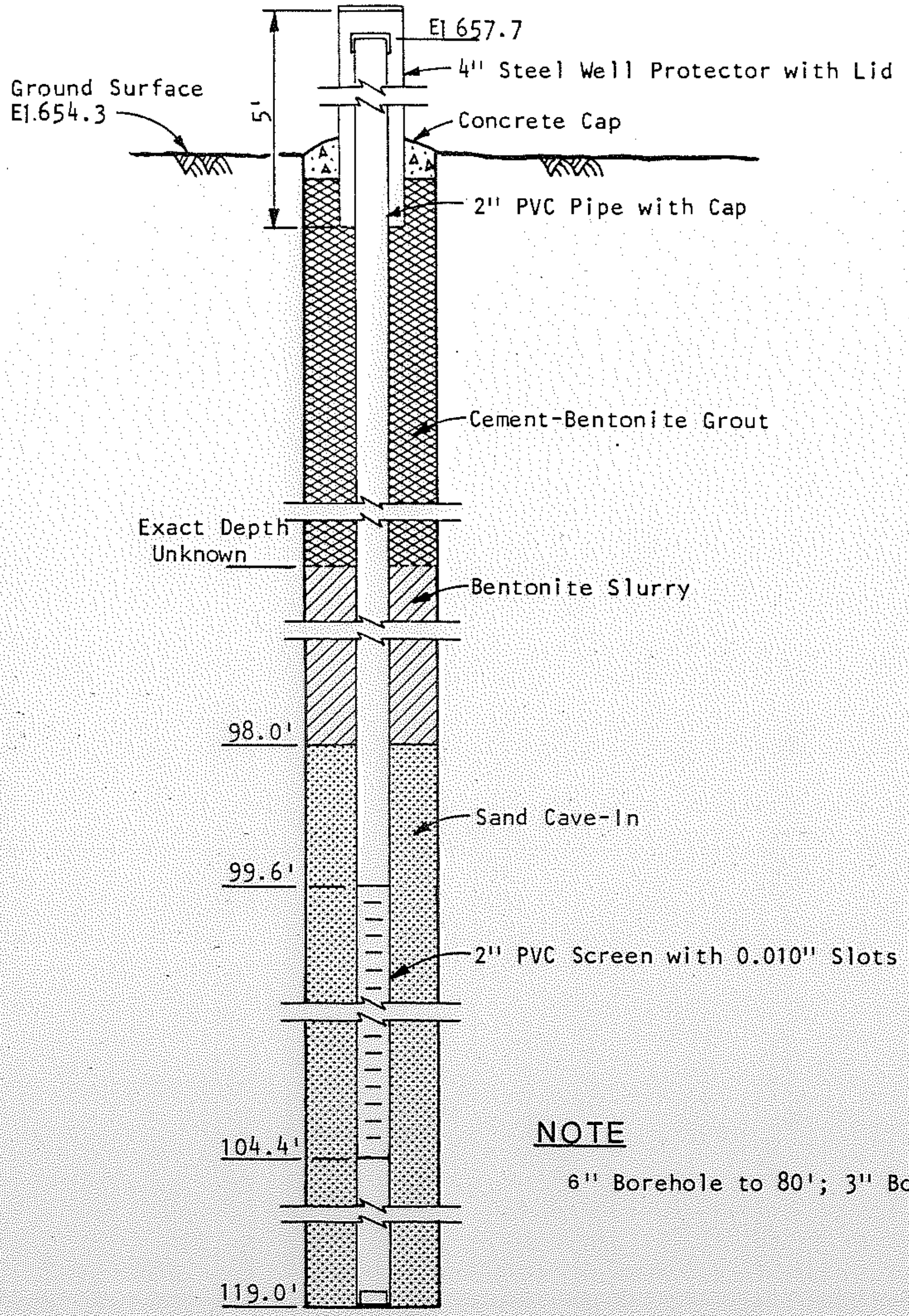
Strata Symbols

- USCS Low Plasticity Lean Clay
- USCS Silt
- USCS Silty Sand
- USCS Poorly-graded Sand with Silt
- USCS Poorly-graded Sand
- USCS Well-graded Sand with Silt
- USCS Sandy Silt
- USCS Low Plasticity Sandy Clay
- USCS Clayey Sand
- USCS Poorly-graded Gravel with Silt
- USCS Poorly-graded Gravel
- USCS High Plasticity Clay
- USCS Poorly-graded Sand with Clay
- Shale
- Fill
- USCS Well-graded Sand
- USCS Low Plasticity Silty Clay
- USCS Low to High Plasticity Clay
- USCS Well-graded Gravel
- Topsoil
- Coal
- USCS Well-graded Sand with Clay

Soil Samplers

- Split Spoon
- Shelby Tube
- Continuous Sample
- Auger Cuttings
- Rock Core
- MacroCore

DD - Dry Density
LL - Liquid Limit
MC - Moisture Content
PCF - Pounds per Cubic Foot
PI - Plasticity Index
PL - Plastic Limit
Qp - Pocket Penetrometer
Qu - Unconfined Compression Test
RQD - Rock Quality Designation
SPT - Split Spoon
TSF - Tons per Square Foot
UCS - Unconfined Compressive Strength
USCS - Unified Soil Classification System



NOTE

6" Borehole to 80'; 3" Borehole below 80'.

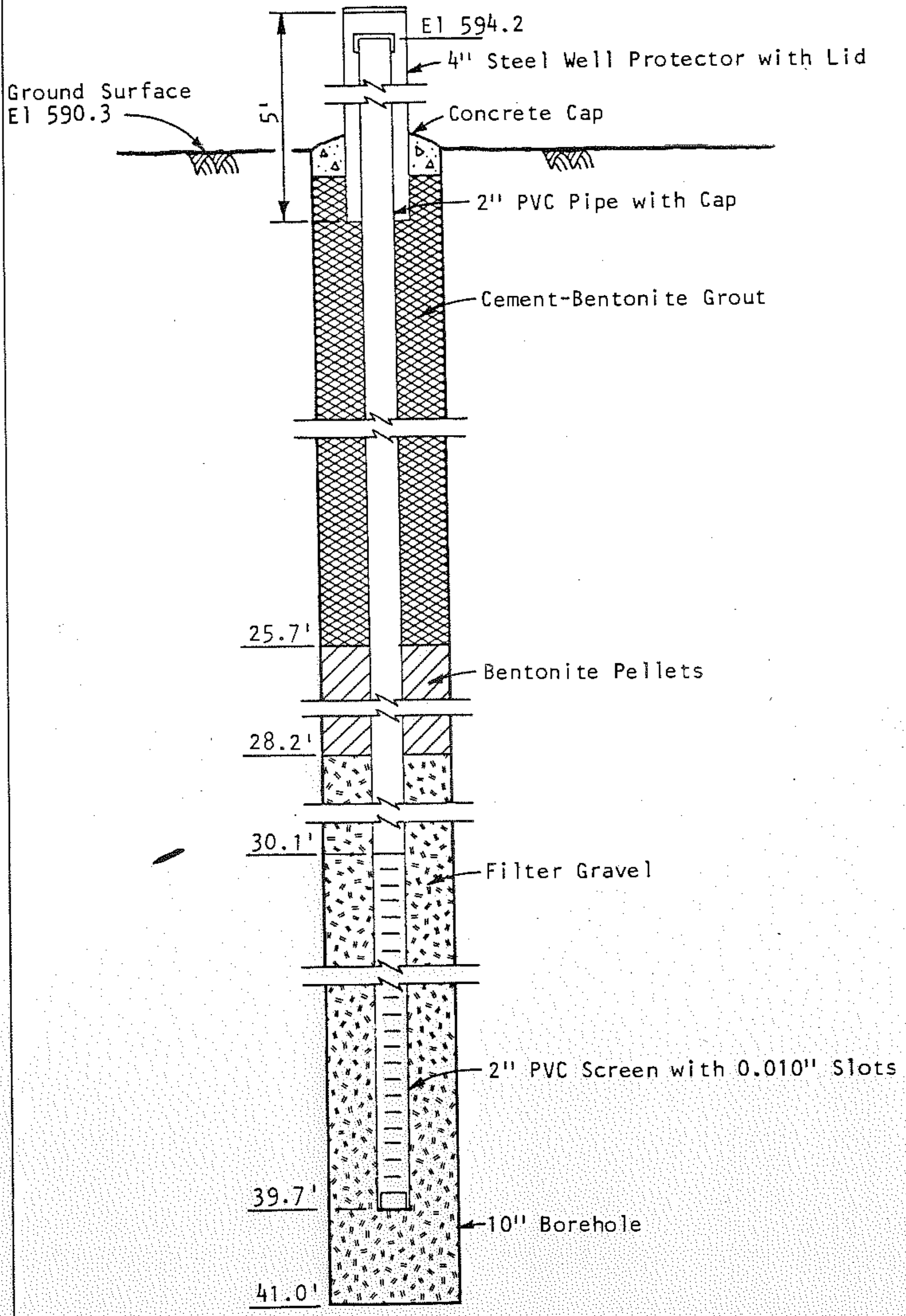
Not to Scale (NTS)

mathes

John Mathes & Associates, Inc.

PIEZOMETER JMA-1

PLATE 6



(NTS)

PIEZOMETER JMA-2A

John Mathes & Associates, Inc.

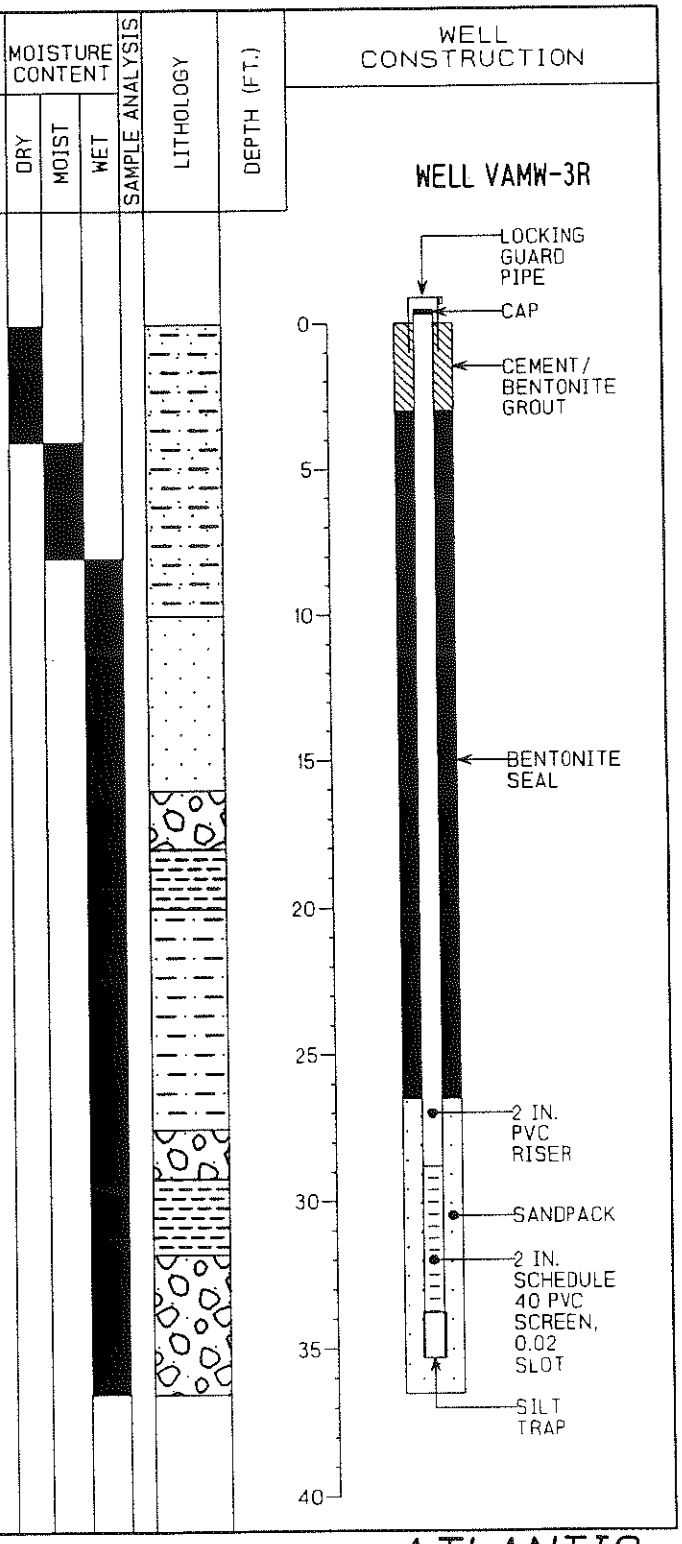
PLATE 7

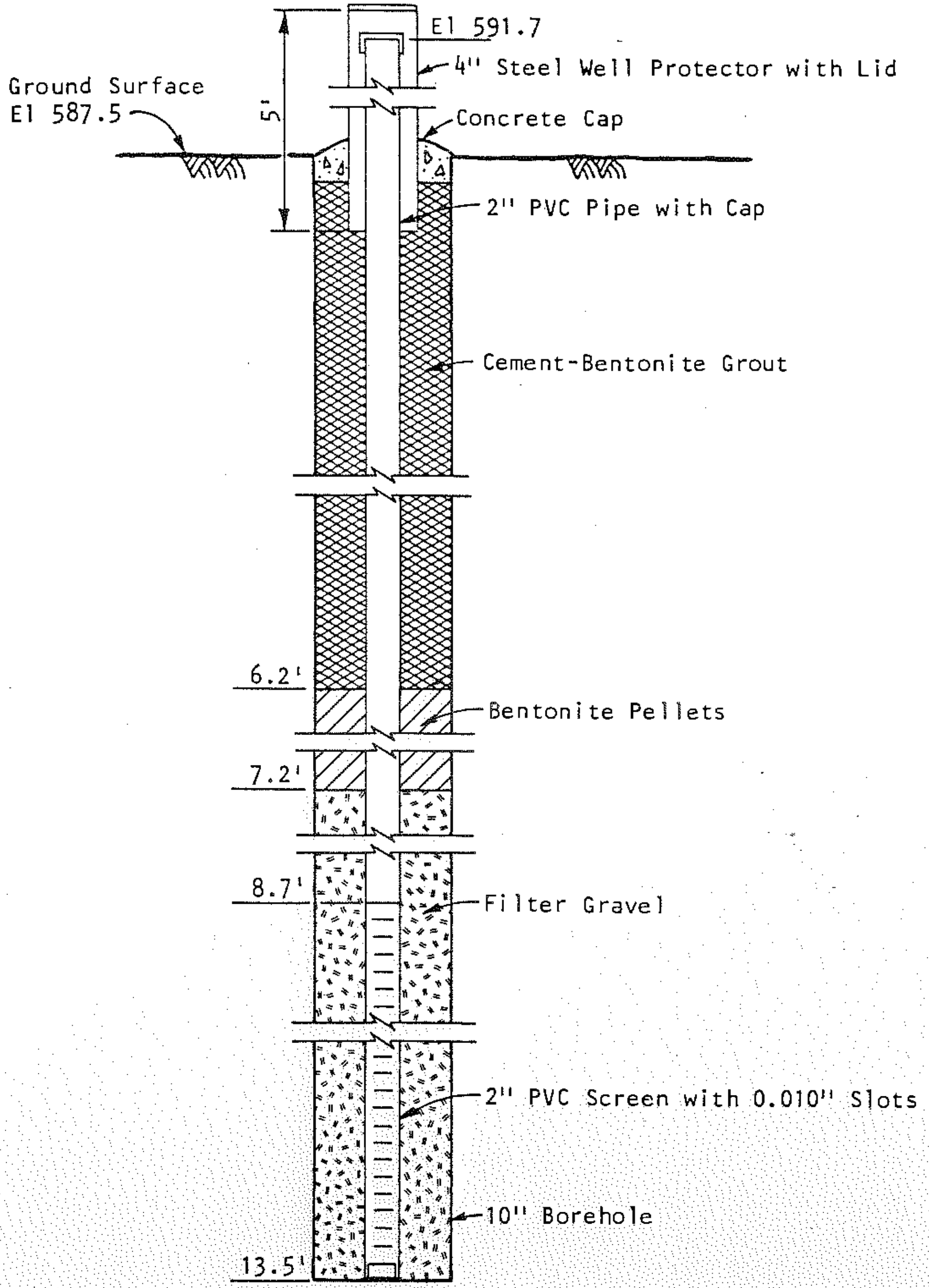
BORING VAMW-3R

PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/7/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: PAUL MAYWOOD
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 5.2 FEET
DATUM: MSL
LOCATION: STATION E

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION: color, density, SOIL, admixture, moisture, other notes, ORIGIN
			Grayish brown to brown fine SAND and SILT, loose, dry to moist by 4
			becoming wet
10-12	0	60	Grayish brown fine SAND, very loose, saturated, no odor, no visible contaminants.
15-17	?,23	60	GRAVEL and SAND mix.
			CLAY.
20-22	18,6 (6")	80	Gray to light grayish brown SILT, stiff, grades to silty clay in parts, very thin sand interbeds.
25-27	19,19	70	
			SAND and GRAVEL, small sulfur pocket at 28
			CLAY
			Fine SAND and GRAVEL
			TD 36.5



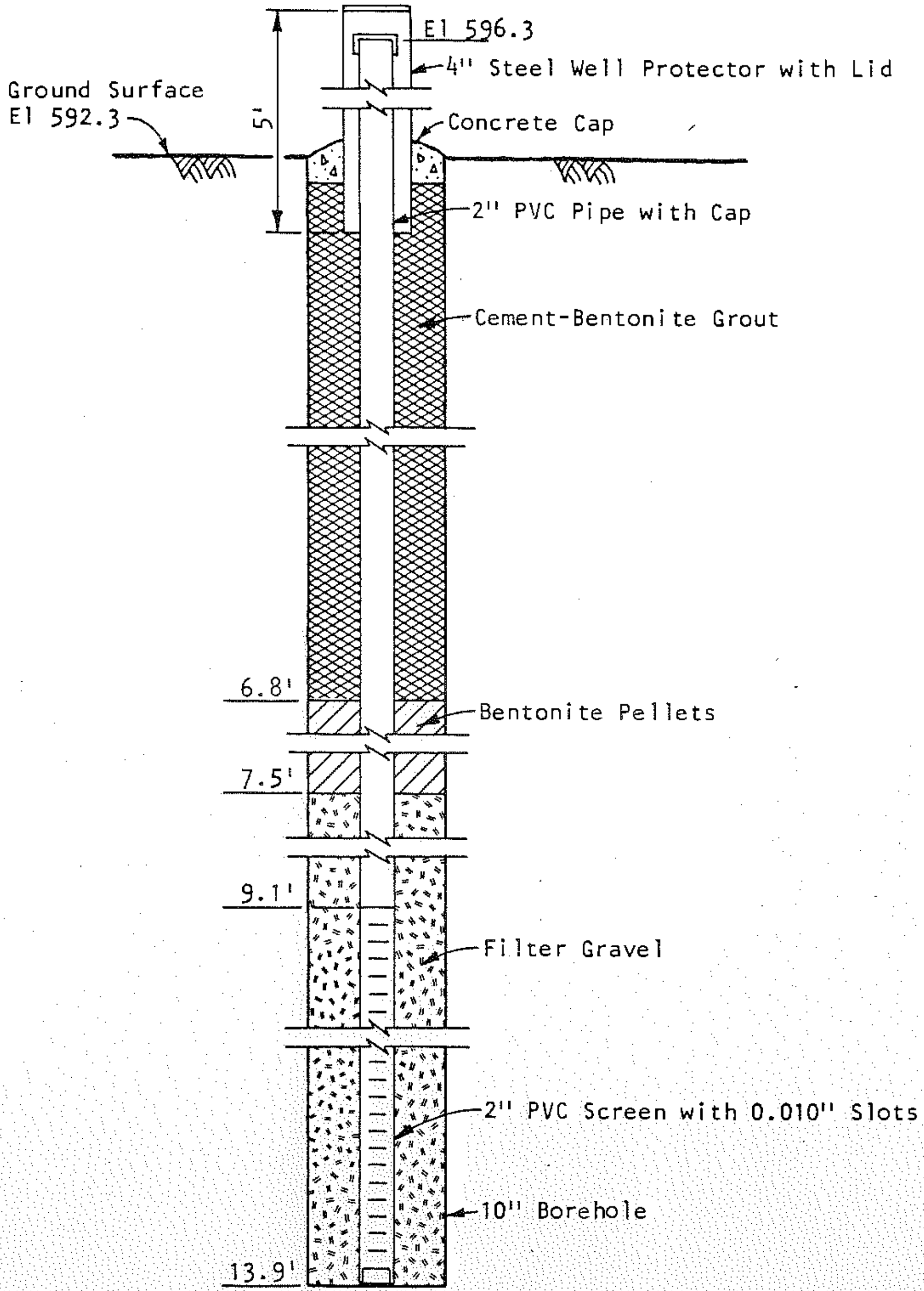


(NTS)

PIEZOMETER JMA-4

John Mathes & Associates, Inc.

PLATE 11



(NTS)

PIEZOMETER JMA-5

John Mathes & Associates, Inc.

PLATE 12

TELEPHONE
309 673-2131

TESTS
DESIGN
REPORTS
ANALYSIS
INSPECTION
CONSULTATION
INVESTIGATIONS

WHITNEY & ASSOCIATES
INCORPORATED
2406 West Nebraska Avenue
PEORIA, ILLINOIS 61604

SPECIALISTS IN
SOILS - PORTLAND CEMENT CONCRETE
STEEL - BITUMINOUS CONCRETE
CONSTRUCTION MATERIALS
AGGREGATES - ASPHALT - POZ-O-PAC

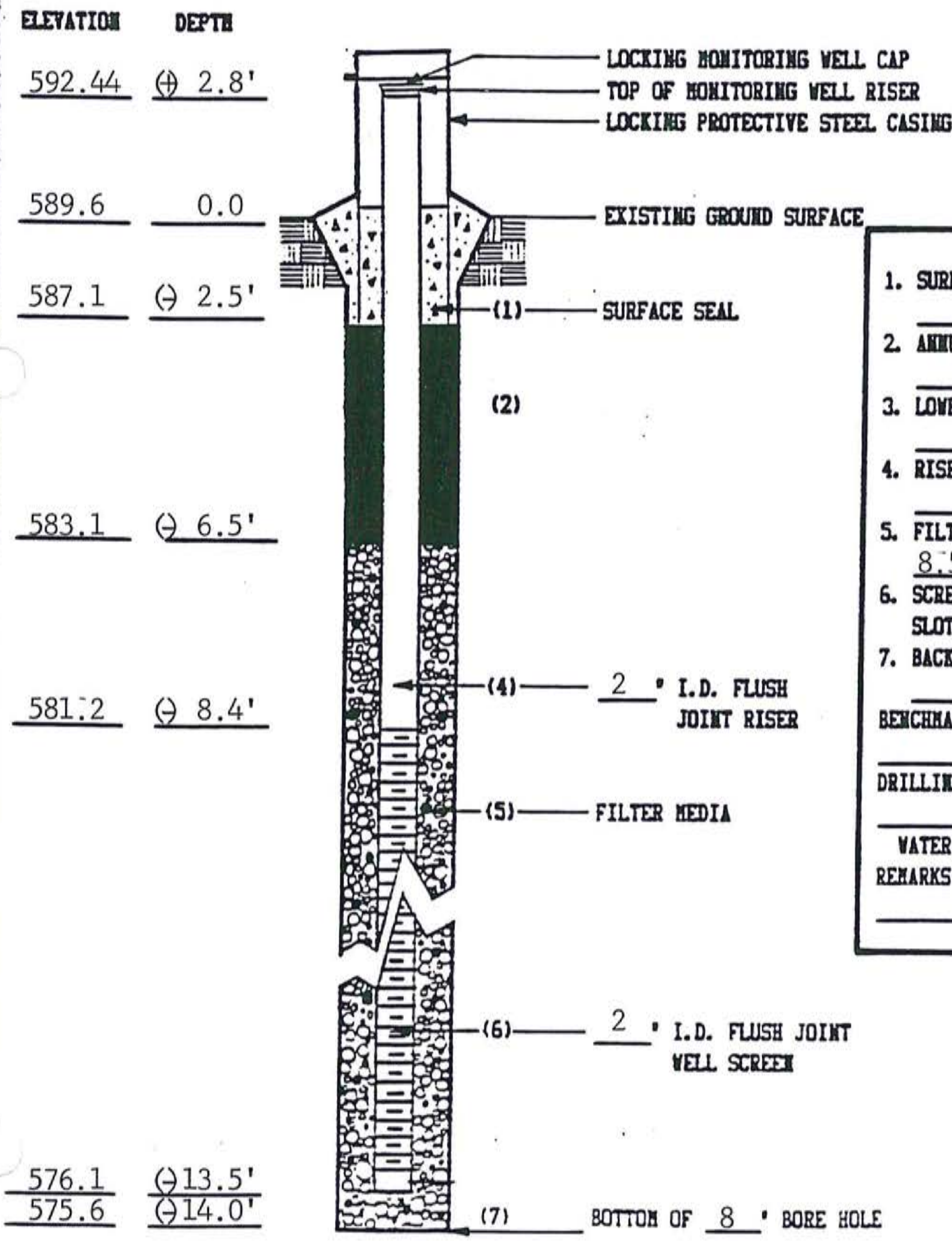
SOILS AND GRAVEL SURVEYS
MATERIALS QUALITY CONTROL
SOIL MECHANICS AND
FOUNDATION ENGINEERING
DRILLING - CORING - TESTING

Fehl
INSTALLED BY

11-23-99
DATE

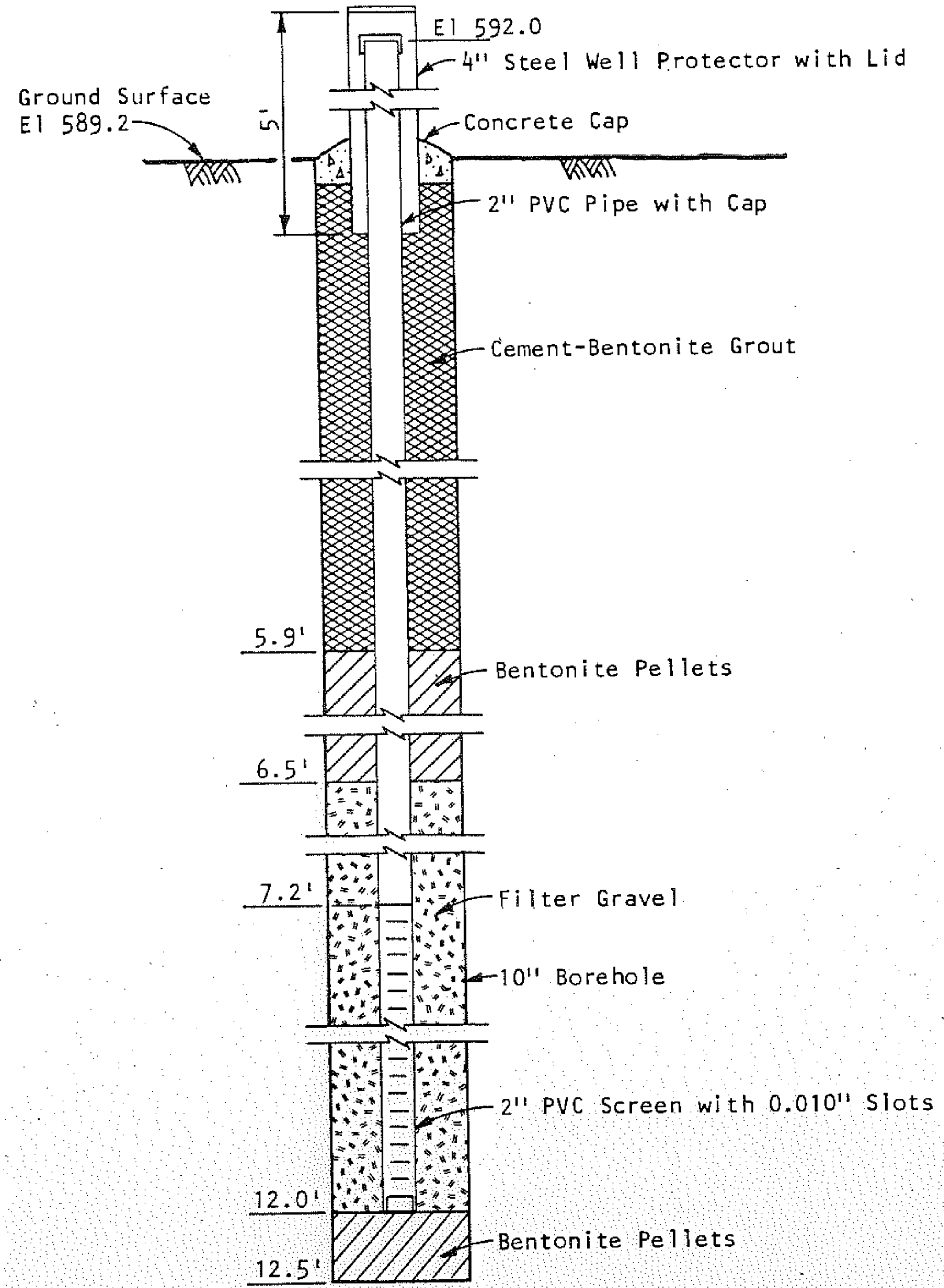
TYPICAL MONITORING WELL DIAGRAM

PROJECT Illinois Power Vermilion Power Station MONITORING WELL NO. MW-6R
LOCATION Oakwood, Illinois INSTALLATION DATE 11-23-99
MONITORING WELL LOCATION See Environmental Engineers Site Plan Sheet



1. SURFACE SEAL Concrete Encasement
2. ANNULAR BACKFILL Bentonite Pellets
3. LOWER SEAL N/A
4. RISER TYPE Schedule 40 PVC
5. FILTER MEDIA Silica Sand (6.5-8.5) Natural Sand (8.5-13.5)
6. SCREEN TYPE Schedule 40 PVC
   SLOT SIZE 0.010" LENGTH 5.0'
7. BACKFILL TYPE Natural Sand

BENCHMARK U.S.G.S Datum / Illinois Power
DRILLING METHOD 4.25" I.D. Hollow Stem Augers
WATER LEVEL @ - HOURS -
REMARKS



(NTS)

John Mathes & Associates, Inc.

PIEZOMETER JMA-~~2B~~ 7

PLATE 8

BORING VAMW-8R

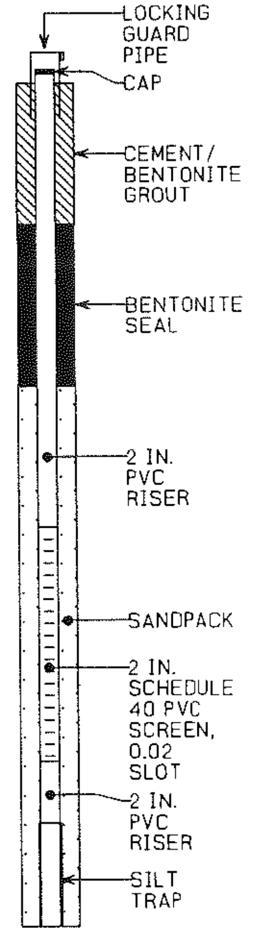
PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/6/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

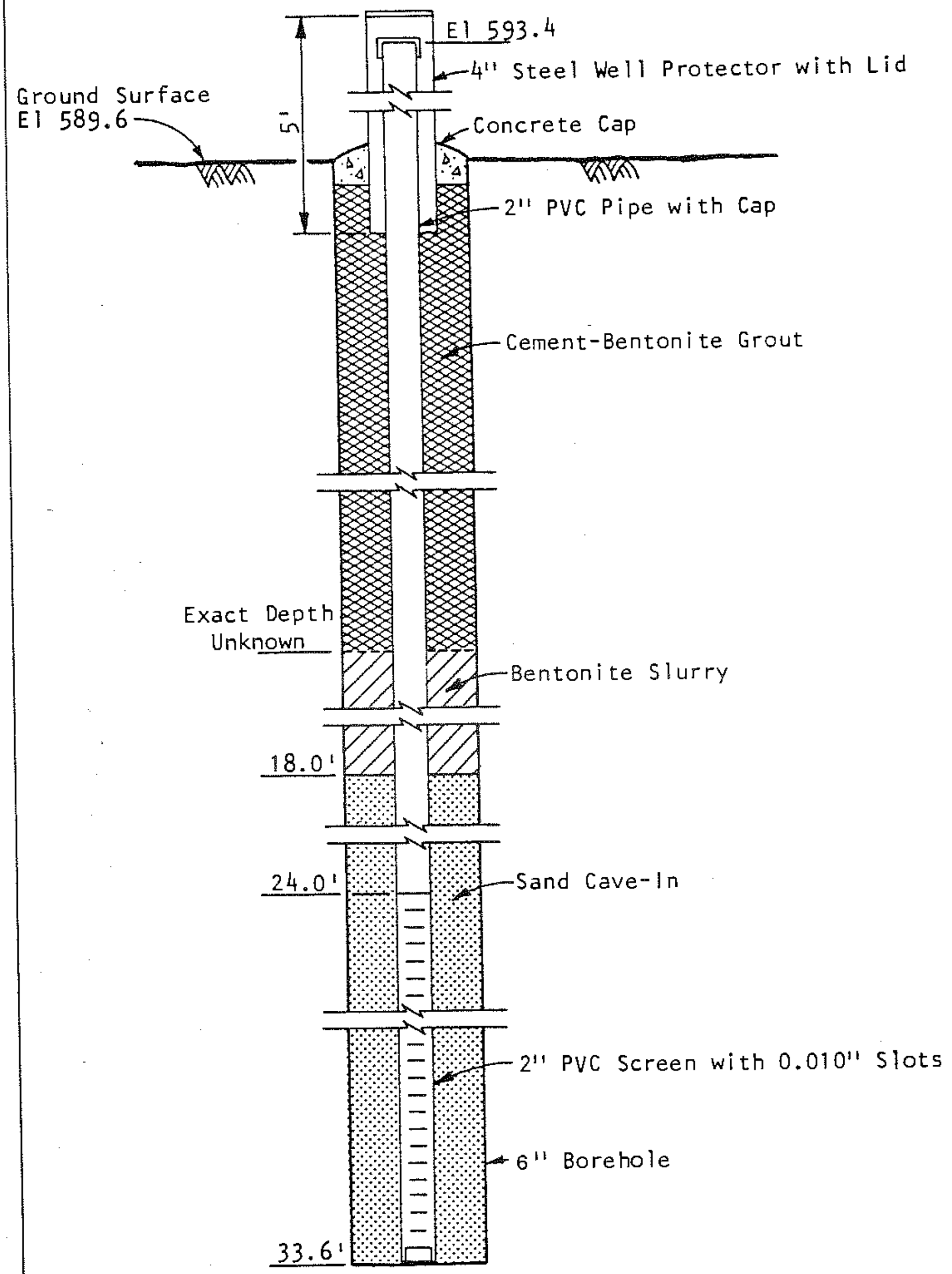
INSPECTOR: PAUL MAYWOOD
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 10.3 FEET
DATUM: MSL
LOCATION: STATION E

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION: color, density, SOIL, admixture, moisture, other notes, ORIGIN	MOISTURE CONTENT (DRY / MOIST / WET)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)
			Grayish brown to brown fine SAND and SILT, loose, dry to moist by 4	DRY (0–4), MOIST (4–8)			0
			becoming wet	WET			5
10–12	0	60	Grayish brown fine SAND, very loose, saturated, no odor, no visible contaminants	WET			10
15–17	?,23	60	GRAVEL and SAND mix	WET			15
			TD 18				20
							25

WELL CONSTRUCTION

WELL VAMW-8R



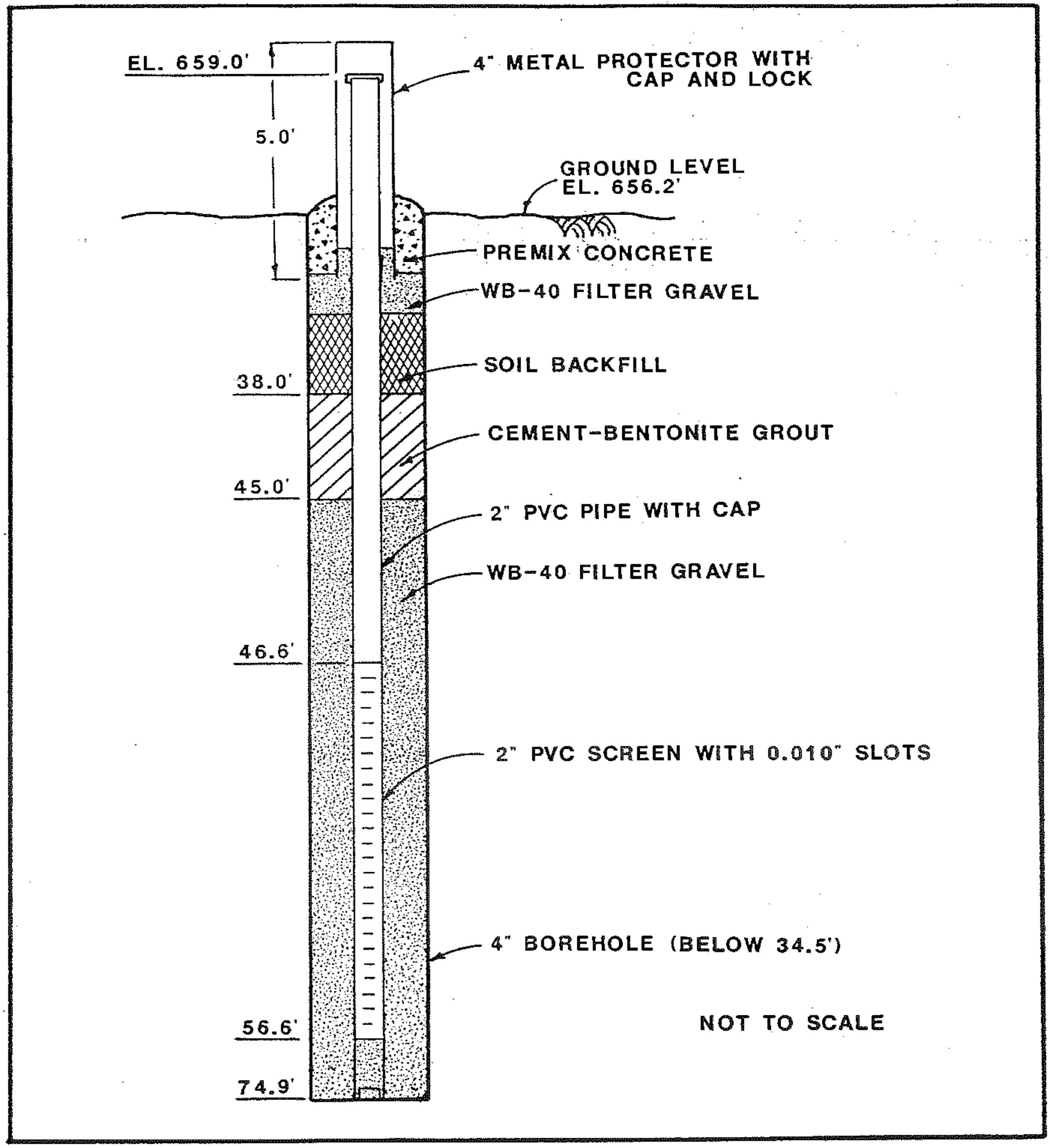


(NTS)

PIEZOMETER JMA-~~6B~~ 9

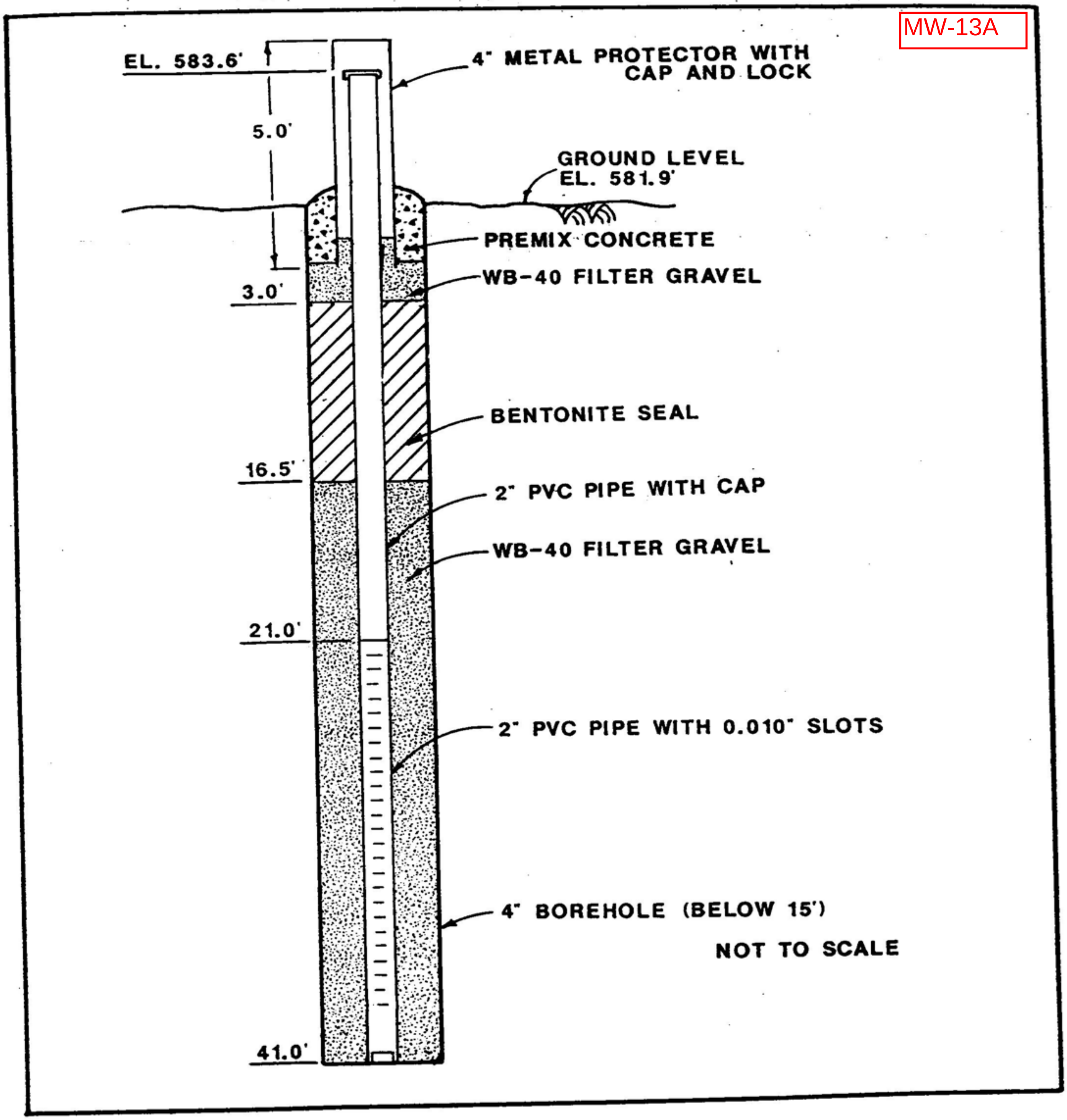
John Mathes & Associates, Inc.

PLATE 14



Mathes Geotechnical Services, Inc.	
ILLINOIS POWER COMPANY VERMILION POWER STATION PIEZOMETER 10	
11872803	FIGURE 7a

MW-13A



Mathes Geotechnical Services, Inc.	
ILLINOIS POWER COMPANY VERMILION POWER STATION PIEZOMETER 13A	
11872803	FIGURE 7f

ILLINOIS DEPARTMENT OF PUBLIC HEALTH DIVISION OF
ENVIRONMENTAL HEALTH
525 W. JEFFERSON ST.
SPRINGFIELD, IL 62761

WATER WELL SEALING FORM

TYPE OR PRESS FIRMLY

RETURN ALL COPIES TO IDPH OR LOCAL HEALTH DEPARTMENT

This form shall be submitted to this Department or the local health department not more than 30 days after a water well, boring or monitoring well is sealed. Such wells are to be sealed not more than 30 days after they are abandoned in accordance with the sealing requirements in the Water Well Construction Code. THE LOCAL HEALTH DEPARTMENT OR REGIONAL PUBLIC HEALTH DEPARTMENT MUST BE NOTIFIED AT LEAST 48 HOURS PRIOR TO SEALING.

1. Ownership (Name of Controlling Party) Dynegy (Well 13A)
2. Well Location - Vermilion Power Station (Address - Lot Number) Oakwood (City) Vermilion (County)

   General Description Township 20N Range 12W Section 21

   NW Quarter of the NW Quarter of the SW Quarter
3. Year Drilled ______
4. Sealing Permit Number (and date, if known) ______
5. Type of Well Bored ☐ Drilled ☐ Other Monitoring Well
6. Total Depth 31 Diameter(inches) 2
7. Formation clear of obstruction ☑ Yes ☐ No
8. DETAILS OF PLUGGING

   Filled With Fill Dirt From 0 to 8 ft.

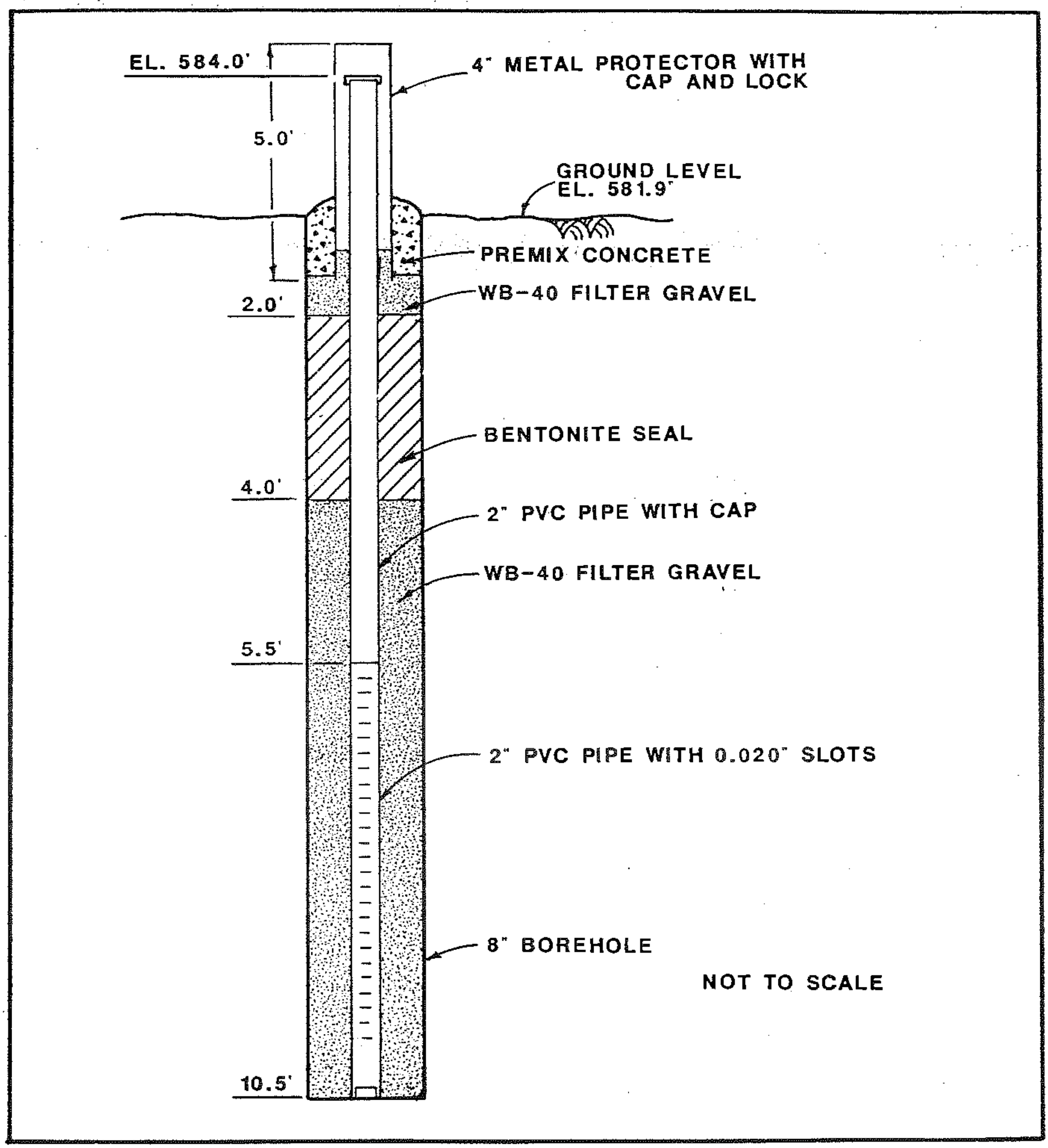
   Kind of Plug Hole Plug From 8 to 31 ft.
9. CASING RECORD Upper 2 feet of casing removed ☑ Yes ☐ No
10. Date well was sealed Month 10 Day 31 Year 2016
11. Licensed water well driller or other person approved by the Department performing well sealing.

    Sarah Gassaway (Name) 092-008929 (Complete License Number)

    405 W Main St. (Address) Downs (City) IL 61736 (State/ZIP)

IL 482-0631

Printed by Authority of the State of Illinois
P.O. #530379 9.6M 4/00



Mathes Geotechnical Services, Inc.	
ILLINOIS POWER COMPANY VERMILION POWER STATION PIEZOMETER 13B	
11872803	FIGURE 7g

WELL INSTALLATION RECORD

Well Number MW-13BR

Borehole Number (if different) ____

Project Name Well Network Upgrade -North and Old East Ash Ponds   Project No. Kelron 2010.17

Client Company Dynegy, Inc.   Cost Code ____

Site Name Vermilion Power Station

Site Address Oakwood, Illinois

Piezometer Diameter 2 inches

Well Type
- ☒ Monitoring Well
- ☐ Piezometer
- ☐ Recovery Well
- ☐ Other ____

Permit
Number ____
Date ____

Conductor Casing (To seal off upper water-bearing zones) ☐ None

Diameter ____ inches
Material ____
Length ____ feet
Depth to Bottom of Casing ____ feet
Seal Material ____

Well Construction Details

Well Component	Material (specify type) PVC	Stainless Steel	Teflon	Other	Length (feet)	Depth Below Grade (feet) Bottom	Top
Borehole							
Bottom Cap/Plug	✓				0.22	10.77	
Sump (Tailpipe below screen)							Same as top of screen.
Screen [Slot Size: 0.010 in.]	✓	(4.62' slotted)			5.02	10.55	5.53
Riser (Blank Casing above Screen)	✓				7.73	Same as bottom of screen.	-2.20

Annular Fill Materials

Use minus sign if top of riser is above ground.

Component	Material Name/Description	Quantity (No. of Bags/ Volume per Bag)	Tremied Yes	No	Depth Below Grade (feet) Bottom	Top
Plug beneath sand pack					10.77	3.50
Sand Pack	Filter Sil Qtz. (Med-Crse)	4×50#		×	~~3.50~~	~~0.50~~ s/c
Bentonite Seal	Pure Gold Med. Chips	1×50#		×	3.50	0.50
Grout Seal						
Backfill (if any)						
Surface Seal	Concrete	—		×		

Well Cover
Finish: ☒ Stick-up ☐ Flush ☐ Vault
Material: ☒ Steel ☐ Aluminum

Lock
☒ Yes Lock Number ____
☐ No

Measuring Point
☒ Top of Riser
☐ Top of Cover

Well Collision Protectors Installed?
☐ Yes Quantity ____
☒ No

Comments Geoprobe 6620 DT. Augers 8¼" OD / 4¼" ID. Shale at 10.4' BLS. Dry hole. (Shale sampled at 10.4 to 12.6' BLS)

Signature [signature]   Date 10-21-10   Reviewer ____   Date ____

State of Illino..
Department of Public Health

WATER WELL CONS..RUCTION REPORT

Complete within 30 days of well completion and send to the appropriate Health Department

Print Form

1. Type of Well

a. **Driven Well:** Casing Diameter (in.) ____ Depth (ft.) ____

b. **Bored Well**: Casing Diameter (in.) ____ Buried Slab? ____

c. **Drilled Well**: PVC Casing Formation Packer set at depth of (ft.) 5.5

d. **Drilled Well**: Steel Casing Mechanically Driven ____

e. Hole Diameter (in.) 8 to (ft.) 10.8 ; (in.) 1.6 to (ft.) 12.6 ; (in.) ____ to (ft.) ____

f.

Type of Grout	# of bags	Grout Weight	From (ft.)	To (ft.)	Tremie Depth (ft.)
Bentonite Chips	1		0.5	3.5	

g. Well Finished within Unconsolidated Materials

h.

Kind of Gravel/Sand Pack	Grain Size/Supplier #	From (ft.)	To (ft.)
Quartz Sand	Morie #1 / FilterSil	3.5	10.8

2. Well Use: Monitoring Well Disinfected? ____

3. Date Well Completed: 10/21/2010 Driller's Estimated Well Yield (gpm): ____

4. Date Permanent Pump Installed: n/a Set at depth (ft.): ____

5. Pump Capacity (gpm): ____

6. Pitless Adapter Model and Manufacturer: ____ Attachment to Casing: ____

7. Well Cap Type & Manufacturer: ____

8. Pressure Tank: Working Cycle (gals.): ____ Captive Air? ____ 9. Pump System Disinfected: ____

10. Name of Pump Company: ____

11. Pump Installer: ____ License # ____

12. ____ Date ____
Licensed Pump Installation Contractor Signature

Illinois Department of Public Health
Division of Environmental Health
525 West Jefferson Street
Springfield, IL 62761

IMPORTANCE NOTICE: This state agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act-0863. Disclosure of this information is Mandatory. This form has been approved by the Forms Management Center.

IL 482-0126

13. Property Owner: Dynegy Midwest Generation, Inc. Well # MW-13BR *

14. Driller: Jerry Hancock License # 092-007590

15. Name of Drilling Company : PSC Industrial Outsourcing 16. Permit Number: ____
Date Issued: n/a 17. Date Drilling Started: 10/21/2010

18. Well Site Address: Vermilion Power Station, Oakwood, IL

19. Township Name: Blount Land I.D. # ____

20. Subdivision Name: ____ Lot # ____

21. Location: a. County Vermilion b. Site Elevation 582.2 ft. (above msl)

c. Township: 20N Range: 12W Section: 21

d. NW Quarter of the NW Quarter of the SW Quarter

e. GPS: Lat: Degrees 40 Minutes 10 Seconds 46.3 N

Lon: Degrees 87 Minutes 44 Seconds 7.6 W

Survey use only

22. Casing and Liner Information

Diameter (in.)	Material, Joint Type	From (ft.)	To (ft.)
2.0	Schedule 40 PVC / threaded	-2.20	5.53
2.0	Schedule 40 PVC bottom plug / threaded	10.55	10.77

23. Is the well screened? Yes If yes

Diameter (in.)	Length (ft.)	Slot Size (in.)	From (ft.)	To (ft.)
2.0	5.0	0.010	5.53	10.55

24. Water from sand at a depth of (ft.) 7.0 To. (ft.) 10.4

a. static wate level (ft.) below casing dry which is (in.) above ground 2.79

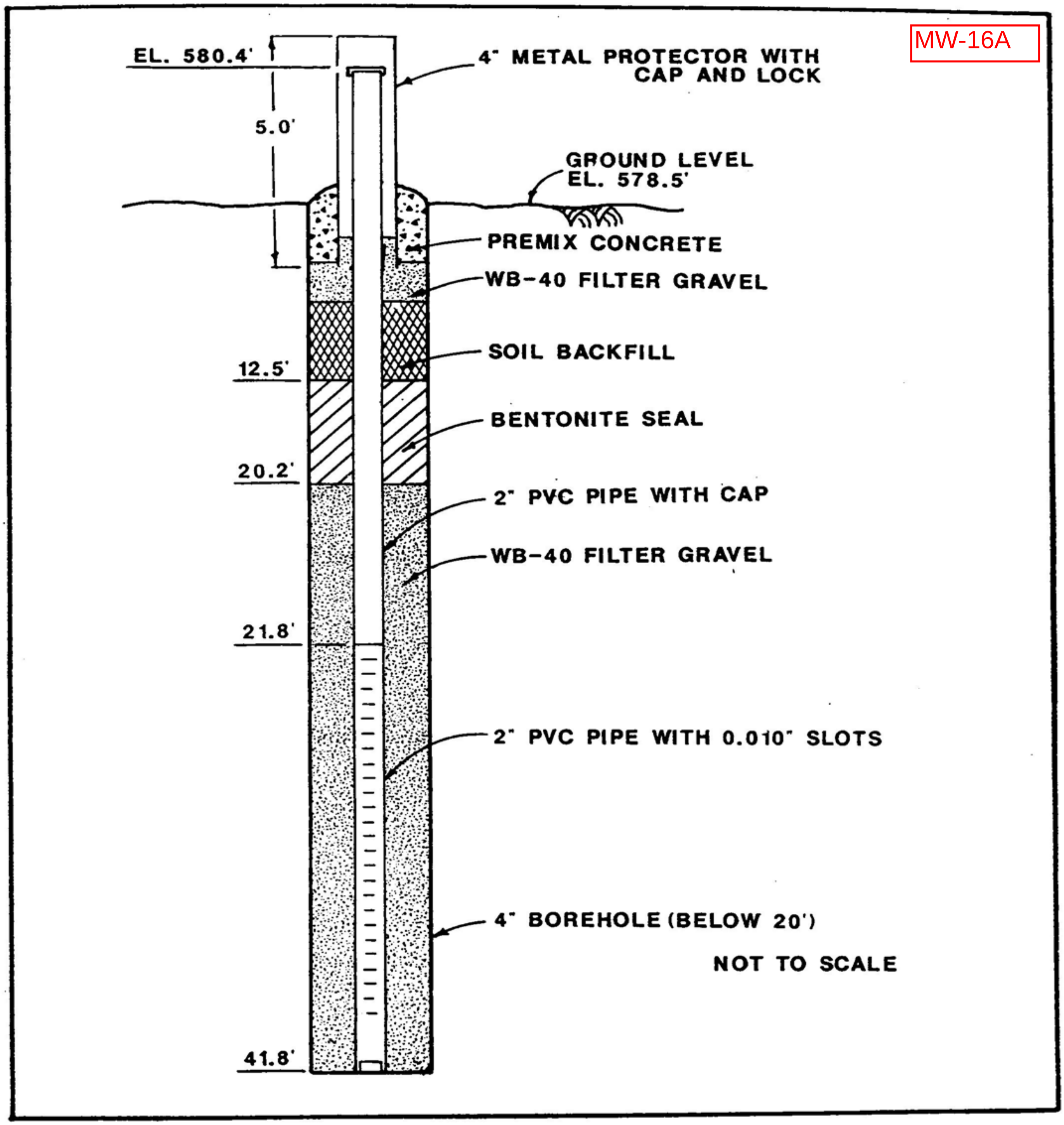
b. pumping level is (ft.) ____ pumping (gpm) ____ for (hours) ____

25.

Earth Materials Passed Through	From (ft.)	To (ft.)
Silty CLAY with Sand, brown, moist	0.0	7.0
SAND (fine-med) with few gravel, trace silt, dry	7.0	9.0
Silty CLAY with Sand, brown, dry	9.0	11.0
SHALE, gray, dry	10.4	12.6
* this is a replacement well for MW-13B (sealed on 10/21/10)		

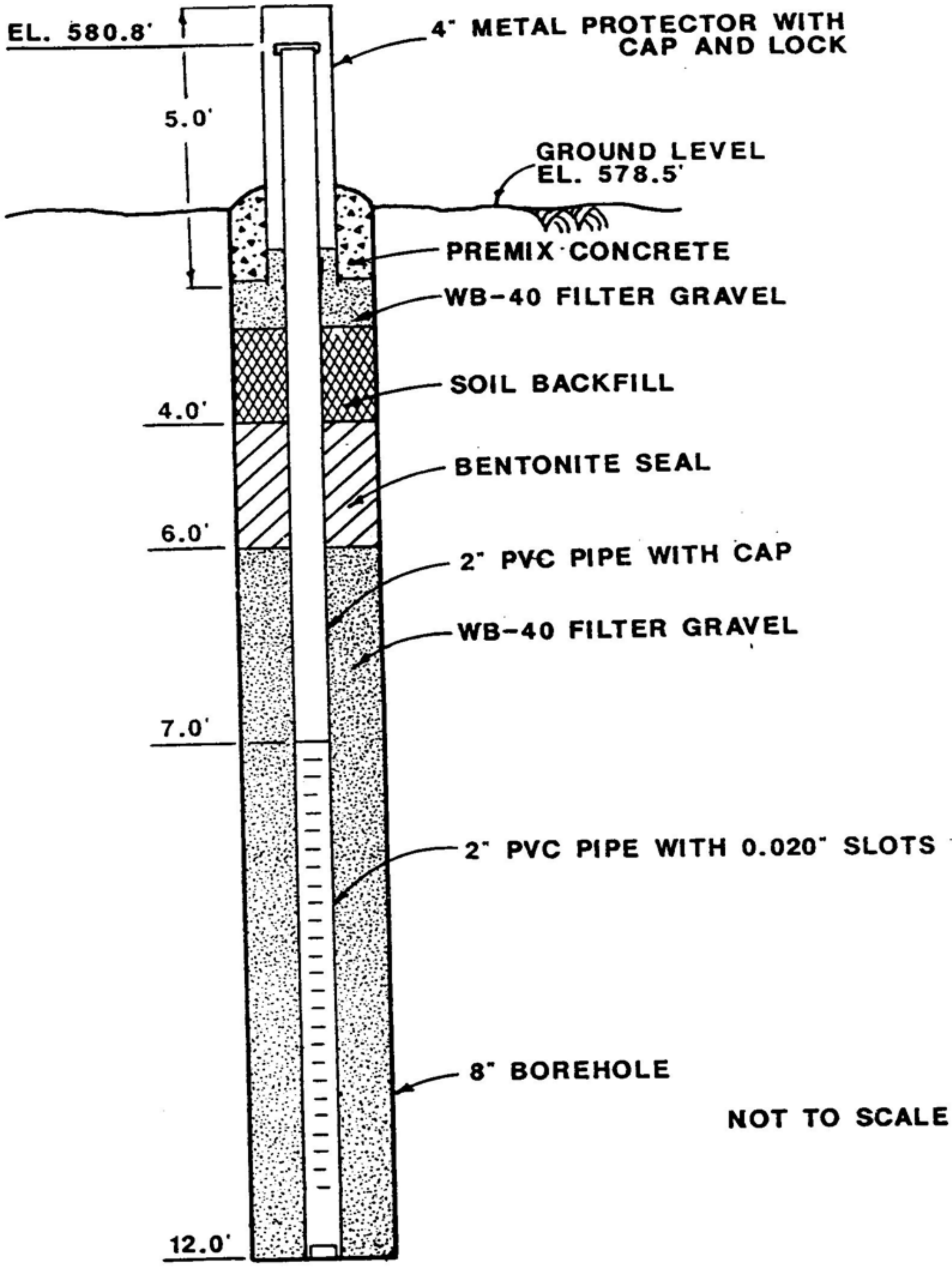
(Attach 2nd page, if necessary) (If DRY HOLE, fill out log & indicate how hole was sealed)

____ License # ____
Licensed Water Well Contractor Signature



Mathes Geotechnical Services, Inc.	
ILLINOIS POWER COMPANY VERMILION POWER STATION PIEZOMETER 16A	
11872803	FIGURE 7m

MW-16B



Mathes Geotechnical Services, Inc.	
ILLINOIS POWER COMPANY VERMILION POWER STATION PIEZOMETER 16B	
11872803	FIGURE 7n

BORING VAMW-17

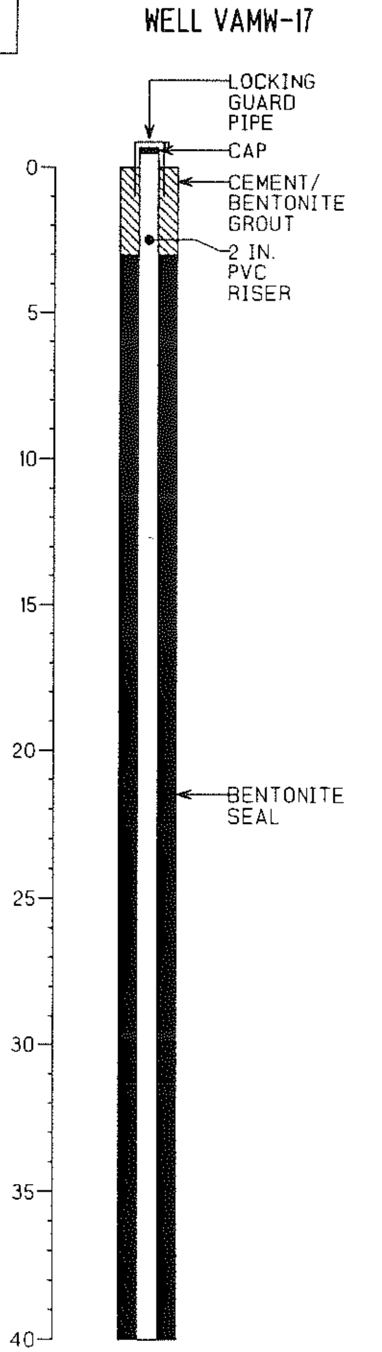
PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/6/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: BRUCE HENSEL
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 37.2 FEET
DATUM: MSL
LOCATION: STATION A

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION: color, density, SOIL, admixture, moisture, other notes, ORIGIN
			Coarse, dry, ASH and FILL.
			Gray fine ASH, wet.
15-17	14,18	21	Orange-brown FILL, wet, poorly sorted, fine to coarse sand.
20-22	22	83	Black ASH, moist, fine to medium grained, layered.
25-27	8,10	67	Brown SILT, well sorted, structureless, few small pebbles.
30-32	8,9	88	Brown silty CLAY, structureless.
			Grading to silty SAND.
35-37	7,9	88	Brown to orange sandy SILT, mottled.
			2" SAND and GRAVEL layer with 1/4" pebbles, moist.

MOISTURE CONTENT: DRY / MOIST / WET — SAMPLE ANALYSIS — LITHOLOGY — DEPTH (FT.)

WELL CONSTRUCTION



ATLANTIC

BORING VAMW-17

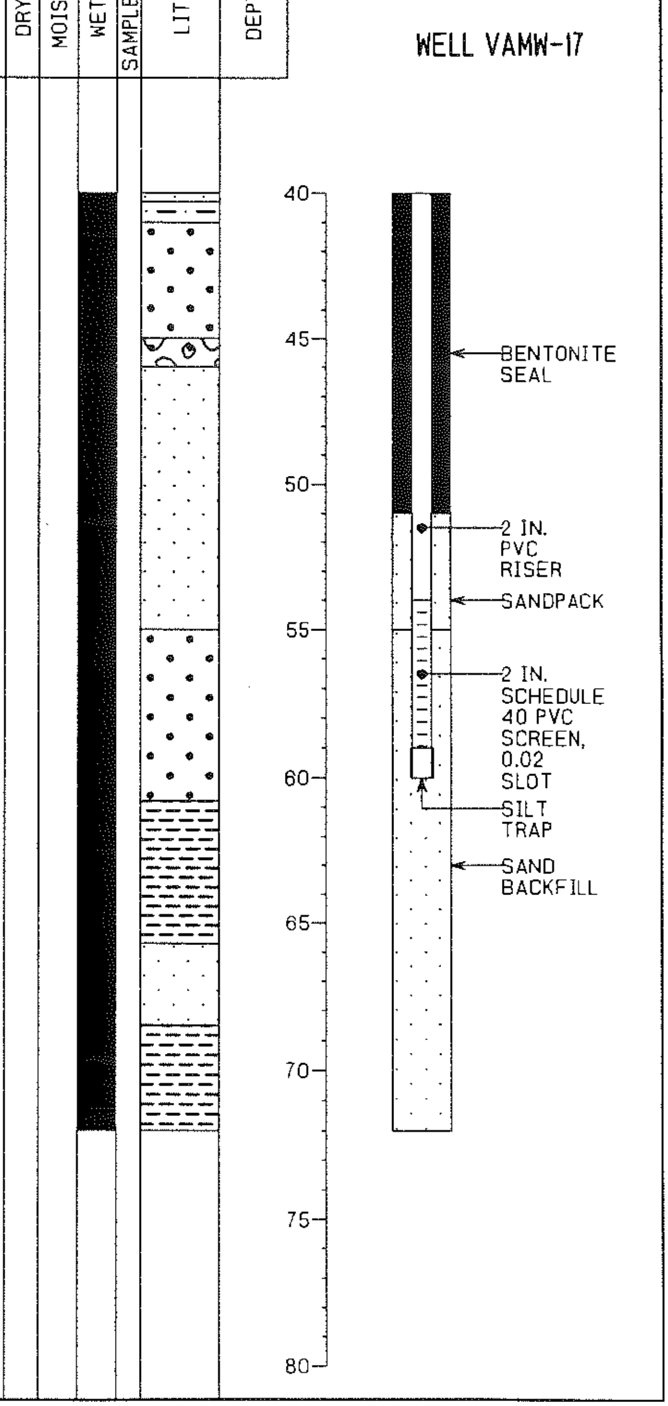
PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/6/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: BRUCE HENSEL
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 37.2 FEET
DATUM: MSL
LOCATION: STATION A

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION (color, density, SOIL,admixture, moisture, other notes, ORIGIN)
40-42	6,21	100	Brown fine SAND, wet, well sorted. Sandy SILT. Medium to coarse SAND with small pebbles, poorly sorted.
45-47	48,35	79	Brown medium to coarse SAND and GRAVEL, wet, poorly sorted. Gray silty SAND with 3/4" pebbles, well sorted.
50-52	19	0	
55-56	17	0	Gray medium SAND, wet.
60-62	78 100 (2")	83	Gray silty and sandy CLAY with 3/4" pebbles, very hard.
65-66	110 (9")	75	Thin layer of gray medium SAND, well sorted. Fine SAND with 1" pebbles, well sorted. Olive green sandy CLAY with 1/4" pebbles, hard.
70-72	120 (9")	38	TD 72

MOISTURE CONTENT: DRY, MOIST, WET; SAMPLE ANALYSIS; LITHOLOGY; DEPTH (FT.)

WELL CONSTRUCTION



BORING VAMW-18

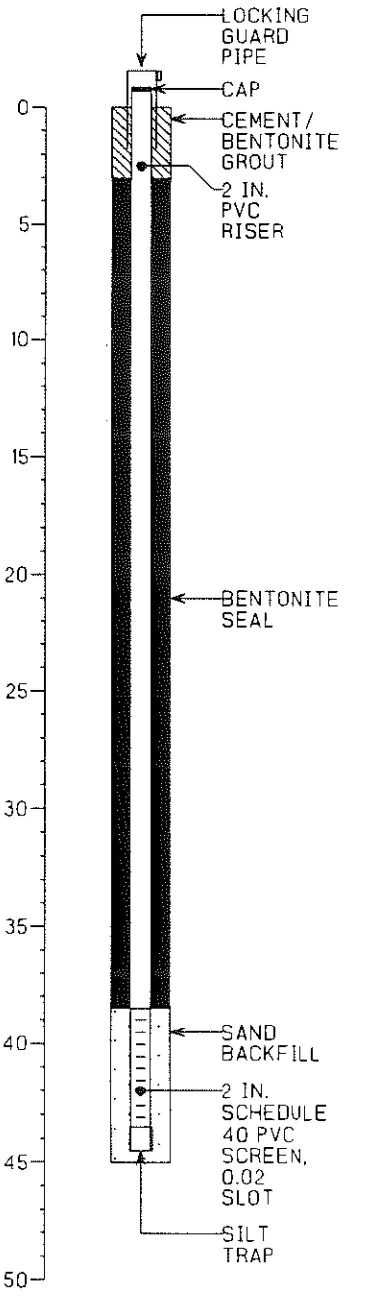
PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/8/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: BRUCE HENSEL
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 20.5 FEET
DATUM: MSL
LOCATION: STATION A

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION (color, density, SOIL, admixture, moisture, other notes, ORIGIN)
			Coarse, dry, ASH and FILL.
			Gray fine ASH, wet.
15-17	14,18	21	Orange-brown FILL, wet, poorly sorted, fine to coarse sand.
20-22	22	83	Black ASH, moist, fine to medium grained, layered.
25-27	8,10	67	Brown SILT, well sorted, structureless, few small pebbles.
30-32	8,9	88	Brown silty CLAY, structureless. Grading to silty SAND.
35-37	7,9	88	Brown to orange sandy SILT, mottled. 2" SAND and GRAVEL layer with 1/4" pebbles, moist.
40-42	6,21	100	Brown fine SAND, wet, well sorted. Sandy SILT. Medium to coarse SAND with small pebbles, poorly sorted.
			TD 45

MOISTURE CONTENT: DRY / MOIST / WET — SAMPLE ANALYSIS — LITHOLOGY — DEPTH (FT.)

WELL CONSTRUCTION



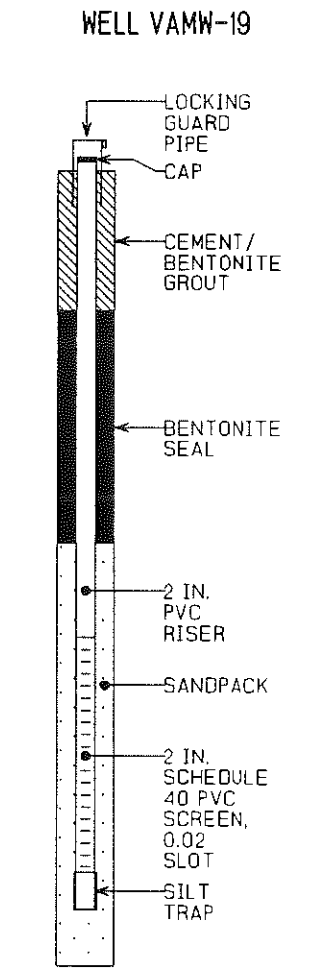
BORING VAMW-19

PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/10/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: PAUL MAYWOOD
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 5.8 FEET
DATUM: MSL
LOCATION: STATION C

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION: color, density, SOIL, admixture, moisture, other notes, ORIGIN	MOISTURE CONTENT: DRY	MOISTURE CONTENT: MOIST	MOISTURE CONTENT: WET	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)
			Light brown to yellowish brown fine to very fine SAND, very silty, soft, loose, wet at 6.						0
5-7	4	75							5
10-12	3,7	75	Brown to varied color medium SAND, medium to poorly sorted, saturated, very loose, silty in parts.						10
•									
15-17	13,16	100	Gray SILT, very stiff, some pebbles.						15
			TD 17						
									20
									25

WELL CONSTRUCTION



BORING VAMW-20

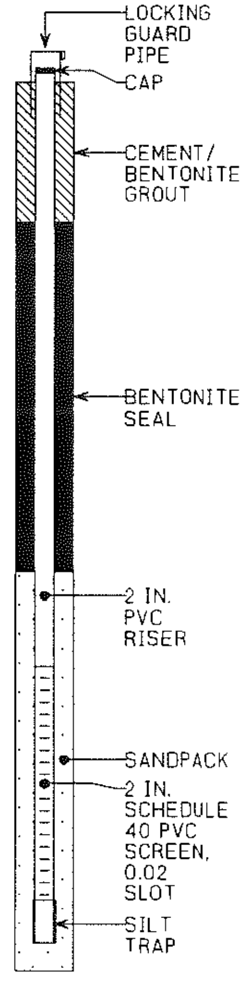
PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/8/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: PAUL MAYWOOD
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 11.8 FEET
DATUM: MSL
LOCATION: STATION D

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 18"	PERCENT RECOVERY	SOIL DESCRIPTION (color, density, SOIL, admixture, moisture, other notes, ORIGIN)	MOISTURE CONTENT (DRY / MOIST / WET)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)
			Fine silty SAND, well sorted, soft, loose, slightly moist, no odor.	MOIST			0
5-6.5	5	73		MOIST			5
10-11.5	5	100	Grading to coarser, very loose SAND.	MOIST			10
			Light olive to light olive brown CLAY, soft, slightly plastic, wet, sticky, silty in parts.	WET			
15-16.5	52	53	Light yellowish brown fine to medium SAND, loose, wet.	WET			15
			Gray GRAVEL, hard, well rounded, poorly sorted, saturated, fine to coarse sand matrix.	WET			
			TD 19				
							20
							25

WELL CONSTRUCTION

WELL VAMW-20



BORING VAMW-21

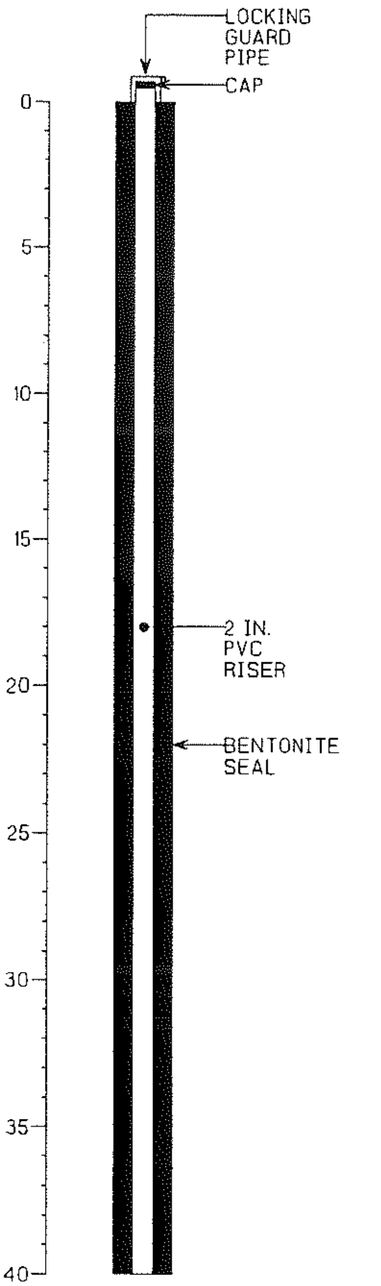
PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/8/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: BRUCE HENSEL
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 87.1 FEET
DATUM: MSL
LOCATION: STATION H

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION: color, density, SOIL, admixture, moisture, other notes, ORIGIN	MOISTURE CONTENT	DEPTH (FT.)
			TOPSOIL, dark brown silt with organic material.	DRY	0
5-7	5,8	100	Gray to orange mottled SILT grading to silty CLAY, soft, organics, moist.	MOIST	5
10-12	5,10	67	Brown to gray silty CLAY with 3/4" pebbles, mottled, soft, moist.	MOIST	10
15-17	29,35	46	Gray silty CLAY with pebbles, wet, medium stiff.	WET	15
20-22	10,23	75		WET	20
25-27	12,23	92	Gray silty CLAY with 1/2" pebbles, wet, stiff.	WET	25
30-32	28,46	50	Brown medium SAND with silt and clay.	WET	30
35-37	32,70	54	Brown medium to coarse SAND with gravel, loose, poorly sorted.	WET	35
					40

WELL CONSTRUCTION

WELL VAMW-21



BORING VAMW-21

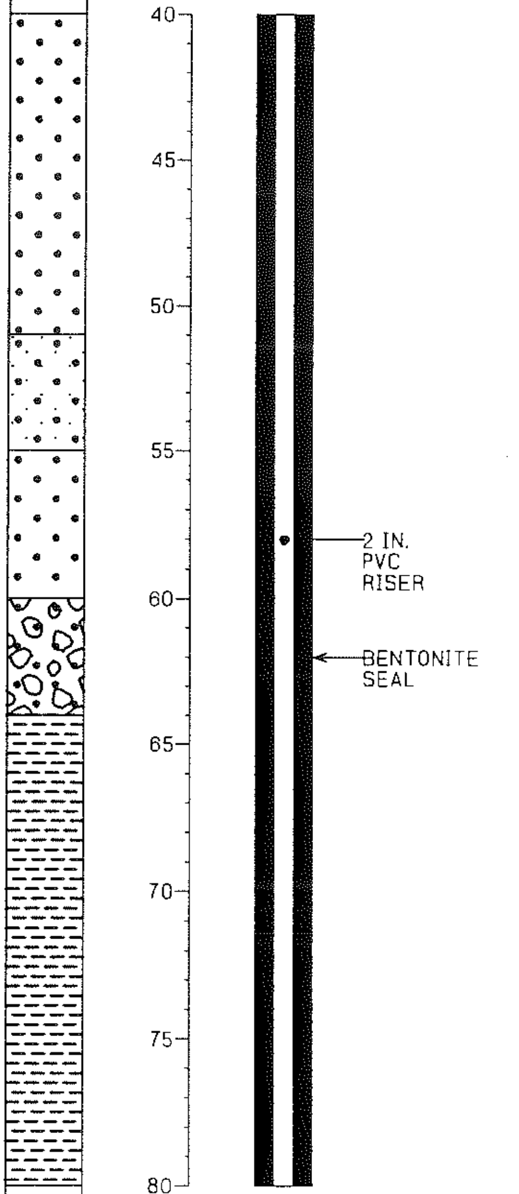
PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/8/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

INSPECTOR: BRUCE HENSEL
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 87.1 FEET
DATUM: MSL
LOCATION: STATION H

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION: color, density, SOIL, admixture, moisture, other notes, ORIGIN	MOISTURE CONTENT
40-42	53,58	54	Some clasts over 1".	WET
45-47	60,58	58		WET
50-52	25,29	83	Grading to brown fine to medium SAND, loose, poorly sorted.	WET
55-57	8,15	100	Brown medium SAND, some gravel, loose, well sorted.	WET
60-62	--	0	SAND and GRAVEL. CLAY.	WET
65-67	50	88	Gray Sandy CLAY with pebbles, very stiff, massive.	WET
70-72	45	92	Olive green sandy CLAY with pebbles, very stiff, massive, 1/4" sand inclusions.	WET
75-77	53	88		WET

SAMPLE ANALYSIS | LITHOLOGY | DEPTH (FT.) | WELL CONSTRUCTION

WELL VAMW-21



BORING VAMW-21

PROJECT: IP/VERMILION ASH POND
PROJECT NO: 1309-07-02
DATE: 12/8/93
DRILLING CONTRACTOR: WHITNEY & ASSOCIATES
DRILLING METHOD: 4.25 INCH HOLLOW STEM AUGER
SAMPLING METHOD: 2 FOOT SPLIT SPOONS

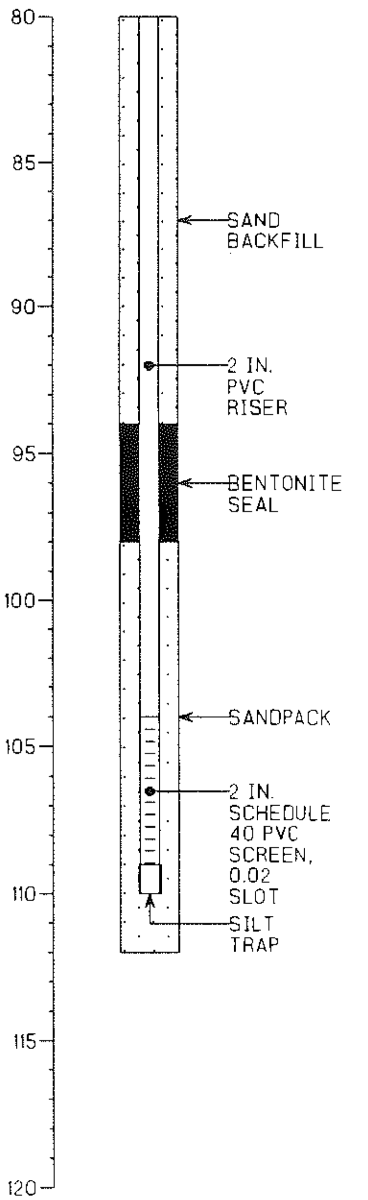
INSPECTOR: BRUCE HENSEL
WELL ELEVATION (FT):
DEPTH TO WATER (FT): 87.1 FEET
DATUM: MSL
LOCATION: STATION H

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 12"	PERCENT RECOVERY	SOIL DESCRIPTION (color, density, SOIL, admixture, moisture, other notes, ORIGIN)
80-82	77	100	
90-92	20,67	79	
95-97	28,50	100	Olive green silty CLAY with 3/4" angular to subangular limestone pebbles, stiff to medium stiff.
100-102	38,68	83	Olive green sandy and silty CLAY with pebbles, very stiff, massive, some fine to medium sand seams.
105-107	46,115	79	Olive green fine SAND and silty CLAY with pebbles.
110-112	38 100 (10")	83	Olive green silty very fine SAND with pebbles, well sorted.
			TD 112

MOISTURE CONTENT: DRY / MOIST / WET — SAMPLE ANALYSIS — LITHOLOGY — DEPTH (FT.)

WELL CONSTRUCTION

WELL VAMW-21



ATLANTIC

Illinois Environmental Protection Agency Well Completion Report

SITE #: IL0004057 (NPDES #) COUNTY: Vermilion WELL #: MW22

SITE NAME: Vermilion Station, Dynegy Midwest Generation, Inc. BOREHOLE #:

STATE PLANE COORDINATE: x 1150083 y 1279669 (or) LATITUDE: ° ' " LONGITUDE: ° ' "

SURVEYED BY: Chastain & Assoc., Inc. ILL. REGISTRATION #: 2217

DRILLING CONTRACTOR: Mid-America Drilling, Inc. DRILLER: Dusty Jackson

CONSULTING FIRM: Kelron Environmental GEOLOGIST: Eric Kovatch (NRT)

DRILLING METHOD: Hollow-Stem Auger/Coring DRILLING FLUIDS (TYPE): Water

LOGGED BY: Eric Kovatch (NRT) DATE STARTED: 12-5-01 DATE FINISHED: 12-5-01

REPORT FORM COMPLETED BY: Stuart Cravens DATE: 2-6-02

ANNULAR SPACE DETAILS

TYPE OF SURFACE SEAL: Cement

TYPE OF ANNULAR SEALANT: Bentonite grout

INSTALLATION METHOD: tremie

SETTING TIME: 24-hours

TYPE OF BENTONITE SEAL - GRANULAR, PELLET, SLURRY (CIRCLE ONE)

INSTALLATION METHOD: through augers

SETTING TIME: 1-hour

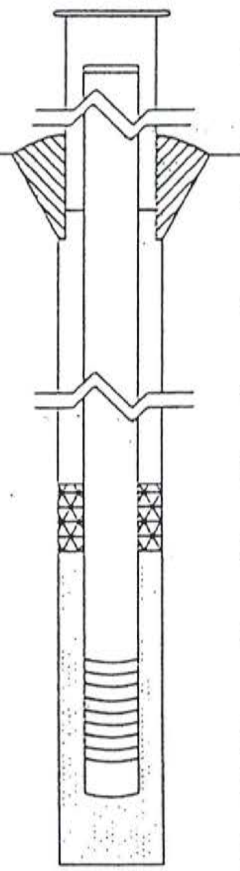
TYPE OF SAND PACK: Silica

GRAIN SIZE: 30 (SIEVE SIZE)

INSTALLATION METHOD: through augers

TYPE OF BACKFILL MATERIAL: (IF APPLICABLE)

INSTALLATION METHOD:



ELEVATIONS (MSL)*	DEPTHS (BGS) (.01 ft)	
		TOP OF PROTECTIVE CASING
658.60	-3.00	TOP OF RISER PIPE
655.60	0.00	GROUND SURFACE
654.60	1.00	TOP OF ANNULAR SEALANT
601.99	53.61	STATIC WATER LEVEL (AFTER COMPLETION)
583.10	72.50	TOP OF SEAL
577.90	77.70	TOP OF SANDPACK
575.60	80.00	TOP OF SCREEN
555.60	100.00	BOTTOM OF SCREEN
555.60	100.00	BOTTOM OF WELL
555.60	100.00	BOTTOM OF BOREHOLE

* REFERENCED TO A NATIONAL GEODETIC VERTICAL DATUM

WELL CONSTRUCTION MATERIALS

(CIRCLE ONE)

PROTECTIVE CASING	SS304, SS316, PTFE, PVC OR OTHER: Steel
RISER PIPE ABOVE W.T.	SS304, SS316, PTFE, PVC OR OTHER:
RISER PIPE BELOW W.T.	SS304, SS316, PTFE, PVC OR OTHER:
SCREEN	SS304, SS316, PTFE, PVC OR OTHER:

CASING MEASUREMENTS

DIAMETER OF BOREHOLE (in)	6 /2.5
ID OF RISER PIPE (in)	2
PROTECTIVE CASING LENGTH (ft)	5
RISER PIPE LENGTH (ft)	83
BOTTOM OF SCREEN TO END CAP (ft)	0
SCREEN LENGTH (1st SLOT TO LAST SLOT) (ft)	20
TOTAL LENGTH OF CASING (ft)	103
SCREEN SLOT SIZE **	0.010

** HAND-SLOTTED WELL SCREENS ARE UNACCEPTABLE

(941014)

Illinois Environmental Protection Agency Well Completion Report

SITE #: IL0004057 (NPDES #) COUNTY: Vermilion WELL #: MW23

SITE NAME: Vermilion Station, Dynegy Midwest Generation, Inc. BOREHOLE #:

STATE PLANE COORDINATE: X 1150788 Y 1280399 (or) LATITUDE: ___° ___' ___" LONGITUDE: ___° ___' ___"

SURVEYED BY: Chastain & Assoc., Inc. ILL. REGISTRATION #: 2217

DRILLING CONTRACTOR: Mid-America Drilling, Inc. DRILLER: Dusty Jackson

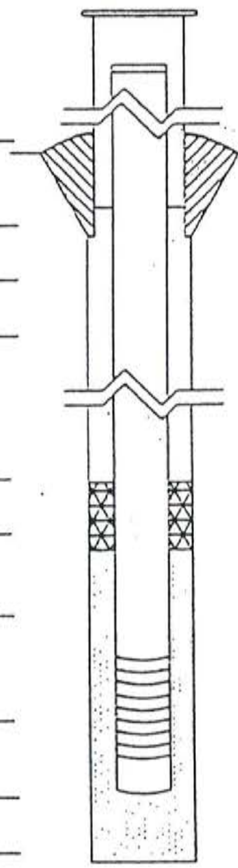
CONSULTING FIRM: Kelron Environmental GEOLOGIST: Rebecca Caudill (NRT)

DRILLING METHOD: Hollow-Stem Auger/Coring DRILLING FLUIDS (TYPE): Water

LOGGED BY: Rebecca Caudill (NRT) DATE STARTED: 12-3-01 DATE FINISHED: 12-3-01

REPORT FORM COMPLETED BY: Stuart Cravens DATE: 2-26-02

ANNULAR SPACE DETAILS



TYPE OF SURFACE SEAL: Cement

TYPE OF ANNULAR SEALANT: ______

INSTALLATION METHOD: ______

SETTING TIME: 24-hours

TYPE OF BENTONITE SEAL - GRANULAR, PELLET, SLURRY (CIRCLE ONE)

INSTALLATION METHOD: through augers

SETTING TIME: 1-hour

TYPE OF SAND PACK: Silica

GRAIN SIZE: 5 (SIEVE SIZE)

INSTALLATION METHOD: through augers

TYPE OF BACKFILL MATERIAL: ______ (IF APPLICABLE)

INSTALLATION METHOD: ______

ELEVATIONS (MSL)*	DEPTHS (BGS) (.01 ft)	
		TOP OF PROTECTIVE CASING
601.89	-2.70	TOP OF RISER PIPE
599.20	0.00	GROUND SURFACE
598.20	1.00	TOP OF ANNULAR SEALANT
588.10	11.09	STATIC WATER LEVEL (AFTER COMPLETION)
592.20	7.00	TOP OF SEAL
590.20	9.00	TOP OF SANDPACK
587.40	11.80	TOP OF SCREEN
577.40	21.80	BOTTOM OF SCREEN
577.20	22.00	BOTTOM OF WELL
577.20	22.00	BOTTOM OF BOREHOLE

* REFERENCED TO A NATIONAL GEODETIC VERTICAL DATUM

WELL CONSTRUCTION MATERIALS
(CIRCLE ONE)

PROTECTIVE CASING	SS304, SS316, PTFE, PVC OR OTHER: Steel
RISER PIPE ABOVE W.T.	SS304, SS316, PTFE, PVC OR OTHER:
RISER PIPE BELOW W.T.	SS304, SS316, PTFE, PVC OR OTHER:
SCREEN	SS304, SS316, PTFE, PVC OR OTHER:

CASING MEASUREMENTS

DIAMETER OF BOREHOLE (in)	6
ID OF RISER PIPE (in)	2
PROTECTIVE CASING LENGTH (ft)	5
RISER PIPE LENGTH (ft)	14.50
BOTTOM OF SCREEN TO END CAP (ft)	0.30
SCREEN LENGTH (1st SLOT TO LAST SLOT) (ft)	9.90
TOTAL LENGTH OF CASING (ft)	24.70
SCREEN SLOT SIZE **	0.010

** HAND-SLOTTED WELL SCREENS ARE UNACCEPTABLE

(941014)

Illinois Environmental Protection Agency Well Completion Report

SITE #: IL0004057 (NPDES #) COUNTY: Vermilion WELL #: MW24

SITE NAME: Vermilion Station, Dynegy Midwest Generation, Inc. BOREHOLE #:

STATE PLANE COORDINATE: X 1150783 Y 1280404 (or) LATITUDE: ° ' " LONGITUDE: ° ' "

SURVEYED BY: Chastain & Assoc., Inc. ILL. REGISTRATION #: 2217

DRILLING CONTRACTOR: Mid-America Drilling, Inc. DRILLER: Dusty Jackson

CONSULTING FIRM: Kelron Environmental GEOLOGIST: Rebecca Caudill (NRT)

DRILLING METHOD: Hollow-Stem Auger/Coring DRILLING FLUIDS (TYPE): Water

LOGGED BY: Rebecca Caudill (NRT) DATE STARTED: 12-3-01 DATE FINISHED: 12-3-01

REPORT FORM COMPLETED BY: Stuart Cravens DATE: 2-26-02

ANNULAR SPACE DETAILS

TYPE OF SURFACE SEAL: Cement

TYPE OF ANNULAR SEALANT: Bentonite grout

INSTALLATION METHOD: tremie

SETTING TIME: 24-hours

TYPE OF BENTONITE SEAL – GRANULAR, PELLET, SLURRY (CIRCLE ONE)

INSTALLATION METHOD: through augers

SETTING TIME: 1-hour

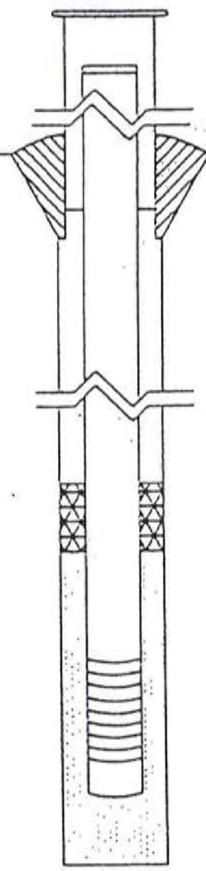
TYPE OF SAND PACK: Silica

GRAIN SIZE: 5 (SIEVE SIZE)

INSTALLATION METHOD: through augers

TYPE OF BACKFILL MATERIAL: (IF APPLICABLE)

INSTALLATION METHOD:



ELEVATIONS (MSL)*	DEPTHS (BGS) (.01 ft)	
		TOP OF PROTECTIVE CASING
601.81	-3.01	TOP OF RISER PIPE
598.80	0.00	GROUND SURFACE
597.80	1.00	TOP OF ANNULAR SEALANT
576.09	22.71	STATIC WATER LEVEL (AFTER COMPLETION)
572.00	26.80	TOP OF SEAL
566.80	32.00	TOP OF SANDPACK
564.00	34.80	TOP OF SCREEN
544.00	54.70	BOTTOM OF SCREEN
543.80	55.00	BOTTOM OF WELL
543.80	55.00	BOTTOM OF BOREHOLE

* REFERENCED TO A NATIONAL GEODETIC VERTICAL DATUM

WELL CONSTRUCTION MATERIALS

(CIRCLE ONE)

PROTECTIVE CASING	SS304, SS316, PTFE, PVC OR OTHER: Steel
RISER PIPE ABOVE W.T.	SS304, SS316, PTFE, PVC OR OTHER:
RISER PIPE BELOW W.T.	SS304, SS316, PTFE, PVC OR OTHER:
SCREEN	SS304, SS316, PTFE, PVC OR OTHER:

CASING MEASUREMENTS

DIAMETER OF BOREHOLE (in)	6 /2.5
ID OF RISER PIPE (in)	2
PROTECTIVE CASING LENGTH (ft)	5
RISER PIPE LENGTH (ft)	34.80
BOTTOM OF SCREEN TO END CAP (ft)	0.30
SCREEN LENGTH (1st SLOT TO LAST SLOT) (ft)	19.90
TOTAL LENGTH OF CASING (ft)	55.00
SCREEN SLOT SIZE **	0.010

** HAND-SLOTTED WELL SCREENS ARE UNACCEPTABLE

(941014)

Illinois Environmental Protection Agency — Well Completion Report

SITE #: IL0004057 (NPDES #) COUNTY: Vermilion WELL #: MW25

SITE NAME: Vermilion Station, Dynegy Midwest Generation, Inc. BOREHOLE #:

STATE PLANE COORDINATE: X 1150916 Y 1278027 (or) LATITUDE: __° __' __" LONGITUDE: __° __' __"

SURVEYED BY: Chastain & Assoc., Inc. ILL. REGISTRATION #: 2217

DRILLING CONTRACTOR: Mid-America Drilling, Inc. DRILLER: Dusty Jackson

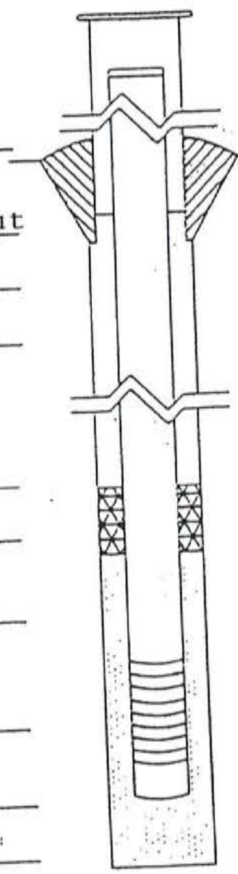
CONSULTING FIRM: Kelron Environmental GEOLOGIST: Rebecca Caudill (NRT)

DRILLING METHOD: Hollow-Stem Auger/Coring DRILLING FLUIDS (TYPE): Water

LOGGED BY: Rebecca Caudill (NRT) DATE STARTED: 12-4-01 DATE FINISHED: 12-4-01

REPORT FORM COMPLETED BY: Stuart Cravens DATE: 2-26-02

ANNULAR SPACE DETAILS



TYPE OF SURFACE SEAL: Cement

TYPE OF ANNULAR SEALANT: Bentonite grout

INSTALLATION METHOD: tremie

SETTING TIME: 24-hours

TYPE OF BENTONITE SEAL – GRANULAR, PELLET, SLURRY (CIRCLE ONE): GRANULAR

INSTALLATION METHOD: through augers

SETTING TIME: 1-hour

TYPE OF SAND PACK: Silica

GRAIN SIZE: 5 (SIEVE SIZE)

INSTALLATION METHOD: through augers

TYPE OF BACKFILL MATERIAL: (IF APPLICABLE)

INSTALLATION METHOD:

ELEVATIONS (MSL)*	DEPTHS (BGS) (.01 ft)	
		TOP OF PROTECTIVE CASING
581.65	-2.80	TOP OF RISER PIPE
578.80	0.00	GROUND SURFACE
577.80	1.00	TOP OF ANNULAR SEALANT
562.78	16.02	STATIC WATER LEVEL (AFTER COMPLETION)
564.00	14.80	TOP OF SEAL
562.00	16.80	TOP OF SANDPACK
559.70	19.10	TOP OF SCREEN
540.10	38.70	BOTTOM OF SCREEN
539.80	39.00	BOTTOM OF WELL
539.80	39.00	BOTTOM OF BOREHOLE

* REFERENCED TO A NATIONAL GEODETIC VERTICAL DATUM

WELL CONSTRUCTION MATERIALS (CIRCLE ONE)

PROTECTIVE CASING	SS304, SS316, PTFE, PVC OR OTHER: Steel
RISER PIPE ABOVE W.T.	SS304, SS316, PTFE, PVC OR OTHER: (PVC circled)
RISER PIPE BELOW W.T.	SS304, SS316, PTFE, PVC OR OTHER: (PVC circled)
SCREEN	SS304, SS316, PTFE, PVC OR OTHER: (PVC circled)

CASING MEASUREMENTS

DIAMETER OF BOREHOLE (in)	6
ID OF RISER PIPE (in)	2
PROTECTIVE CASING LENGTH (ft)	5
RISER PIPE LENGTH (ft)	21.90
BOTTOM OF SCREEN TO END CAP (ft)	0.30
SCREEN LENGTH (1st SLOT TO LAST SLOT) (ft)	19.60
TOTAL LENGTH OF CASING (ft)	41.80
SCREEN SLOT SIZE **	0.010

** HAND-SLOTTED WELL SCREENS ARE UNACCEPTABLE

(941014)

Illinois Environmental Protection Agency Well Completion Report

SITE #: None | COUNTY: Vermilion | WELL #: MW-34

SITE NAME: Vermilion Power Station, Oakwood, IL (Dynegy Midwest Generation, Inc.) | BOREHOLE #: same

STATE PLANE COORDINATE: X 1148079 Y 1282550 (or) LATITUDE: LONGITUDE:

SURVEYED BY: James Anderson, Chastain & Assoc., LLP | ILL REGISTRATION #: 3504

DRILLING CONTRACTOR: PSC Industrial Outsourcing | DRILLER: Jerry Hancock

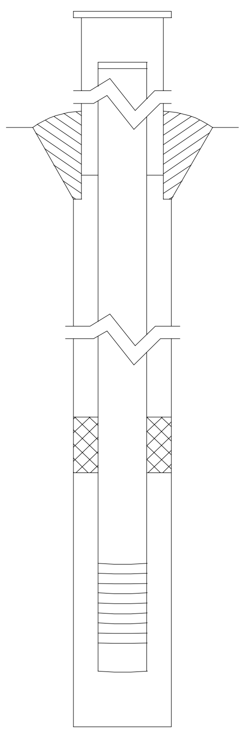
CONSULTING FIRM: Kelron Environmental, Inc. | GEOLOGIST: Stuart J. Cravens

DRILLING METHOD: Hollow-Stem Auger w/ MacroCore sampler | DRILLING FLUIDS (TYPE): water only

LOGGED BY: Stuart J. Cravens | DATE STARTED: 10/20/10 | DATE FINISHED: 10/21/10

REPORT FORM COMPLETED BY: Stuart J. Cravens | DATE : 11/12/10

ANNULAR SPACE DETAILS



TYPE OF SURFACE SEAL: Concrete

TYPE OF ANNULAR SEALANT: Bentonite-Cement Grout

INSTALLATION METHOD: Tremied

SETTING TIME: + 24 hours

TYPE OF BENTONITE SEAL- GRANULAR, PELLET, SLURRY, CHIPS (CIRCLE ONE)

INSTALLATION METHOD: Poured and hydrated

SETTING TIME: ~ 30 minutes

TYPE OF SAND PACK: Quartz

GRAIN SIZE: #1 Morie Sand (crse)

INSTALLATION METHOD: Poured

TYPE OF BACKFILL MATERIAL: Quartz sand (IF APPLICABLE)

INSTALLATION METHOD: Poured

ELEVATIONS (MSL) *	DEPTHS (BGS)	(.01 ft)
		TOP OF PROTECTIVE CASING
592.52	-2.52	TOP OF RISER PIPE
590.00	0.00	GROUND SURFACE
589.00	1.00	TOP OF ANNULAR SEALANT
577.54	12.46	STATIC WATER LEVEL (AFTER COMPLETION)
546.50	43.50	TOP OF SEAL
542.80	47.20	TOP OF SANDPACK
540.90	49.10	TOP OF SCREEN
535.88	54.12	BOTTOM OF SCREEN
535.66	54.34	BOTTOM OF WELL
535.66	54.34	BOTTOM OF BOREHOLE

* REFERENCED TO A NATIONAL GEODETIC VERTICAL DATUM

WELL CONSTRUCTION MATERIALS

(CIRCLE ONE)

PROTECTIVE CASING	SS304, SS316, PTFE, PVC OR OTHER: Steel
RISER PIPE ABOVE W.T.	SS304, SS316, PTFE, PVC OR OTHER:
RISER PIPE BELOW W.T.	SS304, SS316, PTFE, PVC OR OTHER:
SCREEN	SS304, SS316, PTFE, PVC OR OTHER:

CASING MEASUREMENTS

DIAMETER OF BOREHOLE (in.)	8.25
ID OF RISER PIPE (in)	2.0
PROTECTIVE CASING LENGTH (ft)	5.0
RISER PIPE LENGTH (ft)	51.62
BOTTOM OF SCREEN TO END CAP (ft)	5.02
SCREEN LENGTH (1st SLOT TO LAST SLOT) (ft)	4.62
TOTAL LENGTH OF CASING (ft)	56.86
SCREEN SLOT SIZE **	0.01

** HAND-SLOTTED WELL SCREENS ARE UNACCEPTABLE

Illinois Environmental Protection Agency Well Completion Report

SITE #: IL0004057 (NPDES #) COUNTY: Vermilion WELL #: MW32

SITE NAME: Vermilion Station, Dynegy Midwest Generation, Inc. BOREHOLE #:

STATE PLANE COORDINATE: X 1151312 Y 1279850 (or) LATITUDE: ° ' " LONGITUDE: ° ' "

SURVEYED BY: Chastain & Assoc., Inc. ILL. REGISTRATION #: 2217

DRILLING CONTRACTOR: Mid-America Drilling, Inc. DRILLER: Dusty Jackson

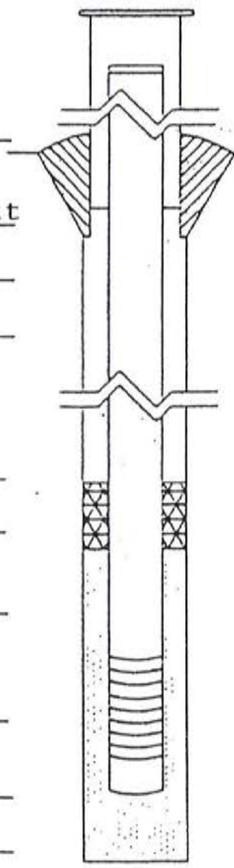
CONSULTING FIRM: Kelron Environmental GEOLOGIST: Rebecca Caudill (NRT)

DRILLING METHOD: Hollow-Stem Auger/Coring DRILLING FLUIDS (TYPE): Water

LOGGED BY: Rebecca Caudill (NRT) DATE STARTED: 12-4-01 DATE FINISHED: 12-4-01

REPORT FORM COMPLETED BY: Stuart Cravens DATE: 2-26-02

ANNULAR SPACE DETAILS



TYPE OF SURFACE SEAL: Cement

TYPE OF ANNULAR SEALANT: Bentonite grout

INSTALLATION METHOD: tremie

SETTING TIME: 24-hours

TYPE OF BENTONITE SEAL – GRANULAR, PELLET, SLURRY (CIRCLE ONE)

INSTALLATION METHOD: through augers

SETTING TIME: 1-hour

TYPE OF SAND PACK: Silica

GRAIN SIZE: 30 (SIEVE SIZE)

INSTALLATION METHOD: through augers

TYPE OF BACKFILL MATERIAL: (IF APPLICABLE)

INSTALLATION METHOD:

ELEVATIONS (MSL)*	DEPTHS (BGS) (.01 ft)	
		TOP OF PROTECTIVE CASING
585.00	-3.1	TOP OF RISER PIPE
581.90	0.00	GROUND SURFACE
580.90	1.00	TOP OF ANNULAR SEALANT
584.91	-3.01	STATIC WATER LEVEL (AFTER COMPLETION)
541.30	40.60	TOP OF SEAL
537.70	44.20	TOP OF SANDPACK
536.10	45.80	TOP OF SCREEN
526.10	55.80	BOTTOM OF SCREEN
526.10	55.80	BOTTOM OF WELL
525.90	56.00	BOTTOM OF BOREHOLE

* REFERENCED TO A NATIONAL GEODETIC VERTICAL DATUM

WELL CONSTRUCTION MATERIALS

(CIRCLE ONE)

PROTECTIVE CASING	SS304, SS316, PTFE, PVC OR OTHER: Steel
RISER PIPE ABOVE W.T.	SS304, SS316, PTFE, PVC OR OTHER:
RISER PIPE BELOW W.T.	SS304, SS316, PTFE, PVC OR OTHER:
SCREEN	SS304, SS316, PTFE, PVC OR OTHER:

CASING MEASUREMENTS

DIAMETER OF BOREHOLE (in)	6 /2.5
ID OF RISER PIPE (in)	2
PROTECTIVE CASING LENGTH (ft)	5
RISER PIPE LENGTH (ft)	48.90
BOTTOM OF SCREEN TO END CAP (ft)	0.30
SCREEN LENGTH (1st SLOT TO LAST SLOT) (ft)	9.90
TOTAL LENGTH OF CASING (ft)	59.10
SCREEN SLOT SIZE **	0.010

** HAND-SLOTTED WELL SCREENS ARE UNACCEPTABLE

(941014)

NATURAL RESOURCE TECHNOLOGY

MONITORING WELL CONSTRUCTION

Facility/Project Name	Local Grid Location of Well	Well Name
Vermilion Power Station	____ft. ☐ N. ☐ S. ____ft. ☐ E. ☐ W.	MW35D
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☒ Lat. 40° 10' 47.142" Long. 87° 44' 8.067" or	
Facility ID	St. Plane 1,279,955.58 ft. N, 1,151,276.17 ft. E. (E)/W	Date Well Installed 03/03/2017
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) Bruno Williamson, Ramsey Geotechnical Engineering
Distance from Waste/Source ft. / State IL	Location of Well Relative to Waste/Source: u ☐ Upgradient; s ☐ Sidegradient; d ☐ Downgradient; n ☐ Not Known / Gov. Lot Number	

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 584.15 ft. MSL

C. Land surface elevation 581.25 ft. MSL

D. Surface seal, bottom 579.3 ft. MSL or 2.0 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 ☐
HSA / Rotary 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):
City of Champaign

E. Bentonite seal, top 551.3 ft. MSL or 30.0 ft.

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

G. Filter pack, top 548.3 ft. MSL or 33.0 ft.

H. Screen joint, top 546.3 ft. MSL or 35.0 ft.

I. Well bottom 536.3 ft. MSL or 45.0 ft.

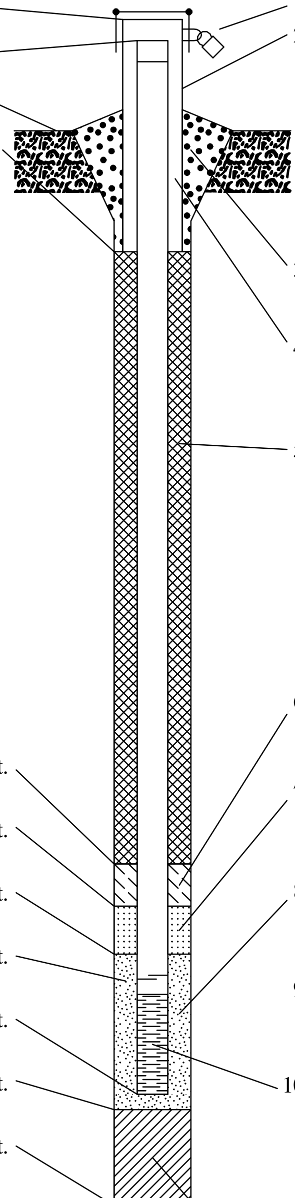
J. Filter pack, bottom 535.5 ft. MSL or 45.8 ft.

K. Borehole, bottom 535.5 ft. MSL or 45.8 ft.

L. Borehole, diameter 7.3 in.

M. O.D. well casing 2.38 in.

N. I.D. well casing 1.99 in.



1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
   a. Inside diameter: 6.0 in.
   b. Length: 6.0 ft.
   c. Material: Steel ☒ Other ☐
   d. Additional protection? ☒ Yes ☐ No
   If yes, describe: 4" diameter protective PVC casing
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. ____ 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. NSF Quartz Sand #10-20
   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 ☐ Other ☐
    b. Manufacturer ____
    c. Slot size: 0.100 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.

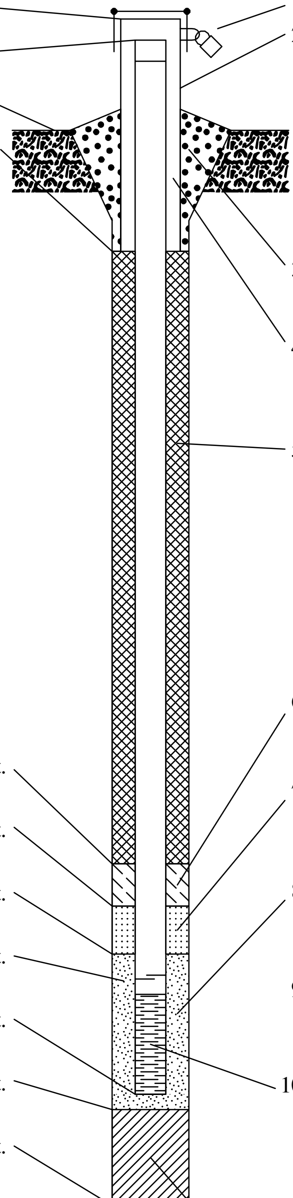
Date Modified: 4/6/2017

Signature	Firm	
[signature]	Natural Resource Technology 234 W. Florida Street, Floor 5, Milwaukee, WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

NATURAL RESOURCE TECHNOLOGY

MONITORING WELL CONSTRUCTION

Facility/Project Name: Vermilion Power Station	Local Grid Location of Well: ______ ft. ☐ N. ☐ S. ______ ft. ☐ E. ☐ W.	Well Name: MW35S
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☒ Lat. 40° 10' 47.170" Long. 87° 44' 8.107" or	
Facility ID	St. Plane 1,279,958.41 ft. N, 1,151,272.97 ft. E. Ⓔ/W	Date Well Installed: 03/01/2017
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) Bruno Williamson, Ramsey Geotechnical Engineering
Distance from Waste/Source: ft. / State: IL	Location of Well Relative to Waste/Source: u ☐ Upgradient; s ☐ Sidegradient; d ☐ Downgradient; n ☐ Not Known / Gov. Lot Number	



A. Protective pipe, top elevation ______ ft. MSL

B. Well casing, top elevation 584.79 ft. MSL

C. Land surface elevation 581.15 ft. MSL

D. Surface seal, bottom 579.2 ft. MSL or 2.0 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): ______

E. Bentonite seal, top 579.2 ft. MSL or 2.0 ft.

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

G. Filter pack, top 578.2 ft. MSL or 3.0 ft.

H. Screen joint, top 577.7 ft. MSL or 3.5 ft.

I. Well bottom 572.7 ft. MSL or 8.5 ft.

J. Filter pack, bottom 572.7 ft. MSL or 8.5 ft.

K. Borehole, bottom 572.7 ft. MSL or 8.5 ft.

L. Borehole, diameter 7.3 in.

M. O.D. well casing 2.38 in.

N. I.D. well casing 1.99 in.

1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
   a. Inside diameter: 4.0 in.
   b. Length: 6.0 ft.
   c. Material: Steel ☒; Other ☐
   d. Additional protection? ☐ Yes ☒ No
   If yes, describe: ______
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. ____ % 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. ______ 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. NSF Quartz Sand #10-20
   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 ☐; Other ☐
   b. Manufacturer ______
   c. Slot size: 0.100 in.
   d. Slotted length: 5.0 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: 4/6/2017

Signature: [signature]

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

Illinois Environmental Protection Agency Well Completion Report

SITE #: None | COUNTY: Vermilion | WELL #: TW-1

SITE NAME: Vermilion Power Station, Oakwood, IL (Dynegy Midwest Generation, Inc.) | BOREHOLE #: same

STATE PLANE COORDINATE: X 1149953 Y 1280575 (or) LATITUDE: LONGITUDE:

SURVEYED BY: James Anderson, Chastain & Assoc., LLP | ILL REGISTRATION #: 3504

DRILLING CONTRACTOR: PSC Industrial Outsourcing | DRILLER: Jerry Hancock

CONSULTING FIRM: Kelron Environmental, Inc. | GEOLOGIST: Stuart J. Cravens

DRILLING METHOD: Hand Auger | DRILLING FLUIDS (TYPE): water only

LOGGED BY: Stuart J. Cravens | DATE STARTED: 10/21/10 | DATE FINISHED: 10/21/10

REPORT FORM COMPLETED BY: Stuart J. Cravens | DATE : 11/12/10

ANNULAR SPACE DETAILS

TYPE OF SURFACE SEAL: Bentonite

TYPE OF ANNULAR SEALANT: none

INSTALLATION METHOD: none

SETTING TIME: none

TYPE OF BENTONITE SEAL- GRANULAR, PELLET, SLURRY, CHIPS (CIRCLE ONE)

INSTALLATION METHOD: Poured

SETTING TIME: ~ 30 minutes

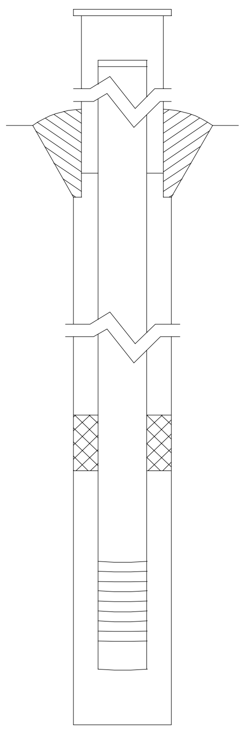
TYPE OF SAND PACK: Quartz

GRAIN SIZE: #1 Morie Sand (crse)

INSTALLATION METHOD: Poured

TYPE OF BACKFILL MATERIAL: Quartz sand (IF APPLICABLE)

INSTALLATION METHOD: Poured



ELEVATIONS (MSL) *	DEPTHS (BGS)	(.01 ft)
		TOP OF PROTECTIVE CASING
577.69	-2.79	TOP OF RISER PIPE
574.90	0.00	GROUND SURFACE
574.90	0.00	TOP OF ANNULAR SEALANT
573.40	1.50	STATIC WATER LEVEL (AFTER COMPLETION)
574.90	0.00	TOP OF SEAL
573.90	1.00	TOP OF SANDPACK
573.83	1.07	TOP OF SCREEN
571.00	3.90	BOTTOM OF SCREEN
571.00	3.90	BOTTOM OF WELL
570.90	4.00	BOTTOM OF BOREHOLE

* REFERENCED TO A NATIONAL GEODETIC VERTICAL DATUM

WELL CONSTRUCTION MATERIALS

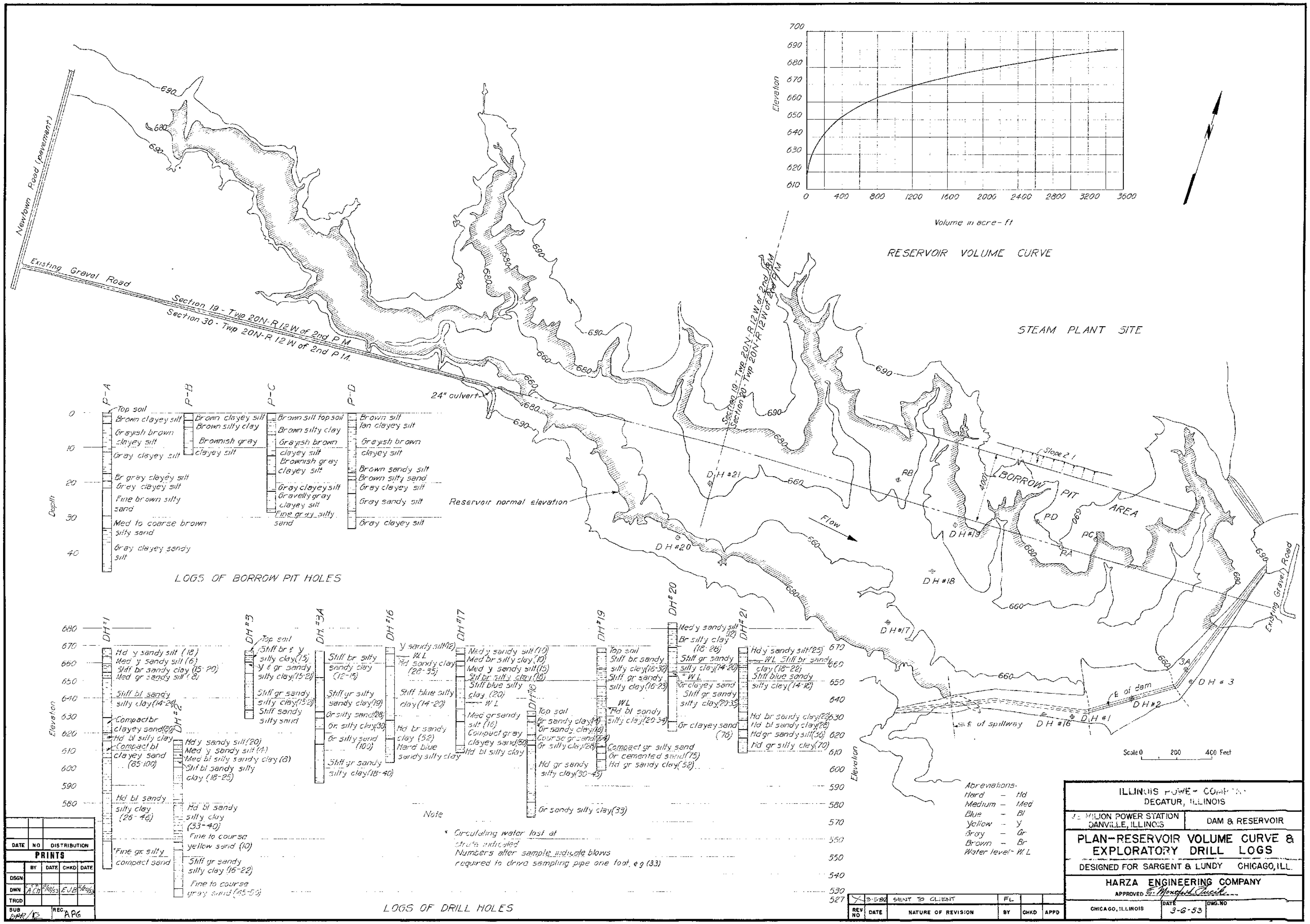
(CIRCLE ONE)

PROTECTIVE CASING	SS304, SS316, PTFE, PVC OR OTHER: Steel
RISER PIPE ABOVE W.T.	SS304, SS316, PTFE, PVC OR OTHER:
RISER PIPE BELOW W.T.	SS304, SS316, PTFE, PVC OR OTHER:
SCREEN	SS304, SS316, PTFE, PVC OR OTHER:

CASING MEASUREMENTS

DIAMETER OF BOREHOLE (in.)	5.25
ID OF RISER PIPE (in)	1.5
PROTECTIVE CASING LENGTH (ft)	4.3
RISER PIPE LENGTH (ft)	3.86
BOTTOM OF SCREEN TO END CAP (ft)	2.83
SCREEN LENGTH (1st SLOT TO LAST SLOT) (ft)	2.40
TOTAL LENGTH OF CASING (ft)	6.69
SCREEN SLOT SIZE **	0.01

** HAND-SLOTTED WELL SCREENS ARE UNACCEPTABLE



RESERVOIR VOLUME CURVE
Elevation
Volume in acre - ft
0 400 800 1200 1600 2000 2400 2800 3200 3600
610 620 630 640 650 660 670 680 690 700
STEAM PLANT SITE
BORROW PIT AREA
Slope 2:1
Newtown Road (pavement)
Existing Gravel Road
Section 19 - Twp 20N-R 12 W of 2nd P.M.
Section 30 - Twp 20N-R 12 W of 2nd P.M.
24" culvert
Reservoir normal elevation
Flow
℄ of dam
℄ of spillway
Existing Gravel Road
Scale 0 200 400 Feet
D H #21
D H #20
D H #19
D H #18
D H #17
D H #16
D H #1
D H #2
D H #3
LOGS OF BORROW PIT HOLES
P-A
Top soil
Brown clayey silt
Grayish brown clayey silt
Gray clayey silt
Br gray clayey silt
Grey clayey silt
Fine brown silty sand
Med to coarse brown silty sand
Gray clayey sandy silt
P-B
Brown clayey silt
Brown silty clay
Brownish gray clayey silt
P-C
Brown silt top soil
Brown silty clay
Grayish brown clayey silt
Brownish grey clayey silt
Gray clayey silt
Gravelly gray clayey silt
Fine gray silty sand
P-D
Brown silt
Tan clayey silt
Grayish brown clayey silt
Brown sandy silt
Brown silty sand
Gray clayey silt
Gray sandy silt
Gray clayey silt
Depth
LOGS OF DRILL HOLES
Elevation
Note
* Circulating water lost at strata indicated
Numbers after sample indicate blows required to drive sampling pipe one foot, e.g (33)
Abbreviations-
Hard - Hd
Medium - Med
Blue - Bl
Yellow - Y
Gray - Gr
Brown - Br
Water level - W.L
ILLINOIS POWER COMPANY
DECATUR, ILLINOIS
VERMILION POWER STATION
DANVILLE, ILLINOIS
DAM & RESERVOIR
PLAN-RESERVOIR VOLUME CURVE & EXPLORATORY DRILL LOGS
DESIGNED FOR SARGENT & LUNDY CHICAGO, ILL.
HARZA ENGINEERING COMPANY
CHICAGO, ILLINOIS
DATE 3-6-53
SENT TO CLIENT
REV NO DATE NATURE OF REVISION BY CHKD APPD
DATE NO DISTRIBUTION
PRINTS

APPENDIX C
GEOTECHNICAL LABORATORY REPORTS

RAMBOLL GEOTECHNICAL REPORT

May 21, 2021

Mr. Scott Woods
Ramboll Environ U.S. Corporation
333 West Wacker Drive, Ste 2700
Chicago, IL 60606-2872

RE: Laboratory Testing Program for the Vermilion Power Station Project – Terracon Project No. 11215020

Dear Mr. Woods,

We are pleased to submit our report pertaining to geotechnical laboratory testing of twenty-five (25) soil samples in reference to the Vermilion Power Station Project. As instructed, Terracon performed the following tests on each of the samples:

- Specific Gravity of Soils – ASTM D854
- Water Content of Soil and Rock – ASTM D2216
- Liquid Limit, Plastic Limit and Plasticity Index of Soils – ASTM D4318
- Permeability of Granular Soils (Constant Head) – ASTM D 2434 *
- Hydraulic Conductivity of Saturated Porous Materials Using a Flexible-Wall Permeameter – ASTM D5084
- Laboratory Determination of Density (Unit Weight) of Soil Specimens – ASTM D7263
- Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis – ASTM D6913
- Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis – ASTM D7928

Seven samples, originally scheduled for hydraulic conductivity tests following ASTM D5084, did not meet the flow criteria for the standard because of the granular matrix of the samples. Instead the tests were run following ASTM D 2434 which allows for greater permeant flow through the specimen.

The test data included in this report, only represent the samples tested and may not reflect actual site materials and/or conditions. The scope of services provided by Terracon did not include interpretation of the laboratory test data, and therefore, we are not liable for any interpretation performed by others. If you wish us to provide you with this service, we would be happy to discuss this matter with you at your convenience. Any reproduction of this report must be done in its entirety.

We are pleased to have the opportunity to provide you with our testing services. Should you have any questions, or require additional assistance, please feel free to contact us at any time.

Sincerely,

Terracon Consultants, Inc.

William P. Quinn
Department Manager – Laboratory Services

Attachments:

Terracon

LABORATORY TESTING SUMMARY

PROJECT NAME: Vermillion Power Station PROJECT NUMBER: 11215020 CLIENT: Ramboll

Boring Number	Sample Number	Depth	Description	USCS	WC %	Dry Density (pcf)	% Gravel	% Sand	% Silt	% Clay	LL	PL	PI	Permeability k (cm/sec)	Specific Gravity
MW-37	0945	5.0'-7.0'	DARK BROWN SANDY LEAN CLAY	CL	19.3	105.8	0.0	39.5	39.8	20.7	27	17	10	4.79E-06	2.697
MW-37	N/A	18.5'-19.0'	GRAY CLAYEY SAND	SC	3.1	122.7	8.2	50.6	23.6	17.6	19	11	8	5.07E-06	2.664
MW-37	1100	25.0'-27.0'	GRAY AND GRAYISH BROWN POORLY GRADED SAND WITH SILT	SP-SM	17.7	98.5	1.4	87.3	8.6	2.7	9	11	NP	2.13E-04	2.684
MW-37	1300	35.5'-36.0'	GRAY AND BROWN SILTY CLAYEY SAND	SC-SM	9.9	130.5	4.2	47.6	29.7	18.5	17	11	6	3.35E-05	2.655
MW-37	1415	50.5'-51.0'	GRAYISH BROWN POORLY GRADED SAND WITH SILTY CLAY	SP-SC	17.7	96.2	0.0	93.1	4.1	2.8	13	7	6	8.16E-04	2.645
MW-37	1500	55.0'-57.0'	GRAY LEAN CLAY - SAND SEAMS NOTED	CL	23.8	101.4	0.0	1.9	62.5	35.6	31	18	13	5.44E-08	2.694
MW-38	0835	5.0'-7.0'	BROWN SILTY SAND	SM	17.1	108.3	0.0	55.6	30.6	13.8	17	14	3	2.20E-06	2.645
MW-38	0910	21.5'-22.0'	BROWNISH GRAY POORLY GRADED SAND WITH SILTY CLAY	SP-SC	12.6	97.2	4.7	86.1	5.2	4.0	11	7	4	1.67E-04	2.706
MW-38	1655	35.0'-37.0'	GRAY SANDY LEAN CLAY - SILT SEAMS NOTED	CL	12.6	125.6	3.9	35.1	39.5	21.5	21	12	9	3.11E-08	2.697
MW-41	0945	8.0'-10.0'	GRAY TRACE BROWN SANDY LEAN CLAY - SAND SEAMS NOTED	CL	12.8	127.7	0.7	43.9	29.5	25.9	23	11	12	3.46E-08	2.718
MW-41	1045	25.0'-25.5'	BROWN POORLY GRADED SAND	SP	16.0	90.5	0.0	95.6	1.6	2.8	13	4	9	2.37E-03	2.651
MW-41	1130	35.0'-37.0'	GRAYISH BROWN SANDY SILTY CLAY	CL-ML	12.3	122.9	0.7	42.9	39.7	16.7	20	14	6	5.74E-07	2.712
MW-43	1330	35.0'-37.0'	GRAY AND GRAYISH BROWN SANDY LEAN CLAY	CL	11.8	128.7	0.0	43.5	30.9	25.6	21	11	10	2.17E-08	2.701
MW-43	1400	50.0'-52.0'	GRAY LEAN CLAY WITH SAND - SAND SEAMS NOTED	CL	16.3	117.1	0.0	23.2	50.5	26.3	28	16	12	1.39E-07	2.687
MW-43	1500	61.0'-61.5'	BROWNISH GRAY LEAN CLAY	CL	22.4	105.2	0.0	0.8	64.9	34.3	33	21	12	4.17E-07	2.684
MW-70SA	1615	16.5'-17.0'	BROWN AND DARK BROWN SILTY SAND	SM	20.8	99.6	0.1	60.0	23.9	16.0	12	12	NP	5.15E-04	2.655
MW-71S	1615	10.0'-10.5'	GRAY POORLY GRADED SAND	SP	20.8	93.2	0.0	95.3	1.7	3.0	17	10	7	1.26E-03	2.653
MW-103	1110	15.0'-17.0'	BROWN AND GRAYISH BROWN LEAN CLAY WITH SAND	CL	16.6	116.8	0.0	14.7	38.6	46.7	30	15	15	3.61E-08	2.702
MW-103	0915	95.5'-96.0'	BROWN AND GRAY SANDY SILTY CLAY	CL-ML	13.9	128.4	0.0	48.2	24.8	27.0	17	10	7	9.35E-06	2.706
MW-103	1150	130.5'-131.0'	GRAY SILTY CLAYEY SAND WITH GRAVEL	SC-SM	8.9	98.8	37.1	50.3	6.9	5.7	16	11	5	2.19E-05	2.688
MW-103	1350	132.5'-133.0'	GRAY AND BROWN POORLY GRADED SAND WITH SILTY CLAY	SP-SC	15.3	95.2	0.0	94.3	2.5	3.2	14	7	7	8.17E-05	2.677
MW-103	1420	140.5'-141.0'	BROWNISH GRAY SANDY LEAN CLAY	CL	10.8	127.5	0.0	42.6	29.2	28.2	23	11	12	3.82E-07	2.704
MW-103	0810	163.0'-163.5'	GRAY SILTY CLAYEY SAND	SC-SM	13.8	109.5	0.0	64.8	19.4	15.8	17	11	6	4.31E-06	2.676
XCM-02	1500	15.5'-16.0'	DARK GRAY SILT	ML	30.7	88.1	0.0	5.1	69.3	25.6	26	28	NP	8.86E-06	2.667
XCM-02	1600	36.0'-36.5'	DARK GRAY ELASTIC SILT WITH SAND	MH	64.2	61.2	0.3	17.8	71.6	10.3	53	57	NP	3.30E-05	2.656

Specific Gravity of Soils
ASTM D854

Terracon
Consulting Engineers & Scientists

SPECIFIC GRAVITY OF SOIL SOLIDS
ASTM D-854
AASHTO T 100

Laboratory Services Group 192 Exchange Blvd. Glendale Heights, Illinois 60139 Ph. (630) 717-4263

Project Number: 11215019
Project Name: Vermillion Power Station
Test Date: 4/1/2021

Results Summary

Boring / Sample	Sample Number	Depth (ft)		Specific Gravity (Gs)
MW-37	0945	5.0'-7.0'		2.697
MW-37	0	18.5'-19.0'		2.664
MW-37	1100	25.0'-27.0'		2.684
MW-37	1300	35.5'-36.0'		2.655
MW-37	1415	50.5'-51.0'		2.645
MW-37	1500	55.0'-57.0'		2.694
MW-38	0835	5.0'-7.0'		2.645
MW-38	0910	21.5'-22.0'		2.706
MW-38	1655	35.0'-37.0'		2.697
MW-41	0945	8.0'-10.0'		2.718
MW-41	1045	25.0'-25.5'		2.651
MW-41	1130	35.0'-37.0'		2.712
MW-43	1330	35.0'-37.0'		2.701
MW-43	1400	50.0'-52.0'		2.687
MW-43	1500	61.0'-61.5'		2.684
MW-70SA	1615	15.5'-17.0'		2.655
MW-71S	1615	10.0'-10.5'		2.653

Tested By: SJH Checked By: WPQ

SPECIFIC GRAVITY OF SOIL SOLIDS
ASTM D-854
AASHTO T 100

Terracon
Consulting Engineers & Scientists

Laboratory Services Group 192 Exchange Blvd. Glendale Heights, Illinois 60139 Ph. (630) 717-4263

Project Number: 11215019
Project Name: Vermillion Power Station
Test Date: 4/1/2021

Results Summary

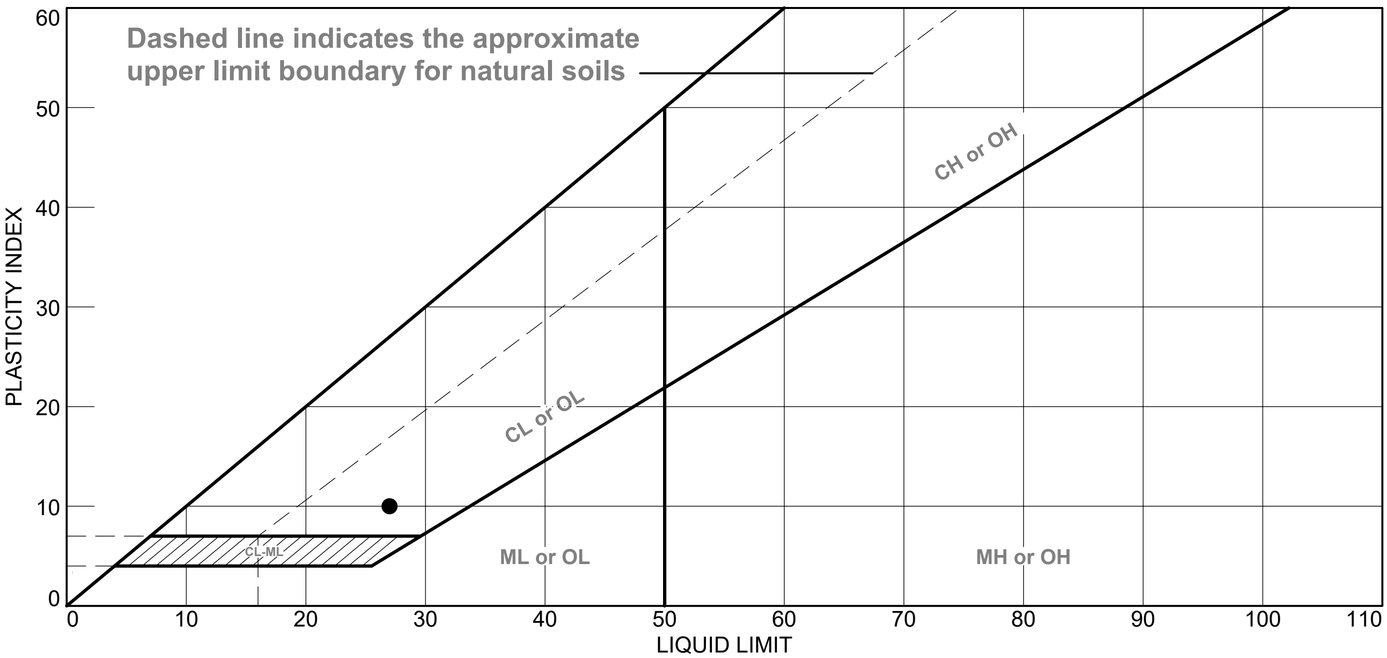
Boring / Sample	Sample Number	Depth (ft)		Specific Gravity (Gs)
MW-103	1110	15.0'-17.0'		2.702
MW-103	0915	95.5'-96.0'		2.706
MW-103	1150	130.5'-131.0'		2.688
MW-103	1350	132.5'-133.0'		2.667
MW-103	1420	140.5'-141.0'		2.704
MW-103	0810	163.0'-163.5'		2.676
XCM-02	1500	15.5'-16.0'		2.667
XCM-02	1600	36.0'-36.5'		2.656

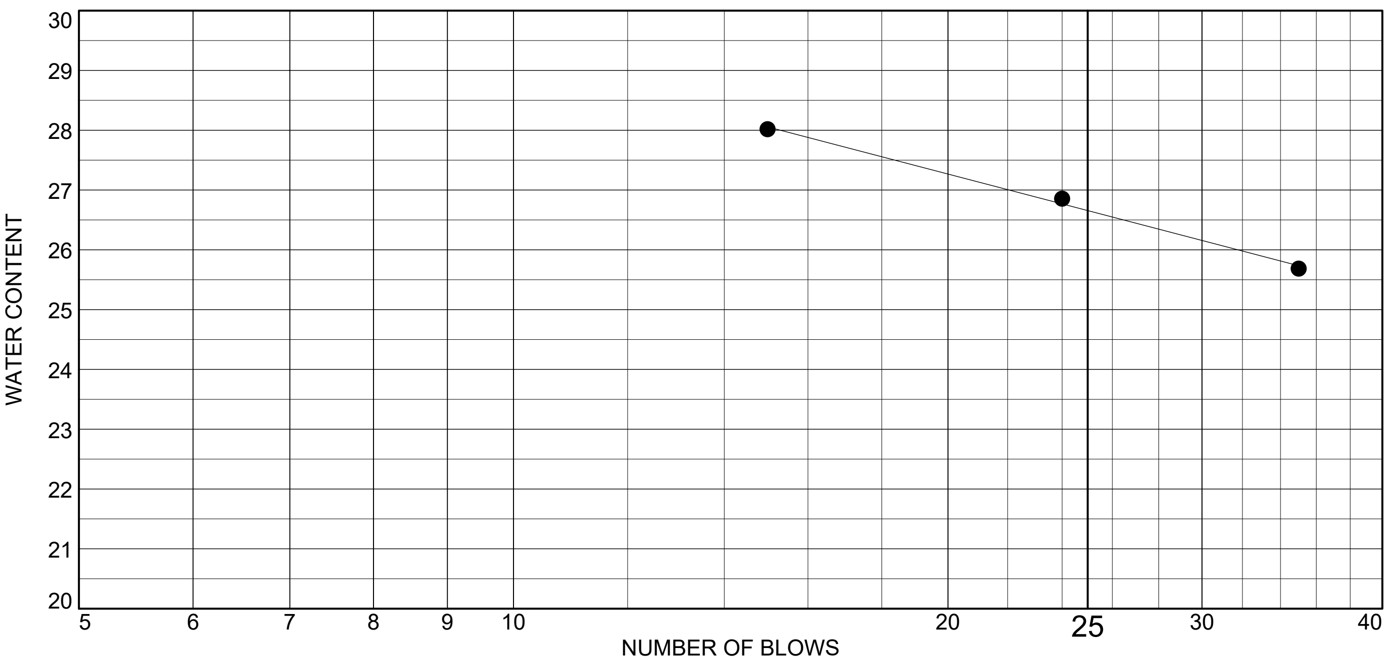
Tested By: SJH

Checked By: WPQ

Liquid Limit, Plastic Limit and Plasticity Index of Soils
ASTM D4318

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK BROWN SANDY LEAN CLAY	27	17	10	99.0	60.5	CL

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: MW-37 **Depth:** 5.0'-7.0'
Sample Number: 0945

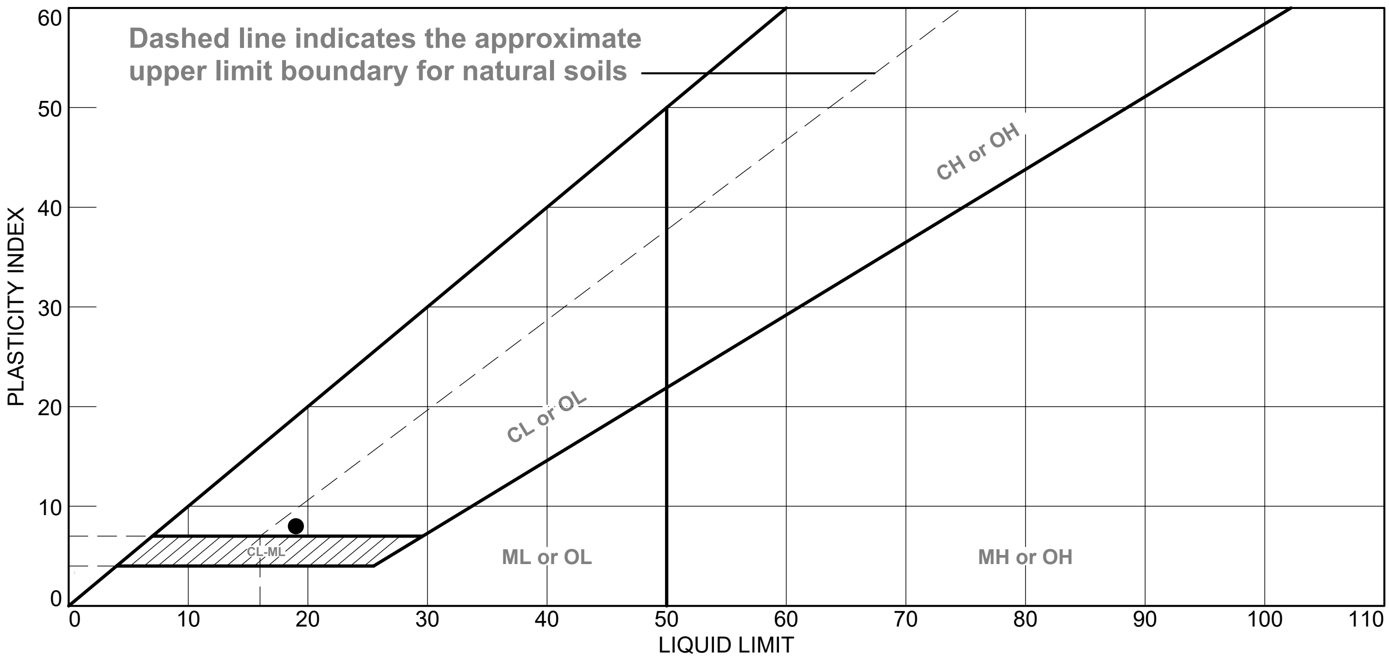
Terracon

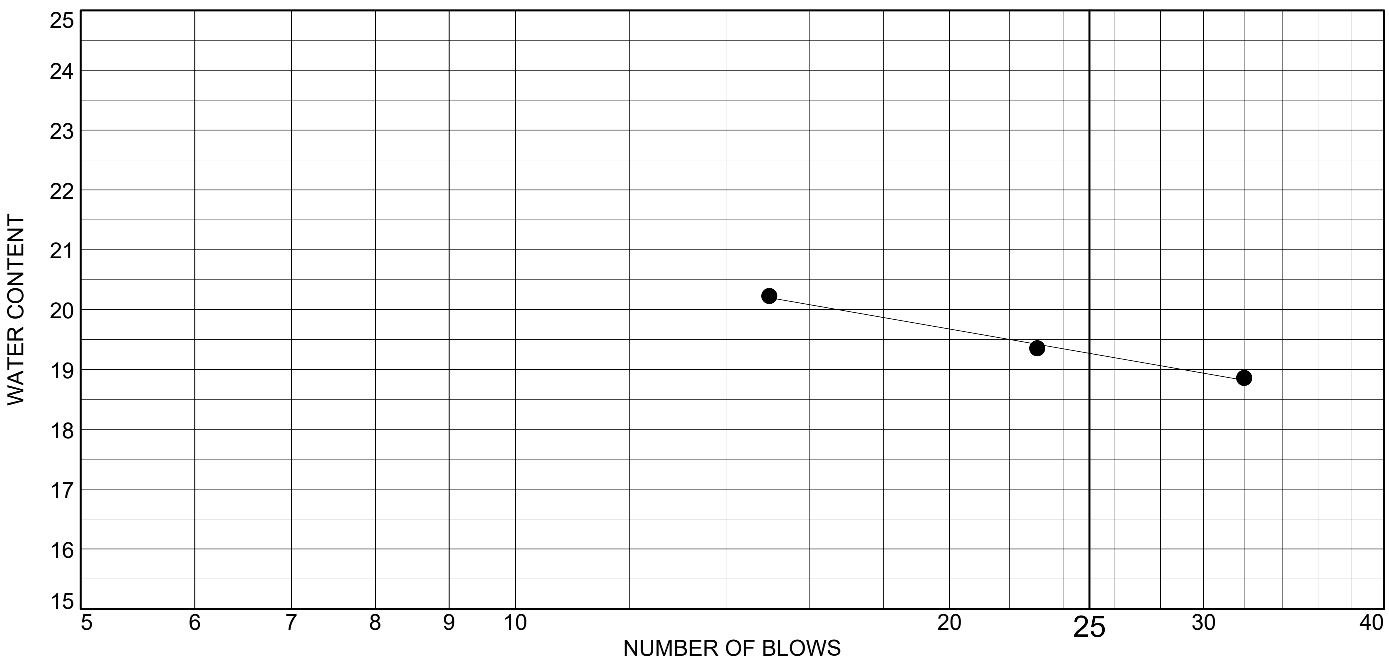
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY CLAYEY SAND	19	11	8	72.0	41.2	SC

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: MW-37 **Depth:** 18.5'-19.0'
Sample Number: N/A

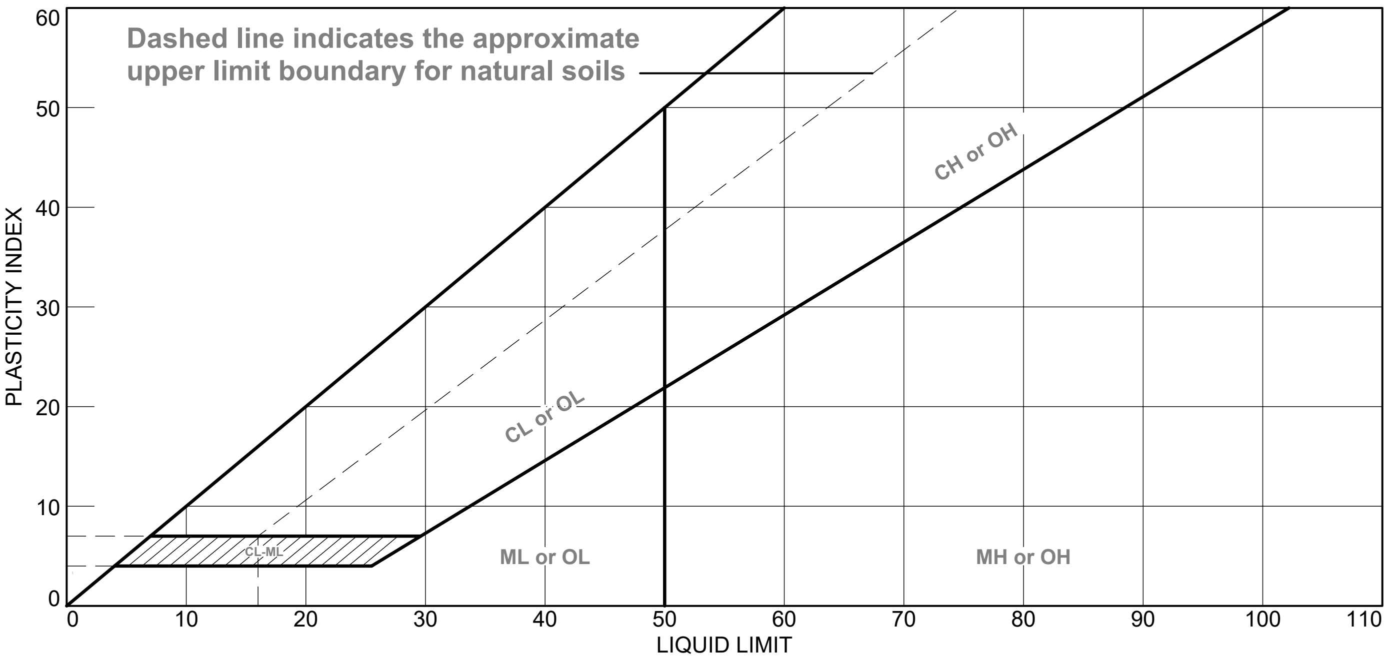
Terracon

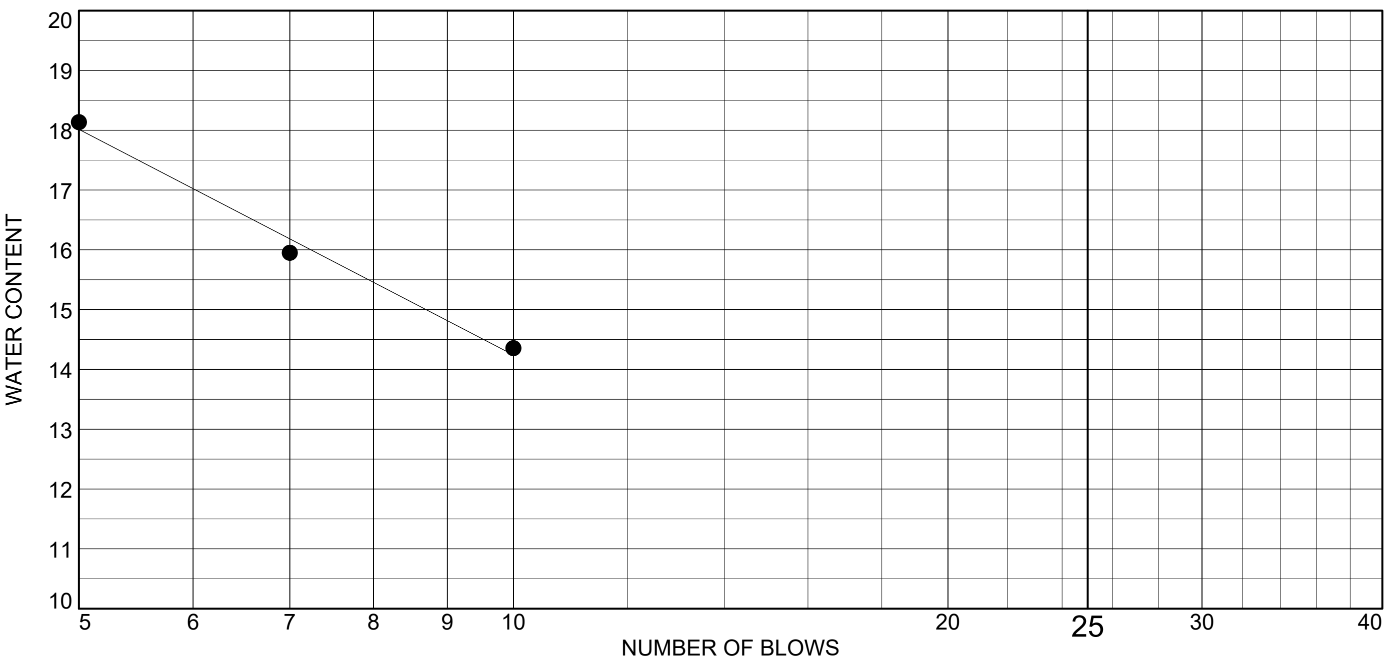
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY AND GRAYISH BROWN POORLY GRADED SAND WITH SILT	9	11	NP	68.0	11.3	SP-SM

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

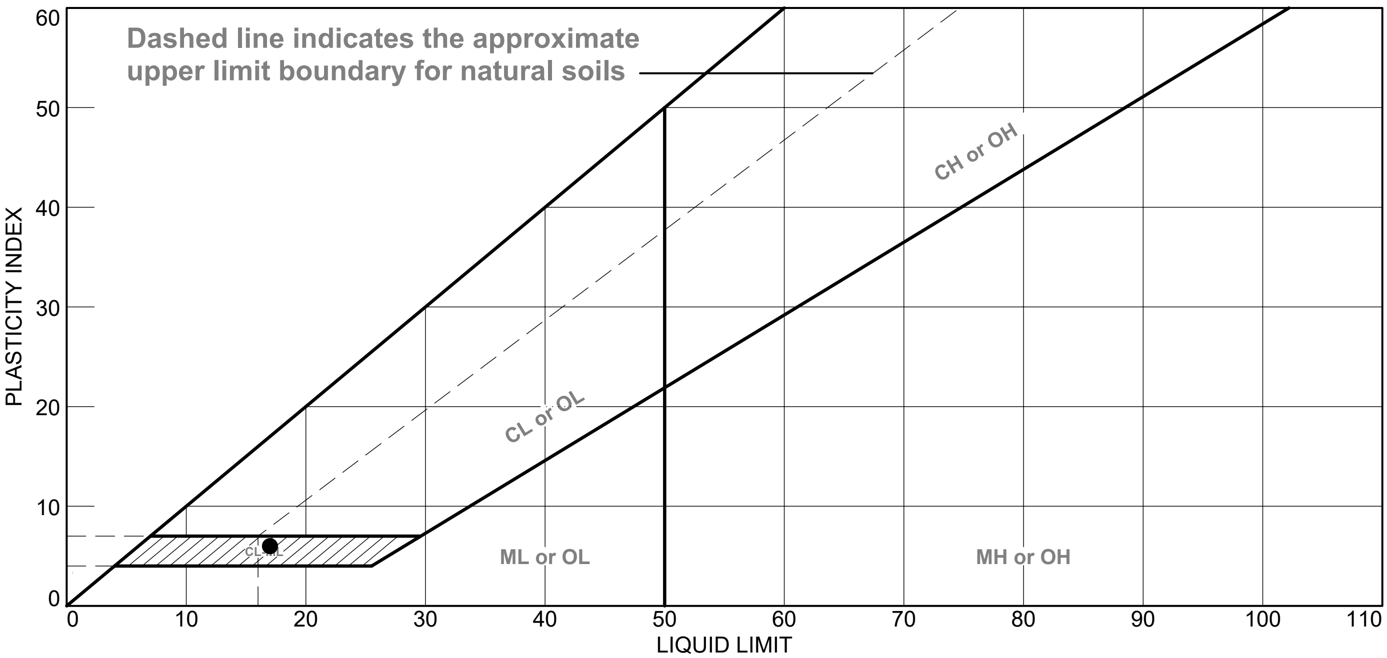
Source of Sample: MW-37 **Depth:** 25.0'-27.0'
Sample Number: 1100

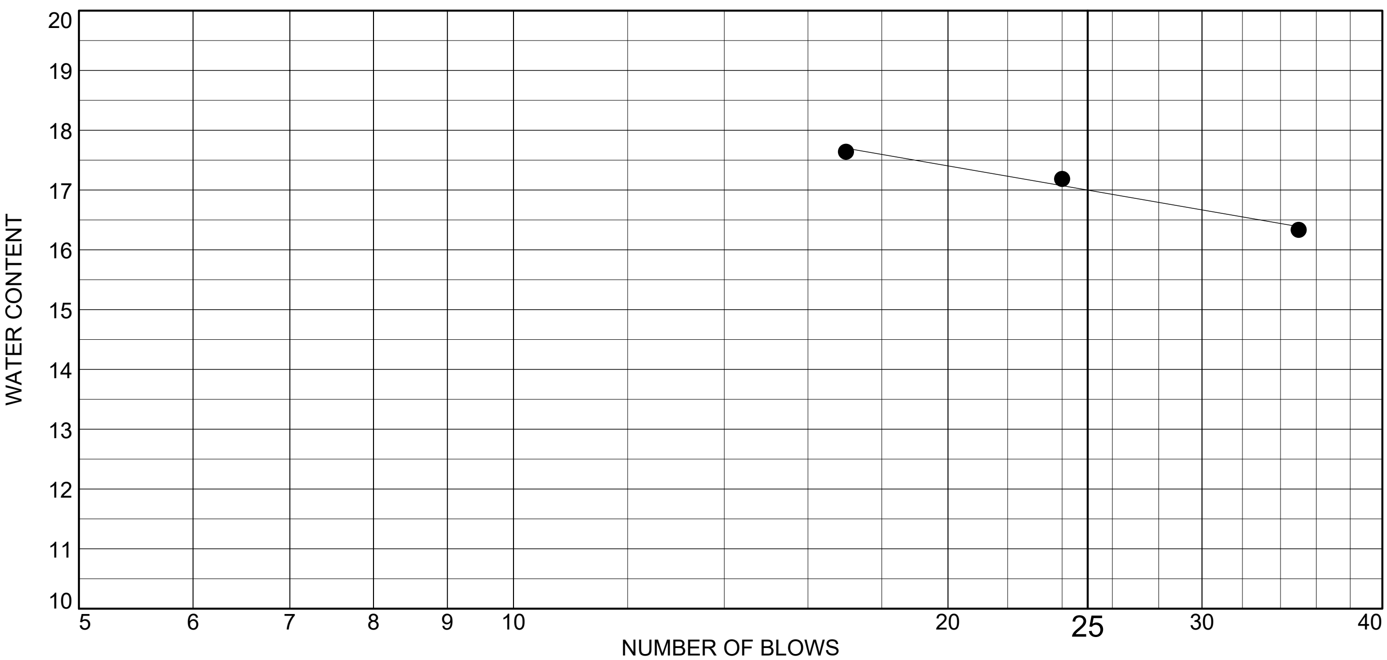
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY AND BROWN SILTY CLAYEY SAND	17	11	6	82.9	48.2	SC-SM

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: MW-37 **Depth:** 35.5'-36.0'
Sample Number: 1300

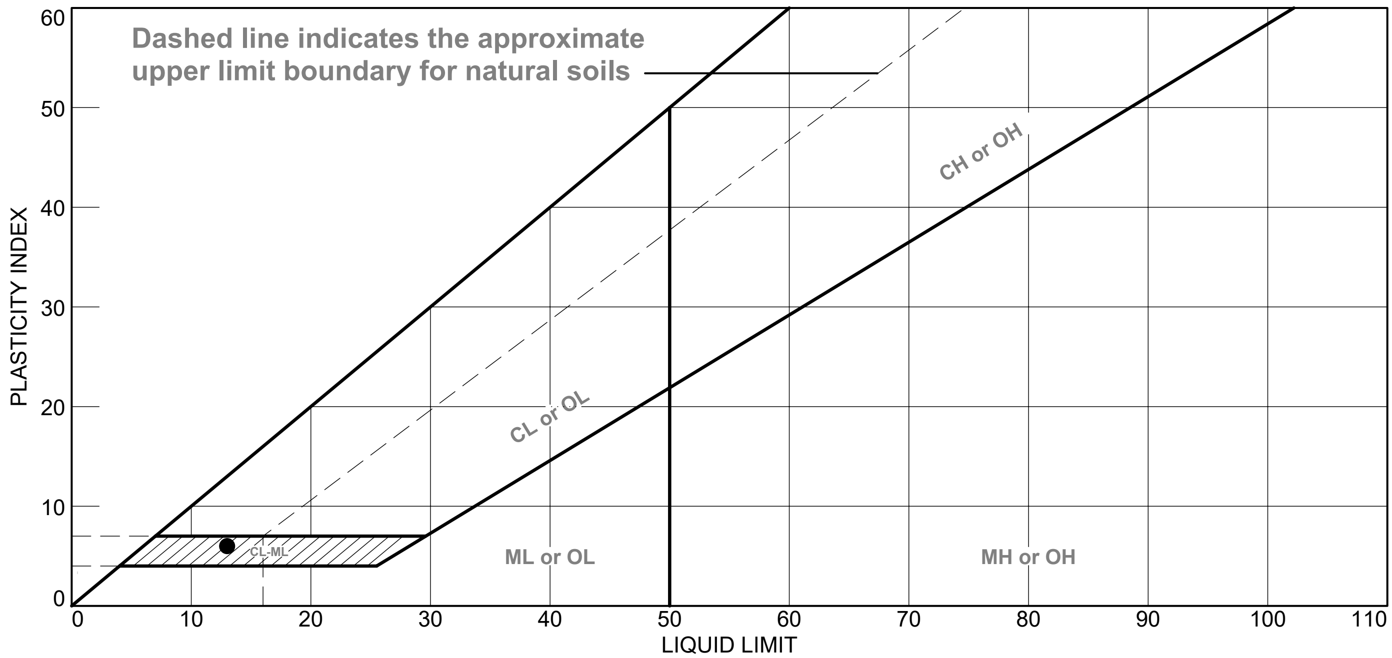
Terracon

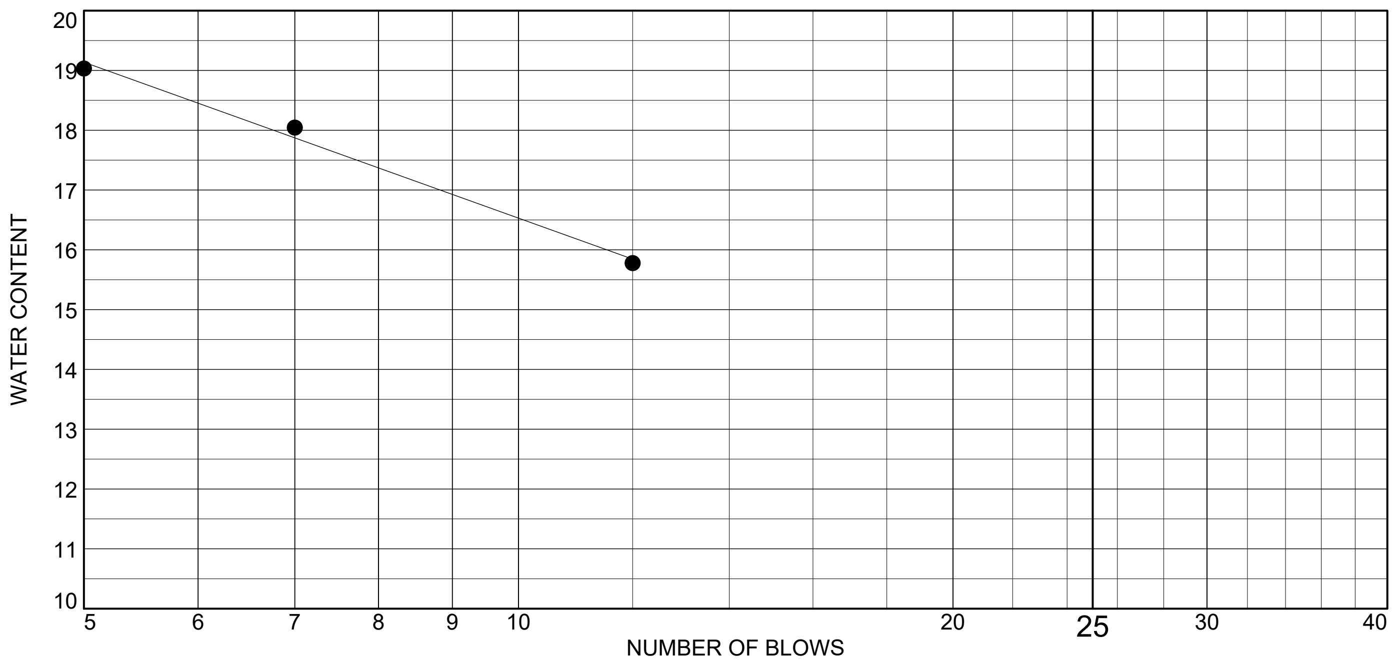
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAYISH BROWN POORLY GRADED SAND WITH SILTY CLAY	13	7	6	97.3	6.9	SP-SC

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

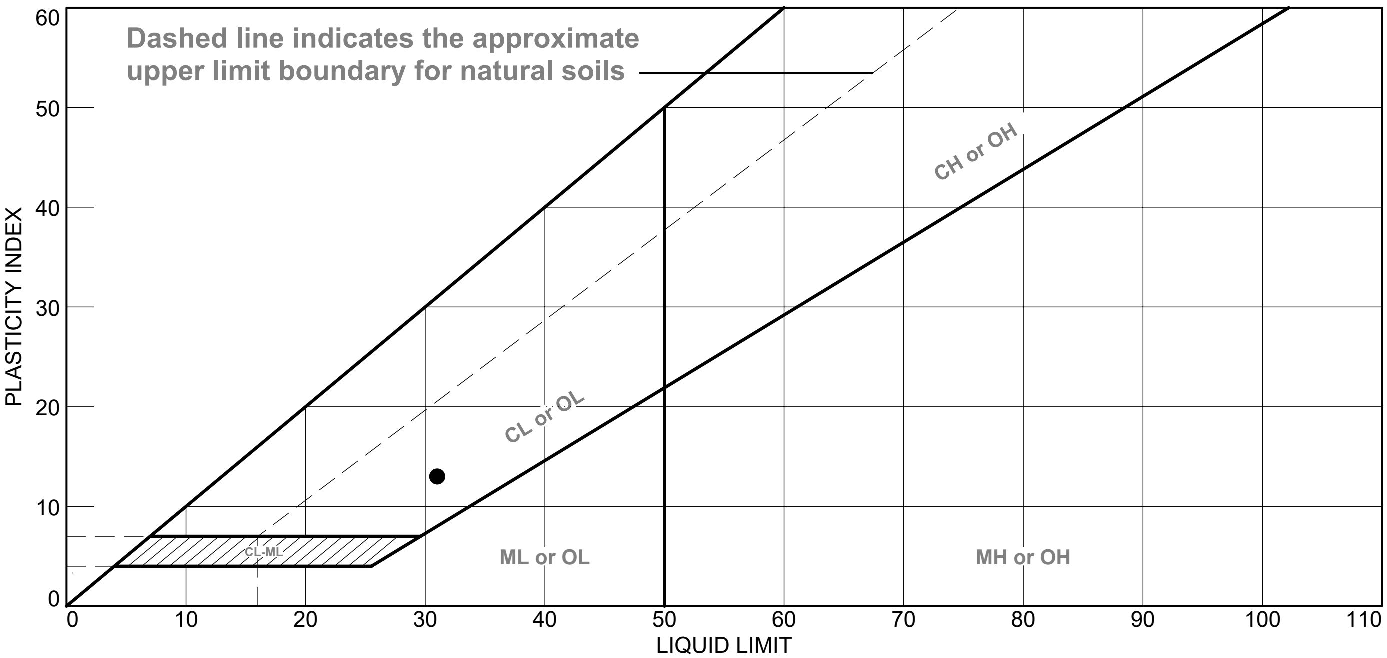
Source of Sample: MW-37 **Depth:** 50.5'-51.0'
Sample Number: 1415

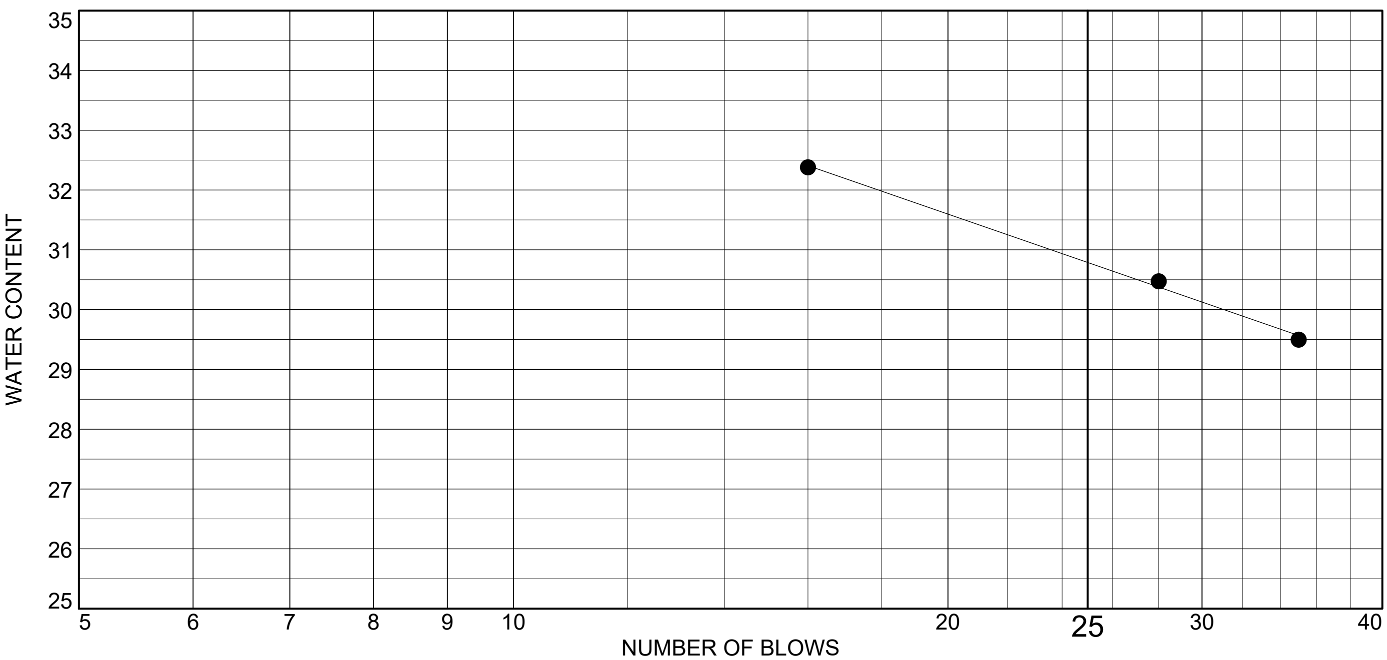
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY LEAN CLAY - SAND SEAMS NOTED	31	18	13	99.7	98.1	CL

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

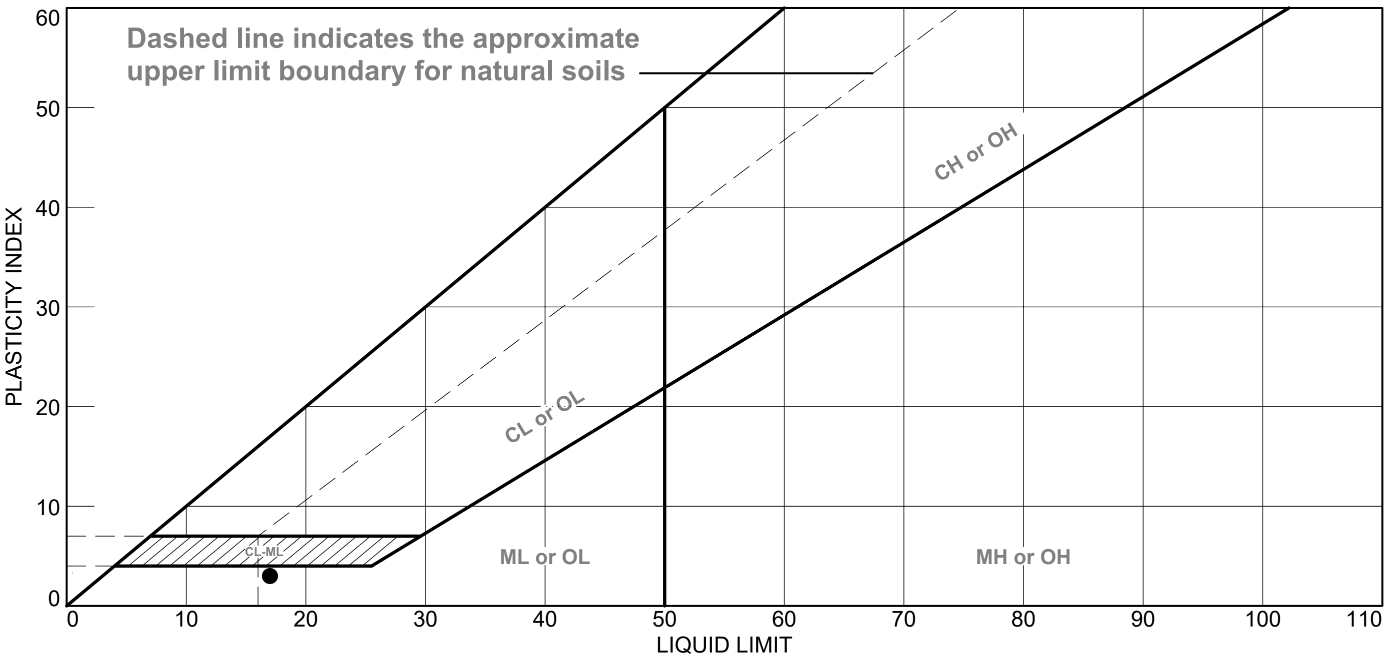
Source of Sample: MW-37 **Depth:** 55.0'-57.0'
Sample Number: 1500

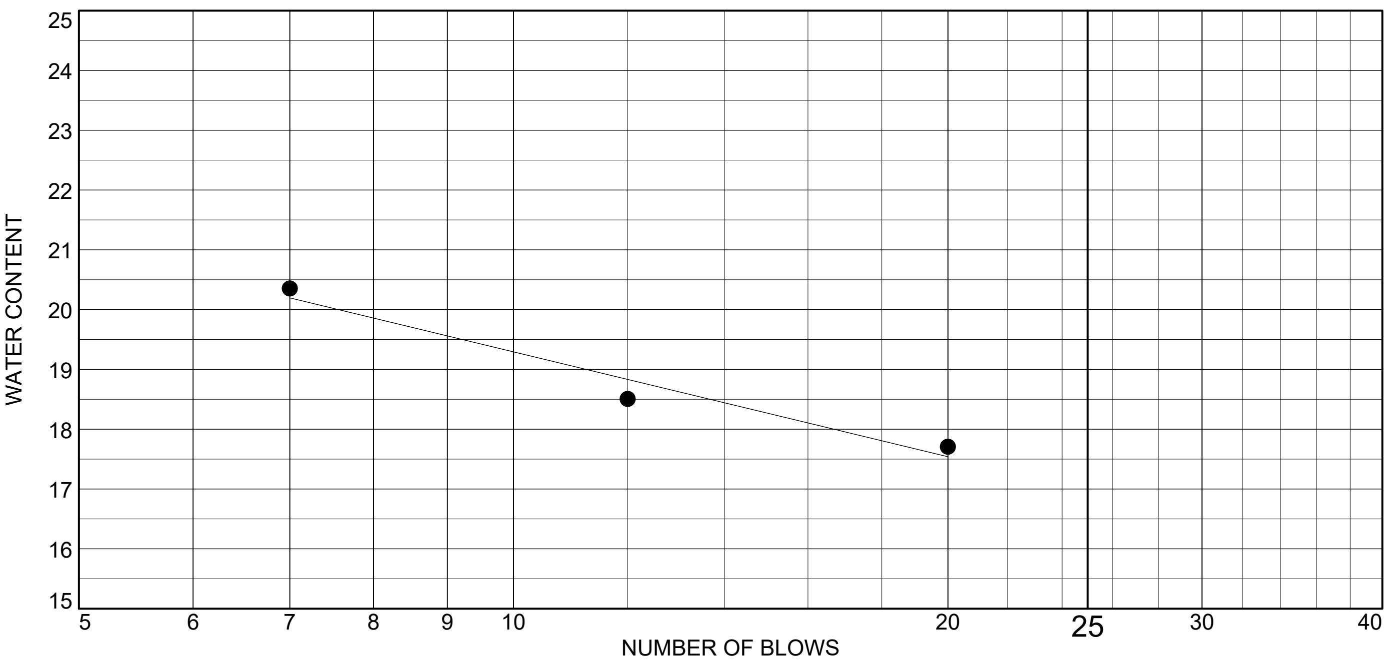
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN SILTY SAND	17	14	3	98.9	44.4	SM

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: MW-38 **Depth:** 5.0'-7.0'
Sample Number: 0835

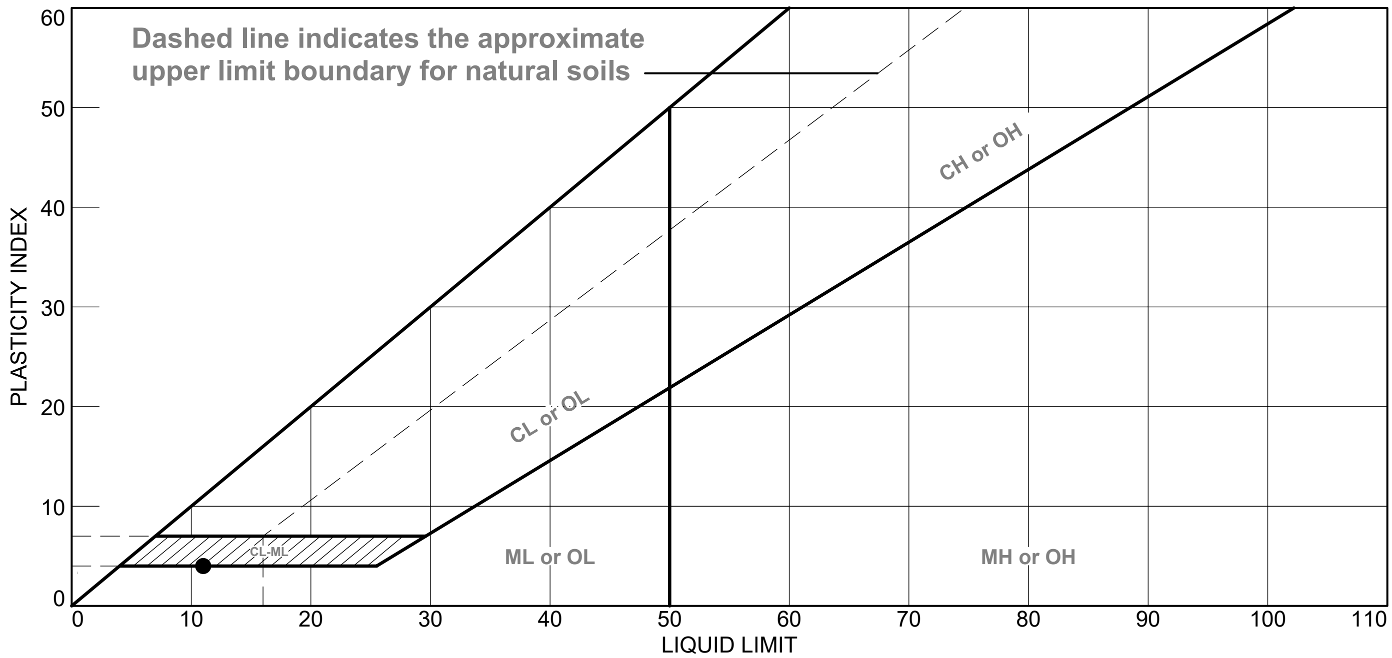
Terracon

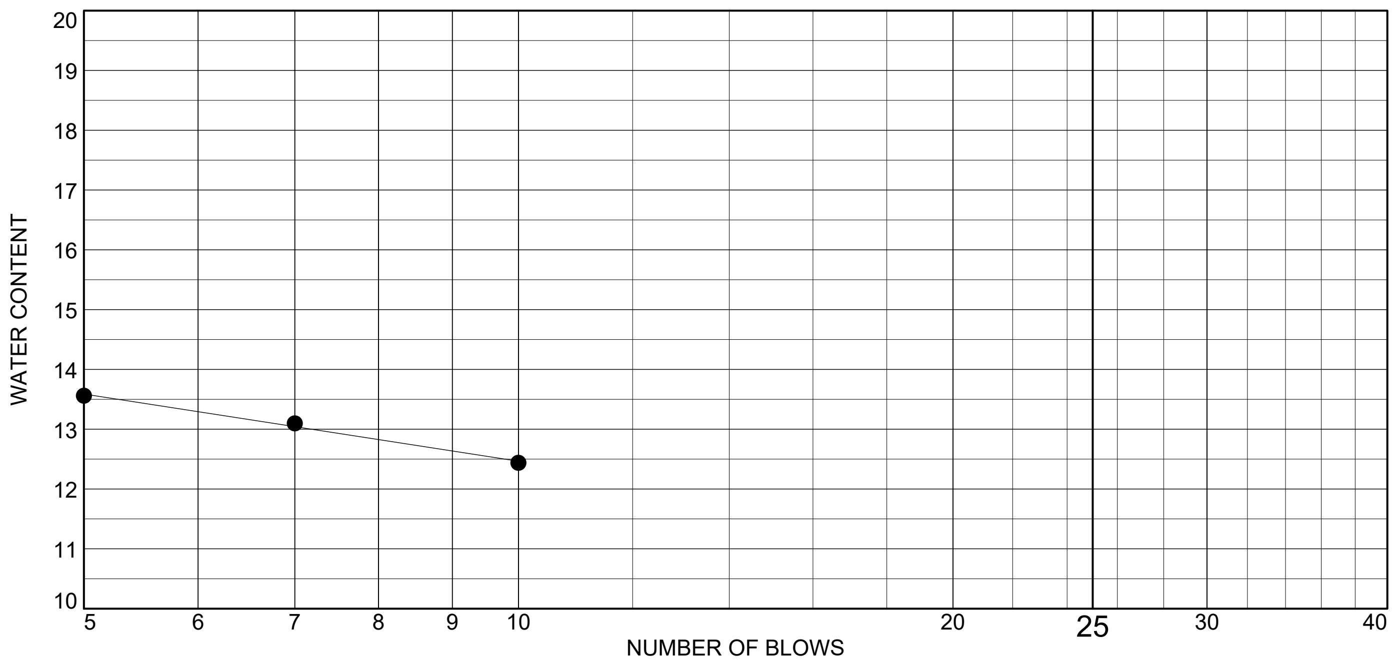
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWNISH GRAY POORLY GRADED SAND WITH SILTY CLAY	11	7	4	57.1	9.2	SP-SC

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: MW-38 **Depth:** 21.5'-22.0'

Sample Number: 0910

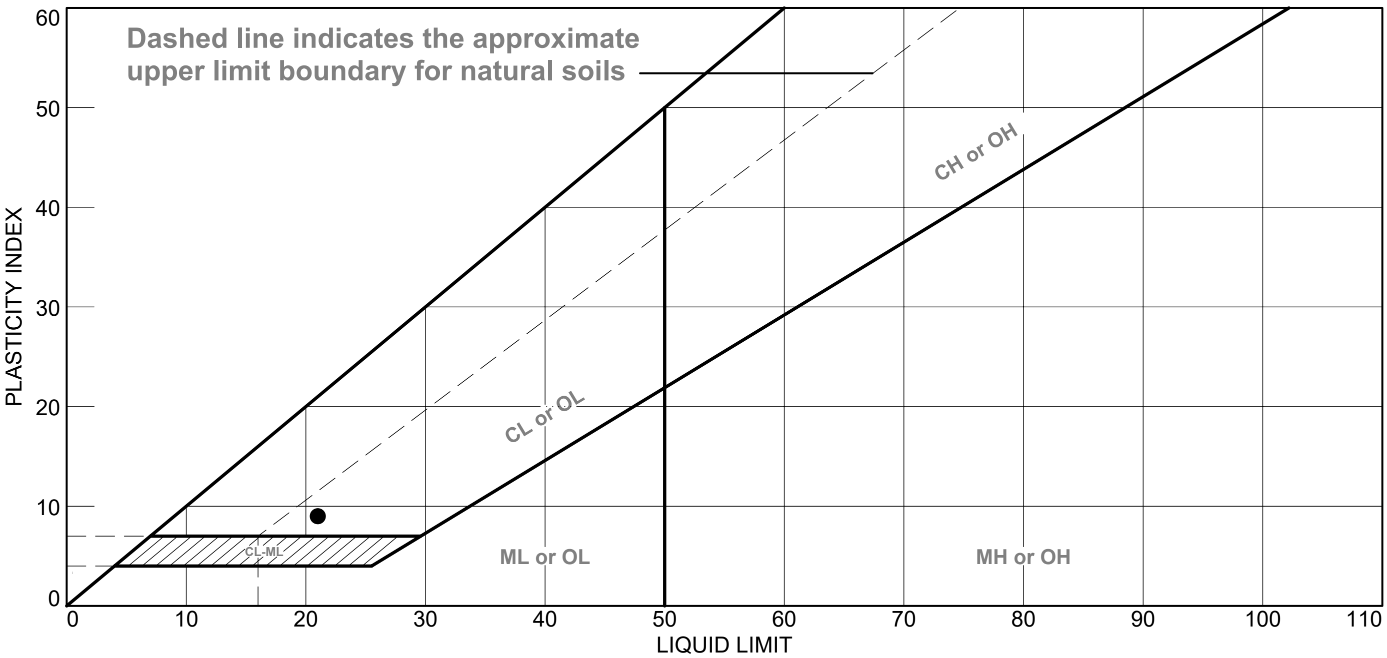
Terracon

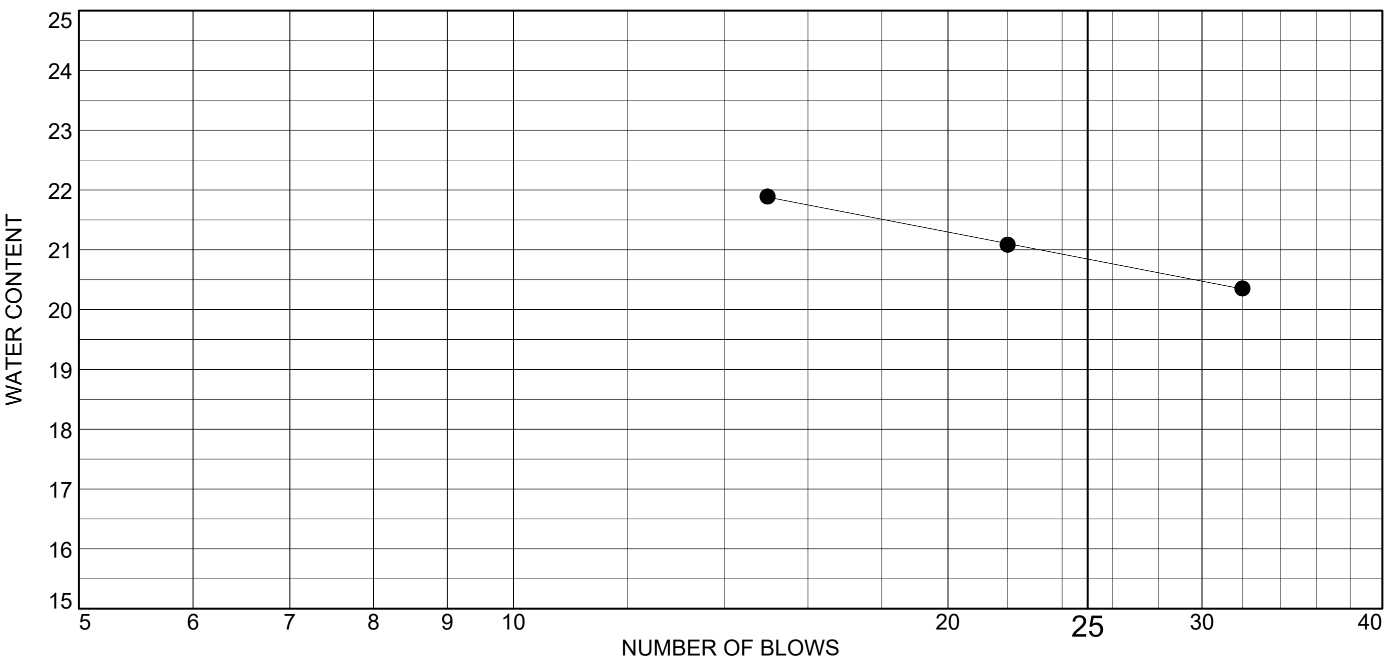
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY SANDY LEAN CLAY - SILT SEAMS NOTED	21	12	9	84.9	61.0	CL

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: MW-38 **Depth:** 35.0'-37.0'

Sample Number: 1655

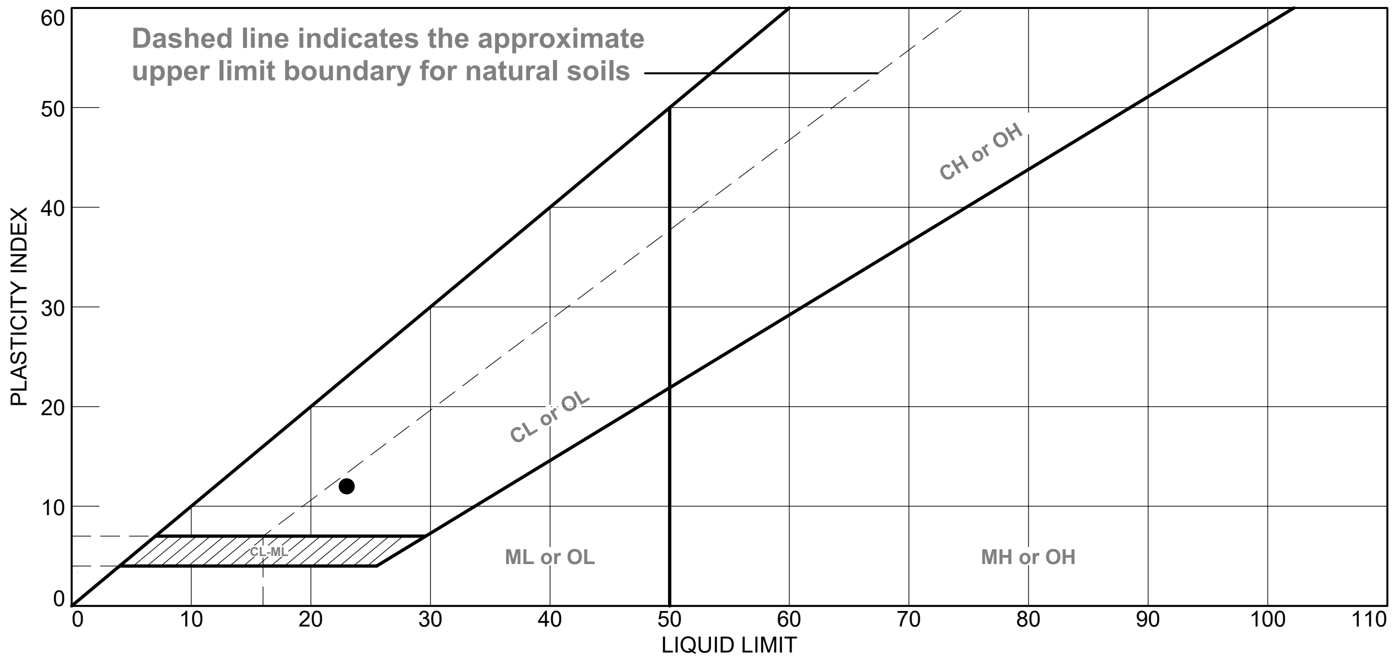
Terracon

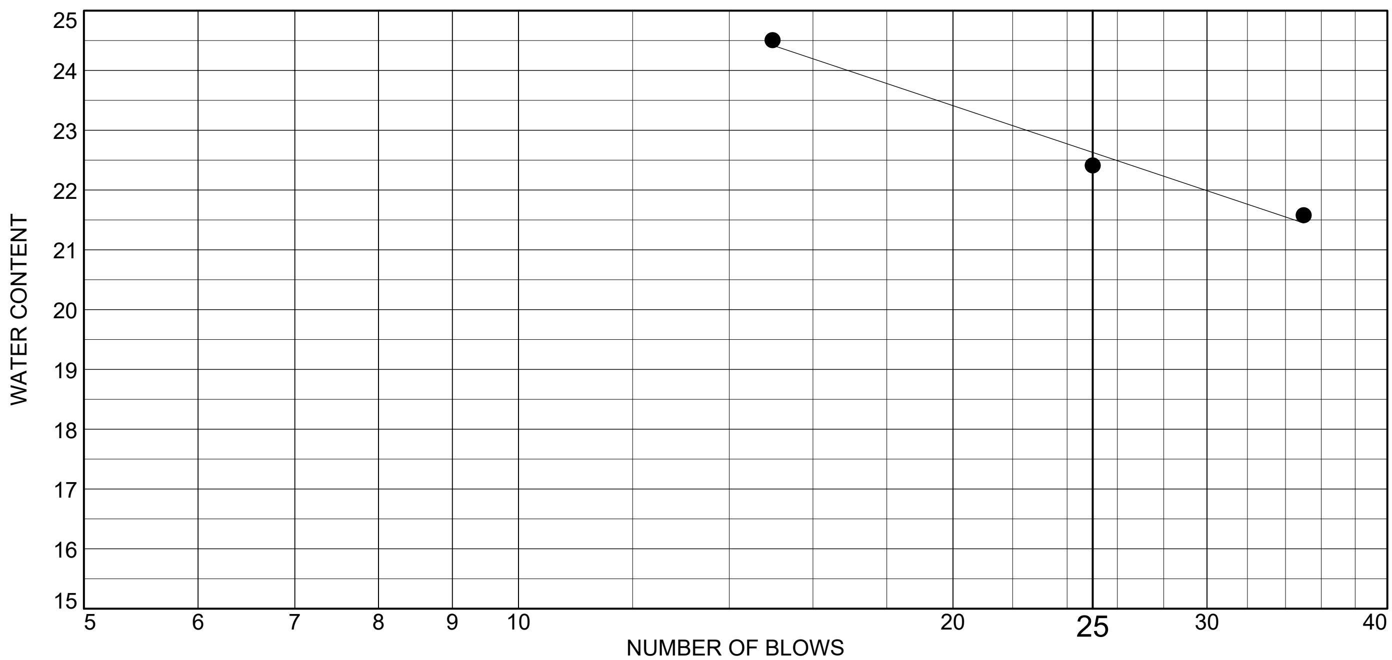
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY TRACE BROWN SANDY LEAN CLAY - SAND SEAMS NOTED	23	11	12	84.7	55.4	CL

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: MW-41 **Depth:** 8.0'-10.0'
Sample Number: 0945

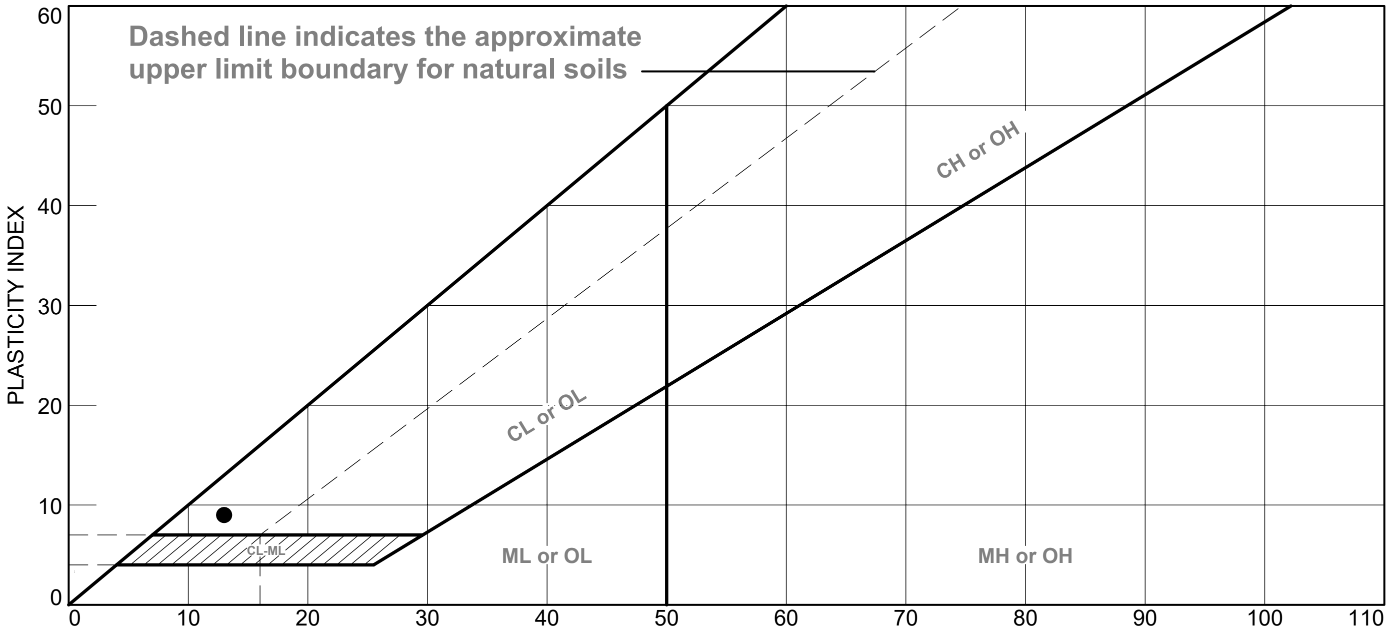
Terracon

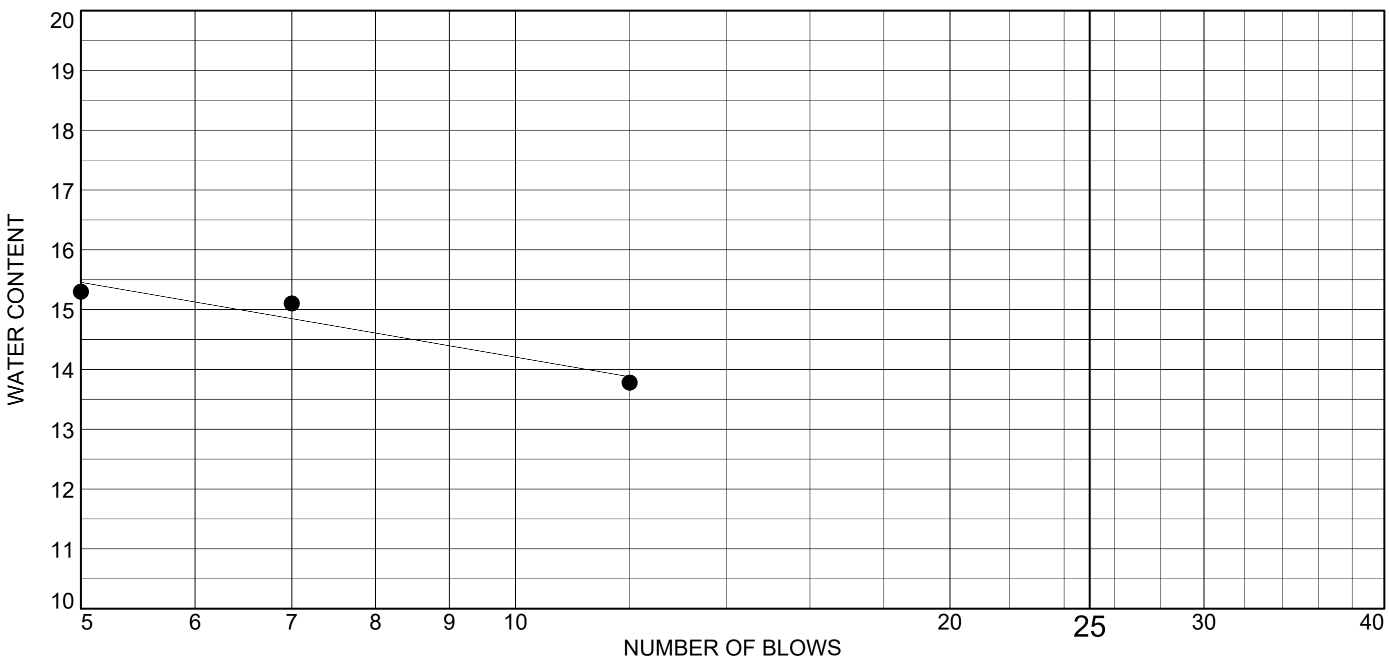
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN POORLY GRADED SAND	13	4	9	89.3	4.4	SP

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: MW-41 **Depth:** 25.0'-25.5'
Sample Number: 1045

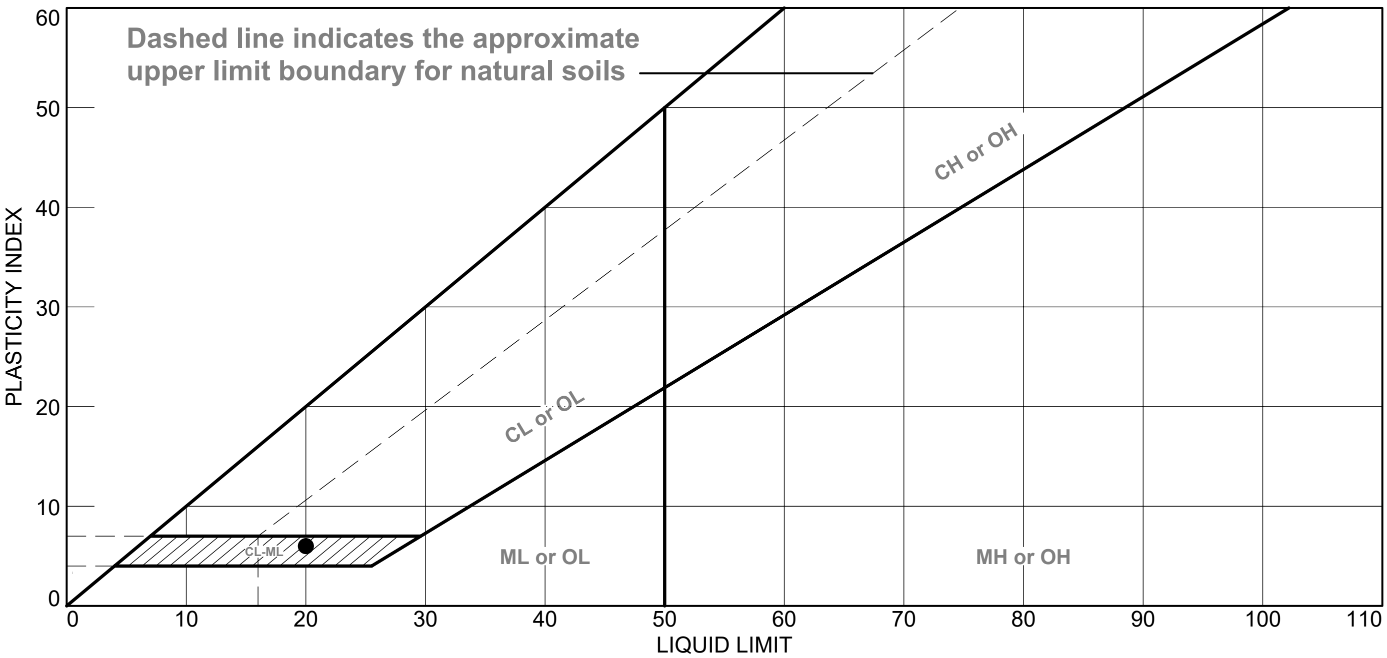
Terracon

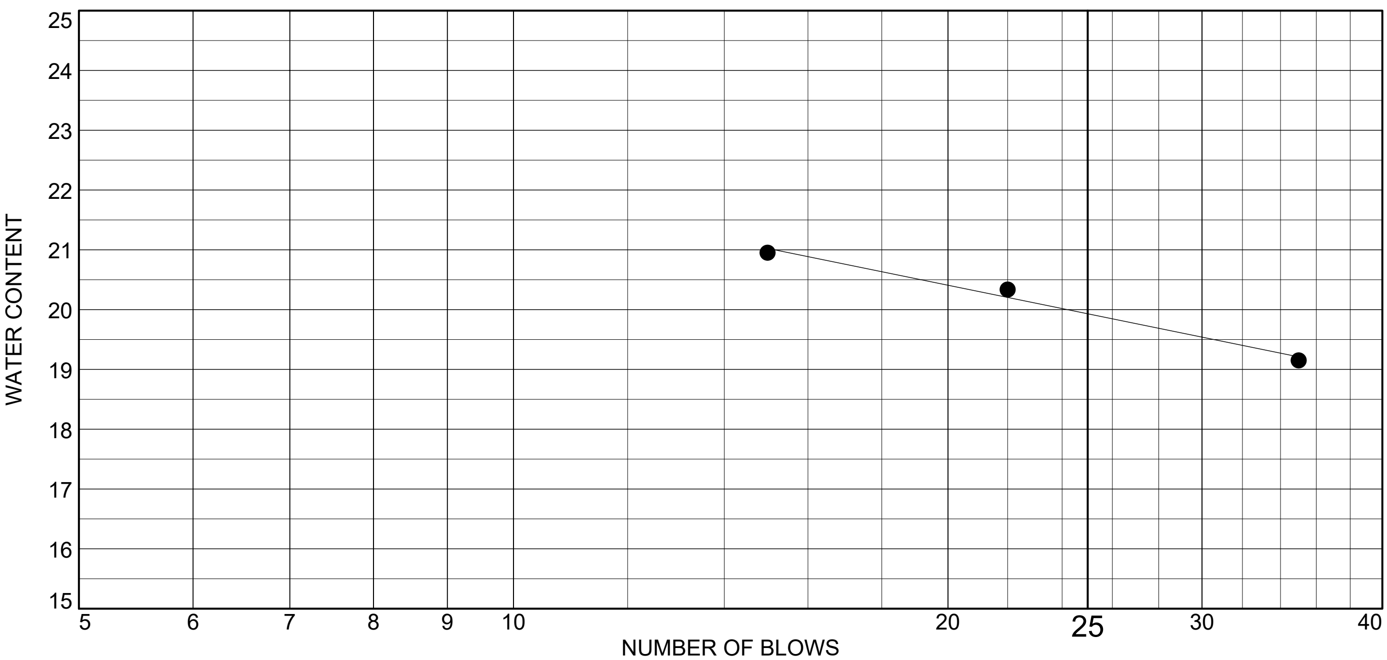
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAYISH BROWN SANDY SILTY CLAY	20	14	6	83.0	56.4	CL-ML

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

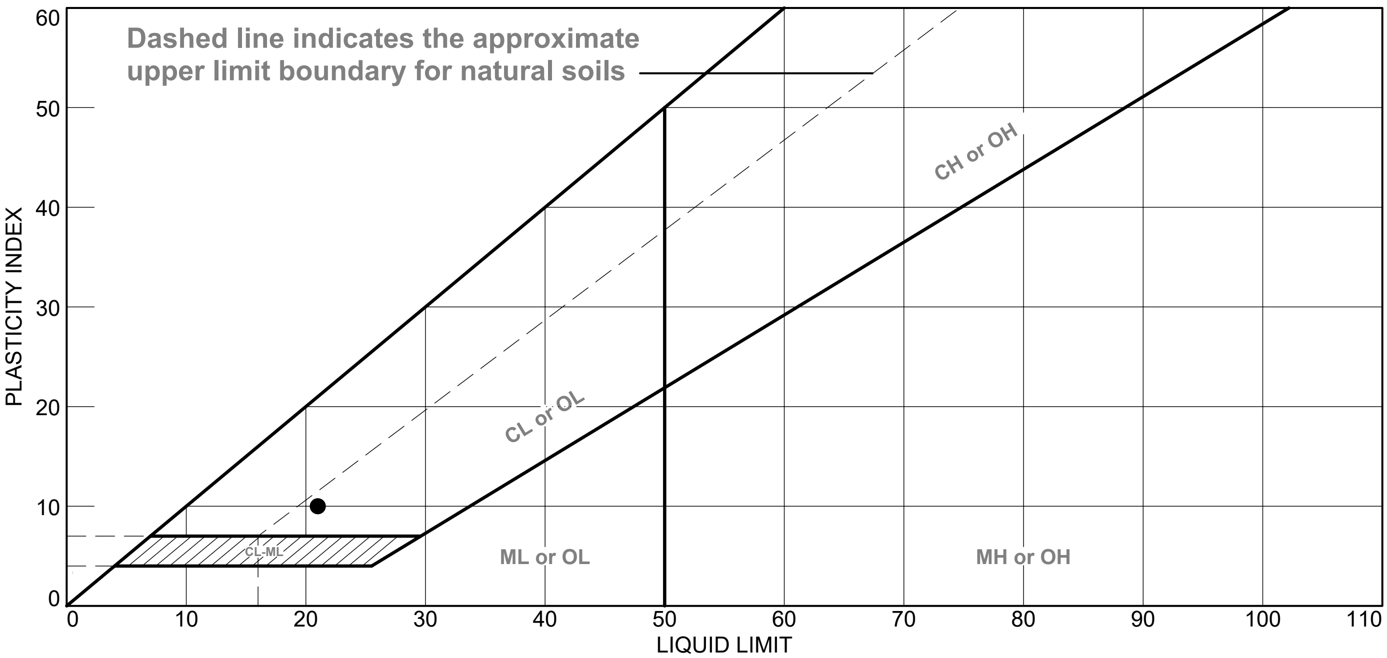
Source of Sample: MW-41 **Depth:** 35.0'-37.0'
Sample Number: 1130

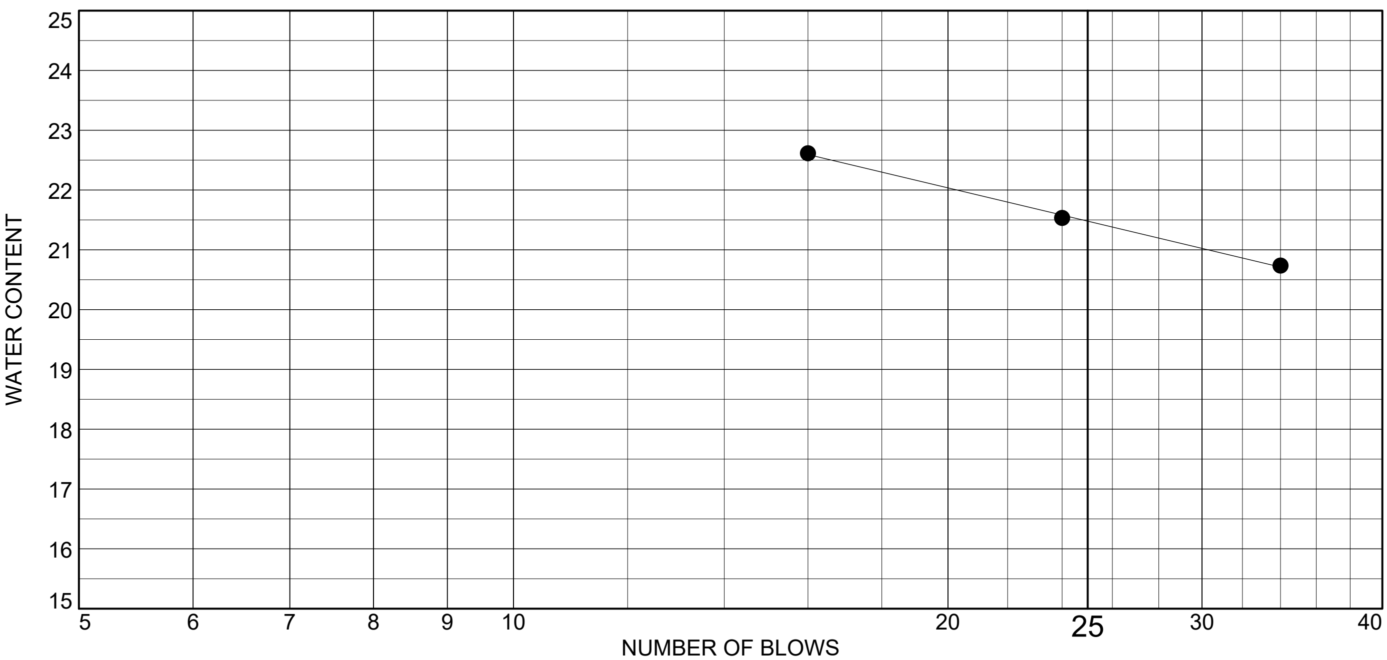
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY AND GRAYISH BROWN SANDY LEAN CLAY	21	11	10	85.6	56.5	CL

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: MW-43 **Depth:** 35.0'-37.0'
Sample Number: 1330

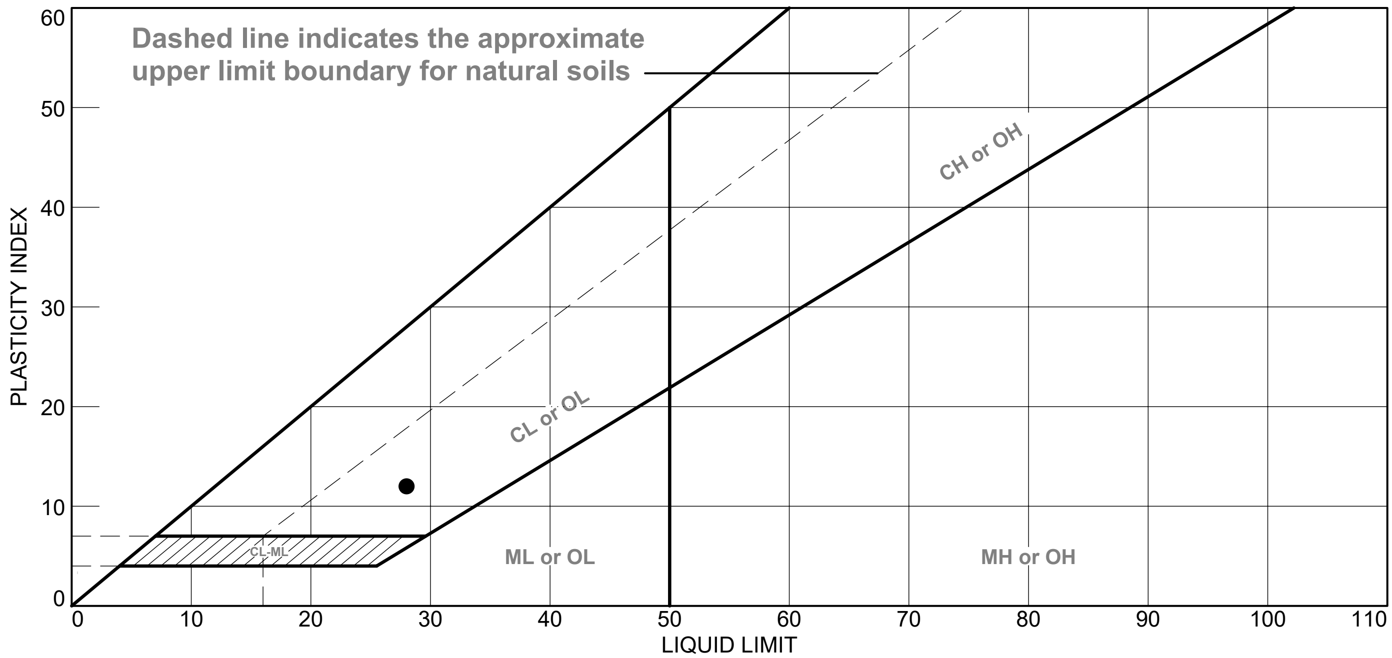
Terracon

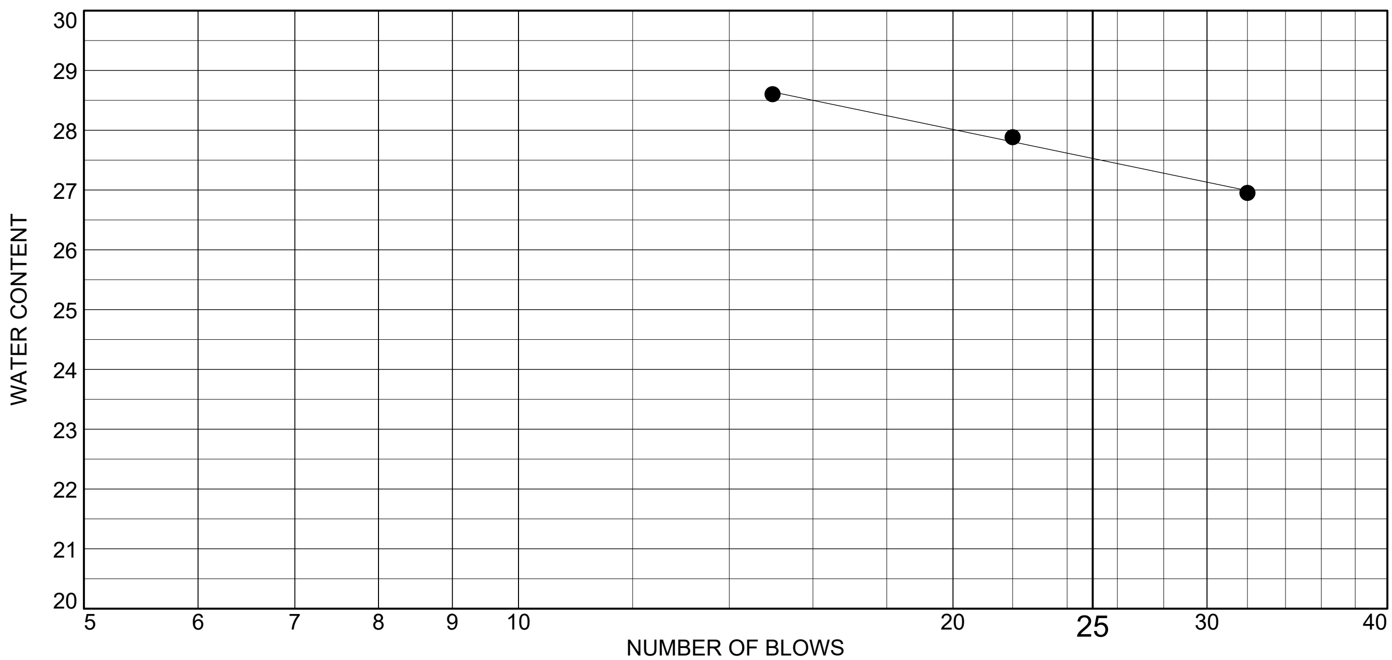
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY LEAN CLAY WITH SAND - SAND SEAMS NOTED	28	16	12	94.1	76.8	CL

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

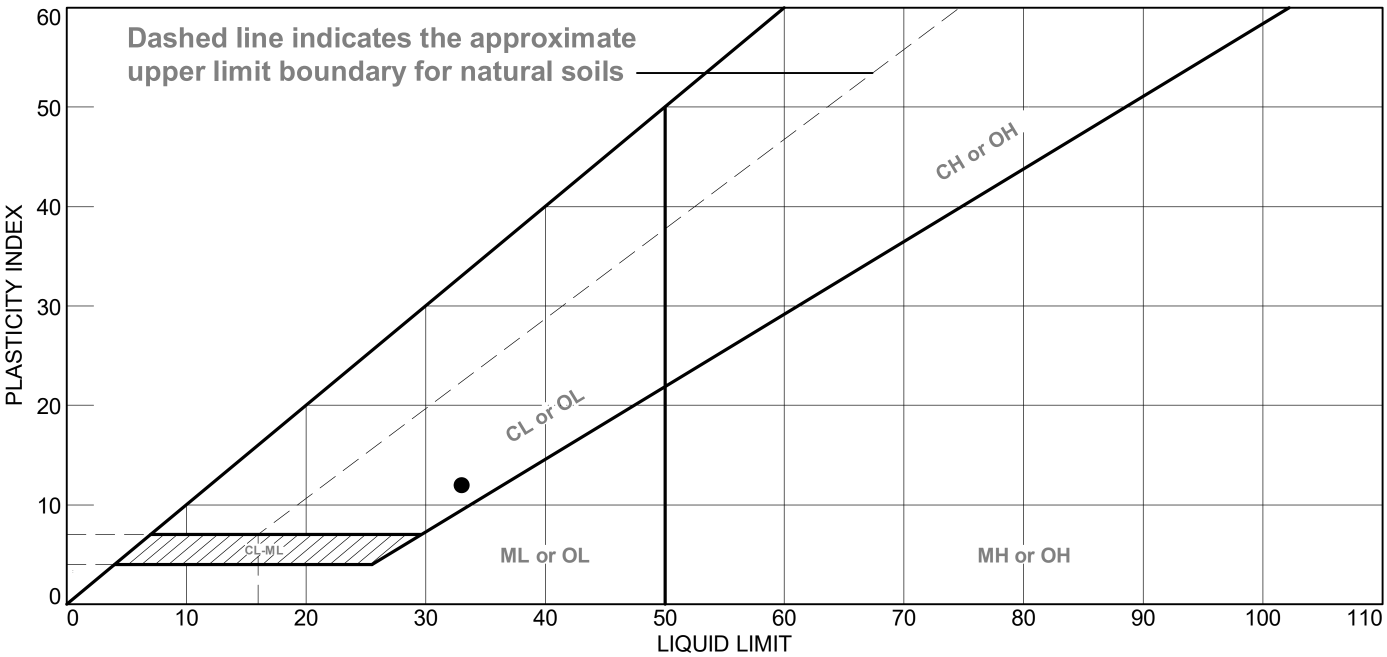
Source of Sample: MW-43 **Depth:** 50.0'-52.0'
Sample Number: 1400

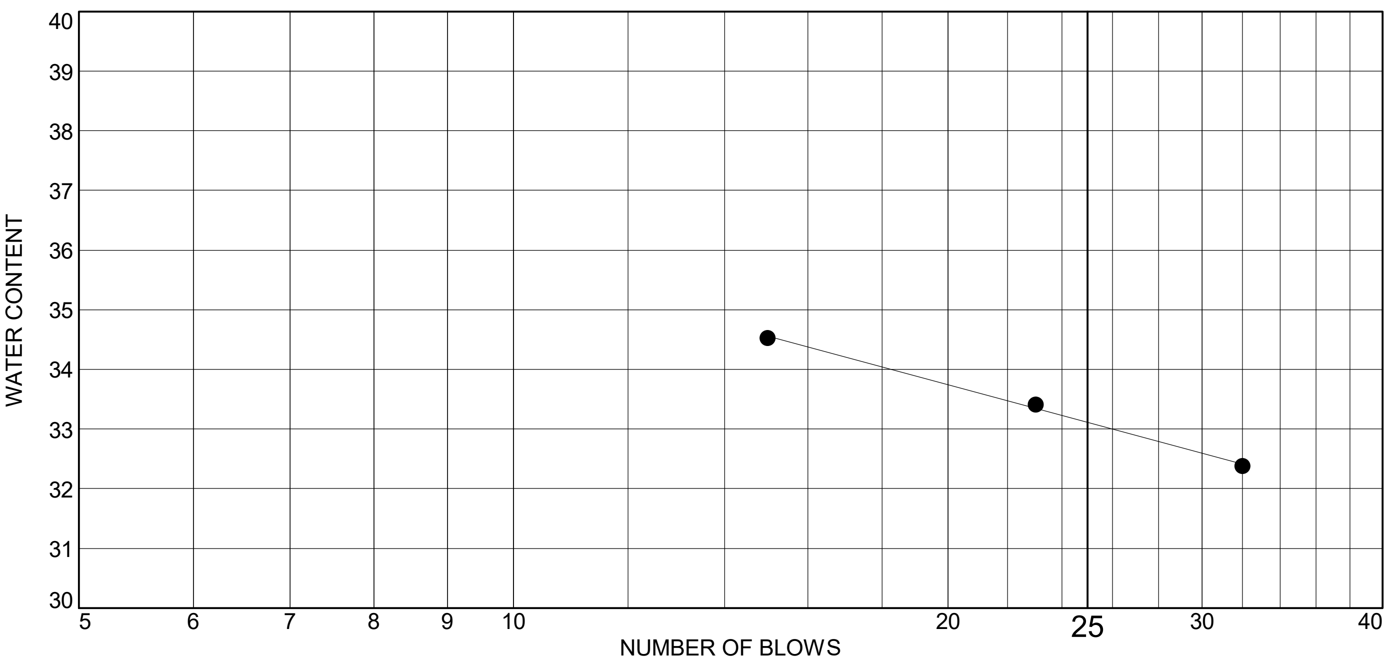
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWNISH GRAY LEAN CLAY	33	21	12	99.9	99.2	CL

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

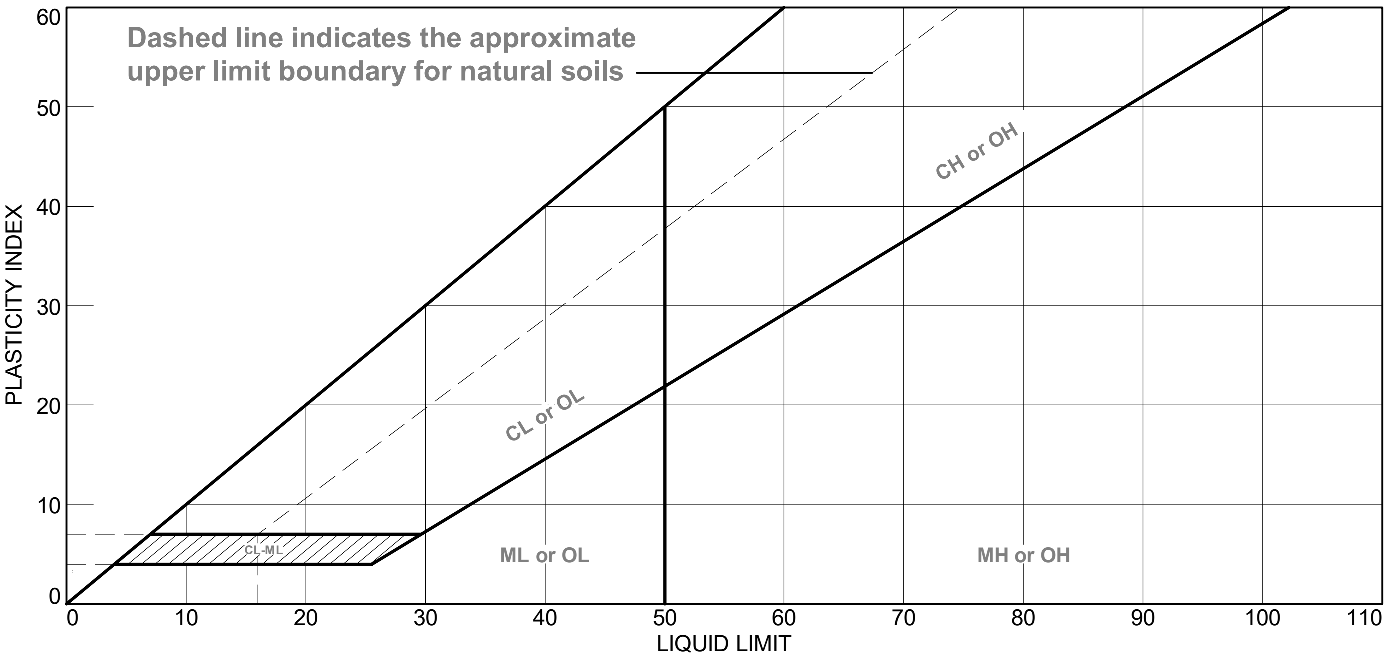
Source of Sample: MW-43 **Depth:** 61.0'-61.5'
Sample Number: 1500

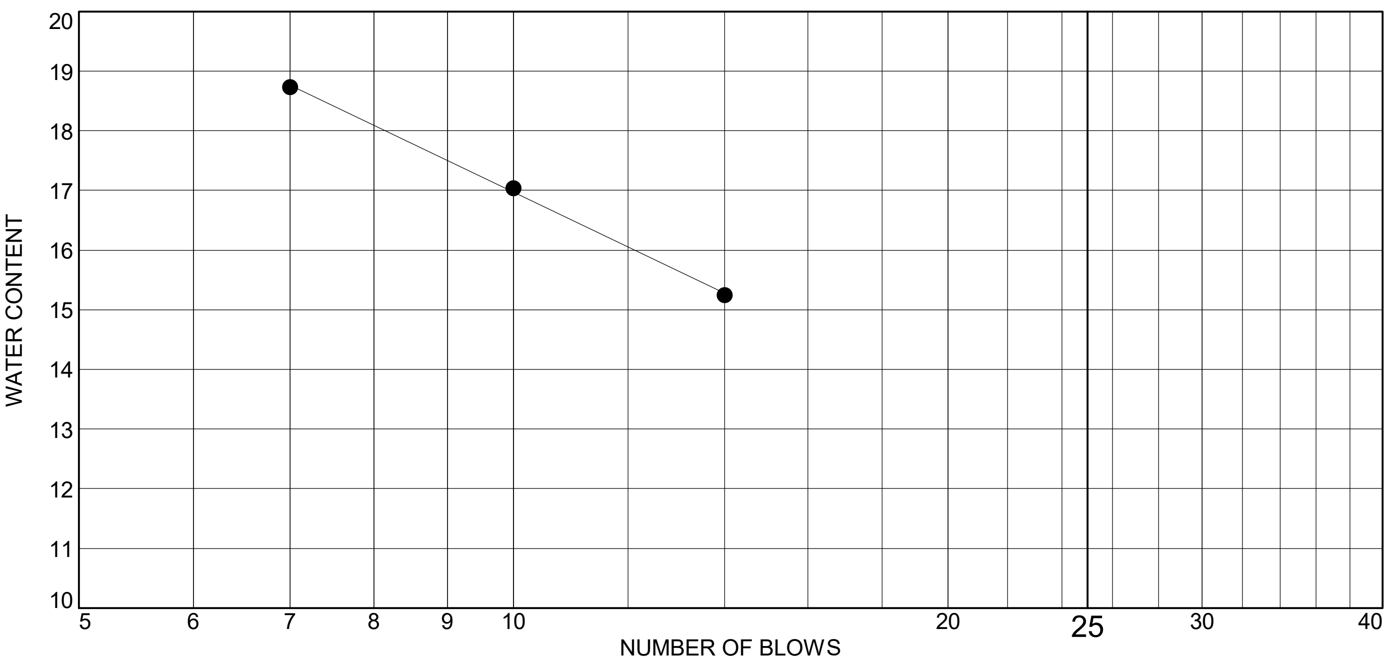
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN AND DARK BROWN SILTY SAND	12	12	NP	94.0	39.9	SM

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

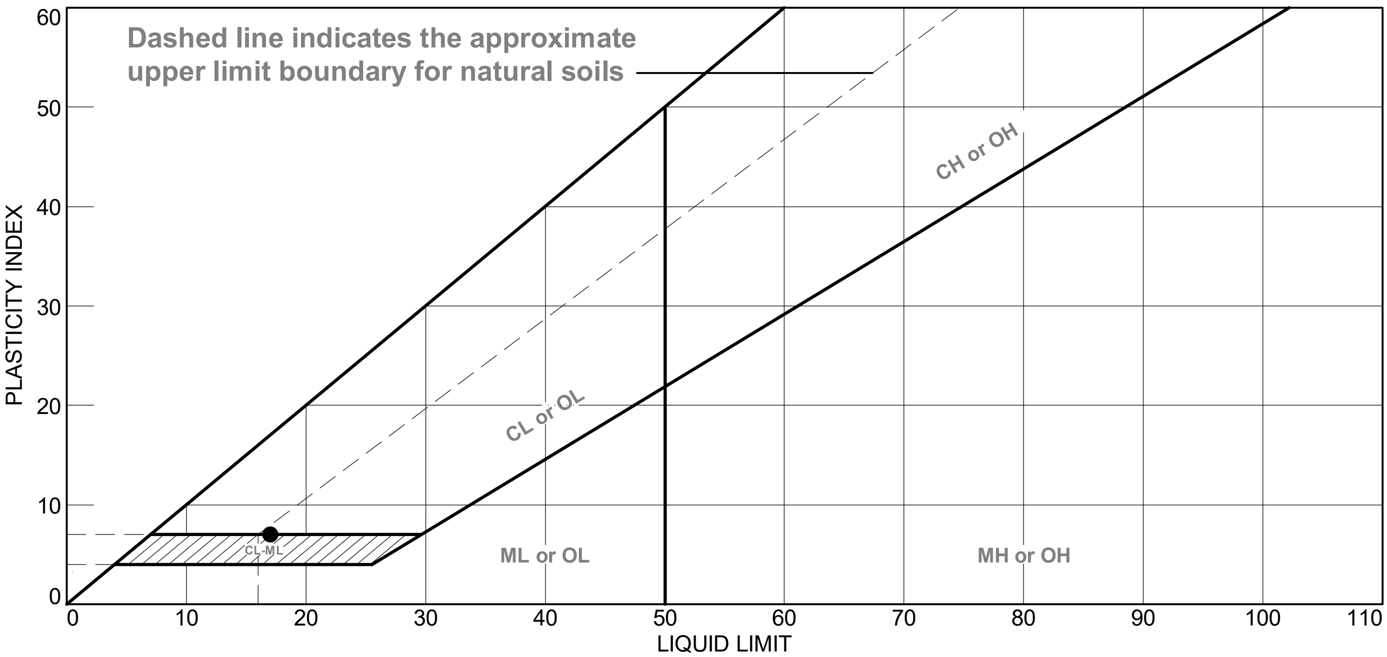
Source of Sample: MW-70SA **Depth:** 16.5'-17.0'
Sample Number: 1615

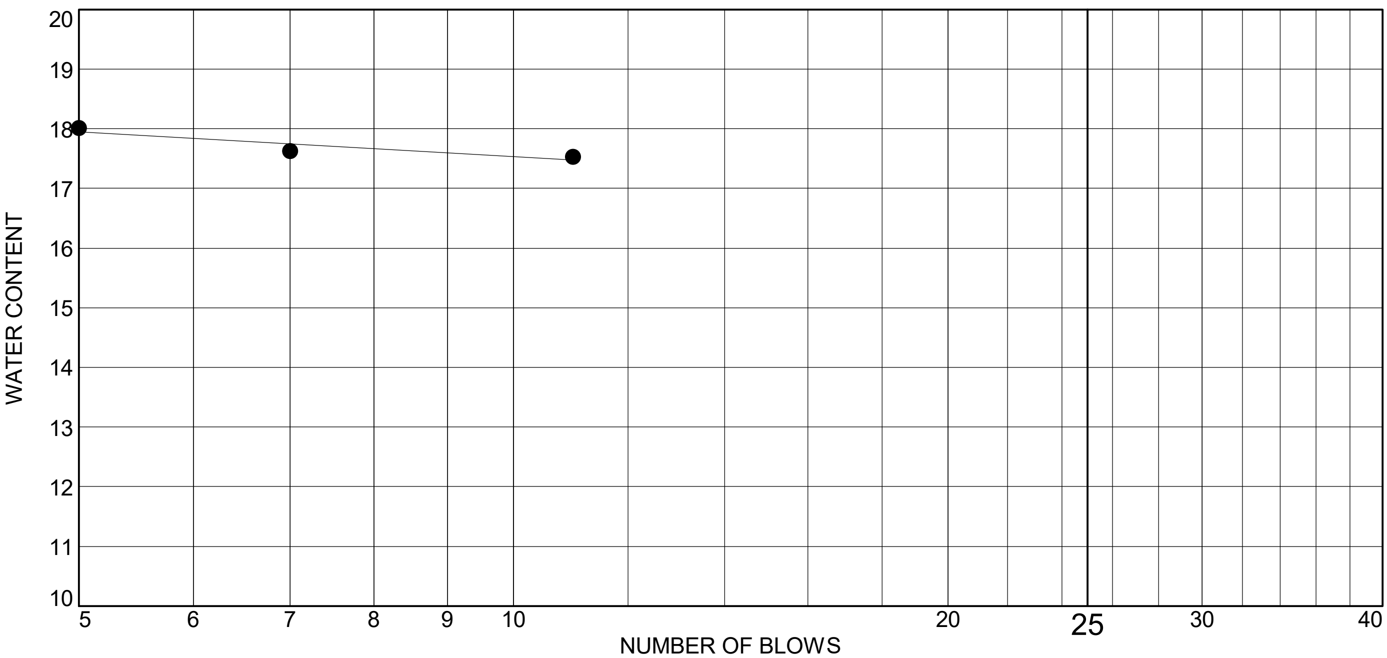
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY POORLY GRADED SAND	17	10	7	96.3	4.7	SP

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: MW-71S **Depth:** 10.0'-10.5'

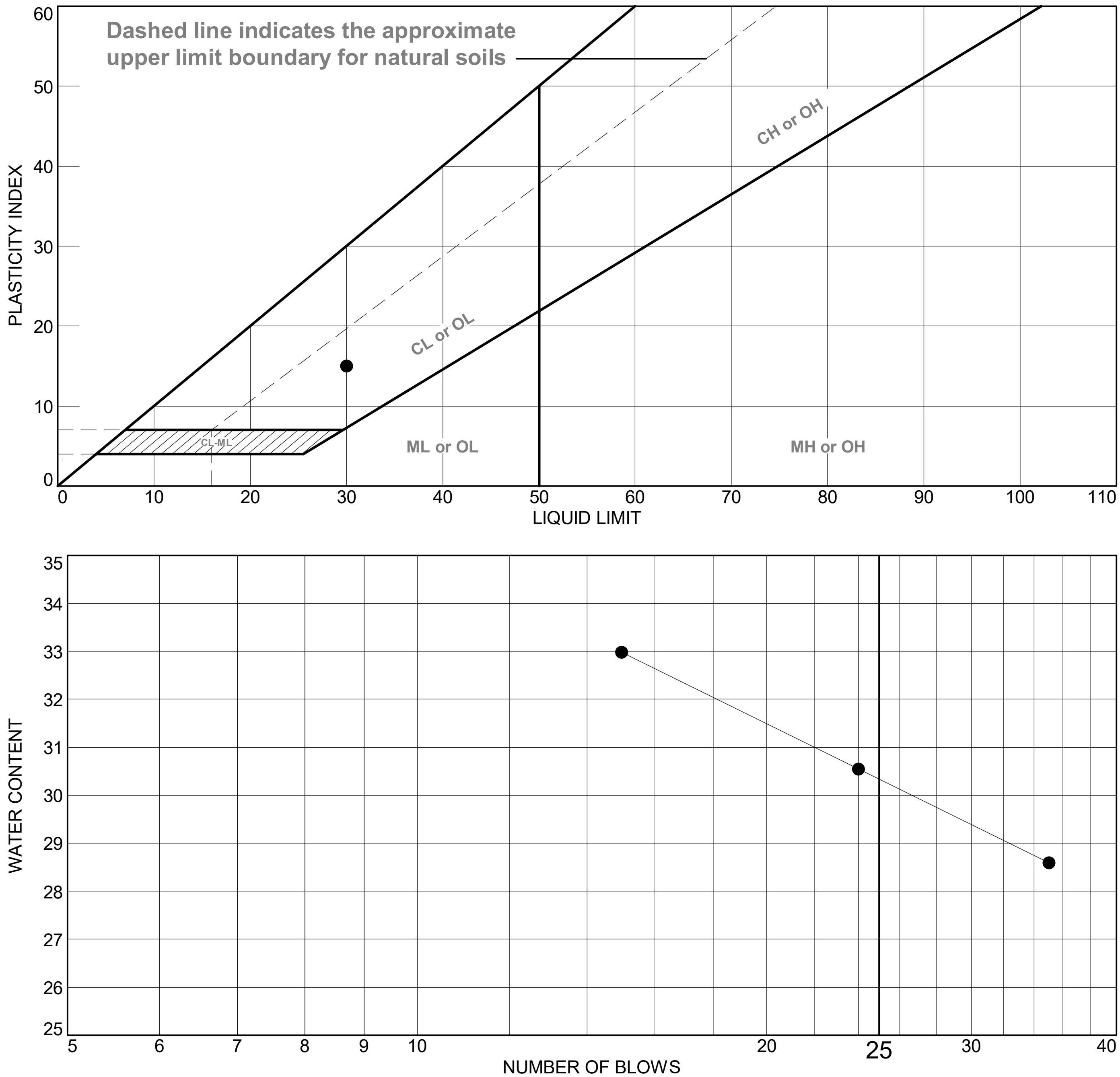
Sample Number: 1615

Remarks:

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	93.1	85.3	CL

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: MW-103 **Depth:** 15.0'-17.0'
Sample Number: 1110

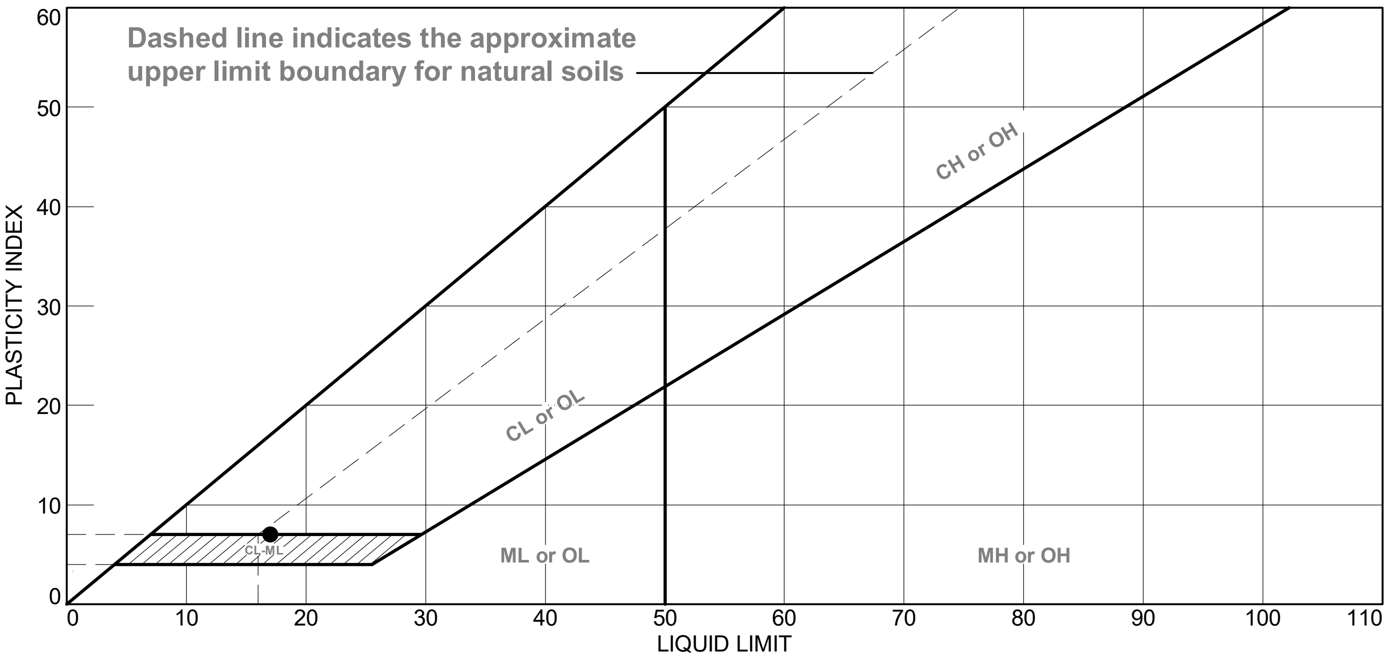
Terracon

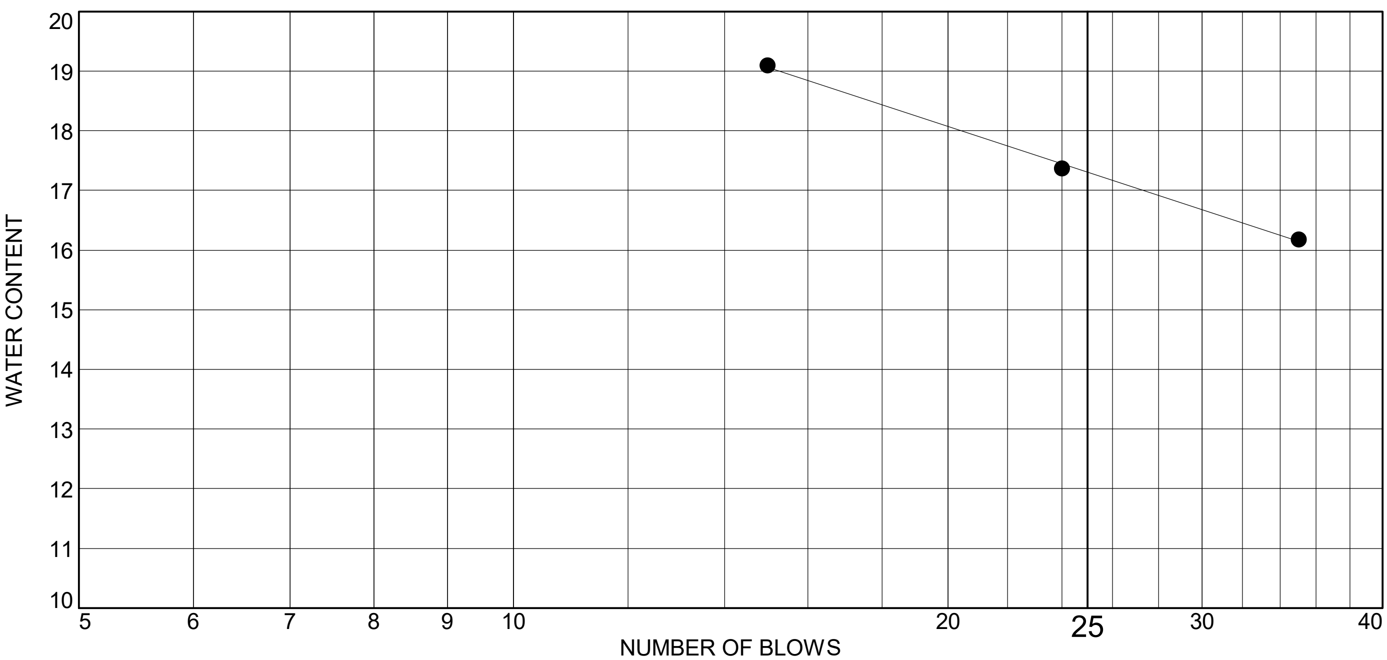
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN AND GRAY SANDY SILTY CLAY	17	10	7	90.0	51.8	CL-ML

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

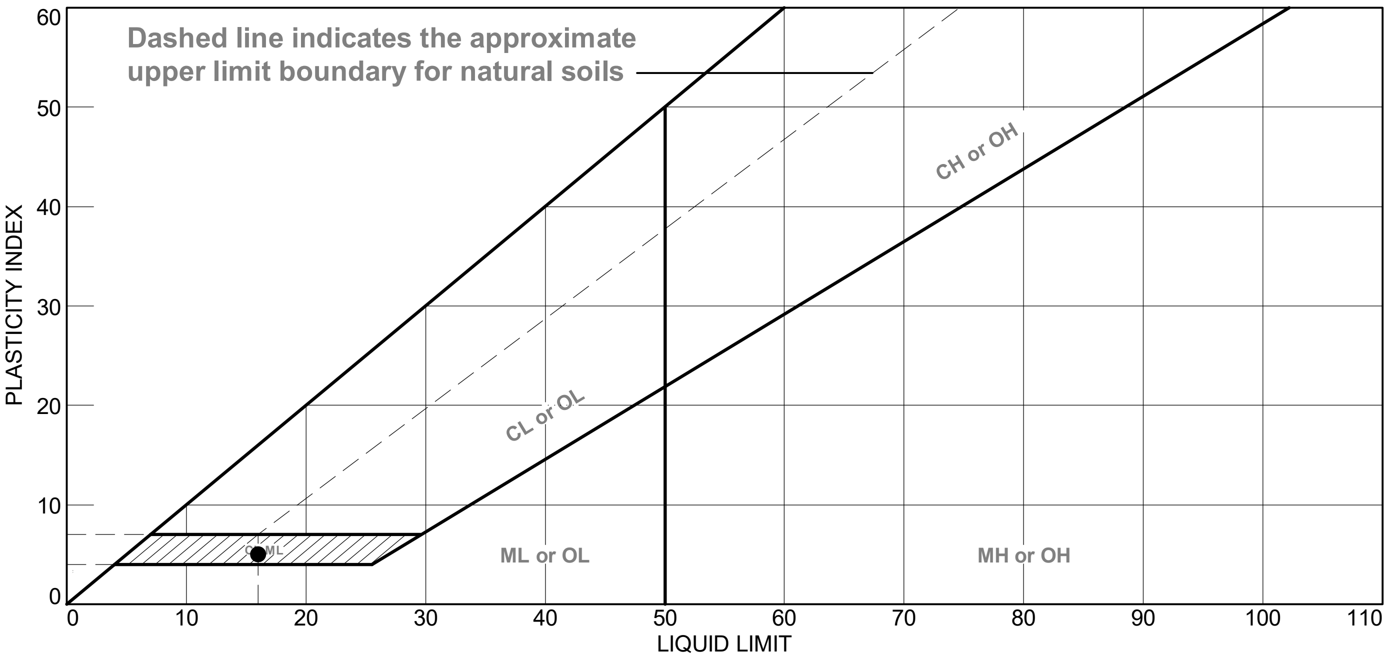
Source of Sample: MW-103 **Depth:** 95.5'-96.0'
Sample Number: 0915

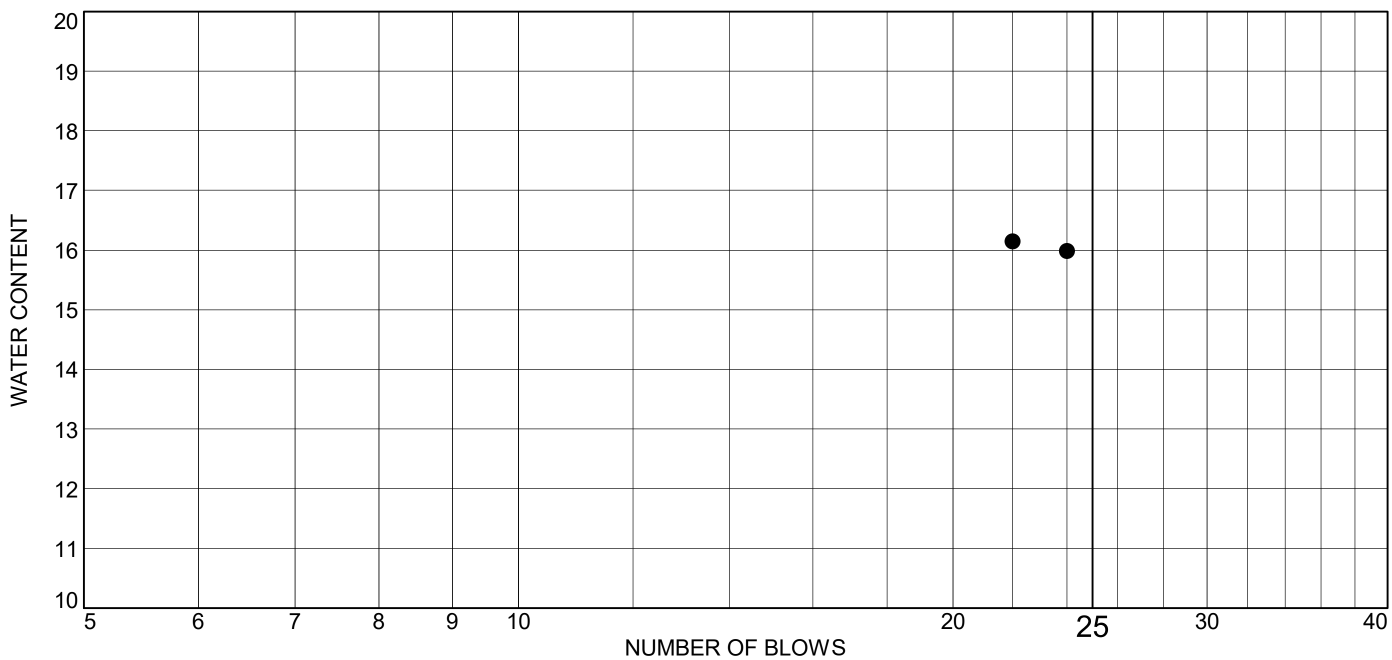
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY SILTY CLAYEY SAND WITH GRAVEL	16	11	5	24.9	12.6	SC-SM

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

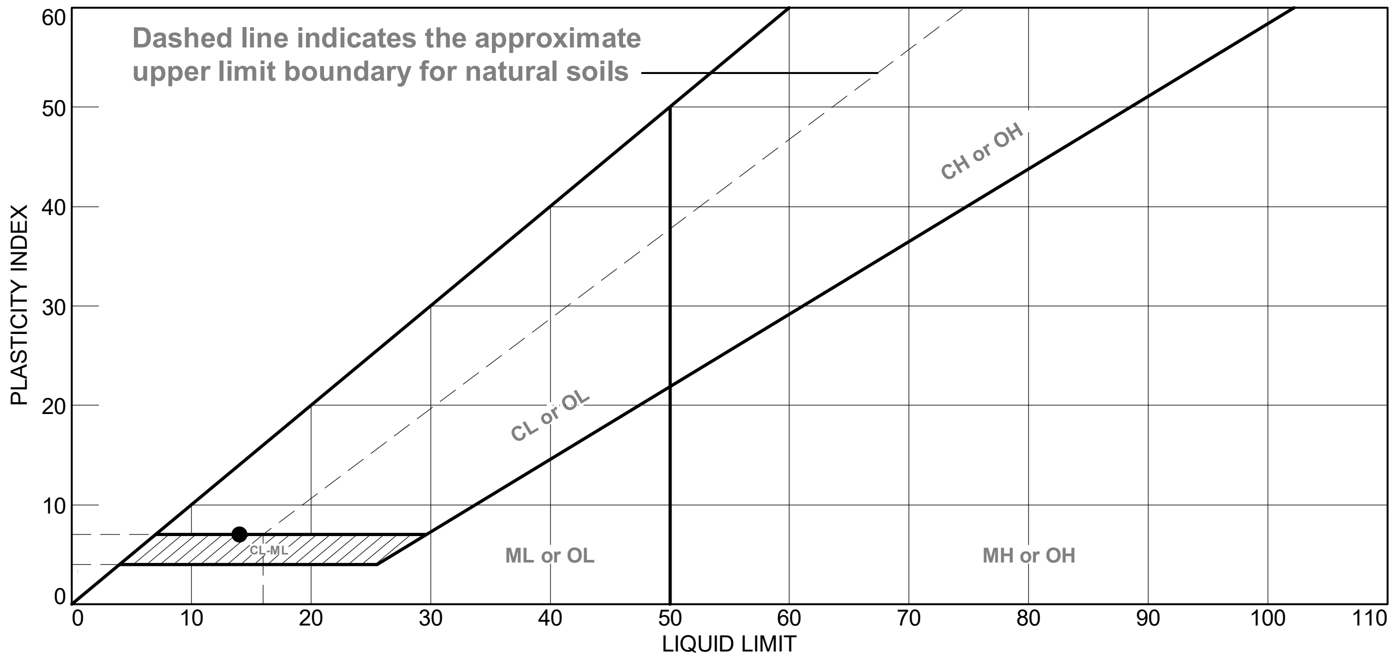
Source of Sample: MW-103 **Depth:** 130.5'-131.0'
Sample Number: 1150

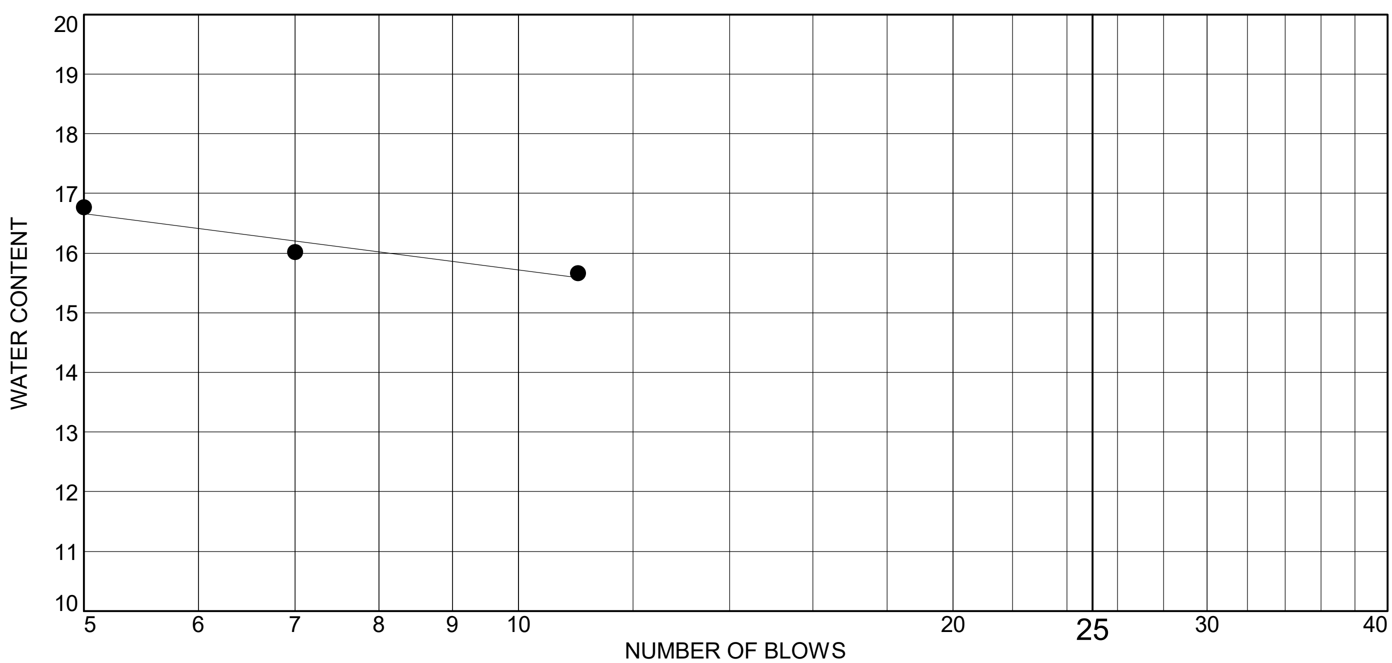
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY AND BROWN POORLY GRADED SAND WITH SILTY CLAY	14	7	7	54.9	5.7	SP-SC

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: MW-103 **Depth:** 132.5'-133.0'
Sample Number: 1350

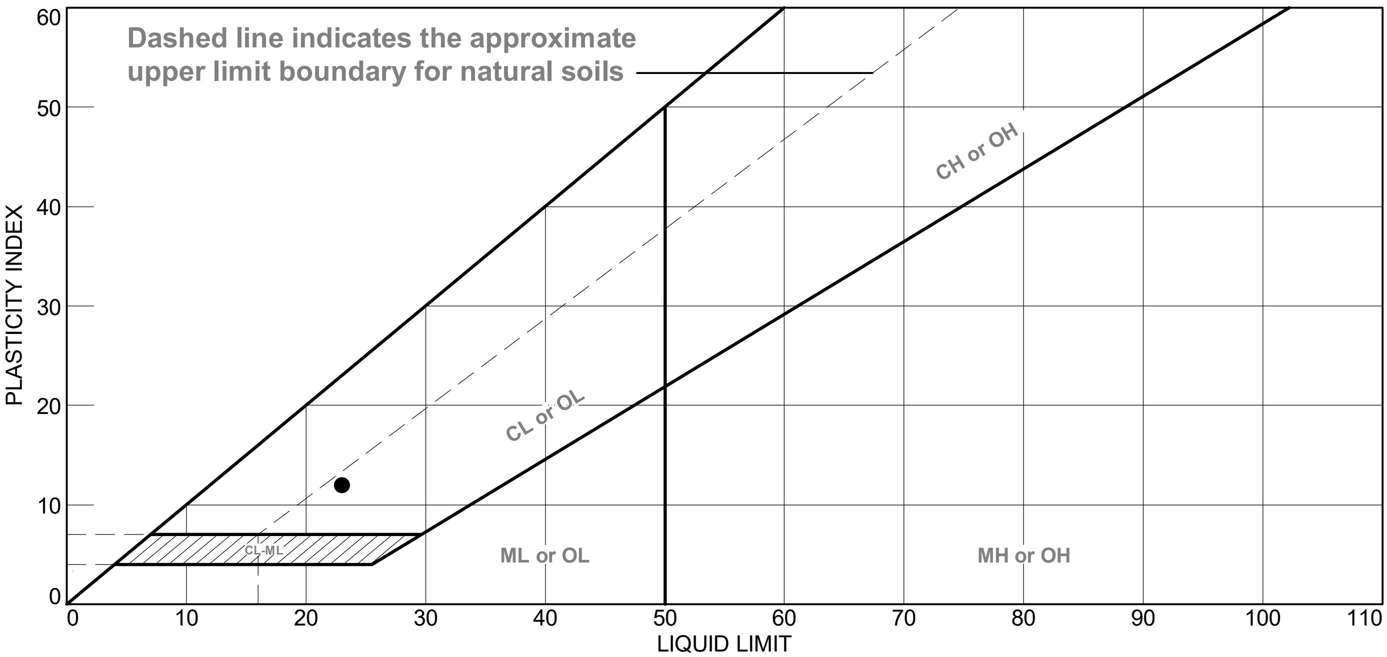
Terracon

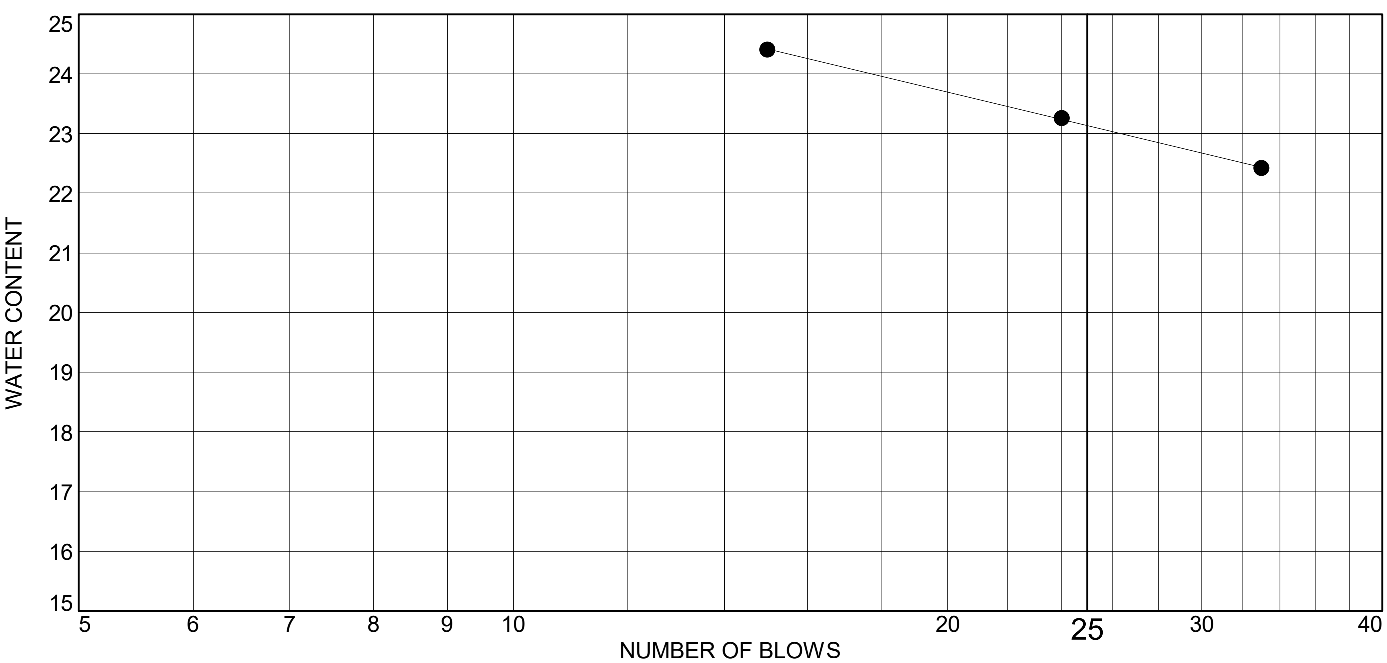
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWNISH GRAY SANDY LEAN CLAY	23	11	12	87.0	57.4	CL

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: MW-103 **Depth:** 140.5'-141.0'

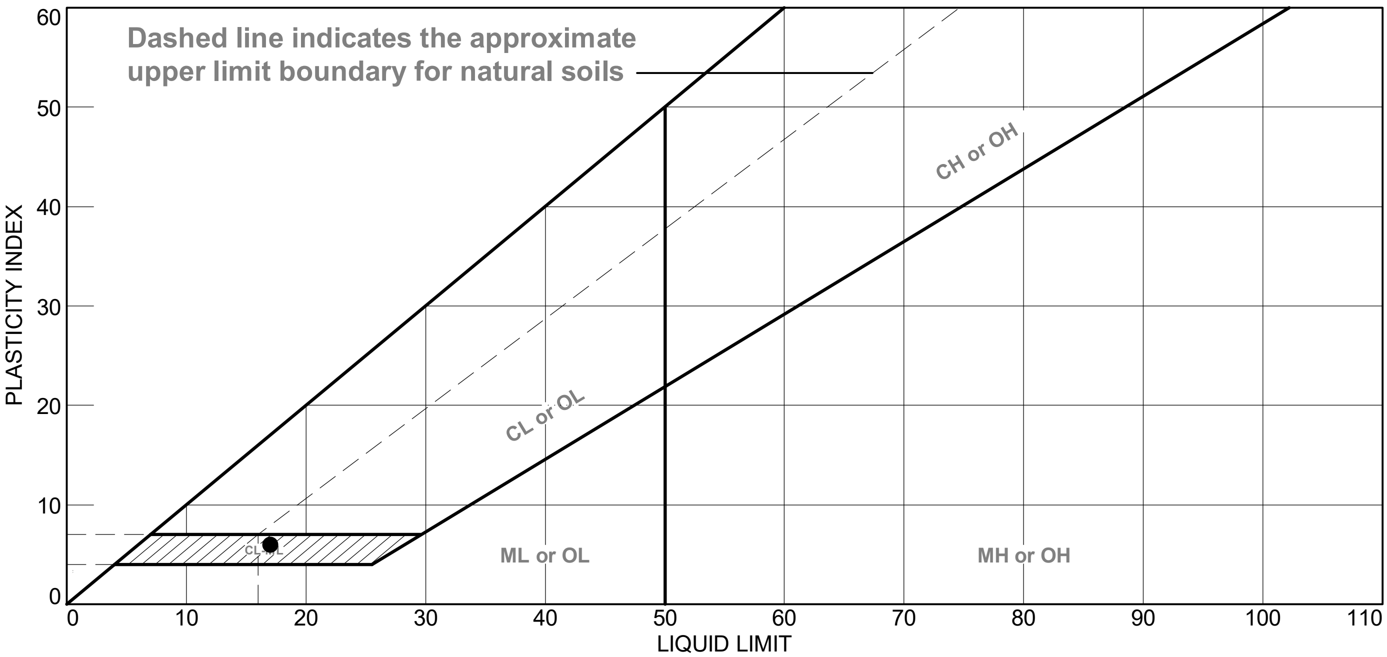
Sample Number: 1420

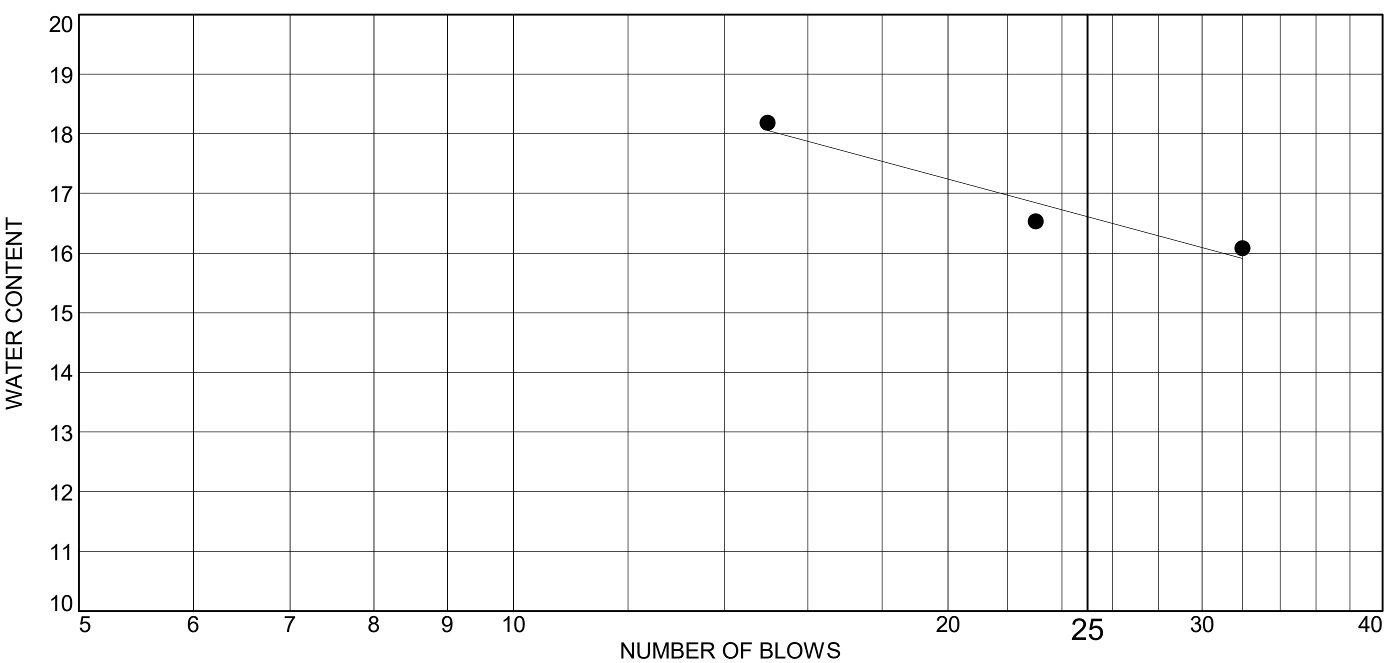
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY SILTY CLAYEY SAND	17	11	6	85.2	35.2	SC-SM

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

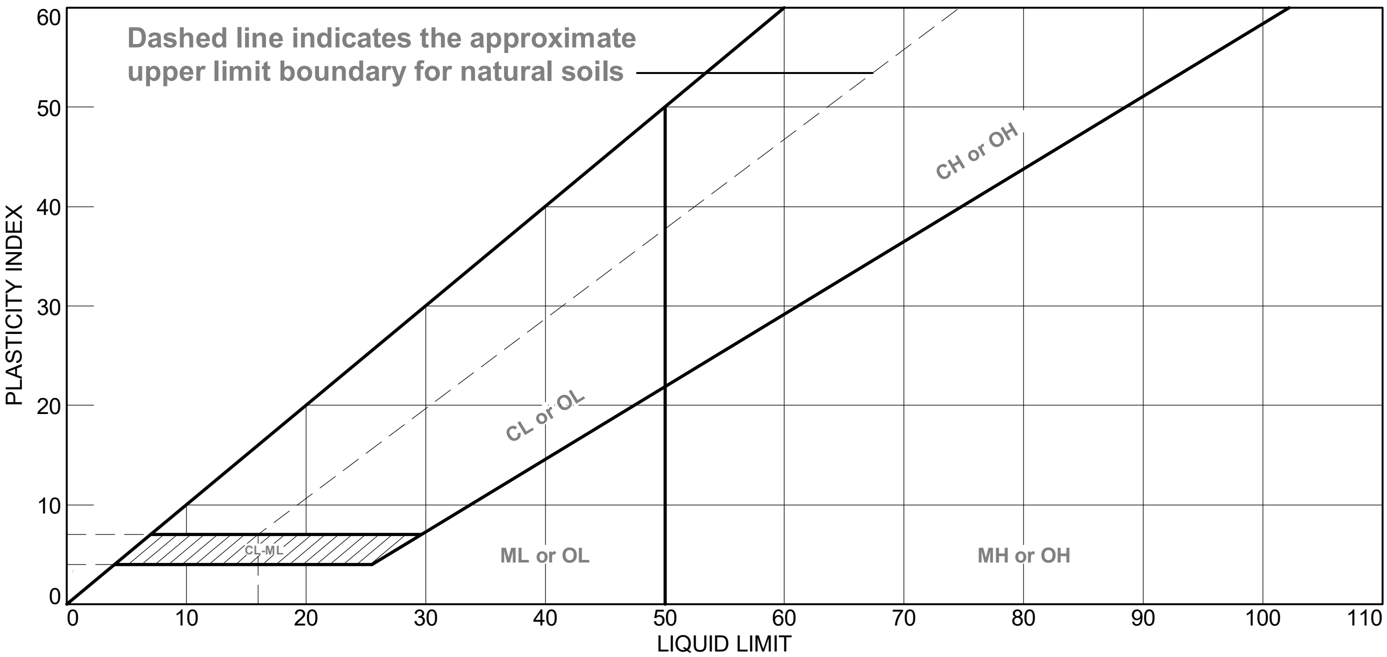
Source of Sample: MW-103 **Depth:** 163.0'-163.5'
Sample Number: 0810

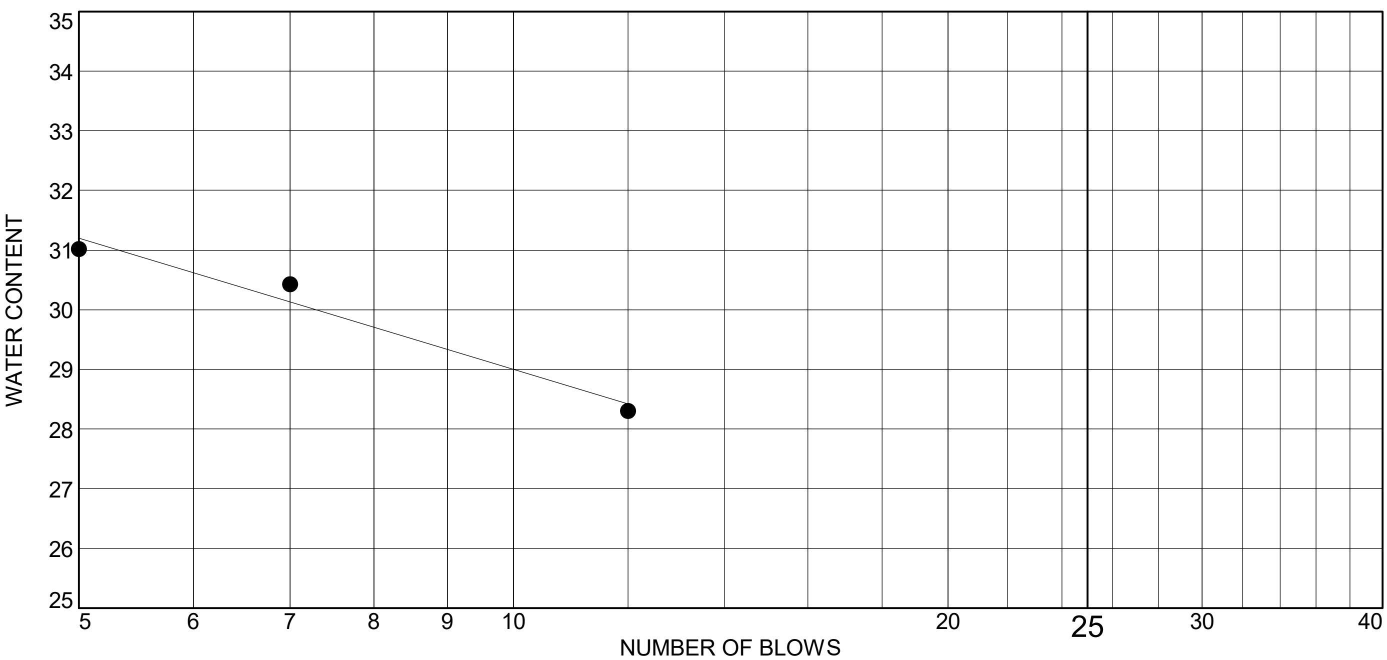
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK GRAY SILT	26	28	NP	99.6	94.9	ML

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: XCM-02 **Depth:** 15.5'-16.0'

Sample Number: 1500

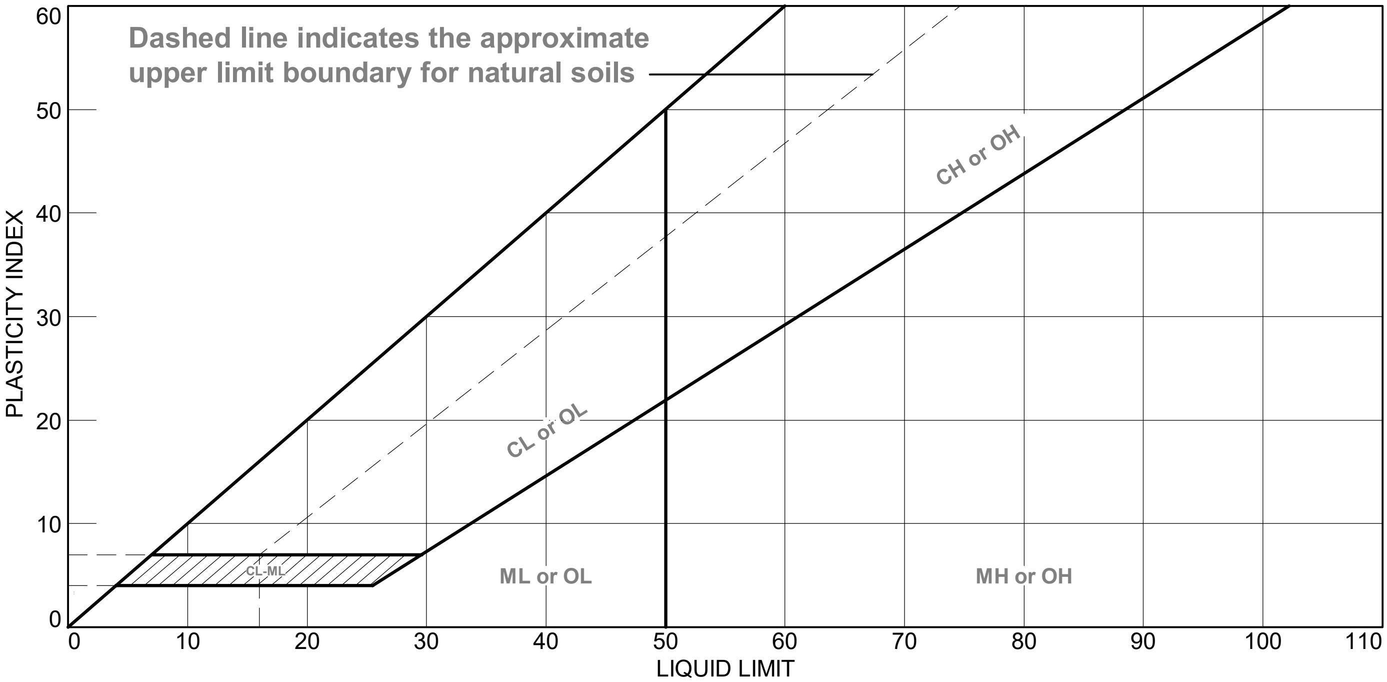
Terracon

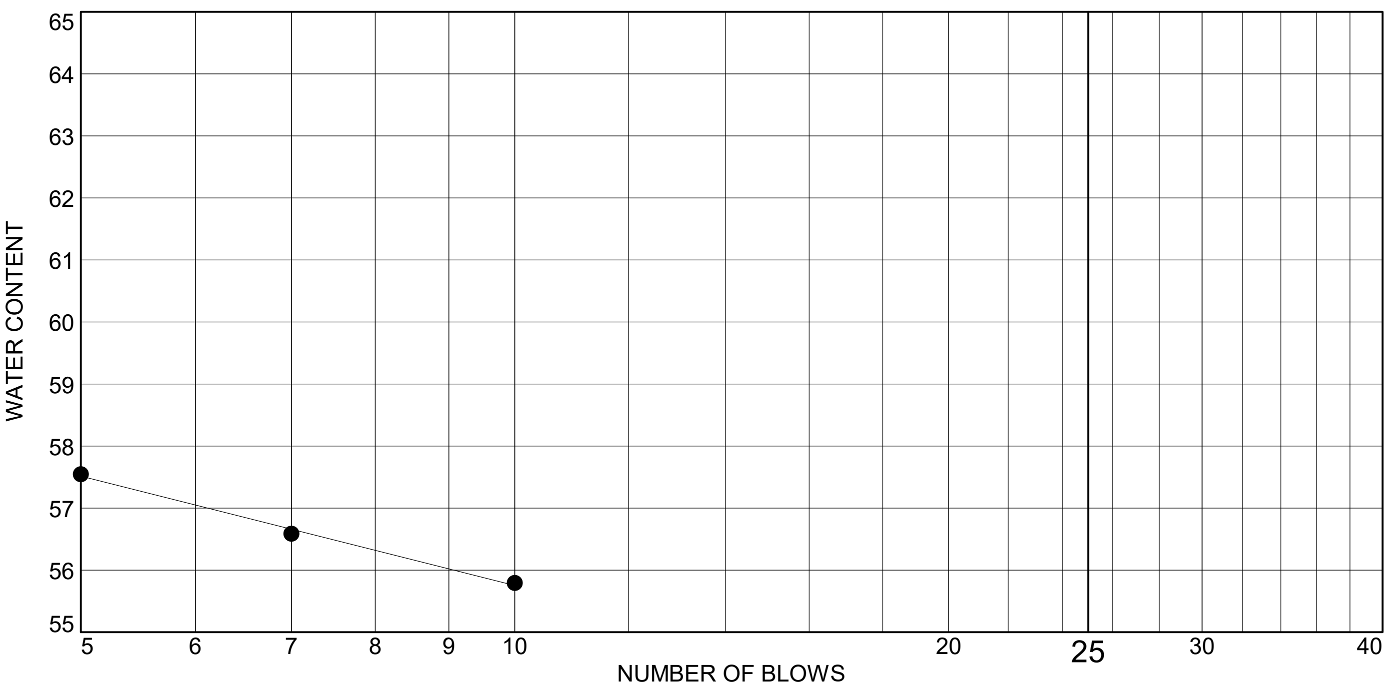
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK GRAY ELASTIC SILT WITH SAND	53	57	NP	95.7	81.9	MH

Project No. 11215020 **Client:** RAMBOLL ENVIRON US CORP.

Project: VERMILLION POWER STATION

Source of Sample: XCM-02 **Depth:** 36.0'-36.5'
Sample Number: 1600

Terracon

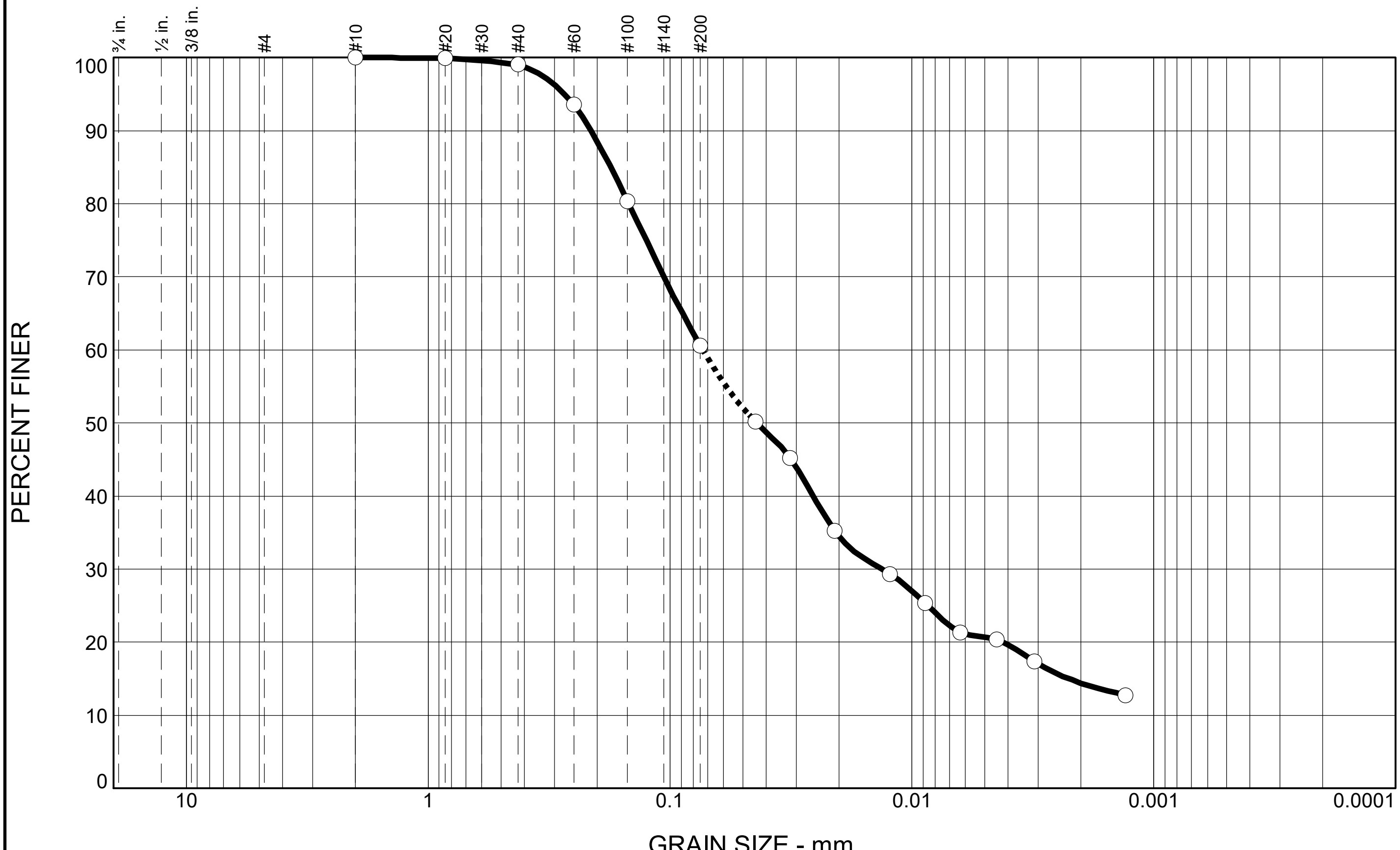
Remarks:

Figure

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
ASTM D6913

Particle-Size Distribution (Gradation) of Fine-Grained Soils
Using the Sedimentation (Hydrometer) Analysis
ASTM D7928

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	1.0	38.5	39.8	20.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	99.0		
#60	93.5		
#100	80.4		
#200	60.5		
0.0443 mm.	50.2		
0.0319 mm.	45.2		
0.0209 mm.	35.3		
0.0123 mm.	29.3		
0.0088 mm.	25.3		
0.0063 mm.	21.3		
0.0045 mm.	20.4		
0.0031 mm.	17.4		
0.0013 mm.	12.7		

* (no specification provided)

Soil Description

DARK BROWN SANDY LEAN CLAY

Atterberg Limits

PL= 17 LL= 27 PI= 10

Coefficients

D_{90}= 0.2122 D_{85}= 0.1757 D_{60}= 0.0734
D_{50}= 0.0438 D_{30}= 0.0133 D_{15}= 0.0023
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-4(3)

Remarks

F.M.=0.24

Source of Sample: MW-37 **Depth:** 5.0'-7.0'
Sample Number: 0945 **Date:** 3-25-21

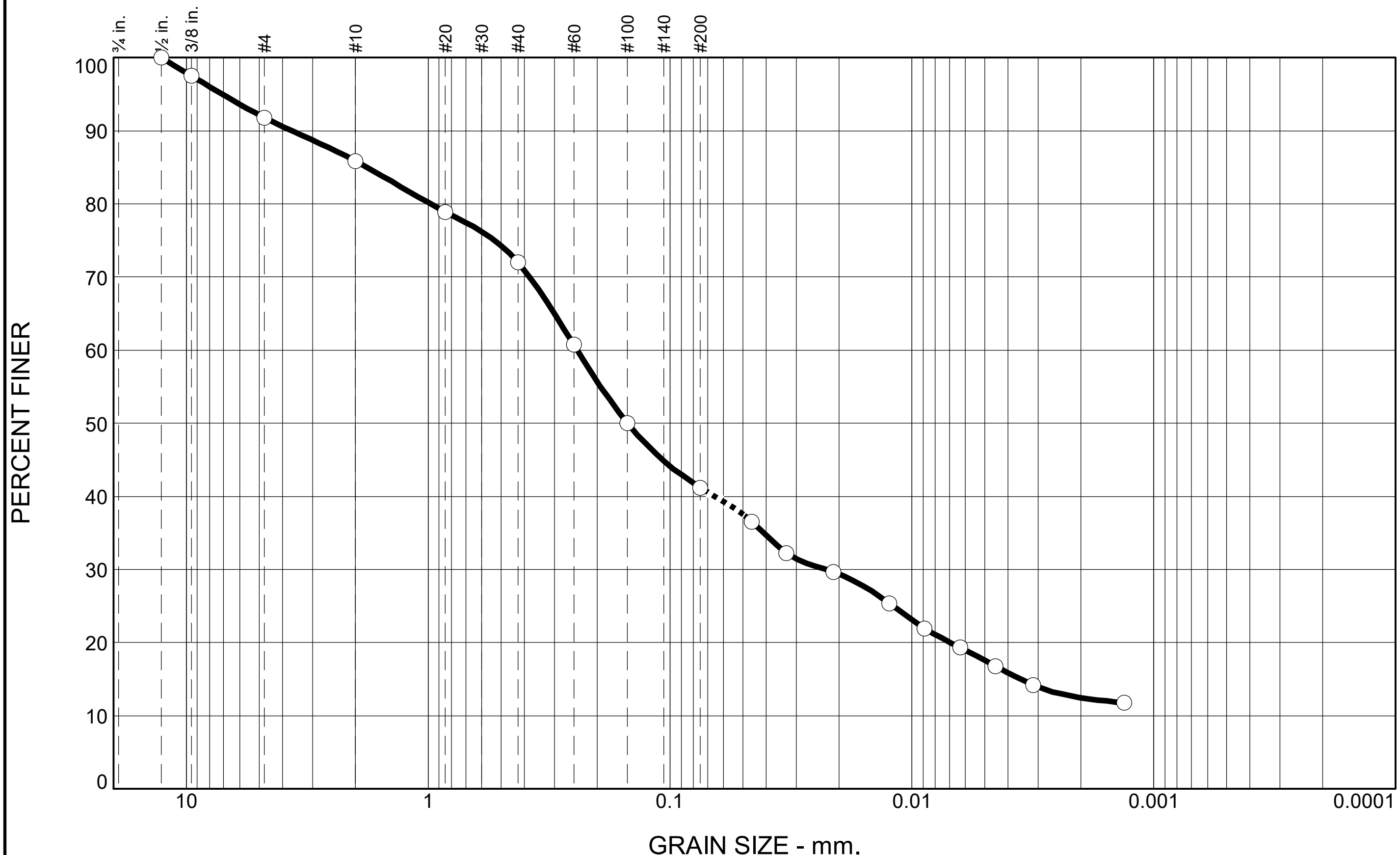
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	8.2	5.9	13.9	30.8	23.6	17.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5	100.0		
.375	97.5		
#4	91.8		
#10	85.9		
#20	78.9		
#40	72.0		
#60	60.7		
#100	50.0		
#200	41.2		
0.0459 mm.	36.5		
0.0330 mm.	32.2		
0.0211 mm.	29.7		
0.0124 mm.	25.4		
0.0089 mm.	21.9		
0.0063 mm.	19.4		
0.0045 mm.	16.8		
0.0032 mm.	14.2		
0.0013 mm.	11.8		

* (no specification provided)

Soil Description

GRAY CLAYEY SAND

Atterberg Limits

PL= 11 LL= 19 PI= 8

Coefficients

D_{90}= 3.6621 D_{85}= 1.7885 D_{60}= 0.2422
D_{50}= 0.1499 D_{30}= 0.0227 D_{15}= 0.0036
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-4(0)

Remarks

F.M.=1.51

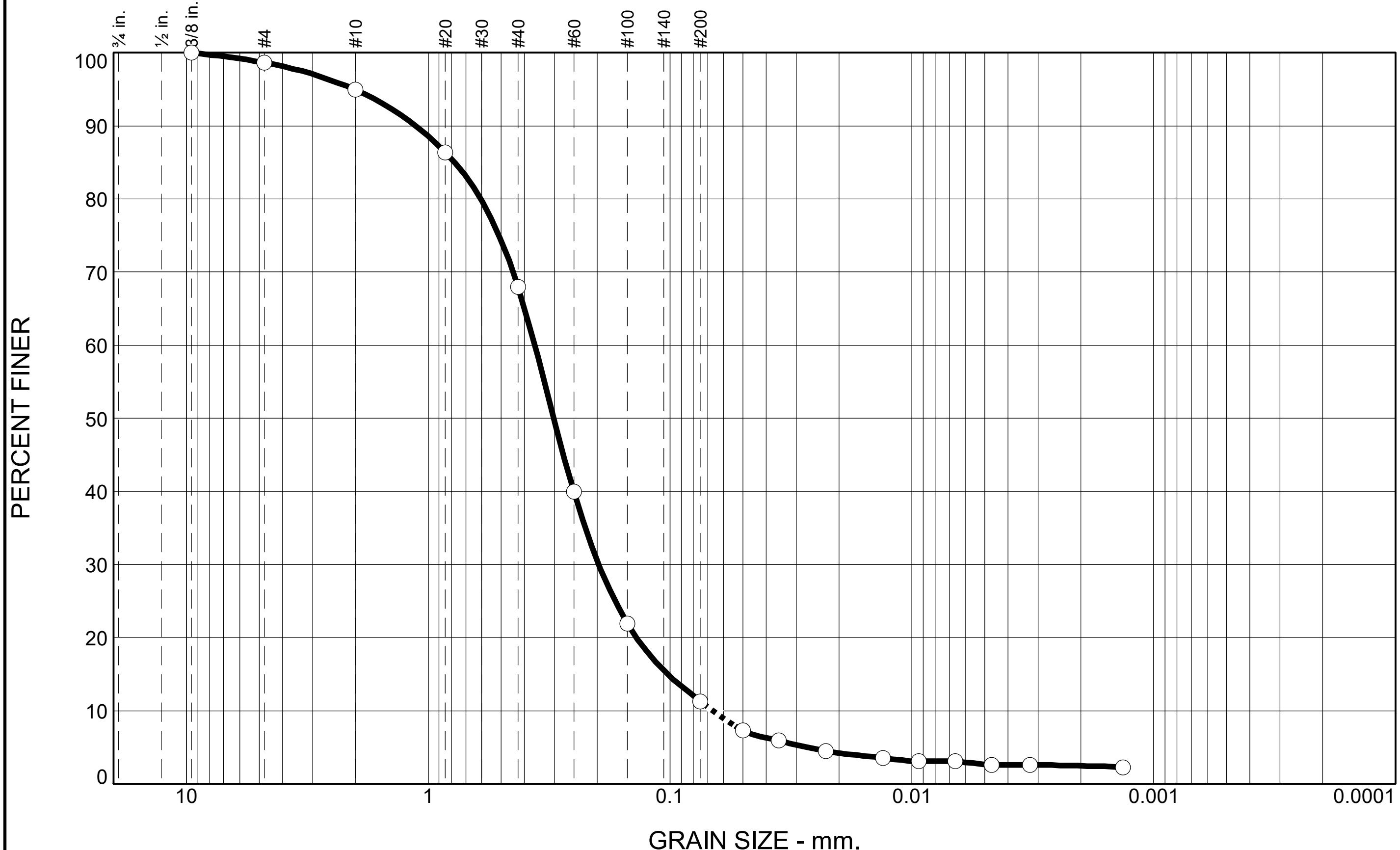
Source of Sample: MW-37 **Depth:** 18.5'-19.0'
Sample Number: N/A **Date:** 4-28-21

Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION
Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.4	3.7	26.9	56.7	8.6	2.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	98.6		
#10	94.9		
#20	86.4		
#40	68.0		
#60	40.0		
#100	21.9		
#200	11.3		
0.0499 mm.	7.3		
0.0356 mm.	5.9		
0.0227 mm.	4.5		
0.0132 mm.	3.5		
0.0093 mm.	3.1		
0.0066 mm.	3.1		
0.0047 mm.	2.6		
0.0032 mm.	2.6		
0.0013 mm.	2.3		

* (no specification provided)

Soil Description

GRAY AND GRAYISH BROWN POORLY GRADED SAND WITH SILT

Atterberg Limits

PL= 11 LL= 9 PI= NP

Coefficients

D_{90}= 1.1232 D_{85}= 0.7780 D_{60}= 0.3623
D_{50}= 0.3023 D_{30}= 0.1971 D_{15}= 0.1021
D_{10}= 0.0668 C_u= 5.43 C_c= 1.61

Classification

USCS= SP-SM AASHTO= A-2-4(0)

Remarks

F.M.=1.64

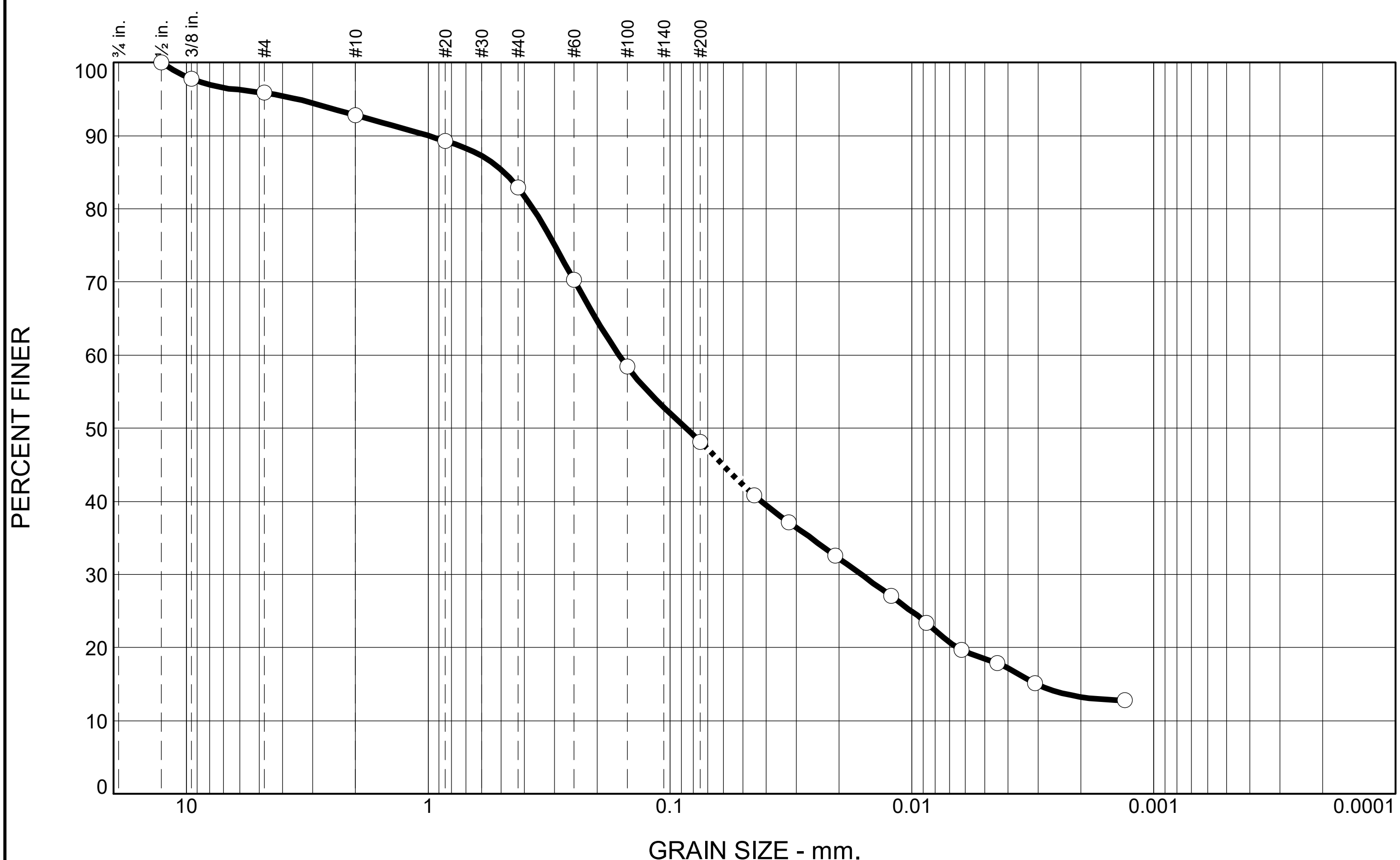
Source of Sample: MW-37 **Depth:** 25.0'-27.0'
Sample Number: 1100
Date: 3-25-21

Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION
Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.2	3.0	9.9	34.7	29.7	18.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5	100.0		
.375	97.8		
#4	95.8		
#10	92.8		
#20	89.3		
#40	82.9		
#60	70.3		
#100	58.4		
#200	48.2		
0.0449 mm.	40.8		
0.0322 mm.	37.1		
0.0207 mm.	32.5		
0.0122 mm.	27.0		
0.0087 mm.	23.4		
0.0062 mm.	19.7		
0.0044 mm.	17.9		
0.0031 mm.	15.1		
0.0013 mm.	12.8		

* (no specification provided)

Soil Description

GRAY AND BROWN SILTY CLAYEY SAND

Atterberg Limits

PL= 11 LL= 17 PI= 6

Coefficients

D_{90}= 1.0012 D_{85}= 0.4864 D_{60}= 0.1626
D_{50}= 0.0858 D_{30}= 0.0162 D_{15}= 0.0031
D_{10}= C_u= C_c=

Classification

USCS= SC-SM AASHTO= A-4(0)

Remarks

F.M.=1.02

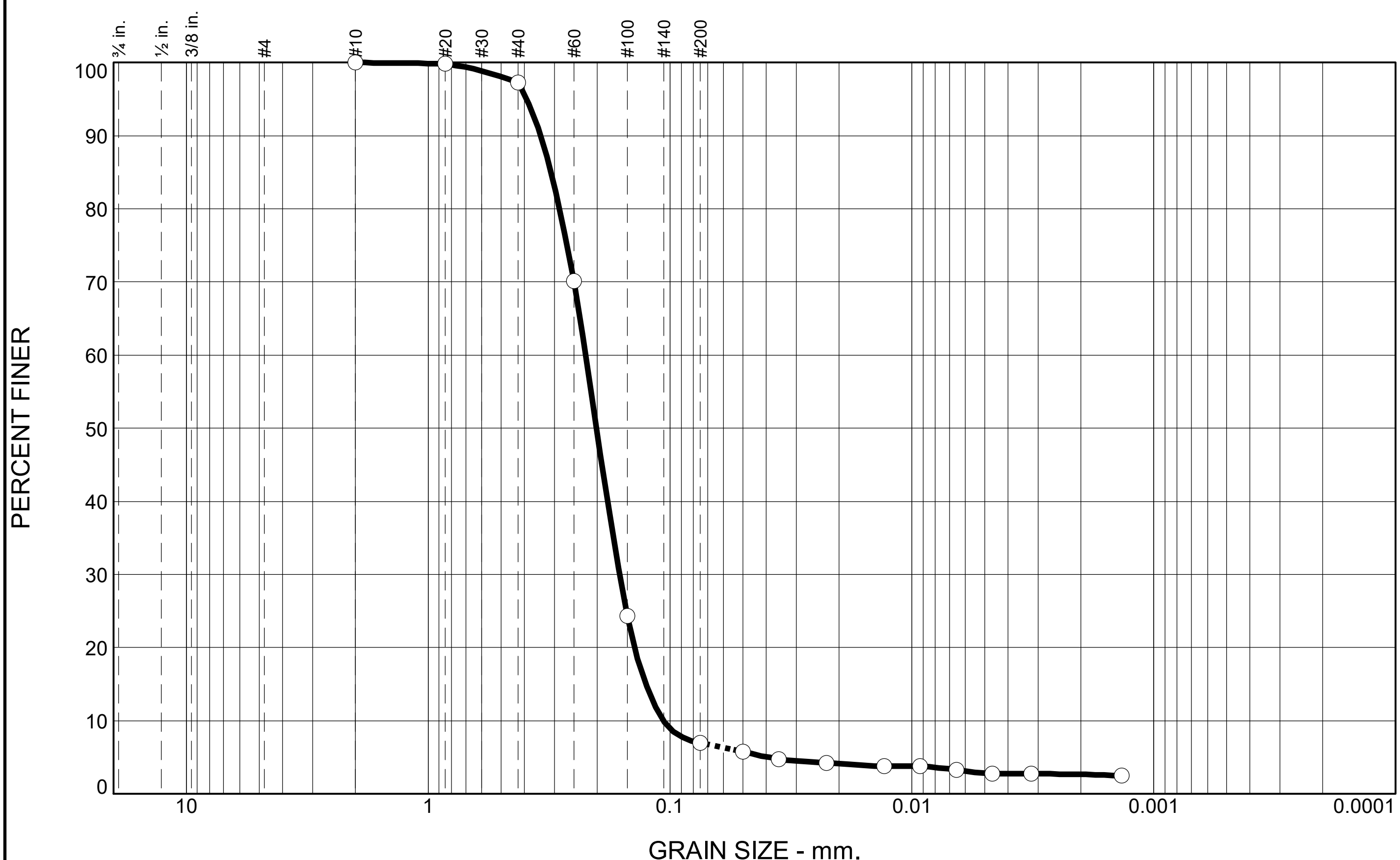
Source of Sample: MW-37 **Depth:** 35.5'-36.0'
Sample Number: 1300 **Date:** 4-2-21

Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION
Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	2.7	90.4	4.1	2.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	97.3		
#60	70.1		
#100	24.3		
#200	6.9		
0.0500 mm.	5.7		
0.0355 mm.	4.7		
0.0225 mm.	4.2		
0.0130 mm.	3.7		
0.0092 mm.	3.7		
0.0065 mm.	3.2		
0.0046 mm.	2.7		
0.0032 mm.	2.7		
0.0014 mm.	2.5		

* (no specification provided)

Soil Description

GRAYISH BROWN POORLY GRADED SAND WITH SILTY CLAY

Atterberg Limits

PL= 7 LL= 13 PI= 6

Coefficients

D_{90}= 0.3426 D_{85}= 0.3102 D_{60}= 0.2233
D_{50}= 0.2012 D_{30}= 0.1617 D_{15}= 0.1261
D_{10}= 0.1064 C_u= 2.10 C_c= 1.10

Classification

USCS= SP-SC AASHTO= A-2-4(0)

Remarks

F.M.=0.94

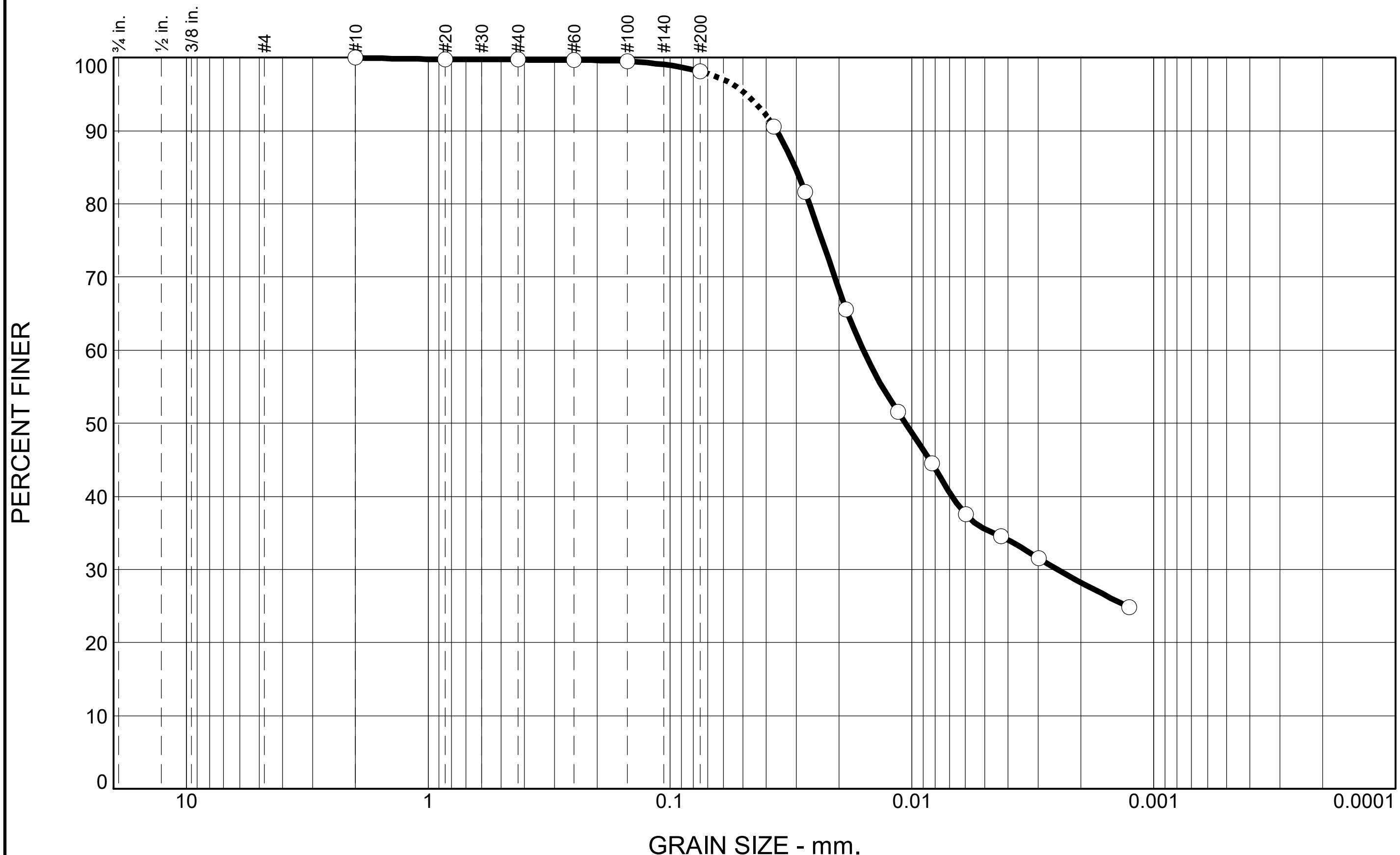
Source of Sample: MW-37 **Depth:** 50.5'-51.0'
Sample Number: 1415 **Date:** 4-2-21

Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION
Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.3	1.6	62.5	35.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.8		
#40	99.7		
#60	99.7		
#100	99.5		
#200	98.1		
0.0373 mm.	90.6		
0.0276 mm.	81.6		
0.0187 mm.	65.6		
0.0114 mm.	51.5		
0.0083 mm.	44.5		
0.0060 mm.	37.5		
0.0043 mm.	34.5		
0.0030 mm.	31.5		
0.0013 mm.	24.8		

* (no specification provided)

Soil Description

GRAY LEAN CLAY - SAND SEAMS NOTED

Atterberg Limits

PL= 18 LL= 31 PI= 13

Coefficients

D_{90}= 0.0364 D_{85}= 0.0304 D_{60}= 0.0159
D_{50}= 0.0106 D_{30}= 0.0025 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(12)

Remarks

F.M.=0.01

Source of Sample: MW-37 **Depth:** 55.0'-57.0'
Sample Number: 1500 **Date:** 3-25-21

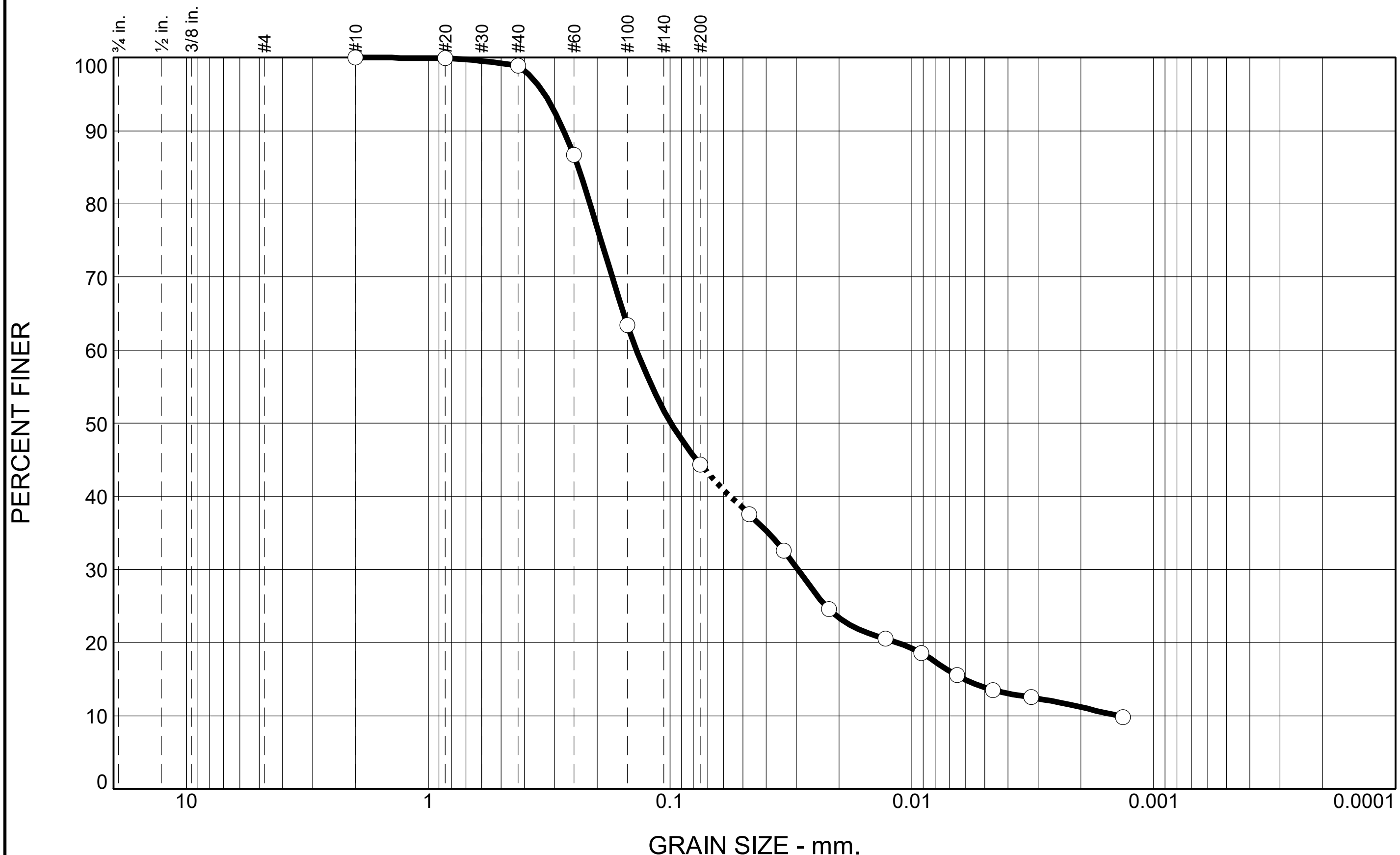
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	1.1	54.5	30.6	13.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	98.9		
#60	86.7		
#100	63.4		
#200	44.4		
0.0471 mm.	37.6		
0.0339 mm.	32.6		
0.0220 mm.	24.5		
0.0128 mm.	20.5		
0.0091 mm.	18.5		
0.0065 mm.	15.5		
0.0046 mm.	13.5		
0.0032 mm.	12.5		
0.0013 mm.	9.8		

* (no specification provided)

Soil Description

BROWN SILTY SAND

Atterberg Limits

PL= 14 LL= 17 PI= 3

Coefficients

D_{90}= 0.2745 D_{85}= 0.2397 D_{60}= 0.1376
D_{50}= 0.0990 D_{30}= 0.0296 D_{15}= 0.0061
D_{10}= 0.0014 C_u= 97.91 C_c= 4.54

Classification

USCS= SM AASHTO= A-4(0)

Remarks

F.M.=0.44

Source of Sample: MW-38 **Depth:** 5.0'-7.0'
Sample Number: 0835 **Date:** 3-25-21

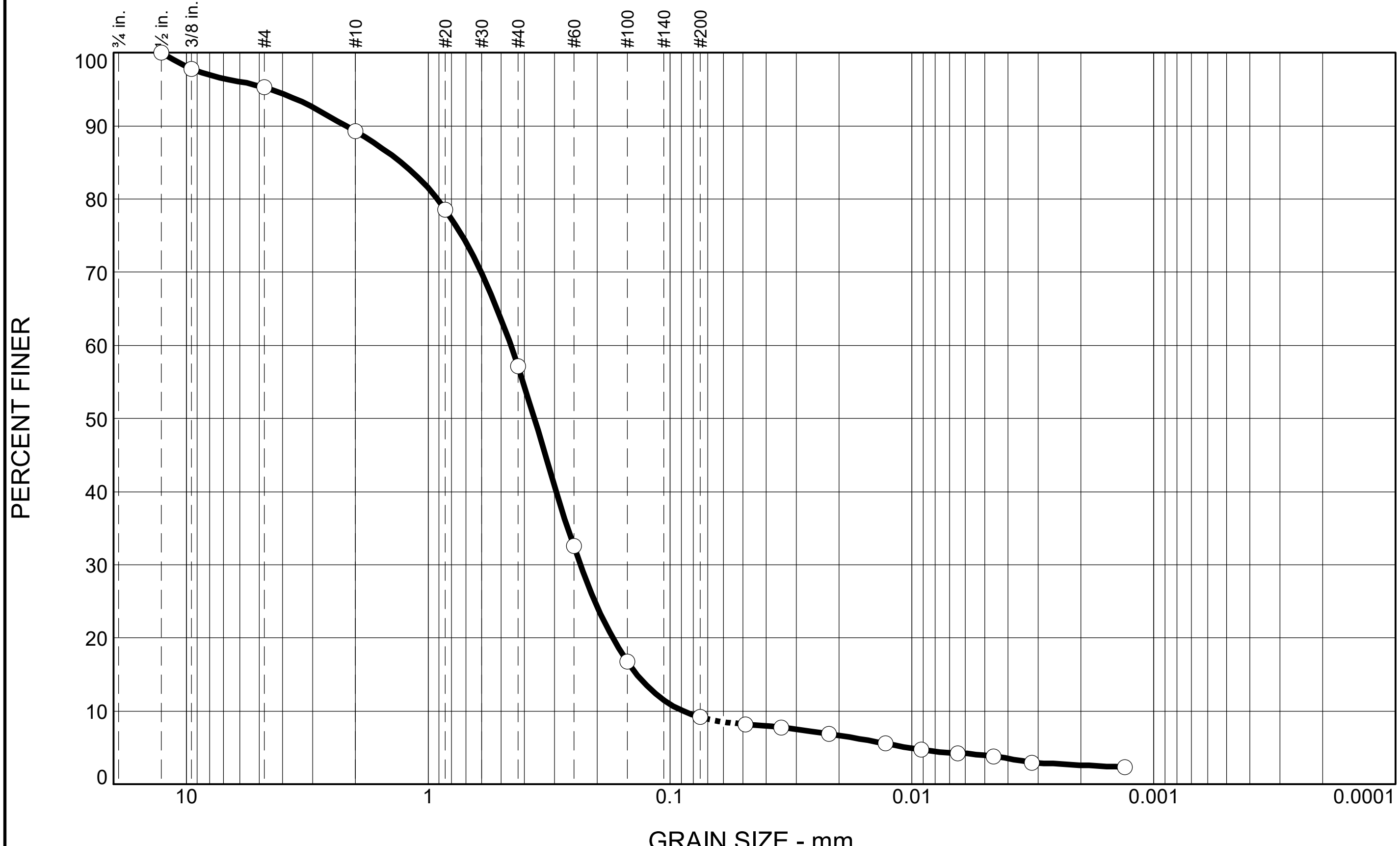
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.7	6.1	32.1	47.9	5.2	4.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5	100.0		
.375	97.8		
#4	95.3		
#10	89.2		
#20	78.5		
#40	57.1		
#60	32.5		
#100	16.7		
#200	9.2		
0.0488 mm.	8.2		
0.0346 mm.	7.8		
0.0220 mm.	6.9		
0.0128 mm.	5.6		
0.0091 mm.	4.7		
0.0065 mm.	4.3		
0.0046 mm.	3.8		
0.0032 mm.	2.9		
0.0013 mm.	2.3		

* (no specification provided)

Soil Description

BROWNISH GRAY POORLY GRADED SAND WITH SILTY CLAY

Atterberg Limits

PL= 7 LL= 11 PI= 4

Coefficients

D_{90}= 2.1869 D_{85}= 1.2912 D_{60}= 0.4551
D_{50}= 0.3636 D_{30}= 0.2348 D_{15}= 0.1371
D_{10}= 0.0883 C_u= 5.15 C_c= 1.37

Classification

USCS= SP-SC AASHTO= A-2-4(0)

Remarks

F.M.=2.05

Source of Sample: MW-38 **Depth:** 21.5'-22.0'
Sample Number: 0910

Date: 4-16-21

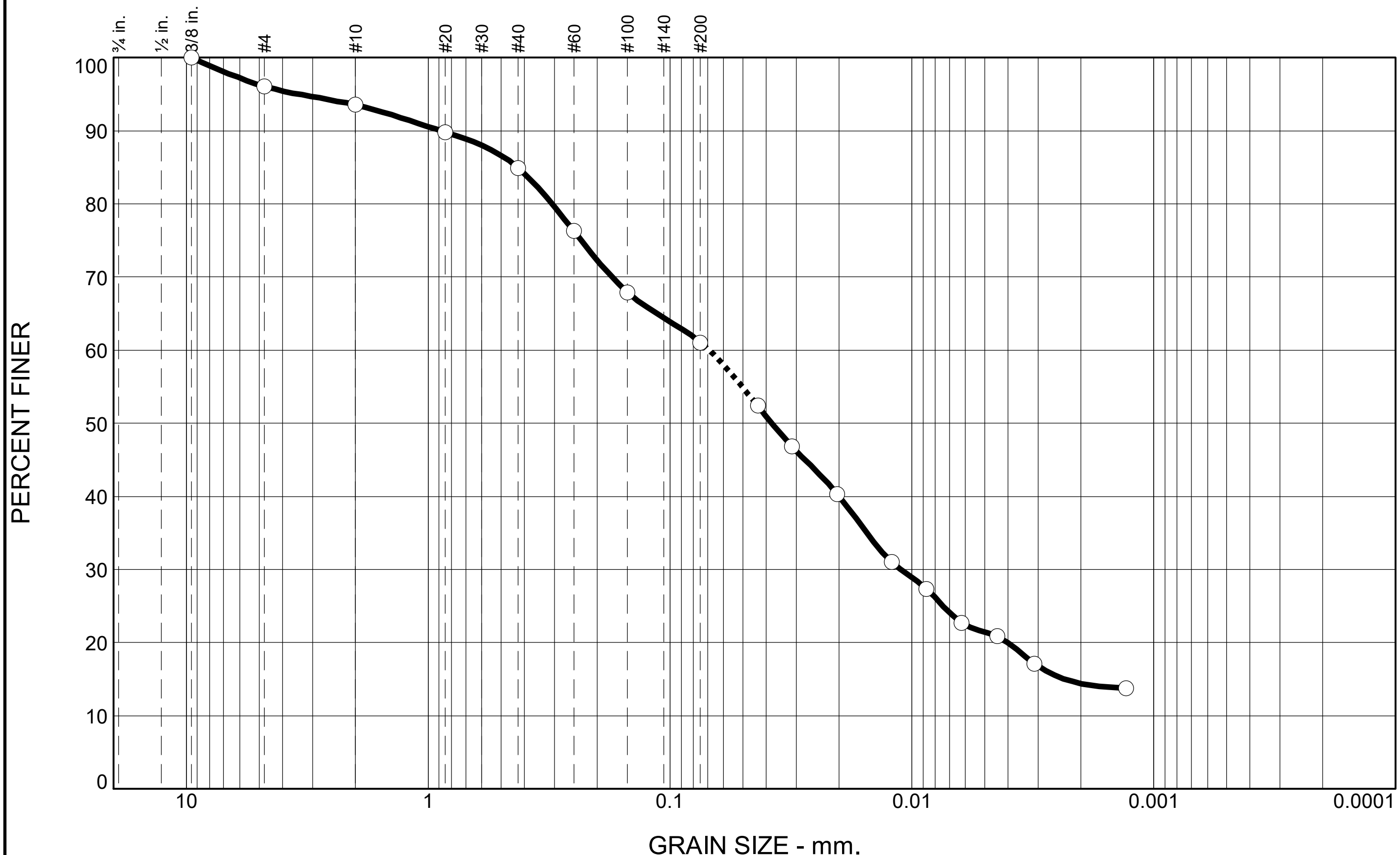
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.9	2.6	8.6	23.9	39.5	21.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	96.1		
#10	93.5		
#20	89.8		
#40	84.9		
#60	76.3		
#100	67.9		
#200	61.0		
0.0433 mm.	52.4		
0.0313 mm.	46.8		
0.0203 mm.	40.3		
0.0121 mm.	31.1		
0.0087 mm.	27.3		
0.0062 mm.	22.7		
0.0044 mm.	20.9		
0.0031 mm.	17.1		
0.0013 mm.	13.7		

* (no specification provided)

Soil Description

GRAY SANDY LEAN CLAY - SILT SEAMS NOTED

Atterberg Limits

PL= 12 LL= 21 PI= 9

Coefficients

D_{90}= 0.8898 D_{85}= 0.4275 D_{60}= 0.0691
D_{50}= 0.0379 D_{30}= 0.0111 D_{15}= 0.0023
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-4(2)

Remarks

F.M.=0.83

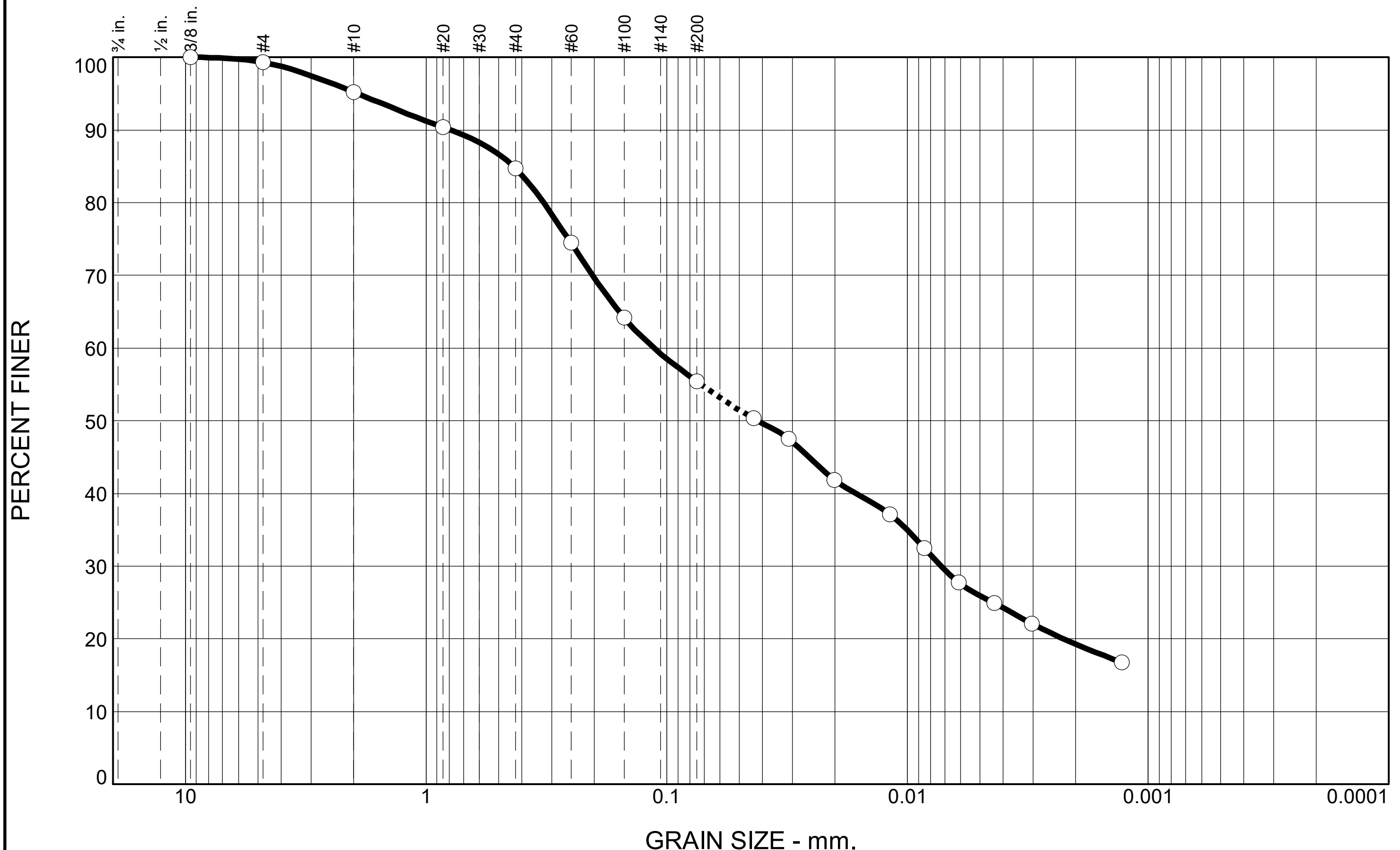
Source of Sample: MW-38 **Depth:** 35.0'-37.0'
Sample Number: 1655 **Date:** 3-25-21

Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION
Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.7	4.1	10.5	29.3	29.5	25.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.3		
#10	95.2		
#20	90.4		
#40	84.7		
#60	74.5		
#100	64.2		
#200	55.4		
0.0436 mm.	50.3		
0.0312 mm.	47.5		
0.0201 mm.	41.9		
0.0118 mm.	37.1		
0.0085 mm.	32.4		
0.0061 mm.	27.7		
0.0044 mm.	24.9		
0.0030 mm.	22.1		
0.0013 mm.	16.8		

* (no specification provided)

Soil Description

GRAY TRACE BROWN SANDY LEAN CLAY - SAND SEAMS NOTED

Atterberg Limits

PL= 11 LL= 23 PI= 12

Coefficients

D_{90}= 0.7945 D_{85}= 0.4337 D_{60}= 0.1130
D_{50}= 0.0418 D_{30}= 0.0073 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(3)

Remarks

F.M.=0.82

Source of Sample: MW-41 **Depth:** 8.0'-10.0'
Sample Number: 0945 **Date:** 3-25-21

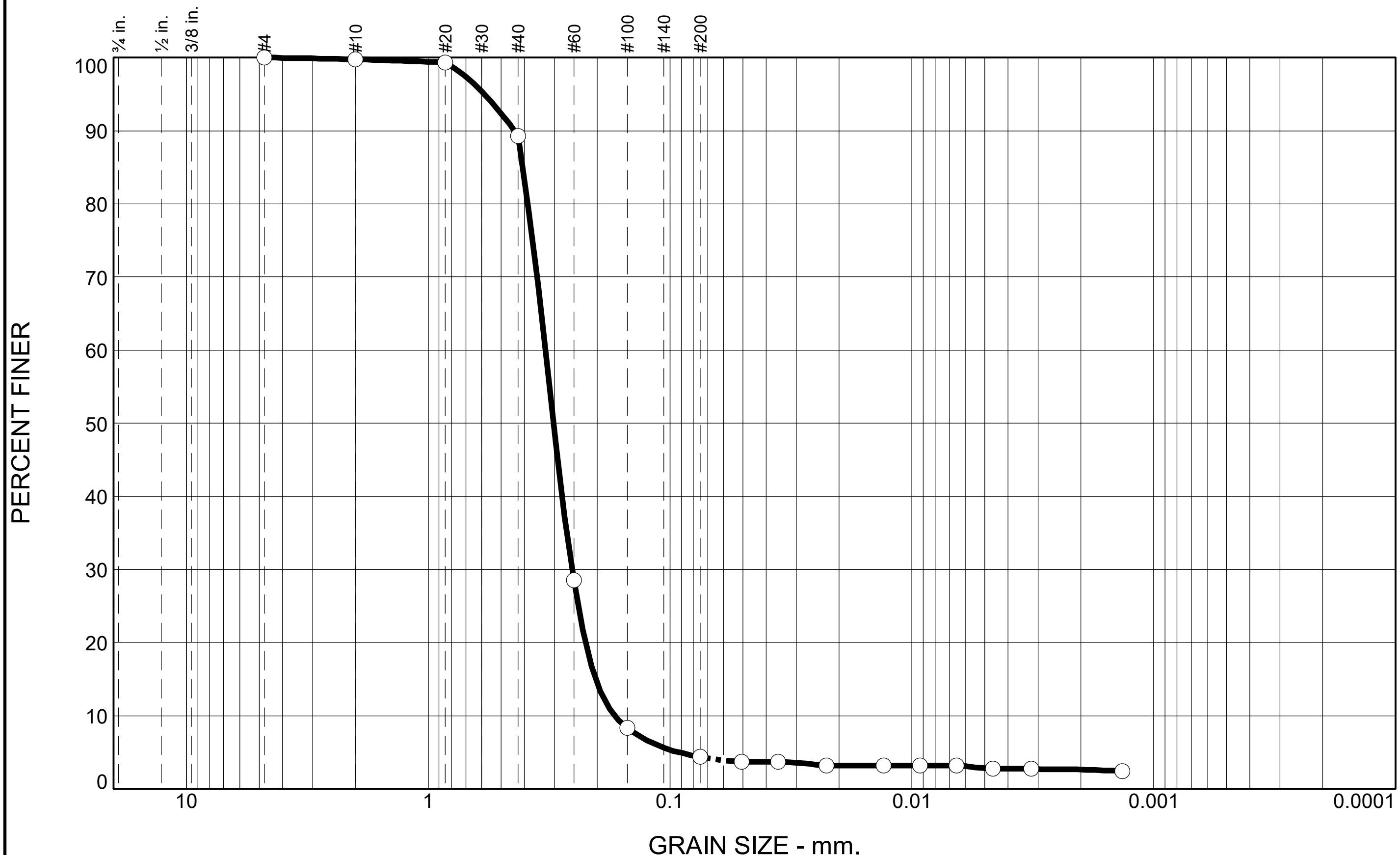
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	10.5	84.9	1.6	2.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#20	99.3		
#40	89.3		
#60	28.5		
#100	8.3		
#200	4.4		
0.0504 mm.	3.7		
0.0357 mm.	3.7		
0.0226 mm.	3.2		
0.0131 mm.	3.2		
0.0092 mm.	3.2		
0.0065 mm.	3.2		
0.0046 mm.	2.7		
0.0032 mm.	2.7		
0.0014 mm.	2.5		

* (no specification provided)

Soil Description

BROWN POORLY GRADED SAND

Atterberg Limits

PL= 4 LL= 13 PI= 9

Coefficients

D_{90}= 0.4405 D_{85}= 0.4054 D_{60}= 0.3275
D_{50}= 0.3028 D_{30}= 0.2541 D_{15}= 0.2027
D_{10}= 0.1697 C_u= 1.93 C_c= 1.16

Classification

USCS= SP AASHTO= A-2-4(0)

Remarks

F.M.=1.48

Source of Sample: MW-41 **Depth:** 25.0'-25.5'
Sample Number: 1045 **Date:** 4-2-21

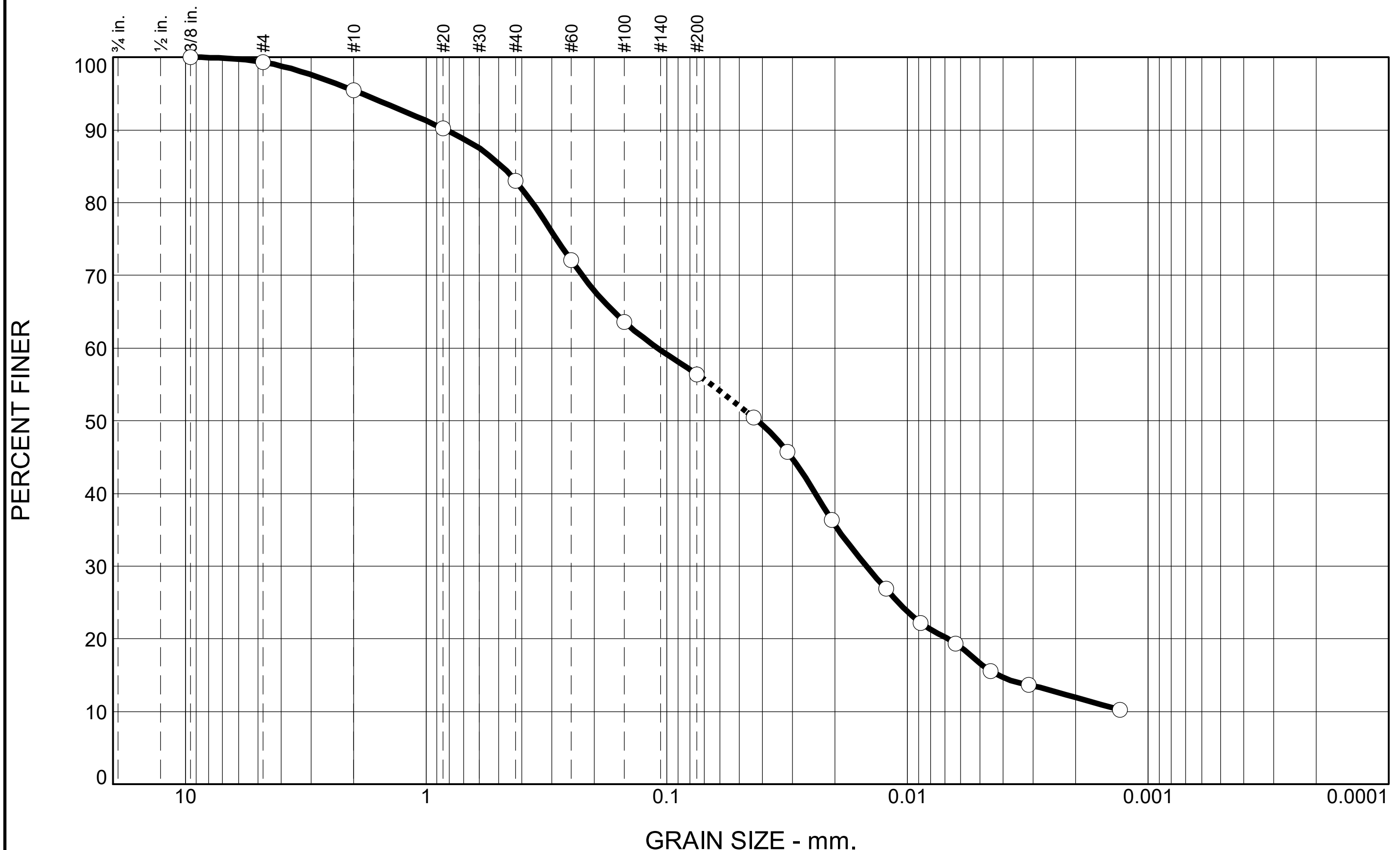
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.7	3.9	12.4	26.6	39.7	16.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.3		
#10	95.4		
#20	90.2		
#40	83.0		
#60	72.1		
#100	63.6		
#200	56.4		
0.0437 mm.	50.5		
0.0314 mm.	45.7		
0.0206 mm.	36.3		
0.0123 mm.	26.9		
0.0088 mm.	22.2		
0.0063 mm.	19.3		
0.0045 mm.	15.6		
0.0031 mm.	13.7		
0.0013 mm.	10.2		

* (no specification provided)

Soil Description

GRAYISH BROWN SANDY SILTY CLAY

Atterberg Limits

PL= 14 LL= 20 PI= 6

Coefficients

D_{90}= 0.8278 D_{85}= 0.4839 D_{60}= 0.1090
D_{50}= 0.0420 D_{30}= 0.0148 D_{15}= 0.0042
D_{10}= C_u= C_c=

Classification

USCS= CL-ML AASHTO= A-4(0)

Remarks

F.M.=0.85

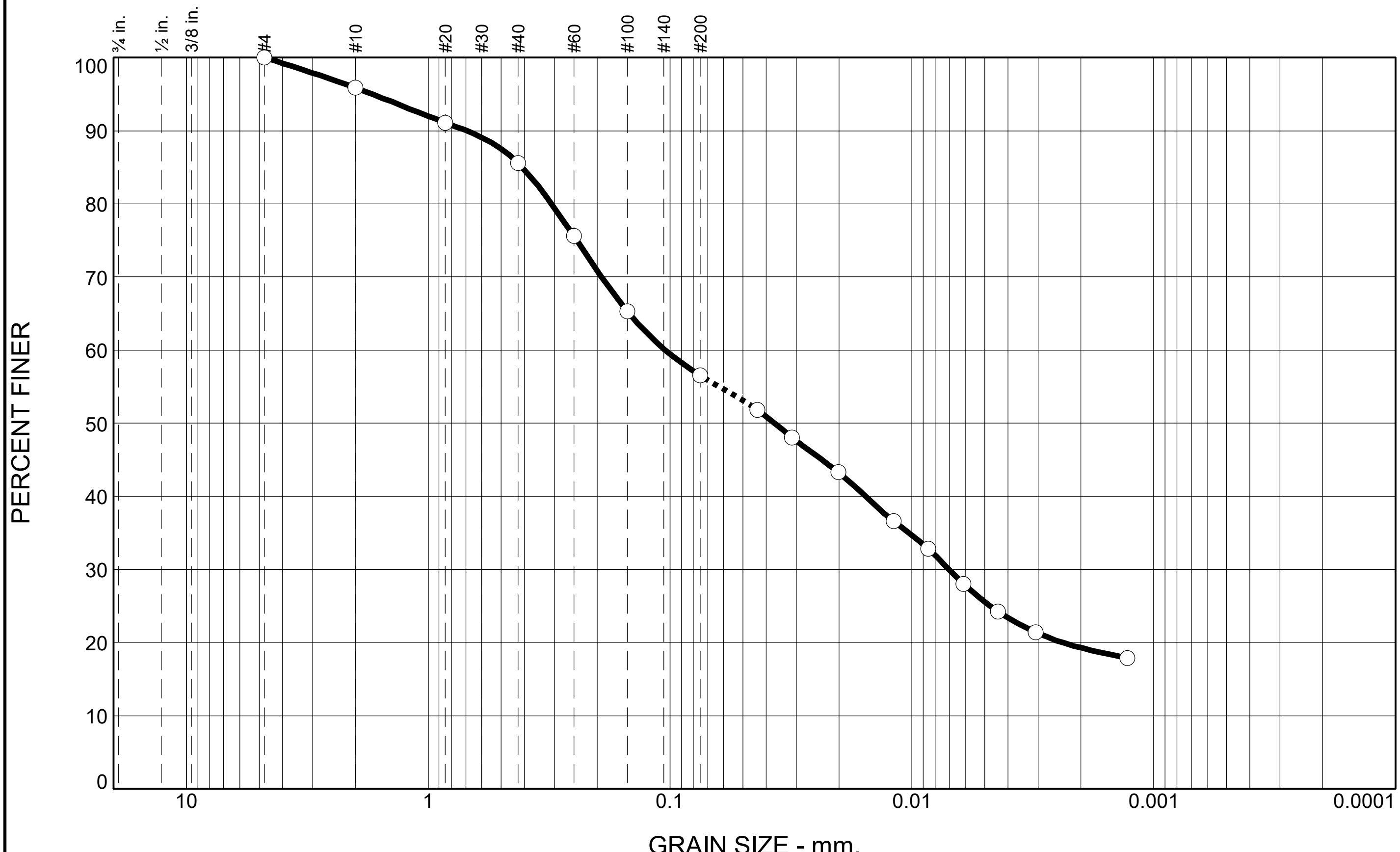
Source of Sample: MW-41 **Depth:** 35.0'-37.0'
Sample Number: 1130 **Date:** 3-25-21

Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION
Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	4.1	10.3	29.1	30.9	25.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	95.9		
#20	91.1		
#40	85.6		
#60	75.6		
#100	65.3		
#200	56.5		
0.0436 mm.	51.8		
0.0313 mm.	48.0		
0.0202 mm.	43.3		
0.0119 mm.	36.6		
0.0085 mm.	32.8		
0.0061 mm.	28.1		
0.0044 mm.	24.3		
0.0031 mm.	21.4		
0.0013 mm.	17.9		

* (no specification provided)

Soil Description

GRAY AND GRAYISH BROWN SANDY LEAN CLAY

Atterberg Limits

PL= 11 LL= 21 PI= 10

Coefficients

D_{90}= 0.6930 D_{85}= 0.4083 D_{60}= 0.1046
D_{50}= 0.0370 D_{30}= 0.0070 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-4(2)

Remarks

F.M.=0.77

Source of Sample: MW-43 **Depth:** 35.0'-37.0'
Sample Number: 1330 **Date:** 3-25-21

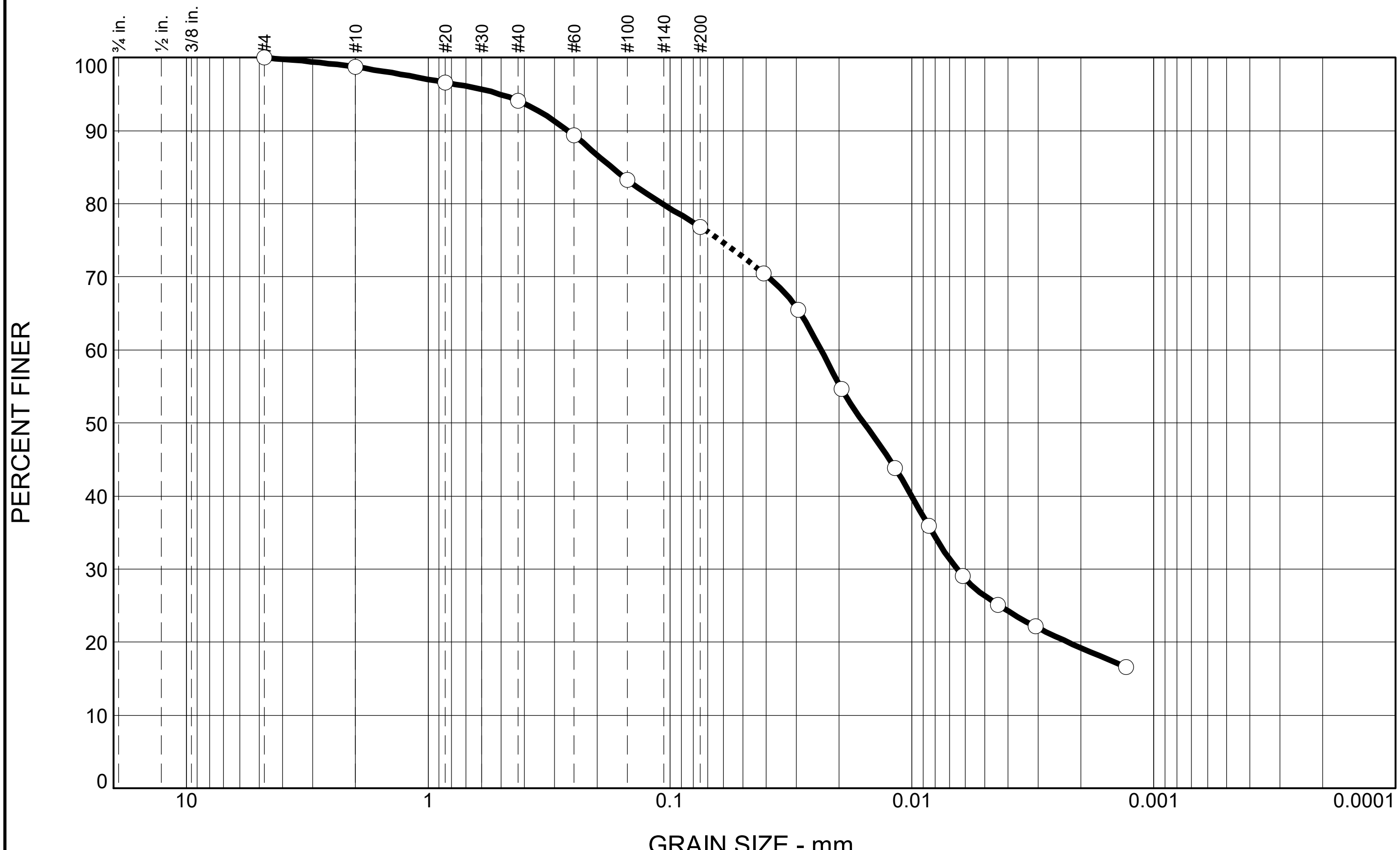
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.3	4.6	17.3	50.5	26.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	98.7		
#20	96.6		
#40	94.1		
#60	89.4		
#100	83.2		
#200	76.8		
0.0409 mm.	70.4		
0.0295 mm.	65.5		
0.0195 mm.	54.7		
0.0117 mm.	43.8		
0.0085 mm.	36.0		
0.0062 mm.	29.1		
0.0044 mm.	25.1		
0.0031 mm.	22.2		
0.0013 mm.	16.6		

* (no specification provided)

Soil Description

GRAY LEAN CLAY WITH SAND - SAND SEAMS NOTED

Atterberg Limits

PL= 16 LL= 28 PI= 12

Coefficients

D_{90}= 0.2641 D_{85}= 0.1746 D_{60}= 0.0238
D_{50}= 0.0158 D_{30}= 0.0065 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(7)

Remarks

F.M.=0.33

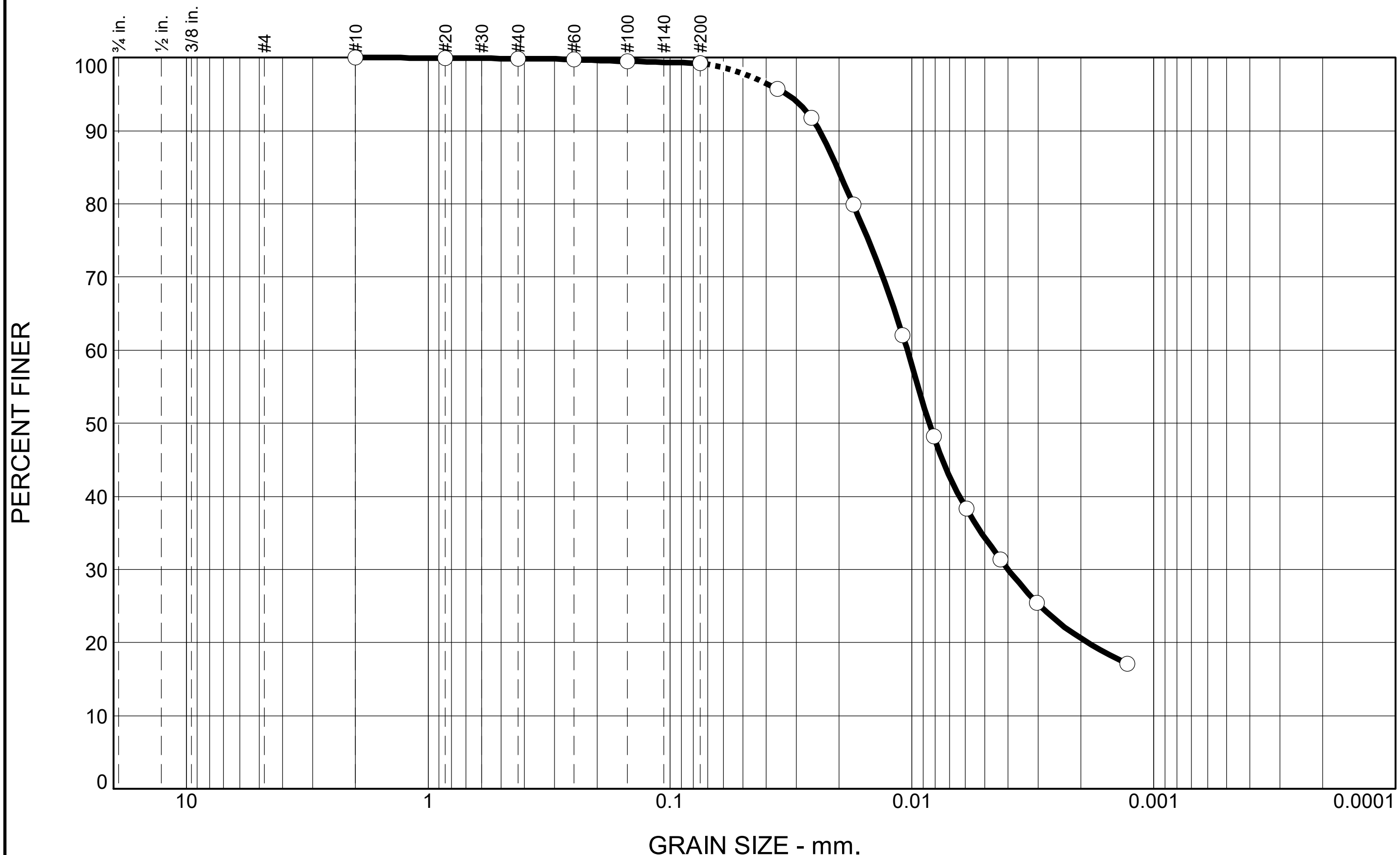
Source of Sample: MW-43 **Depth:** 50.0'-52.0'
Sample Number: 1400 **Date:** 3-25-21

Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION
Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.7	64.9	34.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	99.9		
#60	99.7		
#100	99.5		
#200	99.2		
0.0360 mm.	95.7		
0.0260 mm.	91.8		
0.0175 mm.	79.9		
0.0109 mm.	62.1		
0.0081 mm.	48.2		
0.0060 mm.	38.3		
0.0043 mm.	31.4		
0.0030 mm.	25.5		
0.0013 mm.	17.1		

* (no specification provided)

Soil Description

BROWNISH GRAY LEAN CLAY

Atterberg Limits

PL= 21 LL= 33 PI= 12

Coefficients

D_{90}= 0.0241 D_{85}= 0.0203 D_{60}= 0.0104
D_{50}= 0.0085 D_{30}= 0.0040 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(12)

Remarks

F.M.=0.01

Source of Sample: MW-43 **Depth:** 61.0'-61.5'
Sample Number: 1500 **Date:** 4-16-21

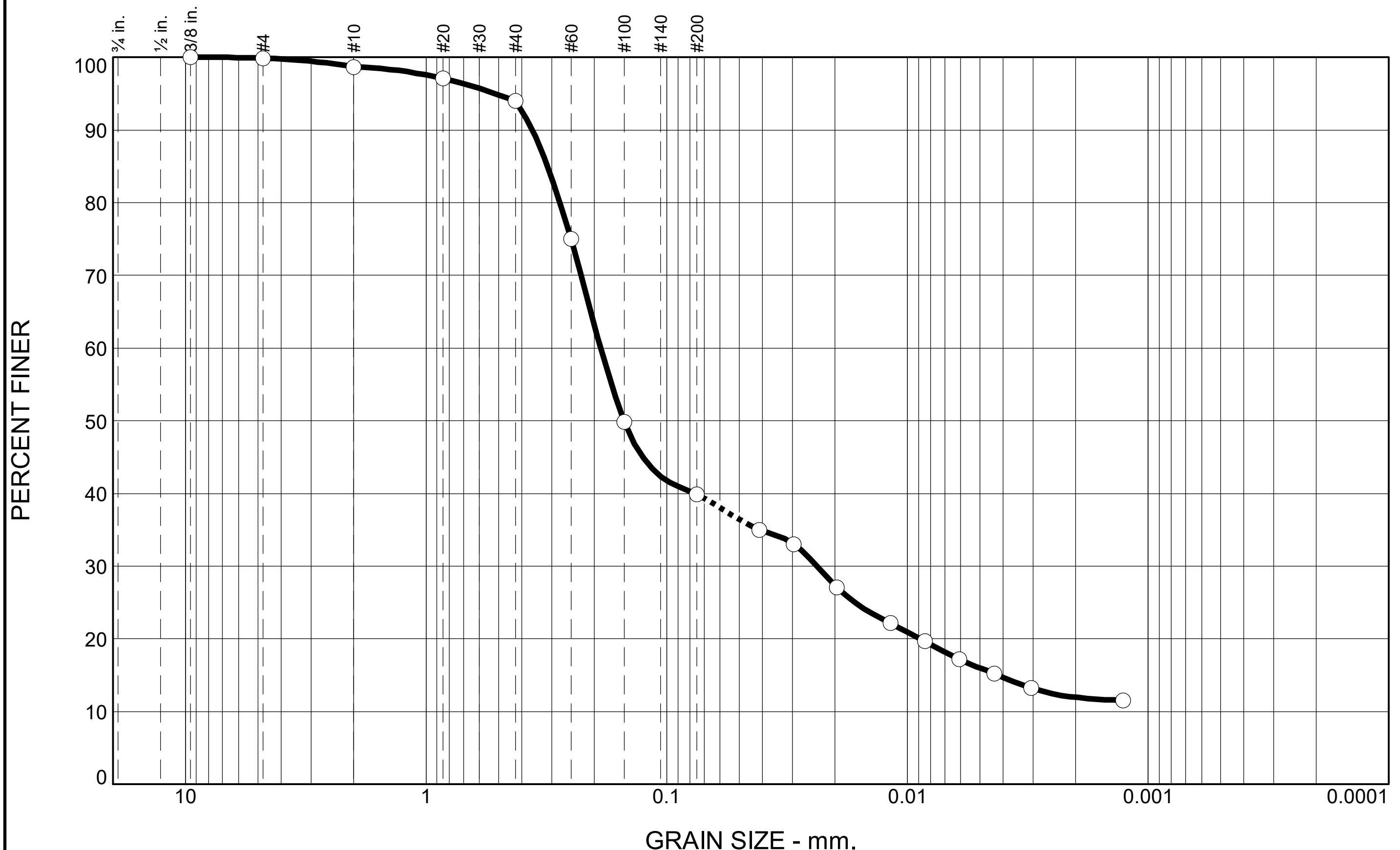
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.1	1.2	4.7	54.1	23.9	16.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.9		
#10	98.7		
#20	97.1		
#40	94.0		
#60	75.0		
#100	49.9		
#200	39.9		
0.0412 mm.	35.0		
0.0296 mm.	33.0		
0.0197 mm.	27.1		
0.0118 mm.	22.1		
0.0085 mm.	19.7		
0.0061 mm.	17.2		
0.0044 mm.	15.2		
0.0031 mm.	13.2		
0.0013 mm.	11.5		

* (no specification provided)

Soil Description

BROWN AND DARK BROWN SILTY SAND

Atterberg Limits

PL= 12 LL= 12 PI= NP

Coefficients

D_{90}= 0.3618 D_{85}= 0.3127 D_{60}= 0.1879
D_{50}= 0.1505 D_{30}= 0.0237 D_{15}= 0.0042
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

F.M.=0.74

Source of Sample: MW-70SA **Depth:** 16.5'-17.0'
Sample Number: 1615 **Date:** 4-16-21

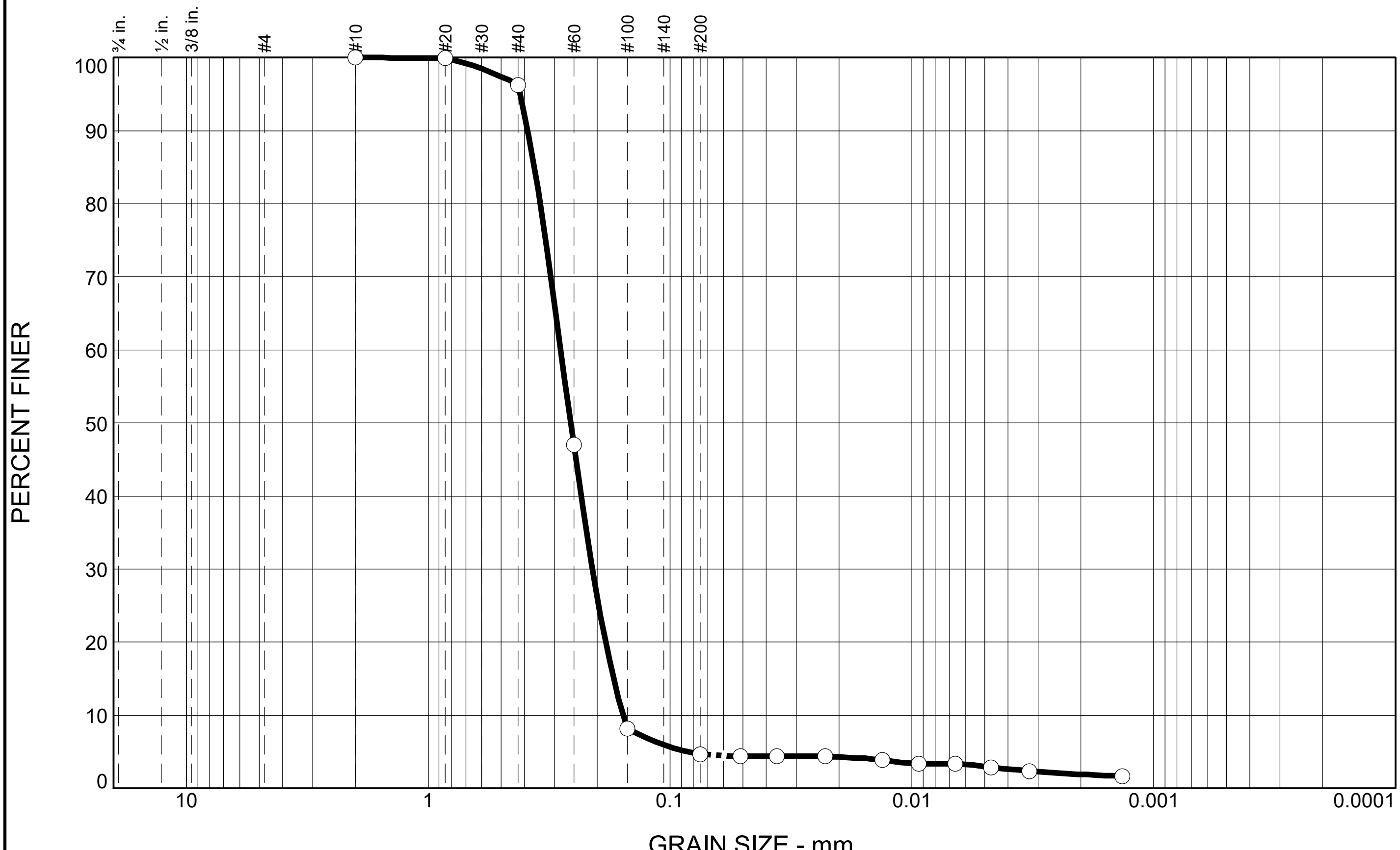
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	3.7	91.6	1.7	3.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	96.3		
#60	47.0		
#100	8.2		
#200	4.7		
0.0510 mm.	4.4		
0.0361 mm.	4.4		
0.0228 mm.	4.4		
0.0132 mm.	3.9		
0.0094 mm.	3.4		
0.0066 mm.	3.4		
0.0047 mm.	2.9		
0.0033 mm.	2.4		
0.0013 mm.	1.6		

* (no specification provided)

Soil Description

GRAY POORLY GRADED SAND

Atterberg Limits

PL= 10 LL= 17 PI= 7

Coefficients

D_{90}= 0.3868 D_{85}= 0.3638 D_{60}= 0.2829
D_{50}= 0.2574 D_{30}= 0.2092 D_{15}= 0.1714
D_{10}= 0.1564 C_u= 1.81 C_c= 0.99

Classification

USCS= SP AASHTO= A-2-4(0)

Remarks

F.M.=1.27

Source of Sample: MW-71S **Depth:** 10.0'-10.5'
Sample Number: 1615 **Date:** 4-16-21

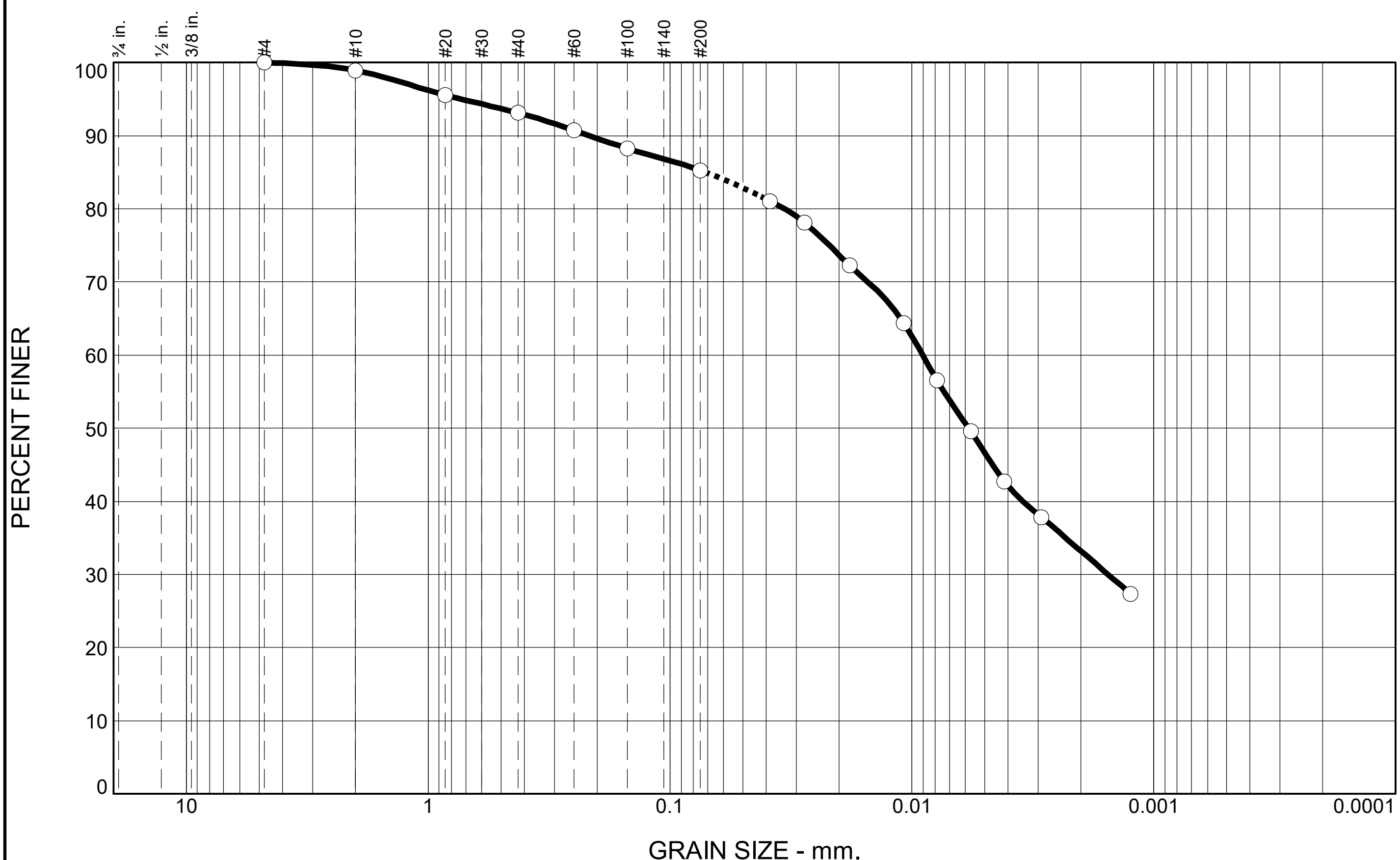
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.1	5.8	7.8	38.6	46.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	98.9		
#20	95.6		
#40	93.1		
#60	90.8		
#100	88.2		
#200	85.3		
0.0387 mm.	81.1		
0.0278 mm.	78.1		
0.0181 mm.	72.2		
0.0108 mm.	64.4		
0.0079 mm.	56.5		
0.0057 mm.	49.6		
0.0041 mm.	42.7		
0.0029 mm.	37.8		
0.0013 mm.	27.3		

* (no specification provided)

Soil Description

BROWN AND GRAYISH BROWN LEAN CLAY WITH SAND

Atterberg Limits

PL= 15 LL= 30 PI= 15

Coefficients

D_{90}= 0.2148 D_{85}= 0.0713 D_{60}= 0.0090
D_{50}= 0.0058 D_{30}= 0.0015 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(11)

Remarks

F.M.=0.30

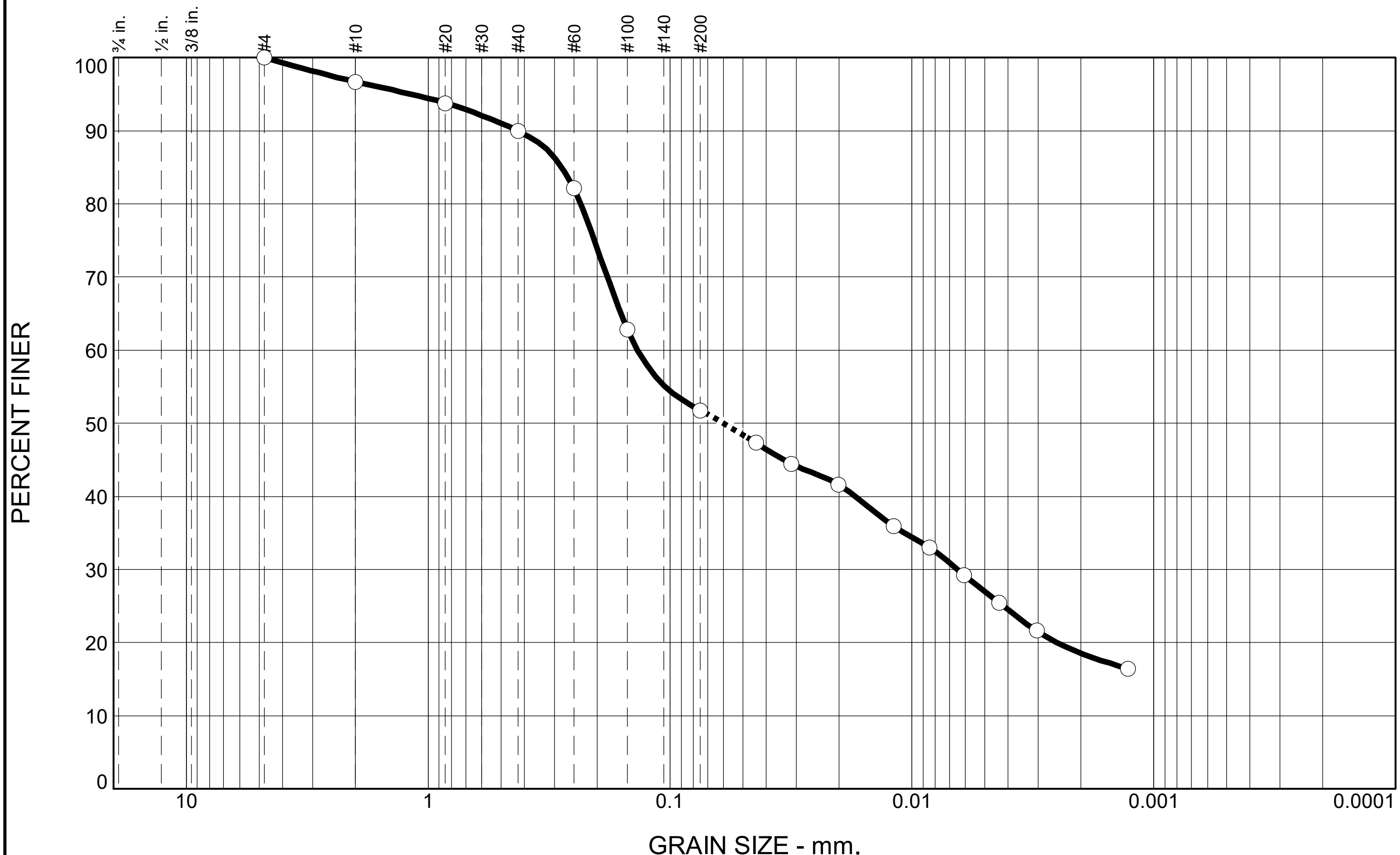
Source of Sample: MW-103 **Depth:** 15.0'-17.0'
Sample Number: 1110 **Date:** 3-25-21

Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION
Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.3	6.7	38.2	24.8	27.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	96.7		
#20	93.8		
#40	90.0		
#60	82.1		
#100	62.8		
#200	51.8		
0.0441 mm.	47.3		
0.0315 mm.	44.5		
0.0202 mm.	41.6		
0.0119 mm.	35.9		
0.0085 mm.	33.0		
0.0061 mm.	29.2		
0.0043 mm.	25.4		
0.0031 mm.	21.6		
0.0013 mm.	16.4		

* (no specification provided)

Soil Description

BROWN AND GRAY SANDY SILTY CLAY

Atterberg Limits

PL= 10 LL= 17 PI= 7

Coefficients

D_{90}= 0.4271 D_{85}= 0.2800 D_{60}= 0.1361
D_{50}= 0.0603 D_{30}= 0.0065 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL-ML AASHTO= A-4(0)

Remarks

F.M.=0.66

Source of Sample: MW-103 **Depth:** 95.5'-96.0'
Sample Number: 0915

Date: 4-16-21

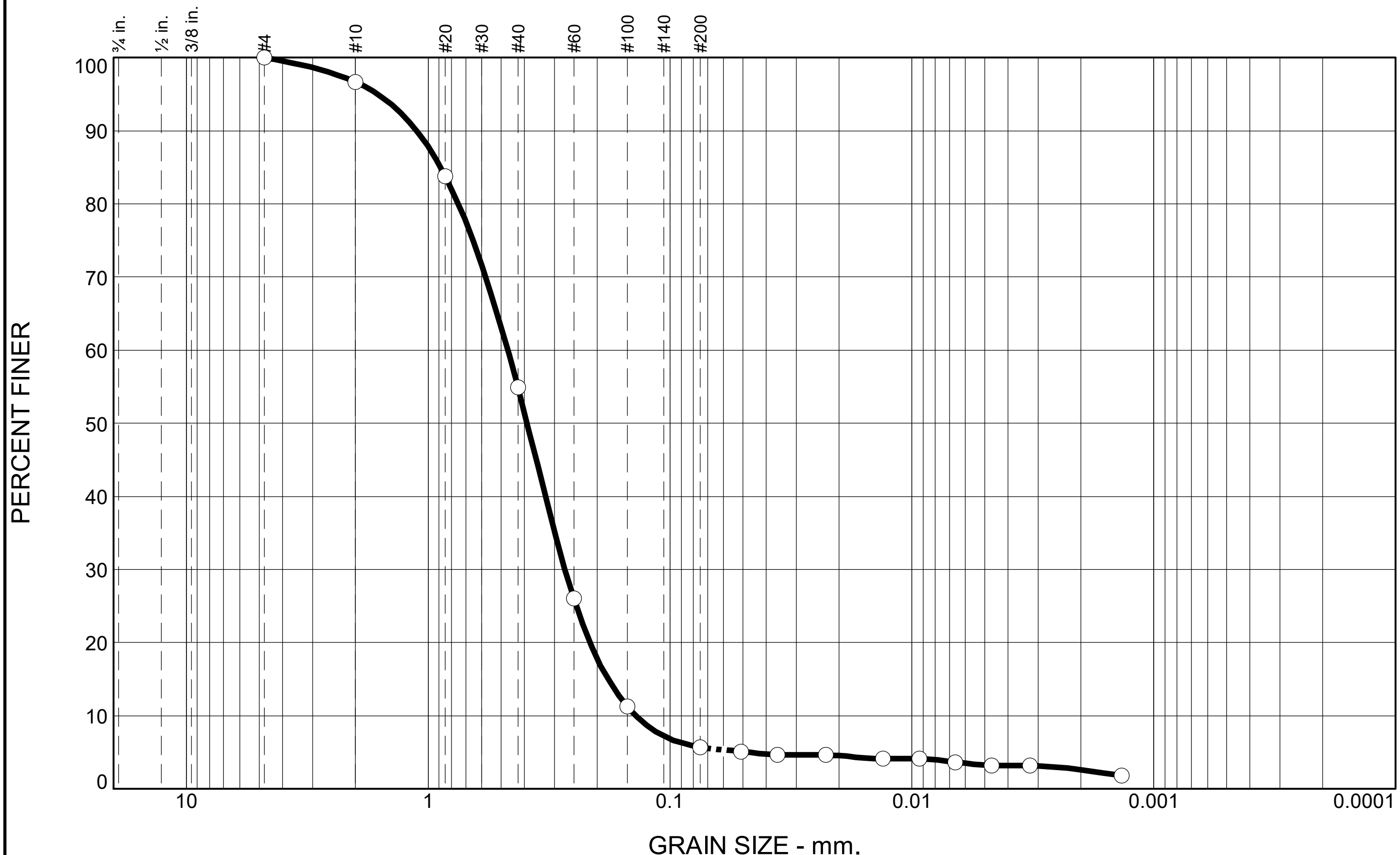
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.3	41.8	49.2	2.5	3.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	96.7		
#20	83.8		
#40	54.9		
#60	26.0		
#100	11.2		
#200	5.7		
0.0507 mm.	5.1		
0.0360 mm.	4.6		
0.0228 mm.	4.6		
0.0132 mm.	4.1		
0.0093 mm.	4.1		
0.0066 mm.	3.6		
0.0047 mm.	3.2		
0.0032 mm.	3.2		
0.0014 mm.	1.8		

* (no specification provided)

Soil Description

GRAY AND BROWN POORLY GRADED SAND WITH SILTY CLAY

Atterberg Limits

PL= 7 LL= 14 PI= 7

Coefficients

D_{90}= 1.1145 D_{85}= 0.8892 D_{60}= 0.4681
D_{50}= 0.3894 D_{30}= 0.2718 D_{15}= 0.1803
D_{10}= 0.1385 C_u= 3.38 C_c= 1.14

Classification

USCS= SP-SC AASHTO= A-2-4(0)

Remarks

F.M.=1.93

Source of Sample: MW-103 **Depth:** 132.5'-133.0'
Sample Number: 1350

Date: 4-28-21

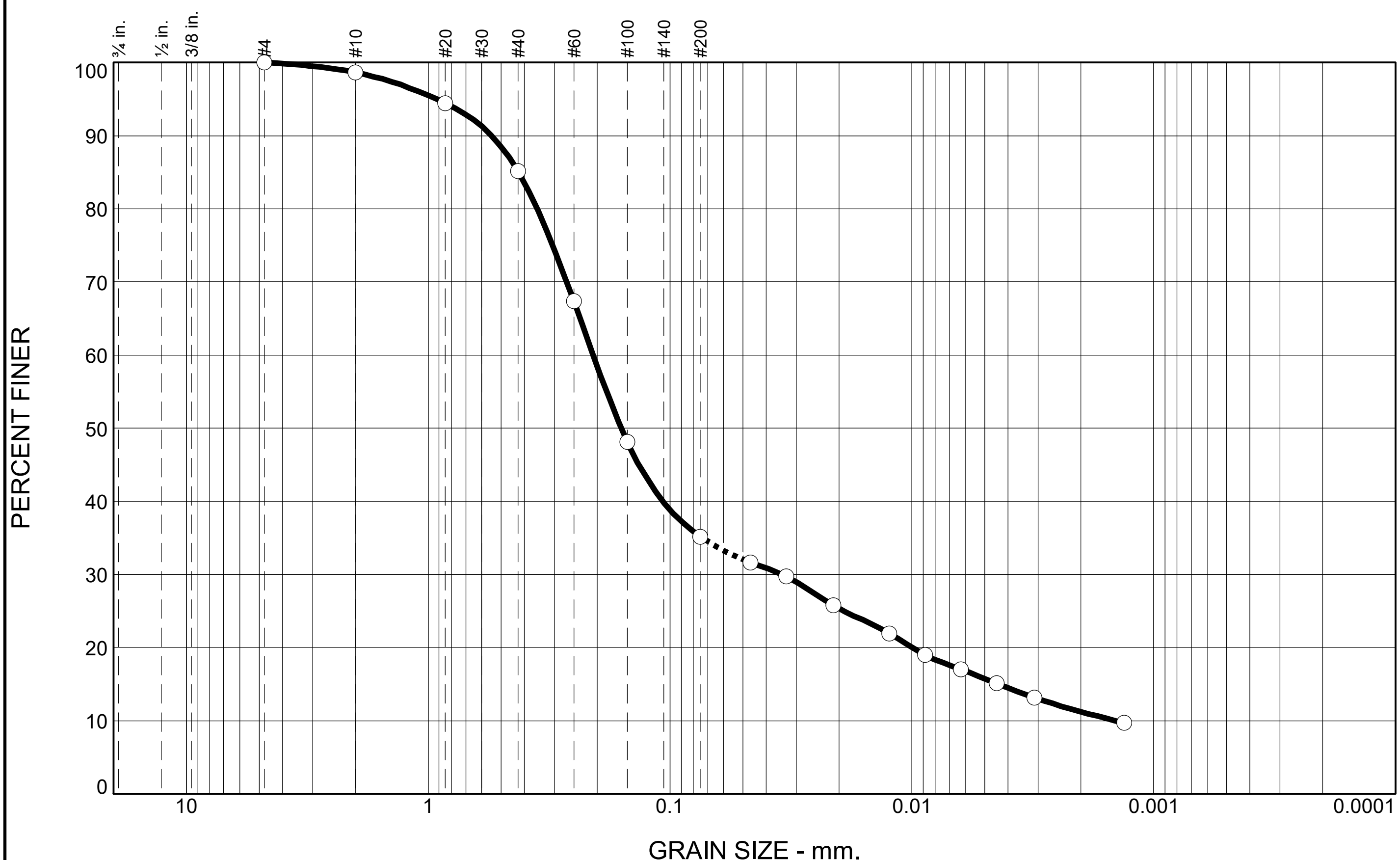
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.3	13.5	50.0	19.4	15.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	98.7		
#20	94.4		
#40	85.2		
#60	67.4		
#100	48.1		
#200	35.2		
0.0465 mm.	31.7		
0.0331 mm.	29.7		
0.0212 mm.	25.8		
0.0124 mm.	21.9		
0.0088 mm.	19.0		
0.0063 mm.	17.0		
0.0045 mm.	15.1		
0.0031 mm.	13.1		
0.0013 mm.	9.7		

* (no specification provided)

Soil Description

GRAY SILTY CLAYEY SAND

Atterberg Limits

PL= 11 LL= 17 PI= 6

Coefficients

D_{90}= 0.5460 D_{85}= 0.4223 D_{60}= 0.2079
D_{50}= 0.1591 D_{30}= 0.0345 D_{15}= 0.0044
D_{10}= 0.0014 C_u= 144.71 C_c= 3.99

Classification

USCS= SC-SM AASHTO= A-2-4(0)

Remarks

F.M.=0.91

Source of Sample: MW-103 **Depth:** 163.0'-163.5'
Sample Number: 0810 **Date:** 4-2-21

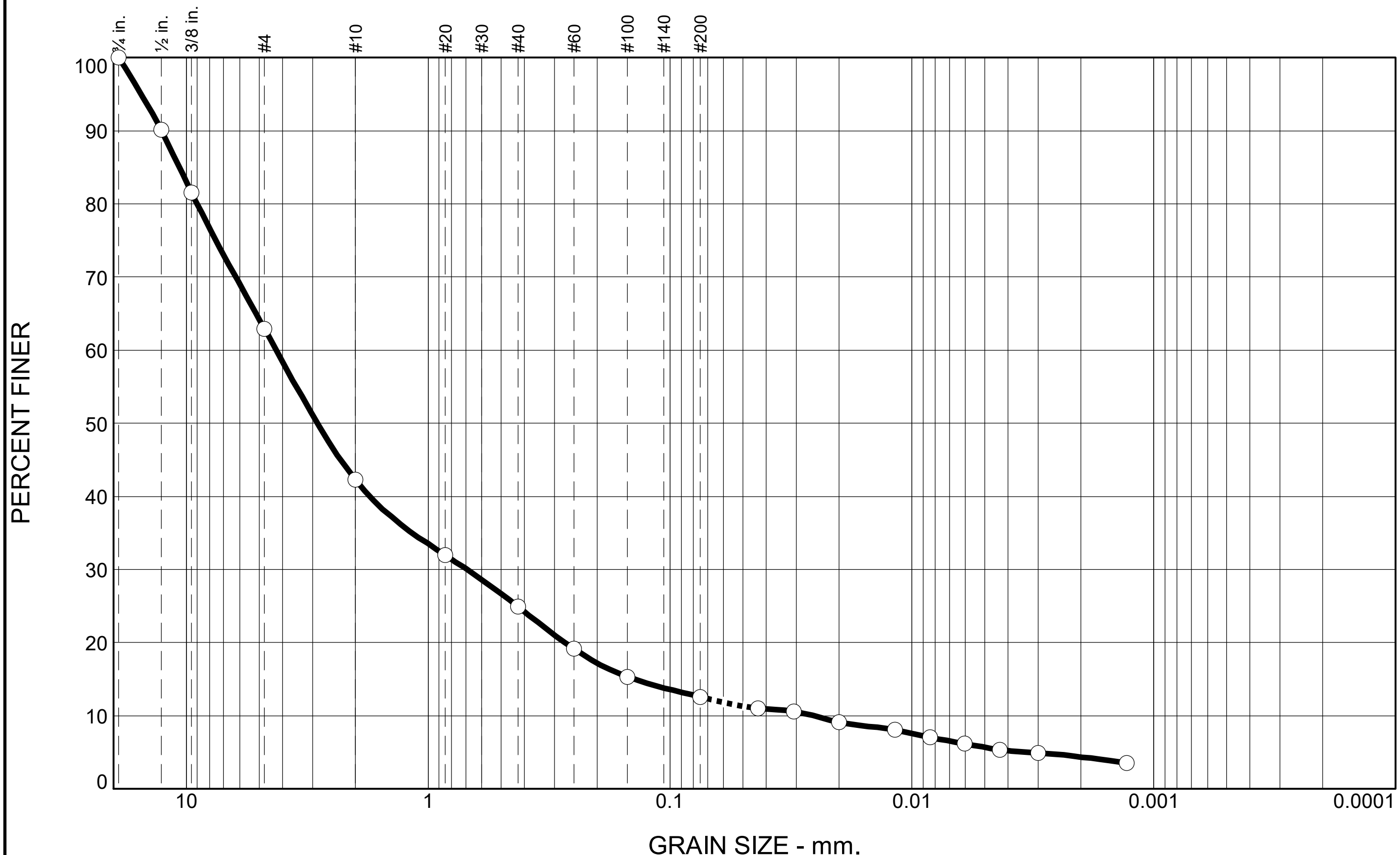
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	37.1	20.6	17.4	12.3	6.9	5.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	90.1		
.375	81.6		
#4	62.9		
#10	42.3		
#20	32.0		
#40	24.9		
#60	19.1		
#100	15.3		
#200	12.6		
0.0432 mm.	11.0		
0.0308 mm.	10.6		
0.0200 mm.	9.1		
0.0117 mm.	8.1		
0.0084 mm.	7.0		
0.0060 mm.	6.2		
0.0043 mm.	5.3		
0.0030 mm.	4.9		
0.0013 mm.	3.6		

* (no specification provided)

Soil Description

GRAY SILTY CLAYEY SAND WITH GRAVEL

Atterberg Limits

PL= 11 LL= 16 PI= 5

Coefficients

D_{90}= 12.6544 D_{85}= 10.6763 D_{60}= 4.2501
D_{50}= 2.8713 D_{30}= 0.6915 D_{15}= 0.1406
D_{10}= 0.0256 C_u= 166.04 C_c= 4.40

Classification

USCS= SC-SM AASHTO= A-1-a

Remarks

F.M.=4.10

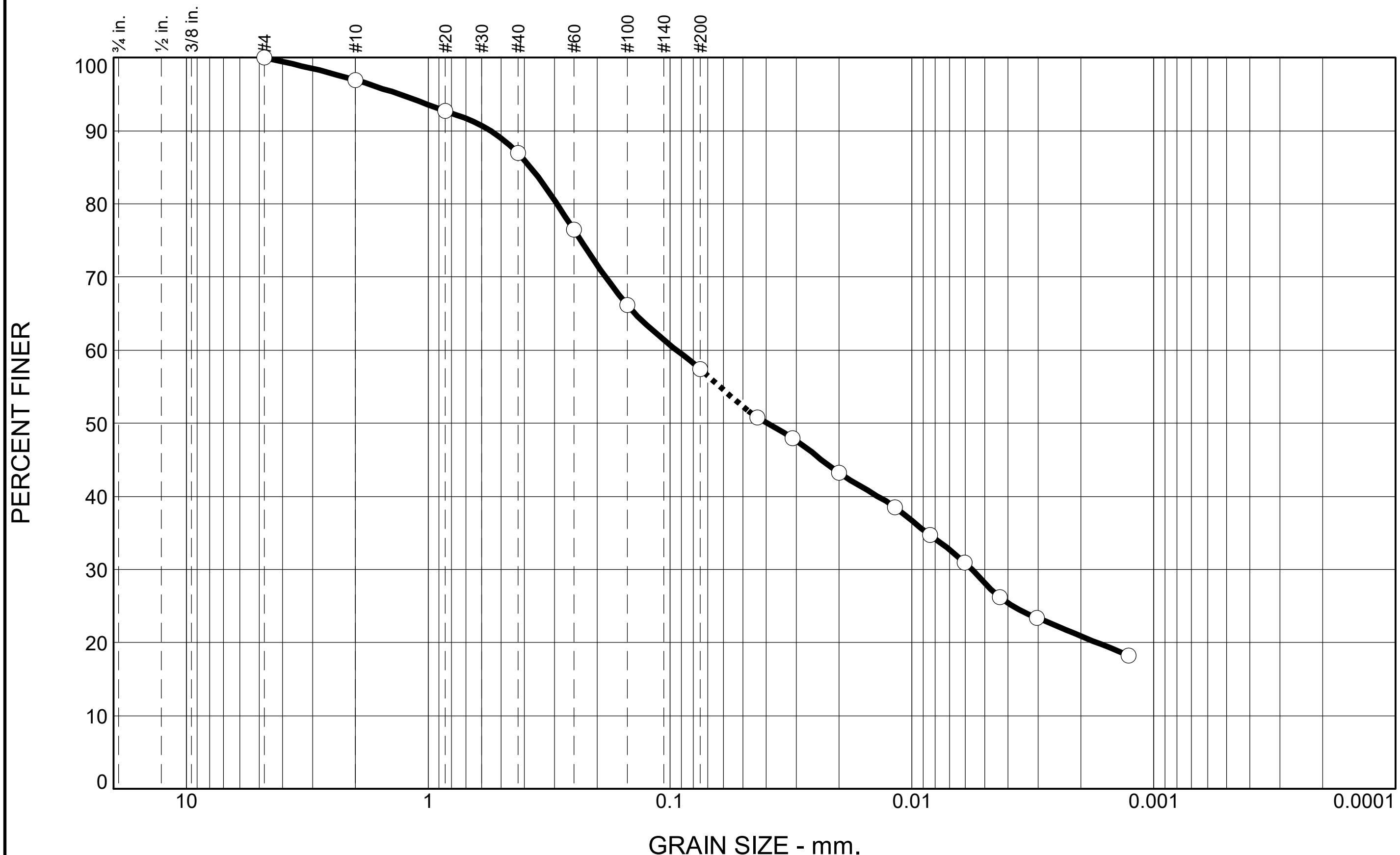
Source of Sample: MW-103 **Depth:** 130.5'-131.0'
Sample Number: 1150 **Date:** 4-2-21

Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION
Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.1	9.9	29.6	29.2	28.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	96.9		
#20	92.7		
#40	87.0		
#60	76.5		
#100	66.2		
#200	57.4		
0.0435 mm.	50.8		
0.0311 mm.	48.0		
0.0200 mm.	43.2		
0.0118 mm.	38.5		
0.0084 mm.	34.7		
0.0060 mm.	30.9		
0.0043 mm.	26.2		
0.0030 mm.	23.4		
0.0013 mm.	18.2		

* (no specification provided)

Soil Description

BROWNISH GRAY SANDY LEAN CLAY

Atterberg Limits

PL= 11 LL= 23 PI= 12

Coefficients

D_{90}= 0.5533 D_{85}= 0.3770 D_{60}= 0.0940
D_{50}= 0.0398 D_{30}= 0.0057 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(3)

Remarks

F.M.=0.71

Source of Sample: MW-103 **Depth:** 140.5'-141.0'
Sample Number: 1420 **Date:** 4-16-21

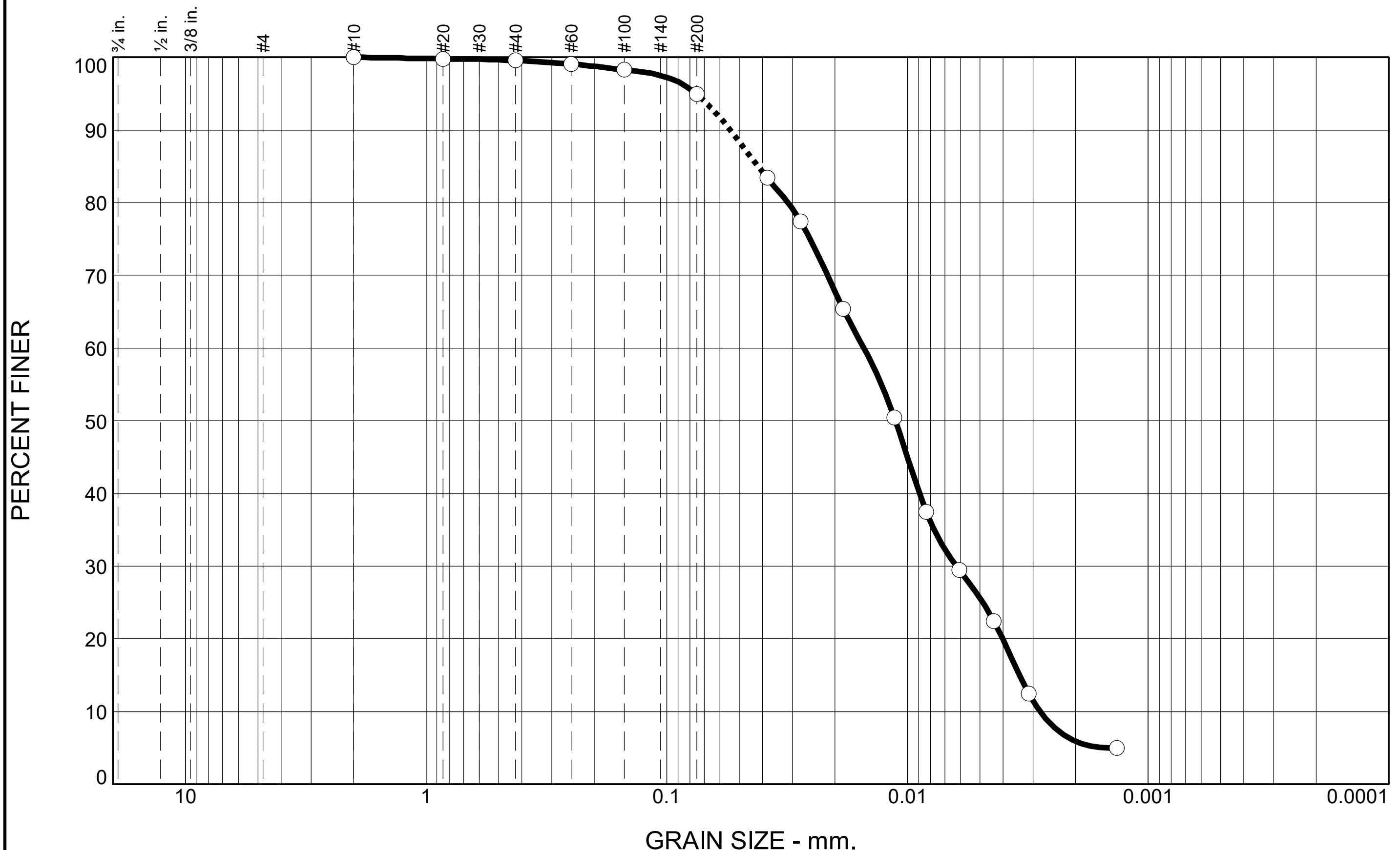
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.4	4.7	69.3	25.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.8		
#40	99.6		
#60	99.1		
#100	98.3		
#200	94.9		
0.0382 mm.	83.4		
0.0278 mm.	77.4		
0.0185 mm.	65.4		
0.0113 mm.	50.4		
0.0084 mm.	37.5		
0.0061 mm.	29.5		
0.0044 mm.	22.5		
0.0031 mm.	12.5		
0.0013 mm.	5.0		

* (no specification provided)

Soil Description

DARK GRAY SILT

Atterberg Limits

PL= 28 LL= 26 PI= NP

Coefficients

D_{90}= 0.0546 D_{85}= 0.0418 D_{60}= 0.0152
D_{50}= 0.0112 D_{30}= 0.0062 D_{15}= 0.0034
D_{10}= 0.0028 C_u= 5.42 C_c= 0.92

Classification

USCS= ML AASHTO= A-4(0)

Remarks

F.M.=0.03

Source of Sample: XCM-02 **Depth:** 15.5'-16.0'
Sample Number: 1500

Date: 4-2-21

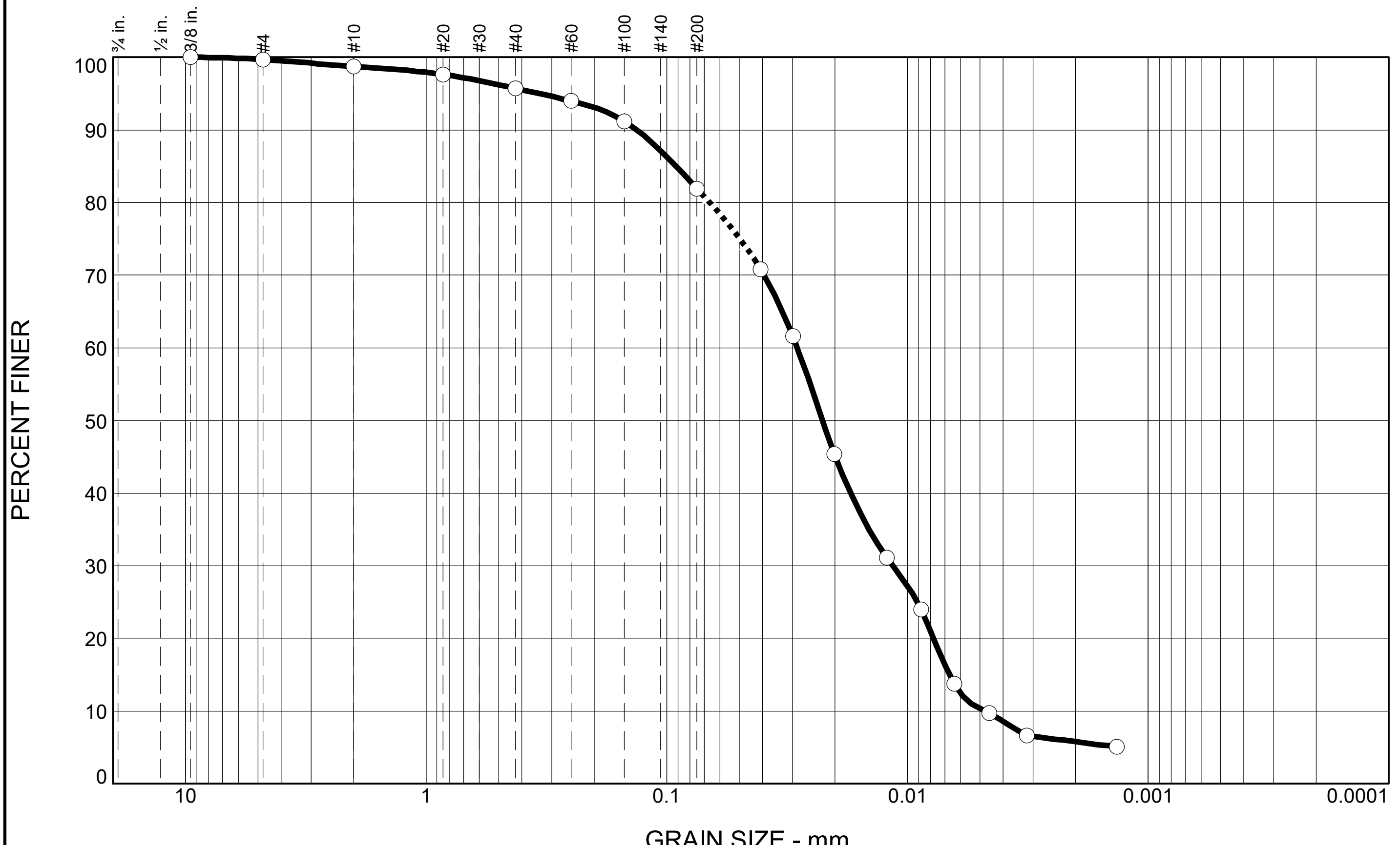
Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Particle Size Analysis of Soils ASTM D6913 and D7928



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.3	1.0	3.0	13.8	71.6	10.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.7		
#10	98.7		
#20	97.6		
#40	95.7		
#60	94.0		
#100	91.2		
#200	81.9		
0.0408 mm.	70.8		
0.0299 mm.	61.6		
0.0201 mm.	45.3		
0.0121 mm.	31.1		
0.0088 mm.	23.9		
0.0064 mm.	13.7		
0.0046 mm.	9.7		
0.0032 mm.	6.6		
0.0014 mm.	5.1		

* (no specification provided)

Soil Description

DARK GRAY ELASTIC SILT WITH SAND

Atterberg Limits

PL= 57 LL= 53 PI= NP

Coefficients

D_{90}= 0.1334 D_{85}= 0.0918 D_{60}= 0.0287
D_{50}= 0.0225 D_{30}= 0.0115 D_{15}= 0.0067
D_{10}= 0.0048 C_u= 6.00 C_c= 0.97

Classification

USCS= MH AASHTO= A-5(3)

Remarks

F.M.=0.21

Source of Sample: XCM-02 **Depth:** 36.0'-36.5'
Sample Number: 1600 **Date:** 4-2-21

Terracon

Client: RAMBOLL ENVIRON US CORP.
Project: VERMILLION POWER STATION

Project No: 11215020 **Figure**

Tested By: SJH **Checked By:** WPQ

Hydraulic Conductivity of Saturated Porous Materials
Using a Flexible-Wall Permeameter
ASTM D5084

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HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

TERRACON PROJECT NO.: **11215020** **5/18/2021**
PROJECT NAME: **VERMILLION POWER STATION**
CLIENT: **RAMBOLL ENVIRON US CORP.**
LOCATION : **CONFIDENTIAL**

SUMMARY OF TEST RESULTS

BORING NO. MW-37

TIME SAMPLED: 9:45

DEPTH: 5.0'-7.0'

CLASSIFICATION DARK BROWN SANDY LEAN CLAY

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	105.8	110.5
WATER CONTENT (%)	19.3	19.0
DIAMETER (cm)	7.262	7.180
LENGTH (cm)	10.116	9.901
B VALUE PARAMETER:	0.96	
HYDRAULIC GRADIENT (MAXIMUM)	19.75	
PERCENT SATURATION	98.6	
HYDRAULIC CONDUCTIVITY k (cm/sec)	4.79E-06	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

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TERRACON PROJECT NO.: **11215020** **5/18/2021**
PROJECT NAME: **VERMILLION POWER STATION**
CLIENT: **RAMBOLL ENVIRON US CORP.**
LOCATION : **CONFIDENTIAL**

SUMMARY OF TEST RESULTS

BORING NO. MW-37

TIME SAMPLED: N/A

DEPTH: 18.5'-19.0'

CLASSIFICATION GRAY SILTY CLAYEY SAND WITH GRAVEL

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	122.7	123.3
WATER CONTENT (%)	11.1	12.9
DIAMETER (cm)	5.959	5.947
LENGTH (cm)	5.812	5.809
B VALUE PARAMETER:	0.96	
HYDRAULIC GRADIENT (MAXIMUM)	28.32	
PERCENT SATURATION	99.2	
HYDRAULIC CONDUCTIVITY k (cm/sec)	5.07E-06	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

TERRACON PROJECT NO.: **11215020** **5/21/2021**
PROJECT NAME: **VERMILLION POWER STATION**
CLIENT: **RAMBOLL ENVIRON US CORP.**
LOCATION : **CONFIDENTIAL**

SUMMARY OF TEST RESULTS

BORING NO. MW-37

TIME SAMPLED: 13:00

DEPTH: 36.0'-36.5'

CLASSIFICATION GRAY AND BROWN SILTY CLAYEY SAND

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	130.5	130.6
WATER CONTENT (%)	8.9	9.7
DIAMETER (cm)	6.015	6.009
LENGTH (cm)	8.469	8.479
B VALUE PARAMETER:	0.96	
HYDRAULIC GRADIENT (MAXIMUM)	11.13	
PERCENT SATURATION	97.6	
HYDRAULIC CONDUCTIVITY k (cm/sec)	3.35E-05	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

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Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

TERRACON PROJECT NO.:	**11215020**	**5/20/2021**
PROJECT NAME:	**VERMILLION POWER STATION**	
CLIENT:	**RAMBOLL ENVIRON US CORP.**	
LOCATION :	**CONFIDENTIAL**	

SUMMARY OF TEST RESULTS

BORING NO.	MW-37
TIME SAMPLED:	15:00
DEPTH:	55.0'-57.0'
CLASSIFICATION	GRAY LEAN CLAY - SAND SEAMS NOTED

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	101.4	104.7
WATER CONTENT (%)	23.8	22.3
DIAMETER (cm)	7.270	7.226
LENGTH (cm)	8.136	7.973
B VALUE PARAMETER:	0.99	
HYDRAULIC GRADIENT (MAXIMUM)	24.55	
PERCENT SATURATION	99.6	
HYDRAULIC CONDUCTIVITY k (cm/sec)	5.44E-08	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

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HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

TERRACON PROJECT NO.: **11215020** **5/21/2021**
PROJECT NAME: **VERMILLION POWER STATION**
CLIENT: **RAMBOLL ENVIRON US CORP.**
LOCATION : **CONFIDENTIAL**

SUMMARY OF TEST RESULTS

BORING NO. MW-38

TIME SAMPLED: 8:35

DEPTH: 5.0'-7.0'

CLASSIFICATION BROWN SILTY SAND

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	108.3	113.6
WATER CONTENT (%)	17.1	16.8
DIAMETER (cm)	7.236	7.151
LENGTH (cm)	8.149	7.949
B VALUE PARAMETER:	0.97	
HYDRAULIC GRADIENT (MAXIMUM)	24.51	
PERCENT SATURATION	98.9	
HYDRAULIC CONDUCTIVITY k (cm/sec)	2.20E-06	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

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HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

TERRACON PROJECT NO.:	**11215020**	**5/21/2021**
PROJECT NAME:	**VERMILLION POWER STATION**	
CLIENT:	**RAMBOLL ENVIRON US CORP.**	
LOCATION :	**CONFIDENTIAL**	

SUMMARY OF TEST RESULTS

BORING NO.	MW-38
TIME SAMPLED:	16:55
DEPTH:	35.0'-37.0'
CLASSIFICATION	GRAY SANDY LEAN CLAY - SILT SEAMS NOTED

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	125.6	127.9
WATER CONTENT (%)	11.9	11.5
DIAMETER (cm)	7.228	7.206
LENGTH (cm)	9.159	9.047
B VALUE PARAMETER:	0.96	
HYDRAULIC GRADIENT (MAXIMUM)	21.81	
PERCENT SATURATION	99.3	
HYDRAULIC CONDUCTIVITY k (cm/sec)	3.11E-08	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

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TERRACON PROJECT NO.:	**11215020**	**5/21/2021**
PROJECT NAME:	**VERMILLION POWER STATION**	
CLIENT:	**RAMBOLL ENVIRON US CORP.**	
LOCATION :	**CONFIDENTIAL**	

SUMMARY OF TEST RESULTS

BORING NO.	MW-41
TIME SAMPLED:	9:45
DEPTH:	8.0'-10.0'
CLASSIFICATION	GRAY AND BROWN SANDY LEAN CLAY - SAND SEAMS NOTED

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	127.7	128.2
WATER CONTENT (%)	12.2	11.6
DIAMETER (cm)	7.218	7.220
LENGTH (cm)	9.238	9.192
B VALUE PARAMETER:	0.98	
HYDRAULIC GRADIENT (MAXIMUM)	21.62	
PERCENT SATURATION	98.6	
HYDRAULIC CONDUCTIVITY k (cm/sec)	3.46E-08	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

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TERRACON PROJECT NO.: **11215020** **5/21/2021**
PROJECT NAME: **VERMILLION POWER STATION**
CLIENT: **RAMBOLL ENVIRON US CORP.**
LOCATION : **CONFIDENTIAL**

SUMMARY OF TEST RESULTS

BORING NO. MW-41

TIME SAMPLED: 11:30

DEPTH: 35.0'-37.0'

CLASSIFICATION GRAYISH BROWN SANDY SILTY CLAY

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	122.9	125.7
WATER CONTENT (%)	12.8	12.6
DIAMETER (cm)	7.220	7.191
LENGTH (cm)	6.812	6.717
B VALUE PARAMETER:	0.96	
HYDRAULIC GRADIENT (MAXIMUM)	29.32	
PERCENT SATURATION	99.2	
HYDRAULIC CONDUCTIVITY k (cm/sec)	5.74E-07	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

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HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

TERRACON PROJECT NO.:	**11215020**	**5/21/2021**
PROJECT NAME:	**VERMILLION POWER STATION**	
CLIENT:	**RAMBOLL ENVIRON US CORP.**	
LOCATION :	**CONFIDENTIAL**	

SUMMARY OF TEST RESULTS

BORING NO.	MW-43
TIME SAMPLED:	13:30
DEPTH:	35.0'-37.0'
CLASSIFICATION	GRAY AND GRAYISH BROWN SANDY LEAN CLAY

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	128.7	131.7
WATER CONTENT (%)	11.8	10.2
DIAMETER (cm)	7.138	7.093
LENGTH (cm)	7.959	7.880
B VALUE PARAMETER:	0.97	
HYDRAULIC GRADIENT (MAXIMUM)	25.10	
PERCENT SATURATION	98.9	
HYDRAULIC CONDUCTIVITY k (cm/sec)	2.17E-08	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

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TERRACON PROJECT NO.: **11215020** **5/21/2021**
PROJECT NAME: **VERMILLION POWER STATION**
CLIENT: **RAMBOLL ENVIRON US CORP.**
LOCATION : **CONFIDENTIAL**

SUMMARY OF TEST RESULTS

BORING NO. MW-43

TIME SAMPLED: 14:00

DEPTH: 50.0'-52.0'

CLASSIFICATION GRAY LEAN CLAY WITH SAND - SAND SEAMS NOTED

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	117.1	117.6
WATER CONTENT (%)	16.3	15.5
DIAMETER (cm)	7.171	7.177
LENGTH (cm)	7.752	7.709
B VALUE PARAMETER:	0.96	
HYDRAULIC GRADIENT (MAXIMUM)	25.77	
PERCENT SATURATION	98.6	
HYDRAULIC CONDUCTIVITY k (cm/sec)	1.39E-07	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

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TERRACON PROJECT NO.:	**11215020**	**5/21/2021**
PROJECT NAME:	**VERMILLION POWER STATION**	
CLIENT:	**RAMBOLL ENVIRON US CORP.**	
LOCATION :	**CONFIDENTIAL**	

SUMMARY OF TEST RESULTS

BORING NO.	MW-43
TIME SAMPLED:	15:00
DEPTH:	60.5'-61.0'
CLASSIFICATION	BROWNISH GRAY LEAN CLAY

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	105.2	107.7
WATER CONTENT (%)	21.0	20.5
DIAMETER (cm)	6.083	6.034
LENGTH (cm)	10.796	10.722
B VALUE PARAMETER:	0.96	
HYDRAULIC GRADIENT (MAXIMUM)	18.50	
PERCENT SATURATION	99.4	
HYDRAULIC CONDUCTIVITY k (cm/sec)	4.17E-07	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

TERRACON PROJECT NO.:	**11215020**	**5/21/2021**
PROJECT NAME:	**VERMILLION POWER STATION**	
CLIENT:	**RAMBOLL ENVIRON US CORP.**	
LOCATION :	**CONFIDENTIAL**	

SUMMARY OF TEST RESULTS

BORING NO.	MW-103
TIME SAMPLED:	11:10
DEPTH:	15.0'-17.0'
CLASSIFICATION	BROWN AND GRAYISH BROWN LEAN CLAY WITH SAND

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	116.8	119.9
WATER CONTENT (%)	16.6	14.8
DIAMETER (cm)	7.234	7.192
LENGTH (cm)	9.109	8.976
B VALUE PARAMETER:	0.96	
HYDRAULIC GRADIENT (MAXIMUM)	21.93	
PERCENT SATURATION	99.1	
HYDRAULIC CONDUCTIVITY k (cm/sec)	3.61E-08	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

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TERRACON PROJECT NO.:	**11215020**	**5/21/2021**
PROJECT NAME:	**VERMILLION POWER STATION**	
CLIENT:	**RAMBOLL ENVIRON US CORP.**	
LOCATION :	**CONFIDENTIAL**	

SUMMARY OF TEST RESULTS

BORING NO.	MW-103
TIME SAMPLED:	9:15
DEPTH:	96.0'-96.5'
CLASSIFICATION	BROWN AND GRAY SANDY SILTY CLAY

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	128.4	129.9
WATER CONTENT (%)	11.7	10.9
DIAMETER (cm)	5.961	5.976
LENGTH (cm)	11.377	11.194
B VALUE PARAMETER:	0.96	
HYDRAULIC GRADIENT (MAXIMUM)	17.56	
PERCENT SATURATION	98.9	
HYDRAULIC CONDUCTIVITY k (cm/sec)	9.35E-06	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

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HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

TERRACON PROJECT NO. **11215020** **5/21/2021**
PROJECT NAME: **VERMILLION POWER STATION**
CLIENT: **RAMBOLL ENVIRON US CORP.**
LOCATION : **CONFIDENTIAL**

SUMMARY OF TEST RESULTS

BORING NO. MW-103

TIME SAMPLED: 11:50

DEPTH: 130.5'-131.0'

CLASSIFICATION BROWN AND GRAY SANDY SILTY CLAY

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	98.8	100.1
WATER CONTENT (%)	8.9	24.1
DIAMETER (cm)	5.968	5.976
LENGTH (cm)	11.377	11.194
B VALUE PARAMETER:	0.99	
HYDRAULIC GRADIENT (MAXIMUM)	8.29	
PERCENT SATURATION	96.5	
HYDRAULIC CONDUCTIVITY k (cm/sec)	2.19E-05	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

Terracon
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HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

TERRACON PROJECT NO.:	**11215020**	**5/21/2021**
PROJECT NAME:	**VERMILLION POWER STATION**	
CLIENT:	**RAMBOLL ENVIRON US CORP.**	
LOCATION :	**CONFIDENTIAL**	

SUMMARY OF TEST RESULTS

BORING NO.	MW-103
TIME SAMPLED:	14:20
DEPTH:	141.0'-141.5'
CLASSIFICATION	BROWNISH GRAY SANDY LEAN CLAY

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	127.5	127.0
WATER CONTENT (%)	10.8	12.0
DIAMETER (cm)	5.959	6.042
LENGTH (cm)	10.998	10.734
B VALUE PARAMETER:	0.96	
HYDRAULIC GRADIENT (MAXIMUM)	18.16	
PERCENT SATURATION	99.4	
HYDRAULIC CONDUCTIVITY k (cm/sec)	3.82E-07	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

TERRACON PROJECT NO.: **11215020** **5/21/2021**
PROJECT NAME: **VERMILLION POWER STATION**
CLIENT: **RAMBOLL ENVIRON US CORP.**
LOCATION : **CONFIDENTIAL**

SUMMARY OF TEST RESULTS

BORING NO. MW-103

TIME SAMPLED: 8:10

DEPTH: 162.5'-1630'

CLASSIFICATION GRAY SILTY CLAYEY SAND

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	109.5	117.7
WATER CONTENT (%)	12.1	15.5
DIAMETER (cm)	6.057	6.053
LENGTH (cm)	12.233	11.398
B VALUE PARAMETER:	0.96	
HYDRAULIC GRADIENT (MAXIMUM)	16.33	
PERCENT SATURATION	99.7	
HYDRAULIC CONDUCTIVITY k (cm/sec)	4.31E-06	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

Terracon
Consulting Engineers & Scientists

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

TERRACON PROJECT NO.: **11215020** **5/21/2021**
PROJECT NAME: **VERMILLION POWER STATION**
CLIENT: **RAMBOLL ENVIRON US CORP.**
LOCATION : **CONFIDENTIAL**

SUMMARY OF TEST RESULTS

BORING NO. XCM-02

TIME SAMPLED: 15:00

DEPTH: 16.0'-16.5'

CLASSIFICATION DARK GRAY SILT

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	88.1	91.5
WATER CONTENT (%)	26.5	30.5
DIAMETER (cm)	5.980	5.960
LENGTH (cm)	10.090	9.785
B VALUE PARAMETER:	0.96	
HYDRAULIC GRADIENT (MAXIMUM)	19.80	
PERCENT SATURATION	99.6	
HYDRAULIC CONDUCTIVITY k (cm/sec)	8.86E-06	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

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HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

TERRACON PROJECT NO.: **11215020** **5/21/2021**
PROJECT NAME: **VERMILLION POWER STATION**
CLIENT: **RAMBOLL ENVIRON US CORP.**
LOCATION : **CONFIDENTIAL**

SUMMARY OF TEST RESULTS

BORING NO. XCM-02

TIME SAMPLED: 16:00

DEPTH: 35.5'-36.0'

CLASSIFICATION DARK GRAY ELASTIC SILT WITH SAND

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	61.2	90.2
WATER CONTENT (%)	57.1	31.2
DIAMETER (cm)	6.047	6.008
LENGTH (cm)	12.530	8.611
B VALUE PARAMETER:	0.96	
HYDRAULIC GRADIENT (MAXIMUM)	15.94	
PERCENT SATURATION	99.3	
HYDRAULIC CONDUCTIVITY k (cm/sec)	3.30E-05	

SPECIMEN PHOTO

(Percent saturation calculation is based on final measurements and a measured specific gravity.)

Deaired water was used as the liquid permeant.

Permeability of Granular Soils (Constant Head)
ASTM D2434

PERMEABILITY OF GRANULAR SOILS
CONSTANT HEAD METHOD IN RIGID WALL PERMEAMETER
ASTM D 2434

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

PROJECT NO.:	11215020
PROJECT:	VERMILLION POWER STATION
DATE:	5/18/2021

SAMPLE INFORMATION

BORING NO.	MW-37
TIME SAMPLED:	11:00
DEPTH:	25.0'-27.0'
CLASSIFICATION	GRA YAND GRAYISH BROWN POORLY GRSDED SAND WITH SILT

	INITIAL
DRY UNIT WEIGHT (pcf)	98.5
WATER CONTENT (%)	15.1
DIAMETER (cm)	2.57
LENGTH (cm)	11.89

SUMMARY OF TEST RESULTS

HYDRAULIC GRADIENT	1.3
HEAD HEIGHT (cm)	15.00
VOID RATIO	0.811
HYDRAULIC CONDUCTIVITY k (cm/sec)	**2.13E-04**

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PERMEABILITY OF GRANULAR SOILS
CONSTANT HEAD METHOD IN RIGID WALL PERMEAMETER
ASTM D 2434

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

PROJECT NO.:	11215020
PROJECT:	VERMILLION POWER STATION
DATE:	5/18/2021

SAMPLE INFORMATION

BORING NO.	MW-37
TIME SAMPLED:	14:15
DEPTH:	51.0'-51.5'
CLASSIFICATION	GRAYISH BROWN POORLY GRADED SAND WITH SILTY CLAY

	INITIAL
DRY UNIT WEIGHT (pcf)	96.2
WATER CONTENT (%)	16.2
DIAMETER (cm)	2.57
LENGTH (cm)	11.84

SUMMARY OF TEST RESULTS

HYDRAULIC GRADIENT	1.3
HEAD HEIGHT (cm)	15.00
VOID RATIO	0.713
HYDRAULIC CONDUCTIVITY k (cm/sec)	**8.16E-04**

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PERMEABILITY OF GRANULAR SOILS
CONSTANT HEAD METHOD IN RIGID WALL PERMEAMETER
ASTM D 2434

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

PROJECT NO.:	11215020
PROJECT:	VERMILLION POWER STATION
DATE:	5/18/2021

SAMPLE INFORMATION

BORING NO.	MW-38
TIME SAMPLED:	9:10
DEPTH:	21.0'-21.5'
CLASSIFICATION	BROWNISH GRAY POORLY GRADED SAND WITH SILT

	INITIAL
DRY UNIT WEIGHT (pcf)	97.2
WATER CONTENT (%)	16.2
DIAMETER (cm)	2.57
LENGTH (cm)	11.82

SUMMARY OF TEST RESULTS

HYDRAULIC GRADIENT	1.7
HEAD HEIGHT (cm)	20.00
VOID RATIO	0.733
HYDRAULIC CONDUCTIVITY k (cm/sec)	**1.67E-04**

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PERMEABILITY OF GRANULAR SOILS
CONSTANT HEAD METHOD IN RIGID WALL PERMEAMETER
ASTM D 2434

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PROJECT NO.:	11215020
PROJECT:	VERMILLION POWER STATION
DATE:	5/18/2021

SAMPLE INFORMATION

BORING NO.	MW-41
TIME SAMPLED:	10:45
DEPTH:	25.5'-26.0'
CLASSIFICATION	BROWN POORLY GRADED SAND

	INITIAL
DRY UNIT WEIGHT (pcf)	90.5
WATER CONTENT (%)	20.2
DIAMETER (cm)	2.57
LENGTH (cm)	11.74

SUMMARY OF TEST RESULTS

HYDRAULIC GRADIENT	1.3
HEAD HEIGHT (cm)	15.00
VOID RATIO	0.824
HYDRAULIC CONDUCTIVITY k (cm/sec)	**2.37E-03**

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PERMEABILITY OF GRANULAR SOILS
CONSTANT HEAD METHOD IN RIGID WALL PERMEAMETER
ASTM D 2434

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

PROJECT NO.:	11215020
PROJECT:	VERMILLION POWER STATION
DATE:	3/18/2021

SAMPLE SPECIFICATIONS

BORING NO.	MW-70SA
TIME SAMPLED:	16:15
DEPTH:	16.5'-17.0'
CLASSIFICATION	BROWN AND DARK BROWN SILTY SAND

	INITIAL
DRY UNIT WEIGHT (pcf)	99.6
WATER CONTENT (%)	15.9
DIAMETER (cm)	2.57
LENGTH (cm)	11.87

SUMMARY OF TEST RESULTS

HYDRAULIC GRADIENT	1.7
HEAD HEIGHT (cm)	20.00
VOID RATIO	0.657
HYDRAULIC CONDUCTIVITY k (cm/sec)	**5.15E-04**

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PERMEABILITY OF GRANULAR SOILS
CONSTANT HEAD METHOD IN RIGID WALL PERMEAMETER
ASTM D 2434

Laboratory Services Group **192 Exchange Blvd** **Glendale Heights, Illinois 60139** **Ph. (630) 717-4263**

PROJECT NO.: 11215020

PROJECT: VERMILLION POWER STATION

DATE: 3/18/2021

SAMPLE SPECIFICATIONS

BORING NO.	MW-71S
TIME SAMPLED:	16:15
DEPTH:	9.5'-10.0'
CLASSIFICATION	GRAY POORLY GRADED SAND

	INITIAL
DRY UNIT WEIGHT (pcf)	93.2
WATER CONTENT (%)	24.8
DIAMETER (cm)	2.57
LENGTH (cm)	11.90

SUMMARY OF TEST RESULTS

HYDRAULIC GRADIENT	0.8
HEAD HEIGHT (cm)	10.00
VOID RATIO	0.772
HYDRAULIC CONDUCTIVITY k (cm/sec)	**1.26E-03**

PERMEABILITY OF GRANULAR SOILS
CONSTANT HEAD METHOD IN RIGID WALL PERMEAMETER
ASTM D 2434

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PROJECT NO.:	11215020
PROJECT:	VERMILLION POWER STATION
DATE:	5/18/2021

SAMPLE INFORMATION

BORING NO.	MW-103
TIME SAMPLED:	13:50
DEPTH:	132.5'-133.0'
CLASSIFICATION	GRAY POORLY GRADED SAND WITH SILT

	INITIAL
DRY UNIT WEIGHT (pcf)	95.2
WATER CONTENT (%)	15.3
DIAMETER (cm)	2.57
LENGTH (cm)	11.85

SUMMARY OF TEST RESULTS

HYDRAULIC GRADIENT	1.3
HEAD HEIGHT (cm)	15.00
VOID RATIO	0.826
HYDRAULIC CONDUCTIVITY k (cm/sec)	**8.17E-05**

URS GEOTECHNICAL REPORT

PIEZOMETRIC CONE PENETRATION TESTING
Dynegy Vermillion Power Plant Ash Ponds
Danville, Illinois

Prepared for:

URS Corporation
1001 Highlands Plaza Drive West, Suite 300
St. Louis, MO 63110
314.429.0100

Prepared by:

STRATIGRAPHICS
The Geotechnical Data Acquisition Corporation
26798 County T
Hillpoint, WI 53937
888.790.CPTU
www.STRATIGRAPHICS.com

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13-130-070

TABLE OF CONTENTS

1.0 EXPLORATION PROGRAM SUMMARY 1

2.0 PENETROMETER EQUIPMENT AND DATA ACQUISITION 2
2.1 Procedure 2
2.1.1 Signal Conditioning and Recording 2
2.2 Soil Shear Resistance Measurements 2
2.3 Piezometric Measurements 2
2.3.1 Piezometer Saturation 3
2.4 Electrical Conductivity Measurements 3
2.5 Natural Gamma Measurements 3
2.6 UV Fluorescence 3
2.7 CPT Seismic Wave Velocity Measurements 3
2.8 CPT-EMOD Measurements 4
2.9 MIP Testing 4
2.10 Penetrometer Geometry 4
2.11 Equipment Decontamination and Grouting 4

3.0 PENETROMETER SAMPLING EQUIPMENT 5
3.1 Groundwater Sampler 5
3.2 Gas Sampler 5
3.3 Soil Samplers 5

4.0 PIEZOMETER INSTALLATION TECHNIQUES 5

5.0 DATA REDUCTION 6

6.0 GENERAL DATA EVALUATION 7
6.1 Sounding Log 7
6.2 Soil Type Classification 7
6.3 Potentiometric Surfaces 7
6.4 Soil Saturation 7
6.5 Soil Hydraulic Conductivity 7
6.6 Soil Electrical Conductivity Behavior 7
6.7 EC Evaluation 8
6.8 UV Fluorescence Behavior 8
6.9 CPT-SPT Correlation 8

7.0 OPTIONAL GEOTECHNICAL DATA CORRELATION 9

8.0 PROGRAM RESULTS 9

9.0 STATEMENT OF LIMITATIONS 9

10.0 REFERENCES 9

FIGURES AND TABULATIONS
APPENDIX A - Evaluation of geotechnical parameters
APPENDIX B - CPTU dissipation test evaluation
APPENDIX C - Seismic low strain property evaluation

1.0 EXPLORATION PROGRAM SUMMARY

STRATIGRAPHICS, The Geotechnical Data Acquisition Corporation, performed geotechnical cone penetrometer exploration for URS Corporation at the Dynegy Vermillion Power Plant Ash Pond site near Danville, Illinois. The purpose of the exploration was to provide supplemental data on subsurface soil foundation conditions at the site. Our rubber tracked ATV CPT rig was used to perform the testing due to access consideration. This ATV CPT rig has a deadweight push capacity of about 10-11 tons, depending on amounts of equipment and water ballast carried on the rig.

The exploration work was performed on July 24, 2013 and consisted of Piezometric Cone Penetration Test (CPTU) soundings at 5 locations. Shallow refusals were encountered at 2 of the 5 locations - CP1301 and CP1304. A second attempt was successful at Location CP1301 with an offset of about 3 ft. Three attempts were made at Location CP1304, with refusal depths at 11.9 ft, 23.9 ft and 24.3 ft. No further attempts were made at this location per the URS representative at the site. All attempts at Location CP1304 were made within an area of about 25 ft of the staked location.

The total CPT exploration footage was 241.6 ft. A total of seventeen CPTU dissipation tests were performed, three in CP-1301a and 14 in CP1302. These two soundings evidenced the best pore pressure response at the site, and had the thickest sequences of saturated fine grained soils.

This electronic report is presented as a PDF document, including CPT sounding logs, summary tables and report text. Numerical data tabulation files are also embedded within the PDF document. The tabulated data are presented in ASCII *.txt and MS Excel *.xls formats. Details of penetrometer exploration techniques are included in the main body of the report. Additional details of CPT data evaluation are presented in the report appendices.

We have also included a copy of our STRATIGRAPHICS Graphical CPT Data Viewer utility. This utility is a greatly simplified version of our powerful, in-house CPT software program STRATIGRAPHER V8.3. The viewer utility allows viewing the CPT soundings on screen, and to look at features in numerical detail through cursor controls. The utility does not support editing or printing sounding logs. If you need such changes, please contact us.

The viewer requires no installation or setup, and will not change your system configuration. To launch the Viewer utility, open the "STRATIGRAPHICS [ProjectName] Graphical CPT Data Viewer" folder and double click on 'STRATIGRAPHICS CPT Data Viewer version 1.5 beta.exe'. Follow the on screen prompts to get it up and running. Use the File Open command to select the CPT sounding you wish to view. Please disregard the contact information on the viewer utility screen. If you have any questions, please contact us via e-mail at stratigraphics@stratigraphics.com or at 888-790-2788.

2.0 PENETROMETER EQUIPMENT AND DATA ACQUISITION

2.1 Procedure The Cone Penetration Test (CPT) consists of smoothly and continuously pushing an instrumented probe (penetrometer) deep into the ground while recording the soil response to penetration (Figure 1). The CPT penetrometer models a foundation pile under plunging failure load conditions. CPT data are used to develop continuous, high resolution profiles of in situ soil conditions rapidly, accurately and economically.

The soil resistance to penetration acting on the tip and along the sides of the penetrometer is measured during CPT. CPT soil resistance measurements are accurate and highly repeatable. The measurements are used for the evaluation of stratigraphy and various geotechnical parameters. Performance of CPT is specified by ASTM Standard D5778. A fluid pressure transducer is added to acquire hydrogeologic data (Saines and others, 1989) and is called a Piezometric Cone Penetration Test (CPTU). A soil electrical conductivity sensor is added to the penetrometer (CPTU-EC) to acquire qualitative moisture information in vadose zone soils and general groundwater quality data (Strutynsky and others, 1991, 1998). Penetrometer groundwater, soil, and soil gas samplers are used for direct sampling (Strutynsky and Sainey, 1990, Strutynsky and others, 1998). Other sensors, described in the report text, are often included during CPT.

The penetrometer is mounted at the tip of a string of sounding rods. A hydraulic ram is used to push the rod string into the ground at a constant rate of 4 ft per minute. Electronic signals from downhole sensors are transmitted to a data acquisition system for display and recording. Heavy trucks or other deployment systems are used to perform CPT. Truck weight and ballast serve to counteract the thrust of the hydraulic ram. Enclosed truck rig work areas allow all-weather operations. Computers, samplers, electrical power, lighting, compressed air, pressure washer, grout pump, and water tank are included on truck mounted rigs, providing for self-contained operations. Onboard GPS receivers are used to record location positions.

No borehole is required during CPT because penetrometers are directly thrust into the soil. Pressures of over 3 million pounds per square foot can be applied to the tip of the penetrometer for penetration of most soils finer than medium gravel. Asphalt pavements up to 6 inches thick can often be penetrated by penetrometer methods without pre drilling. Site disturbance is reduced since no borehole cuttings or drilling fluids are generated during penetrometer operations. Personnel exposure to contaminated soil is less than exposures during drilling and sampling operations. CPT equipment can be decontaminated during retrieval.

Four to thirteen hundred feet of CPT can be performed in a day, depending on site access. Depths of more than 200 ft can be achieved depending on stratigraphy. Where soils are exceptionally dense, gravelly or rubble filled, an uninstrumented prepunch tool can be used for probing. Information obtained using the prepunch tool can be similar to mechanical (Dutch) cone data, and are indicative of subsurface conditions.

2.1.1 Signal Conditioning and Recording CPT data are acquired using a high channel count, 16 bit (resolution of 1 part in 32,768) industrial data logger and an MS Windows computer. Data are recorded on multiple hard and solid state disks for backup, data processing and archiving. Data are graphically displayed during field testing using commercially available Labview software. CPT data processing is performed using a proprietary software package STRATIGRAPHER (tm) developed by STRATIGRAPHICS.

2.2 Soil Shear Resistance Measurements The soil penetration resistance is measured on the tip and along the sides of the CPT penetrometer using strain gage loadcells (Figure 1, Strutynsky and others, 1985). The conical tip of the penetrometer has a projected cross-sectional area of 15 square centimeters (2.3 sq. in.) and a diameter of 1.7 inches. The cone tip resistance reflects the deep bearing capacity of a soil. Soil friction is measured along a cylindrical sleeve mounted behind the cone tip. The friction sleeve has a surface area of 200 square centimeters (31.0 sq. in.), a length of 5.8 inches, and a diameter slightly larger than the cone tip. The cone tip measurement has a layer resolution of about 2 to 4 inches, while the friction sleeve resolution is about 6 inches.

2.3 Piezometric Measurements A fluid pressure transducer is mounted inside the CPTU penetrometer to measure the soil pore water pressure response to penetration. The advance of the penetrometer causes local, intense volumetric distortion of surrounding soil. This generates a localized pore water pressure field in saturated soils. These generated pressures dissipate almost instantaneously (drained loading) in soils of high permeability, so equilibrium water pressures are typically measured during CPTU in coarse sand and gravel. In medium or low permeability soils, the generated pore water pressure field is sustained for a substantial period of time (partially drained to undrained loading) and can be either negative (dilative) or positive (compressive) relative to the equilibrium (hydrostatic) water pressure field existing before penetration.

The dissipation of generated pore water pressures is recorded during pauses in penetration. The rate of dissipation can be used to estimate soil hydraulic conductivity and consolidation characteristics. If the pauses are long enough for all of the generated water pressures to dissipate, equilibrium potentiometric surface measurements can be obtained at multiple depths in a single CPTU sounding. The CPTU piezometric measurement has a layer resolution of about 1 inch.

2.3.1 Piezometer Saturation The CPTU piezometric measurement system is saturated fully assembled in a 15-50 micron Hg vacuum chamber using silicon oil. This procedure is used to remove as much air as practically possible from the piezometric assembly, to provide as near to an incompressible condition as possible so that near instantaneous responses (zero lag time) to rapidly changing generated pore water pressures are measured during CPTU. High piezometric system saturation levels are indicated by sharp responses at soil interfaces and immediate regeneration of piezometric pressures after pauses in penetration.

Low piezometric measurement system saturation levels leading to poor (lagging) measurements can be caused by inadequate system preparation. Soil suction above the water table, cavitation in highly dilative soils, filter clogging in fine grained soils and filter damage on coarse soil particles or pavement can also occur and cause less than ideal measurements. These problems are beyond the control of the operator and occur with some frequency when testing soils on land. Overwater work provides a more benign environment for CPTU measurements. CPTU piezometric measurements are often less repeatable than CPT tip and friction sleeve resistance measurements.

2.4 Electrical Conductivity and Thermal Measurements A CPTU-EC penetrometer including tip, sleeve, piezometric, temperature, and electrical conductivity (EC) sensors can be used to simultaneously acquire geotechnical, hydrogeological and qualitative geochemical information. Soil EC is measured using a two electrode array, energized with a 3 kHz signal, mounted on the penetrometer tip. The EC measurement has a resolution of about 1 inch. The CPT thermal sensor is used to acquire soil thermal properties.

2.5 Natural Gamma Measurements A CPTU-EC-G penetrometer incorporating cone, friction, piezometric, soil electrical conductivity and natural gamma (G) sensors can be used to simultaneously acquire geotechnical, hydrogeological, qualitative geochemical and radiological information. Gamma measurements can be used to detect radionuclide contamination and to enhance lithologic evaluation.

2.6 UV Fluorescence A CPTU-EC-UVF penetrometer incorporating cone, friction, piezometric, soil electrical conductivity, and Ultraviolet Fluorescence (UVF) sensors can be used to simultaneously acquire geotechnical, hydrogeological, and qualitative geochemical information. The UVF system consists of a sapphire window in the penetrometer, a monochromatic LED UV excitation light source, and photodiode light detectors. UV light is transmitted through the window into the adjacent soil. If the soil contains compounds such as petroleum hydrocarbons that fluoresce, the photodiodes are used to detect the resulting light. The UV excitation has a wavelength of 250 nm. The photodiode sensors are longpass filtered to monitor resulting fluorescent light emissions above 280 nm.

2.7 CPT Seismic Wave Velocity Measurements A vibration receiver module is attached to the penetrometer to acquire seismic (vibration) wave velocity data. CPT vibration sensors have exceptionally good coupling to the surrounding soil resulting in good reception of the high amplitude S-wave arrival. Sensor coupling using packers in cemented and cased boreholes, in contrast, is typically much poorer than that using CPT deployment methods.

The STRATIGRAPHICS CPT seismic wave measurement system consists of downhole vibration sensors, an uphole manual or autohammer wave source with timing trigger, industrial multi-channel, high speed analog to digital converter, and PC signal acquisition and analysis software.

The seismic test procedure is as follows: 1) the CPT and vibration sensor module is pushed to a test depth while acquiring the continuous CPT data; 2) a repeatable shear source wave is generated at the surface; 3) vibration sensor output is recorded as a function of time after source wave triggering; and 4) a consistent reference point on the recorded wave form is picked to indicate wave arrival. The procedure is repeated at multiple depths during the penetration process to allow calculation of pseudo-interval wave velocities between adjacent tests.

Two types of vibration sensors can be used for CPT seismic testing. A low frequency response geophone can be used to acquire data at sites where background environmental noise levels are high. Triaxial accelerometer sensors can be used to acquire multi-channel S-wave data at quiet sites. The accelerometers have a much wider frequency response as compared to the geophones, and are much more sensitive to vibrations. This sensitivity can result in noisy recordings which can preclude good picks of wave arrivals at some industrial sites.

2.8 CPT-EMOD Measurements The standard CPT procedure is conducted as a constant rate of strain test, resulting in a continuous measurement of soil ultimate bearing and frictional strength. By conducting CPT under monotonically increasing stress conditions, soil deformation properties can be evaluated. The CPT-EMOD test is conducted during short pauses in the continuous push process. Load/settlement data are analyzed using elastic theory, as is done for a plate load test for evaluation of Young's Modulus at various stress levels.

2.9 MIP Testing A MIP (Membrane Interface Probe) adapter can be added to the CPT rod string to allow geochemical testing of penetrated soils. The MIP consists of a permeable membrane, heater block with thermocouple and gas carrier tubing. The heater block is set to a temperature of 120-130 degrees C, which heats up the surrounding soil, and volatilizes contaminants in the soil. The volatiles pass through the permeable membrane, and are swept up to the surface by a carrier gas, typically nitrogen, which passes across the back of the membrane.

Once the carrier gas brings the volatiles to the surface, various detectors can be used to characterize the contaminants. A simple photoionization detector (PID) sensor suite is available for rapid screening studies. Two PID sensors, one with a lamp of 10.6 eV energy, and the second with a 9.6 eV lamp, are included in this simple screening suite. More sophisticated analytical equipment, such as GC-MS, can also be used to analyze the volatiles swept up by the carrier gas.

2.10 Penetrometer Geometry The CPT penetrometer external geometry is specified by ASTM standards. Differences in penetrometer internal design can lead to some variability in response between penetrometers of different manufacture, especially in very soft clays. STRATIGRAPHICS uses a cone with a 15 sq cm tip and a 200 sq cm sleeve. The CPTU measurement of generated water pressure depends on external filter geometry. Measurements of equilibrium water pressures after pauses in the penetration process are not sensitive to geometry, and reflect undisturbed conditions.

CPTU piezometric filters are typically mounted on either the cone tip (U1 position) or just ahead of the friction sleeve (U2 position). Each position has advantages and disadvantages. Measurements taken with the cone tip U1 filter are at a maximum and show high resolution of thin soil seams. The cone tip U1 filter is prone to damage on coarse soil particles. Negative pressures are often measured in dense, silty or clayey sands and hard clays when using the U2 friction sleeve filter. These low pressures are probably caused by soil elastic rebound (expansion) as the soil moves from the intensely loaded region beneath the cone tip to the less loaded region next to the friction sleeve. Soil expansion can induce large suction forces on the U2 friction sleeve filter, which can result in decreased filter saturation levels.

Site characteristics and data usage determine which piezometric filter geometry is appropriate. The piezometric filter is placed at the U2 friction sleeve position on the STRATIGRAPHICS CPTU-EC penetrometer. The filter housing is internal to the cone tip. Generally good results can be obtained using this geometry when proper filter preparation techniques are followed.

2.11 Equipment Decontamination and Grouting The rod string is retrieved through a rodwasher mounted on the hydraulic ram assembly. A pressure washer is used to spray water from internal nozzles within the rod washer to clean the rod string. Wash water (about ½ gallon per 10 ft of rod) can be captured for disposal.

The STRATIGRAPHICS grouting system can be used to seal open hole. As penetrometers are being advanced, bentonite grout (about ¼ to ¾ gallon per 10 ft of open hole) is pumped into the annular space formed between the smaller diameter sounding rods and the larger diameter penetrometer. A bypass is opened and additional grout is pumped to seal the hole during rod string retrieval. Pressure grouting during sounding advance can control cross-contamination between different strata. The grout decreases the contact of downhole equipment with contaminated soil. The grout also can decrease rod friction which may allow deeper penetration. Grout levels are checked after sounding completion, and more grout is added to account for penetration of grout into permeable strata.

3.0 PENETROMETER SAMPLING EQUIPMENT

Groundwater, soil gas, and soil samplers are deployed in the same manner as CPT penetrometers. Good sample isolation is achieved because no open hole exists during penetrometer operations.

3.1 Groundwater Sampler The STRATIGRAPHICS groundwater sampler is a shielded wellpoint sampler of heavy construction. The shield controls cross contamination of the sampler while penetrating soils above the sampling depth. Where LNAPL or DNAPL is expected, the sampler and rod string can be prefilled with distilled water during deployment, to provide positive pressure within the sampler, which prevents any product from entering the sampler prior to sampler opening. The DI water is pumped out immediately before opening the sampler. After shield retraction and sampler opening, groundwater flows under in situ pressure conditions, through a 20 inch long screen, into the 350 ml sample barrel, and up the rod string. Small diameter pumps can be used with the sampler to acquire large volumes of sample. This sampler can be deployed in most soils capable of being penetrated by the CPTU-EC penetrometer (Strutynsky and others, 1998).

For the best isolation of samples, the groundwater sampler is first deployed to the shallowest sampling interval, opened, and sample is acquired. The sampler is retrieved to pour off the sample and for decontamination. This process is repeated at each subsequently deeper sampling interval (top/down sampling).

A less expensive method of groundwater sampling is to use a “bottom/up” deployment mode. The groundwater sampler is deployed to the deepest interval, opened, and sample is pumped to the surface. The sampler is then pulled up to the next shallower interval, purged, and sample is pumped again. This procedure is repeated until the shallowest sample has been obtained. If the sampler screen clogs due to fines in the sampled formations, the sampler must be tripped out, deconned, and re-deployed. Bottom/up sampling is most often used at sites with very dense sands and gravels where deep deployment is a problem. The sampler is typically deployed down the same pathway created by the CPTU-EC stratigraphy tool. Since sands cannot maintain an open hole below the water table, good isolation of sampling intervals can be achieved using the bottom/up method.

A pressure transducer can be placed inside the groundwater sampler barrel. This allows the measurement of sample inflow rate. Analysis of inflow data using rising head slug test methods can provide a means of estimating soil hydraulic conductivities. If equilibrium conditions are reached, a measurement of the static water pressure head is obtained during groundwater sampling.

3.2 Soil Gas Sampler The STRATIGRAPHICS soil gas sampler is a shielded screen sampler, similar to the groundwater sampler. The shield is opened by pulling back the rod string during sampling, and soil gases are then purged and extracted. The shield can be closed, and the rod string advanced to another depth, allowing multiple samples during a single rod trip. A vacuum box can be used to inflate Tedlar bags for off site analysis. Portable analytical equipment can be used to allow immediate soil gas profiling.

3.3 Soil Samplers Fixed piston samplers are used to obtain soil samples during penetrometer exploration. A piston, locked into the tip of the barrel to prevent soil from entering the sampler prematurely, is released at the sampling depth. The barrel is then advanced to the bottom of the sampling interval. The soil enters the 1.25 inch diameter, 14 inch long barrel and is retained by a core catcher. The sampler is retrieved to remove the sample and for sampler decontamination. The sampler can be pushed into soils as dense as about 350-400 TSF cone tip resistance, or about 50 to 80 blows per foot SPT.

4.0 PIEZOMETER INSTALLATION TECHNIQUES

Penetrometer methods can be used to install piezometers for water level measurements, slug testing, groundwater sampling, and for remediation activities, such as sparging and soil vapor extraction (SVE). Various installation techniques are available (Saines and others, 1989). Proprietary, low volume change piezometers also can be installed using penetrometer equipment. These piezometers are often used for long term water pressure measurements during geotechnical projects. PVC piezometers are installed using a steel casing pushed to depth. The casing is sealed with an expendable tip which prevents soil from entering the casing during deployment. The PVC screen and risers are lowered into the casing, the casing is then withdrawn, leaving the PVC in place.

5.0 DATA REDUCTION

Test data are monitored as the soundings are performed. Data are recorded on hard disk and may consist of: depth, time, tip and sleeve resistance, generated water pressure, EC, UVF, temperature and natural gamma. Data are processed in-house and undergo quality control review prior to final reporting.

Several parameters can be computed to enhance data correlation:

friction ratio, FR (in %):

FR = fs/qc * 100 (Eq. 1); and

pore pressure ratio, Bq (dimensionless):

Bq = (U-Ue)/(qc-Sv) (Eq. 2);

where: *fs* is the measured friction sleeve resistance, in TSF;
qc is the measured cone end bearing resistance, in TSF;
U is the measured generated pore water pressure, in TSF;
Ue is the measured or estimated equilibrium pore water pressure, in TSF; and
Sv is the total soil overburden pressure, in TSF.

Measured data, computed and correlated parameters are presented in a graphical sounding log format for each sounding; numerical data are typically tabulated at 0.5 ft intervals. Digital data are also included on disk.

CPTU dissipation test data are recorded as a function of time during pauses in the penetration process. Dissipation data are normalized using the following equation:

normalized dissipation level, U* (dimensionless):

(Ut - Ue) / (U0 - Ue) (Eq. 3);

where: *Ut* is the excess pore water pressure at time t, in TSF;
Ue is the measured or estimated equilibrium, undisturbed pore water pressure (in situ pore water pressure before penetrometer insertion), in TSF; and
U0 is the excess pore water pressure at time equal to zero, at the start of the dissipation test, in TSF

The normalized dissipation level is plotted versus log time. In uniform soils, the plot takes the shape of a reverse S-curve, beginning at one at zero time (at the instant the penetration process is stopped) and falling to zero when equilibrium pressures are achieved. Boundary effects in interbedded deposits can cause deviation from this ideal.

An estimate of the horizontal coefficient of soil consolidation can be calculated (Baligh and Levadoux, 1980) using: Ch (in cm**2/sec) = (r**2*T)/t (Eq. 4a).

Estimates of soil hydraulic conductivity in the horizontal direction can be calculated using:

kh (in cm/s) = ((r**2*T)/t)*RR*(Gw/(2.3*Sv')) (Eq. 4b);

where: *r* is the penetrometer radial dimension at the plane of the piezometric filter, equal to 2.2 cm for the U2 friction sleeve filter and 1.9 cm for the U1 cone tip filter;
T is a dimensionless time factor at the 50% normalized dissipation level, equal to 5.5 for the U2 friction sleeve filter and 3.8 for the U1 cone tip filter;
t is the measured time, in seconds, at which the normalized dissipation level is 50%;
RR is a dimensionless soil compressibility parameter;
Gw is the unit weight of water, in kg/cm***3; and
Sv' is the effective soil vertical overburden pressure, in kg/cm**2.

Dissipation test data can be presented in graphical plots and are summarized in tabular form.

6.0 GENERAL DATA EVALUATION

6.1 Sounding Log The CPT sounding logs provide high resolution information on subsurface conditions. Soil layering is often highly apparent. Soil relative strength and saturation levels can also be evaluated. Zones of anomalous soil electrical conductivity can be identified. Apparent lateral continuity of conditions can be evaluated by comparing adjacent soundings. Digital CPT data files can be used in two and three dimensional data visualization, CAD or GIS software programs.

6.2 Soil Type Classification Correlations between penetrometer data and soil classification have been developed from geotechnical bearing capacity theory and a relational database on adjacent CPT soundings and drilled boreholes (Douglas and Olsen, 1981). A CPT soil type chart based on cone tip resistance and friction ratio is presented in Appendix A.

The CPT tip resistance increases exponentially with soil grain size. For example, tip resistance in dense sands ranges from about 100 to 400 tons per square foot (TSF), while tip resistance in a stiff clay ranges from about 5 to 15 TSF. The friction ratio (Section 5.0) is also used for indication of soil type. The friction ratio increases with the fines content and compressibility of a soil. The friction ratio is less than about 1% in a sand and greater than about 3% in a clay. CPT soil types reflect the soil shear resistance to penetration. Soil shear resistance is not entirely controlled by grain size distribution. However, CPT soil types generally agree with classifications based on grain size distribution methods, such as the Unified Soil Classification System (USCS).

The generated pore water pressure measurement is also useful for evaluation of saturated soils. Penetration of coarse sand and gravel occurs under drained loading conditions, and thus equilibrium pressures are measured during CPTU. The pore pressure ratio (Section 5.0) is zero in high permeability soils. For saturated soils of permeability less than about 1*10E-2 cm/sec, undrained loading with significant excess water pressure generation occurs during CPTU. Positive excess water pressures are generally measured during penetration of silt or clay soils when using either the U1 cone tip or U2 friction sleeve filter penetrometer (Section 2.7). Pore pressure ratios of fine grained soils typically range from about 0.4 to 1.0.

Positive excess water pressures are also usually measured in dense, silty or clayey sands when using the U1 filter penetrometer, with pore pressure ratios from about 0 to 0.3. Due to geometric effects (Section 2.7), negative pressures are usually measured in dense, silty or clayey sands, sandy silts, or hard sandy clays with the U2 filter penetrometer. Thus, it is important to note the type of piezometer filter in use. The CPTU-EC penetrometer uses a U2 friction sleeve piezometric filter.

6.3 Potentiometric Surfaces Equilibrium water pressures are measured during penetrometer advance in saturated, coarse sand and gravel. Measurements of equilibrium water pressures can be obtained during CPTU in lower permeability soils by pausing during penetration and allowing generated water pressures to dissipate.

6.4 Soil Saturation Soil saturation often can be evaluated using the CPTU sounding log. Atmospheric (zero) pressure is measured during CPTU in unsaturated soils. Hydrostatic pressures are measured in saturated, high permeability soils. Significant water pressures are generated in saturated, low permeability soils due to penetrometer advance. Decreased levels of water pressure generation can be indicative of partially saturated soils. Decreased water pressure generation also may occur in organic soils due to the high compressibility of organic soil particles and the presence of biogenic gases, such as methane and hydrogen sulfide.

6.5 Soil Hydraulic Conductivity Excess water pressures are generated by penetrometer advance in saturated soils with permeability of less than about 1*10E-2 cm/sec. These generated pressures can be allowed to dissipate during pauses in the penetration process. The CPTU dissipation test is similar to a slug test and can be used to estimate soil hydraulic conductivity in the horizontal direction. Very high water pressures are typically generated in low permeability soils by penetrometer advance, so soil compressibility (storage) effects must be included in analyses. The CPTU tip resistance provides an index of soil compressibility for these computations.

6.6 Soil Electrical Conductivity Behavior Soil electrical conductivity (EC) is controlled by the conductance of both the soil particles and soil pore fluids. The ratio between pore fluid and soil-pore fluid electrical conductivity is termed the formation factor (Archie, 1942). Clays can be electrically conductive due to adsorbed water and ionic electrical charges on the clay platelets. Thus, clay EC depends on mineralogy, porosity and pore fluid characteristics. Sand grains are typically non-conductive, so granular soil conductance is primarily dependent on the conductance of pore fluids and the sand's porosity.

Pore fluids play a major role in sand EC. A dry sand has low EC since both the sand grains and the air in the pore space have very low conductance. Sands saturated with conductive liquids, such as brine or landfill leachates, have high EC. Hydrocarbons typically decrease EC because of their low conductance. **Soil saturation** has a pronounced effect on sand EC, as conductance increases with water saturation. Low saturation is typically associated with low EC. The low **porosity** of a dense sand results in less pore fluid available for electrical conductance and thus lower EC; the high porosity of a loose sand is often associated with higher EC. Formation factors vary as an inverse function of porosity, from about 3 at high porosity to about 4.5 at low porosity. The addition of as little as 5% clay to a sand can increase soil EC (Windle, 1977).

The high resolution of the STRATIGRAPHICS CPTU-EC electrode array makes measurements sensitive to gravel content. Two behaviors can occur when penetrating gravelly soils. One can occur when a large particle is crushed against an electrode, masking it from the pore fluids, which results in low EC values. An opposite behavior is observed in gravel deposits which contain few fine grained intersticial soils. The high resolution EC measurement can result in electrical conductance paths within the soil pore space. In this situation, high EC measurements more closely reflect pore fluid EC, rather than soil EC.

6.7 EC Evaluation EC data are evaluated in conjunction with CPTU-EC piezometric data and soil types for qualitative geochemical characteristics. Anomalous zones possibly indicative of contaminants can be directly sampled for quantitative chemical analysis.

Vadose Zone Low or zero EC values are typically measured in dry sandy soils. Increased EC in vadose zone sands may indicate moisture infiltration. Low EC data in vadose zone silty or clayey soils can be anomalous as fine grained soils often retain significant amounts of moisture within their pore spaces due to capillarity. Elevated EC values in the vadose zone may be associated with road deicing salts, buried metals and rusted metal objects, flyash and cinders, among others.

Saturated Soils Low EC values in saturated soils can be indicative of anomalous geochemistry. In particular, depressed EC zones immediately at the water table may be associated with floating (LNAPL) compounds. Very low EC zones at interfaces between aquifers and aquitards may be associated with either LNAPL or DNAPL compounds. Gravel interference must be considered when evaluating depressed EC zones in saturated soils.

Elevated EC values in saturated soils can be due to increased soil clay content or to increased dissolved salts in the ground water. Increased clay contents are evaluated based on the CPTU-EC piezometric data and soil type information. Zones of elevated EC immediately above an aquiclude may be associated with brines or landfill leachates (Strutynsky and others, 1998).

6.8 UV Fluorescence Behavior Fluorimetry (measurement of fluorescence) has been used for many years for the detection and identification of various compounds and minerals. An excitation light of short wavelength is used to expose the specimen. If fluorescent compounds or minerals are present, light of longer wavelength, as compared to the excitation wavelength, will be emitted from the specimen. This resulting light can be monitored for intensity and spectral distribution.

Compounds that fluoresce include a wide range of hydrocarbon and other organic compounds. Heavy hydrocarbons (e.g. fuel oil and coal tars) fluoresce at relatively long wavelength excitation. As excitation wavelength decreases below about 300 nm, fluorescence from lighter hydrocarbons (e.g. jet fuel and gasoline) is observed. In addition to hydrocarbons, other compounds and minerals, such as fluorites and other carbonates, also exhibit fluorescence. Compounds that fluoresce include dyes and optical brighteners, used in paints, detergents, antifreeze compounds, some food additives and cosmetics, among others. UVF response will be affected by the presence of any such compounds.

6.9 CPT-SPT Correlation Since most geoscientists are familiar with drilling and split spoon sampling, CPT data have been correlated with SPT blowcount N-values. The SPT N-value is defined by ASTM to be the number of blows of a 140 lb hammer, dropped 30 inches, required to drive a 2 inch outside diameter sampler 12 inches into the bottom of the borehole, after an initial seating drive of 6 inches. Correlations of CPT to the crude SPT have been based on numerical modeling of the two penetration processes and on side by side comparisons (Douglas and others, 1981). Additional details on CPT-SPT correlations are included in Appendix A.

7.0 GEOTECHNICAL DATA CORRELATION

CPT data have been correlated with soil type, drained friction angle, undrained shear strength, relative density and SPT blowcounts, among others. A correlation scheme including tip resistance and friction ratio has generally proved most useful for evaluating CPT data. Correlation of CPT data with other parameters has been developed using: 1) comparisons between CPT data and results of other in situ and laboratory tests in adjacent boreholes; 2) CPT testing on large scale soil samples of known composition; and 3) geotechnical bearing capacity and cavity expansion theory. Site specific information can be used to fine tune correlations. Additional information on correlation techniques, including overburden pressure normalization, test drainage conditions and recommended practices, is presented in Appendix A.

8.0 PROGRAM RESULTS

Acquired data are presented following the report text and consist of: 1) sounding logs with lithologic evaluation; 2) data presentation sounding logs; and 3) tabulations of correlated geotechnical parameters, including soil classifications. Digital data are presented on the attached disk, and include statistical summaries of evaluated strata for each sounding, among other data presentations. It should be noted that the computerized evaluations of soil types and other geotechnical properties were generated using a global rather than site specific data base. Use of site specific data was beyond the scope of this study.

9.0 STATEMENT OF LIMITATIONS

Subsurface information was gathered only at the sounding locations. Extrapolation of sounding data to develop stratigraphic continuity is conjectural. Actual site conditions between sounding locations may differ. Evaluation of soil saturation and potentiometric surfaces is only representative of conditions encountered during the field program. Seasonal variation must be expected.

Correlation of penetrometer data with other parameters was performed using generalized, global charts rather than on site specific information. Site specific correlation work based on results of detailed, complementary laboratory testing was beyond the scope of this study.

Data gathering for this study was attempted to be performed in general accordance with accepted procedures and practices. Correlation of penetrometer data with other parameters is empirical and should not be considered as the exact equivalent of laboratory testing. STRATIGRAPHICS shall not be responsible for another's interpretation of the information obtained for this study.

10.0 REFERENCES

Archie, G.E.,1942. The Electrical Resistivity Log as an Aid in Determining some Reservoir Characteristics. AIME Vol. 146.

Baligh, M.M. and J. Levadoux, "Pore Pressure Dissipation After Cone Penetration," Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1980.

Davidson, J.L., A. Boghrat, 1983. Displacement and Strains around Probes in Sand. Geotechnical Practice in Offshore Engineering, ASCE.

Douglas, B.J., G. Martin, 1981. Evaluation of the Cone Penetrometer for Liquefaction Studies, Imperial Valley Earthquake, California. Fugro, Inc., report for U.S. Geological Survey, No. 81-502.

Douglas, B.J., R. Olsen, 1981. Soil Classification using the Electric Cone Penetrometer. Cone Penetrometer Testing and Experience, ASCE.

Douglas, B.J., R. Olsen, G. Martin, 1981. Evaluation of the Cone Penetrometer Test for use in SPT Liquefaction Potential Assessment. In Situ Testing for Liquefaction Evaluation, ASCE.

Douglas, B.J., A. Strutynsky, 1984. Cone Penetration Test, Pore Pressure Measurements, and SPT Hammer Energy Calibration for Liquefaction Hazard Assessment. The Earth Technology Corporation, report for U.S. Geological Survey, No. 14-08-0001-19105.

Douglas, B.J., A. Strutynsky, S. Brown, 1984. In Situ Testing II, Peoples' Republic of China. The Earth Technology Corporation, report to the National Science Foundation, No. CEE 8311873.

Douglas, B.J., A. Strutynsky, L. Mahar, J. Weaver, 1985. Soil Strength Determinations from the Cone Penetrometer Test. Civil Engineering in the Arctic Offshore, ASCE.

Durgunoglu, H.T., J. Mitchell, 1974. Influence of Penetrometer Characteristics on Static Penetration Resistance. First European Symposium on Penetration Testing.

Lunne, T., O. Eide, J. de Ruiter, 1976. Correlations between Cone Resistance and Vane Shear Strength in Scandinavian Soft to Medium Stiff Clays. Canadian Geotechnical Journal, Vol. 13.

Mayne, P.W.,1988. Determining OCR in Clays from Laboratory Strength. ASCE Journal of Geotechnical Engineering, Vol.114, No. 1.

Mayne, P.W., 1991. Determination of OCR in clays by piezocone tests using cavity expansion and critical state concepts. Soils and Foundations, 31(2), 65-76.

Mayne, P.W., 1993. In-situ Determination of Clay Stress History by Piezocone. Predictive Soil Mechanics. Proceedings of the Wroth Memorial Symposium.

Olsen, R.S., J. Farr, 1986. Site Characterization using the Cone Penetrometer Test. Use of In Situ Tests in Geotechnical Engineering, ASCE.

Rocha-Filho, P., 1979. Behavior of Cone Penetrometer in Saturated Sands. Ph.D. Thesis, Imperial College, London, England.

Saines, M., A. Strutynsky and G. Lytwynyshyn, 1989. Use of Piezometric Cone Penetration Testing In Hydrogeologic Investigations. First USA/USSR Conference on Hydrogeology, Moscow, USSR.

Sanglerat, G., 1972. The Penetrometer and Soil Exploration. Elsevier Publishing Co.
Schmertmann, J.H., 1978. Guidelines for Cone Penetration Testing, Performance and Design. U.S. Department of Transportation, FHWA-TS78-209.

Seed, H.B., K. Mori, C. Chan, 1977. Influence of Seismic History on Liquefaction of Sands. ASCE Journal of Geotechnical Engineering, Vol. 103, No. GT4.Seed, H.B., K. Tokimatsu, L. Harder, R. Chung, 1984. The Influence of SPT Procedures in Soil Liquefaction Resistance Evaluations. University of California, report to the National Science Foundation and National Bureau of Standards, No. UCB/EERC84/15.

Strutynsky, A.I., 1988. Stress History and Normalized Soil Behavior from CPT. Presented at the session on site characterization, First International Symposium on Penetration Testing.

Strutynsky, A.I., B. Douglas, L. Mahar, G. Edmonds, E. Hencey, 1985. Arctic Penetration Test Systems. Civil Engineering in the Arctic Offshore, ASCE.

Strutynsky, A.I., R. Sandiford, D. Cavaliere, 1991. Use of Piezometric Cone Penetration Testing with Electrical Conductivity Measurements (CPTU-EC) for Detection of Hydrocarbon Contamination in Saturated Granular Soils. Current Practices in Ground Water and Vadose Zone Investigations, ASTM.

Strutynsky, A.I., T. Sainey, 1990. Use of the Piezometric Cone Penetration Test and Penetrometer Groundwater Sampling for Volatile Organic Contaminant Plume Detection. Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Prevention, Detection and Restoration. API/NWWA.

Villet, W.C.B., J. Mitchell, 1981. Cone Resistance, Relative Density and Friction Angle. Cone Penetrometer Testing and Experience, ASCE.

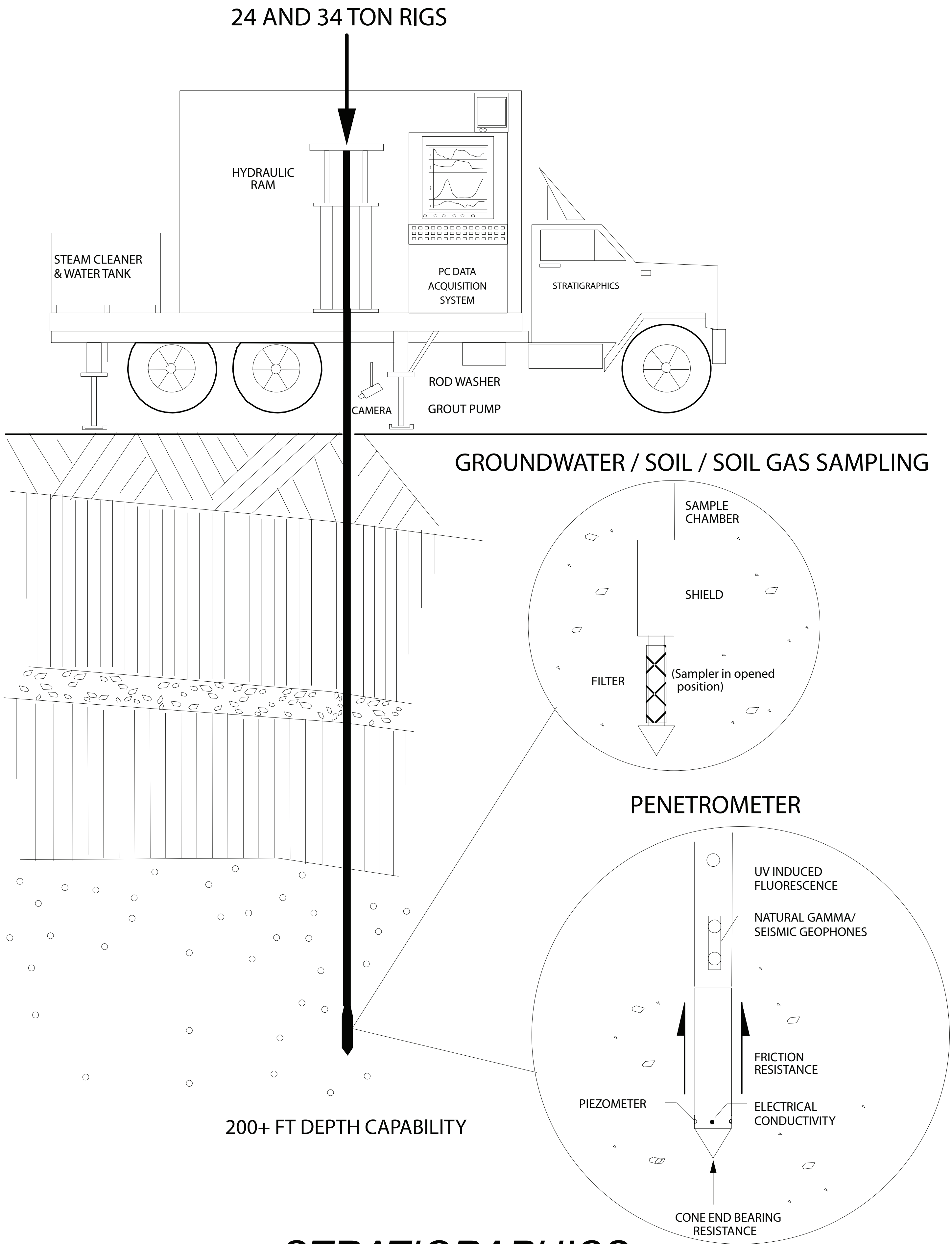

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Figure 1

APPENDIX A
TABLE OF CONTENTS

A1.0 EVALUATION OF GEOTECHNICAL PARAMETERS	A1
A1.1 Soil Behavior Types	A1
A1.2 Relative Density	A1
A1.3 Static Drained Strength	A1
A1.4 Static Undrained Strength	A1
A1.5 Evaluation of Stress History	A2
A1.6 SPT Blowcount Values	A2
A2.0 OVERBURDEN PRESSURE NORMALIZATION	A3
A3.0 TEST DRAINAGE CONDITIONS	A4
A4.0 RECOMMENDED PRACTICES	A4

1.0 EVALUATION OF GEOTECHNICAL PARAMETERS

CPT data have been correlated with soil type, drained friction angle, undrained shear strength, relative density, and equivalent SPT blowcounts, among others. Correlations have been developed by comparing CPT results to laboratory tests on drilled samples and to other in situ tests, such as vane and pressuremeter. Laboratory CPT testing on large scale samples of known composition and classical bearing capacity and cavity expansion theory have also been used. Site specific information, where available, can be used to fine tune correlations.

A two parameter correlation scheme has proved useful for CPT data evaluation. Geotechnical properties often exhibit well defined trends when plotted against the logarithm of the CPT cone end bearing resistance and friction ratio. For instance, increased grain size increases cone end bearing resistance, while increased plasticity and compressibility increase friction ratio. A chart illustrating these and other trends is presented in Figure A1. A discussion of CPT data evaluation is presented in Douglas and Olsen, 1981.

<u>A1.1 CPT Soil Behavior Types</u> CPT soil behavior type correlations (Figure A2) have been developed from geotechnical theory and comparisons of borehole data with CPT data (Douglas and Olsen, 1981). The CPT soil type tabulations are indicative of the response of the soil to the large shear deformations imposed on the soil during penetrometer advance. Soil shear response is not entirely controlled by grain size distribution. However, it has been found that CPT soil types generally agree with classifications based on soil grain size distribution methods such as the Unified Soil Classification System (USCS).

<u>A1.2 CPT Relative Density</u> Relative densities of granular soils are correlated with CPT data (Figure A3) on the basis of laboratory CPT on large scale samples of known composition (Schmertmann, 1978, and Villet and Mitchell, 1981). The effect of soil fines content has been empirically accounted for by extrapolating trends in the two parameter correlation model (Douglas and Strutynsky, 1984).

<u>A1.3 CPT Drained Static Strength</u> Drained friction angles have been correlated with CPT data (Figure A3) on the basis of CPT soundings and laboratory tests on drilled samples, and on theoretical analyses of the cone end bearing capacity problem (Schmertmann, 1978, Durgunoglu and Mitchell, 1974, and Villet and Mitchell, 1981). The effect of soil fines content on friction angles has been accounted for by extrapolating trends in the two parameter correlation model, as was done for the relative density correlation.

<u>A1.4 CPT Undrained Static Strength</u> The correlation between CPT data and undrained shear strength has been extensively studied (Douglas and others, 1984, Lunne and others, 1976, Sanglerat, 1972, and Schmertmann, 1978). The following bearing capacity equation can be used for computing undrained shear strength from CPT data: qu = (Su * Nc) + Sv (Eq. A1); where: qu = ultimate bearing capacity; Su = undrained shear strength; Nc = a dimensionless bearing capacity factor; and Sv = the estimated total vertical stress. By setting qu equal to the cone end bearing resistance, qc, and rearranging the equation, a value of the undrained shear strength can be computed as: Su = (qc - Sv) / Nk (Nk is equivalent to Nc in Eq. A1) (Eq. A2).

The primary difficulty in using this equation has been the selection of Nk applicable to cone penetration in a particular soil. Bearing capacity and cavity expansion theory and other in situ and laboratory test results performed adjacent to CPT soundings have been used to calculate Nk values. These Nk values have ranged from 5 to over 25, but are most often between about 12 and 20. Higher Nk values are typically associated with overconsolidated clays and lower plasticity clays and clayey silts.

A compilation of Nk values as a function of cone end bearing resistance and friction ratio is presented in Figure A4. This figure was developed from comparisons of CPT to results of laboratory consolidated-undrained (CU) strength tests. This is important to note as undrained shear strength is not a unique property of a soil - it is test type and stress path dependent.

Many design methodologies are based on a particular strength test on a particular type of sample. These semi-empirical design methods are successfully used by experienced designers. Engineering judgment must be applied in using the results of any type of testing to assure both adequate safety and design economy.

<u>High Strain, Remolded Strength</u> Another measure of the in situ undrained shear strength is provided by the CPT friction sleeve resistance. The friction sleeve interacts with soil that has already undergone bearing capacity failure induced by the tip of the penetrometer. Thus, the friction sleeve resistance is a measure of soil large strain, remolded strength. The ratio between strengths calculated from the cone end bearing and from the friction sleeve is indicative of soil sensitivity.

In moderately to highly overconsolidated, non-sensitive clays, friction sleeve resistances can indicate higher strengths than those calculated using the cone end bearing resistance. This often reflects the dilative (strain hardening) nature of shear failure in overconsolidated soils. Engineering judgment must be applied in deciding which strain level, and thus which strength, is representative for the design problem to be solved.

<u>A1.5 Evaluation of Soil Stress History</u> The results of penetrometer testing can often be evaluated for indication of clay soil stress history or pre-consolidation pressure. Several methods are available for this evaluation. The first method consists of computing a normally consolidated cone end bearing resistance profile, based on estimated soil unit weights, water table information, cohesion at the ground surface, and an assumed c/p ratio and cone factor Nk for the clay strata in question. This normally consolidated profile is then compared to the measured profile, and differences between the two can be assumed to be due to past stress history events (Schmertmann, 1977). A back calculation is then performed on the difference, using the assumed c/p ratio and Nk, and a pre-consolidation pressure is calculated. OCR's can then be calculated based on estimated existing stress conditions. SHANSEP procedures used during triaxial testing of clay soils may be useful in this method, especially for definition of c/p ratios.

Other methods for estimating stress history from CPT data are summarized in Mayne (1991 and 1993). These include approaches based on cavity expansion theory and critical state soil mechanics or on empirical methods based on data sets, primarily from sites in offshore oil fields. Results from each method should be compared, and engineering judgment should be used to decide which method gives the most appropriate result for the design at hand.

<u>A1.6 Equivalent SPT Blowcount N-Values</u> An equivalent SPT blowcount can be correlated with CPT data by using an analytical model of the SPT procedure (Douglas and Olsen, 1981). This procedure has been checked by comparison to SPT results at various sites throughout the world (Douglas and others, 1981, Douglas and Strutynsky, 1984, and Olsen and Farr, 1986) with generally good results.

The particular SPT equipment used to develop the CPT-SPT correlation chart (Figure A5) consisted of a SPT trip hammer system. This SPT hammer is characterized by reasonably repeatable, measured hammer input energy efficiencies of about 60 to 70% (Douglas and Strutynsky, 1984). This hammer input energy level is similar to that recommended (Seed and others, 1984) as the "standard" Standard Penetration Test input energy.

SPT results are both equipment and operator dependent. SPT hammer efficiencies have been measured to range from 35 to over 90% of the theoretical 4200 in-lbs (30 inch fall, 140 lbs hammer) SPT input energy. Variable SPT input energy results in variable blowcounts (Douglas and Strutynsky, 1984, Seed and others, 1984). Non-uniform SPT input energy is a limitation for use of SPT for quantitative design purposes.

The approach of using the extensive SPT data base by performing CPT and then deriving equivalent SPT blowcount N-values, can result in better site characterization. This is because CPT is continuous, has higher resolution, is less expensive, and is much more consistent and repeatable than SPT. The chart that was used for correlating CPT to SPT for this study is presented in Figure A5. After determining the overburden normalized equivalent SPT N'-value, the equivalent SPT blowcount N-value was calculated by dividing the overburden normalized value by the overburden normalization factor CN, as defined in Eq. A3.

The equivalent SPT N-values reflect the higher resolution of the CPT measurements as compared to actual SPT. Performance of actual SPT includes averaging of soil resistance over about a 24 inch interval (18 inch sampler embedment and 2 to 3 sampler diameters ahead of the sampler). Equivalent SPT values have a resolution of about six inches. Rather than coarsen the 6 inch resolution equivalent SPT N-value to fit a 24 inch resolution actual SPT N-value, equivalent values are based on point by point CPT data. These high resolution, equivalent SPT values should be more useful for design purposes, especially in interlayered deposits, where thin, weak soil seams cannot be adequately characterized by actual SPT blowcount methods. The high resolution equivalent SPT values and actual SPT measurements should be similar in thick homogeneous strata.

Discrepancies between CPT equivalent SPT N-values and actual, measured SPT N-values are often due to inconsistencies in the performance of actual SPT. Poor fit of CPT equivalent and actual SPT in weak soils with very low blowcounts (0 to 3) can be due to limited accuracy of high capacity CPT loadcells used at the extreme low end of their range, but are more likely caused by extensive borehole disturbance in easily disturbed soil, and set of the SPT sampler under the self-weight of the hammer and drillrods. Discrepancies between equivalent and actual SPT values in very dense or hard soils with high blowcounts, especially in gravelly soils, can be due to both erratic penetrometer or SPT sampler interaction with large soil particles, and basic differences in modes of penetration of the two techniques.
Indications of weak soils, using any method, should strongly encourage additional testing, including undisturbed sampling and sophisticated laboratory testing.

A2.0 OVERBURDEN PRESSURE NORMALIZATION

Overburden normalization of CPT data for correlation purposes is necessary in order to remove the effects of increasing overburden pressure with depth on measured results. Cone tip resistances can be normalized to an effective vertical overburden pressure of 1 TSF by using the following equations: qc1 = qc * CN (Eq. A3); and CN = 1.0 - 0.5 * log (Sv') (Eq. A4); where: qc1 is the overburden normalized cone tip resistance, in TSF; qc is the measured cone tip resistance, in TSF; CN is the overburden normalization factor; and Sv' is the effective vertical overburden stress in TSF.

Overburden normalization curves are variable (Douglas and Martin, 1980) and were developed using laboratory CPT and SPT on large samples of clean sands. Application of these laboratory results to natural soils may be limited. The CN presented in Equation A4 is similar to that proposed (Seed and others, 1977) for the effect of overburden on SPT blowcounts.

The friction ratio is not normalized based on the assumption that overburden pressure affects friction sleeve and cone tip resistance similarly. Since the quantities are divided by each other to compute friction ratio, overburden effects should cancel. Some experience (Olsen and Farr, 1986) indicates that this assumption may oversimplify actual conditions for deep soundings. The friction resistance may be less sensitive to overburden pressure than the cone tip resistance. Thus, in soundings deeper than about 100 ft, the friction ratio may gradually decrease with increased penetration, independent of any changes in soil conditions, other than overburden pressure. Due to the variability in overburden normalization curves, no specific correction for overburden pressure on friction ratio has been recommended or used for this study. For this study, effective stresses in Equation A4 were computed using assumed water tables and soil unit weights.

A3.0 TEST DRAINAGE CONDITION

The CPT loading rate is such that drained and undrained conditions exist during testing of sands and clays, respectively. Partial drainage may occur in mixed (granular and fine grained) soils. CPTU piezometric data indicate that minor differences in cone tip and friction ratio response can correspond with major changes in pore water pressure response (Douglas and others, 1985). The complex volumetric strain field around the penetrometer (Davidson and Boghrat, 1983) precludes reliable geotechnical effective stress analysis of CPTU results in partially drained soil.

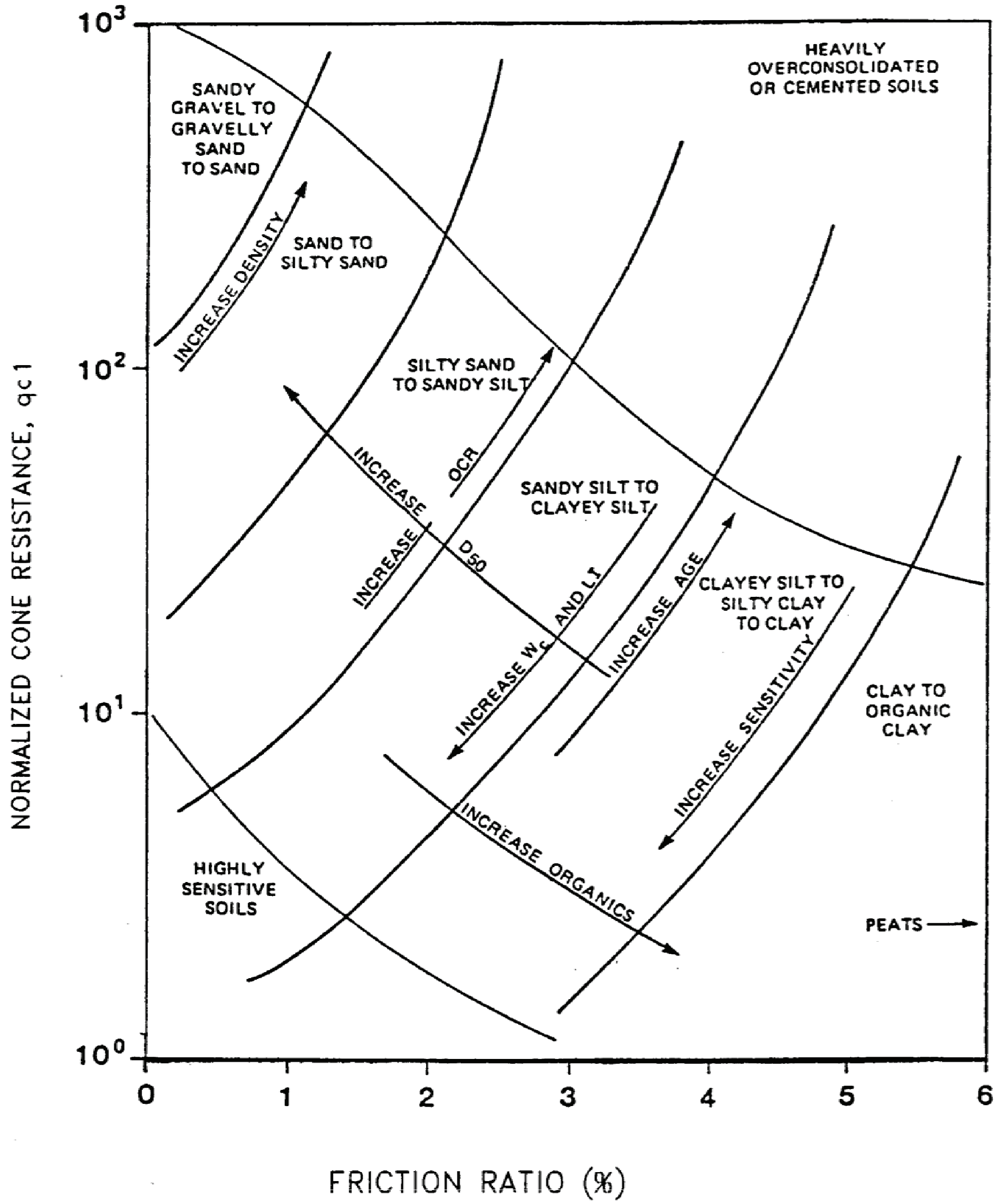
Empirical estimates of either drained or undrained parameters can be made in mixed soils. These parameters must not be combined and must be used alternatively. Combination of drained and undrained parameters will result in significant overestimation of in situ shear strength. Structure rate of loading will help determine whether drained or undrained parameters should be appropriate for design use. Depending on project needs and site conditions, geotechnical laboratory testing including consolidation and CU tests with pore pressure measurements will also be useful in assigning appropriate design parameters. Field instrumentation during construction using low volume change piezometers may be appropriate for some projects.

A4.0 RECOMMENDED PRACTICES

The STRATIGRAPHICS data evaluation program uses a series of global correlation charts, Figures A1 through A5. Parameters are computer evaluated and tabulated at discrete intervals. Stratigraphic units should be defined on the basis of the continuous sounding logs and project requirements. The correlations are then used in evaluation of layer properties. Use of the tabulations without the review of the CPT sounding logs can lead to the choice of non-representative parameters, especially in interlayered deposits. It should be noted that taking discontinuous borehole soil samples also often provides a poor representation of subsurface conditions.

CPT correlations have been developed using empiricism. The data base is world-wide and includes decades of CPT experience. However, local conditions may differ from those in the global data base. Thus, the evaluated parameters should be viewed as indicating trends rather than as the exact equivalent of specific laboratory tests performed under boundary and drainage controlled conditions. The derived parameters are not intended to replace appropriate drilling and undisturbed sampling, other in situ and laboratory testing, and use of engineering judgment.

Review of CPT results and project requirements is used to define the need for additional information. Zones delineated by CPT (or, in fact, any other test) providing low factors of safety should be further explored. For example, high quality undisturbed sampling followed by geotechnical triaxial and consolidation testing may be indicated for low strength cohesive or partially drained mixed soil strata. Monitoring wells may be installed or groundwater samples taken in high hydraulic conductivity strata during geo-environmental exploration. Non-CPT test results can often be extrapolated across the site based on CPT evaluated stratigraphy.

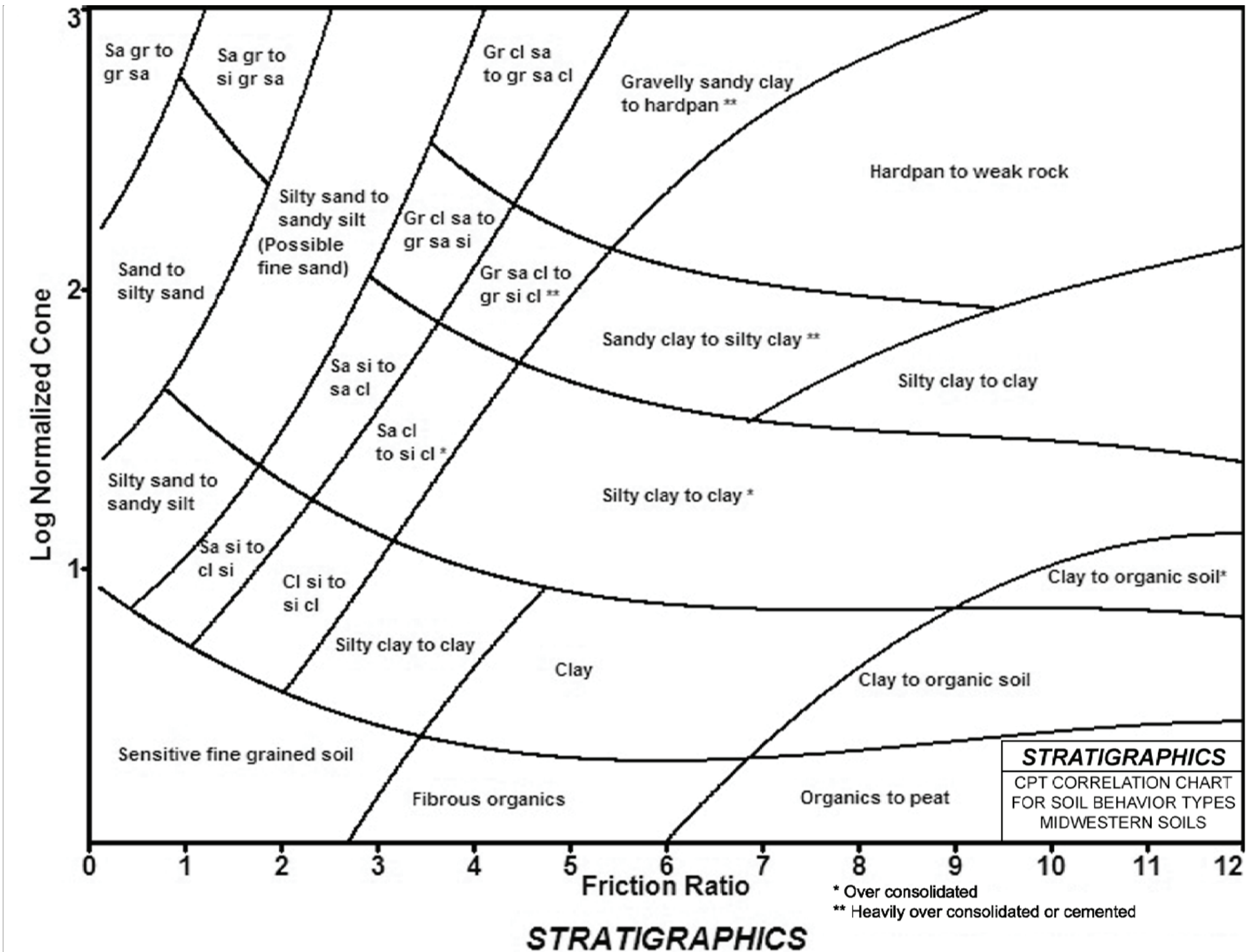


SOIL BEHAVIOR TYPE CLASSIFICATION CHART

After Douglas and Olsen, 1981

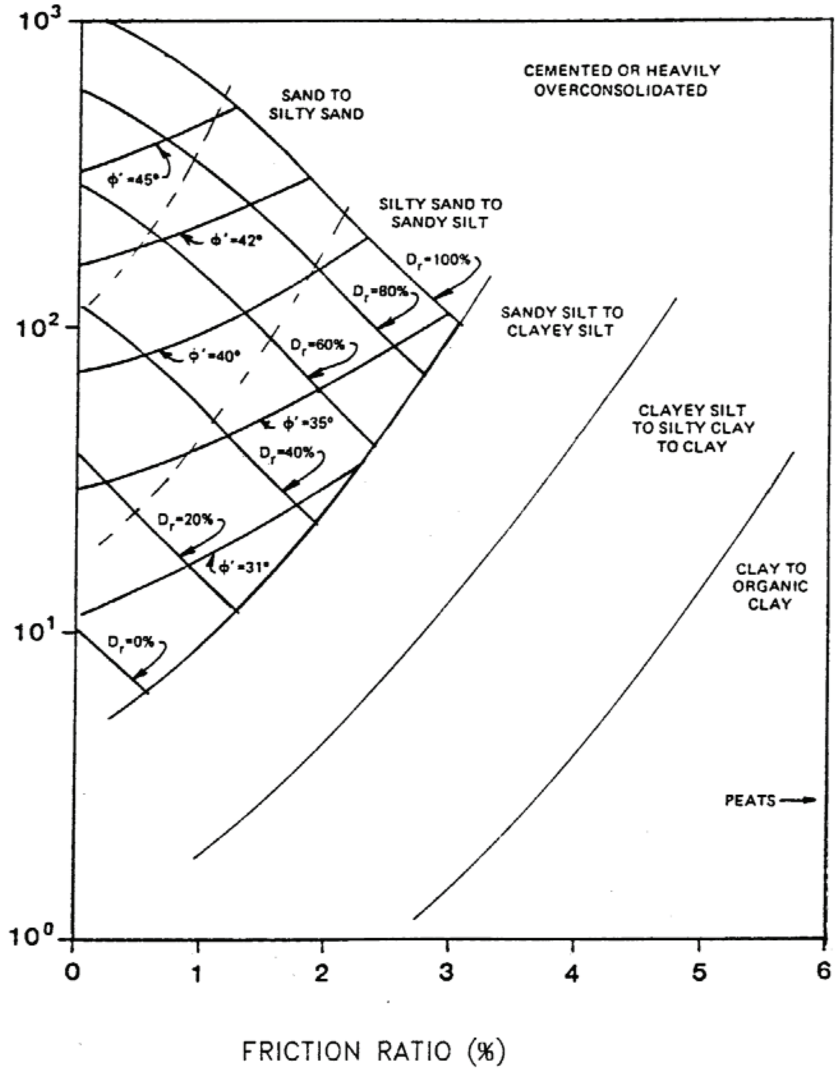
STRATIGRAPHICS

Figure A1



Sa gr to gr sa
Sa gr to si gr sa
Gr cl sa to gr sa cl
Gravelly sandy clay to hardpan **
Hardpan to weak rock
Silty sand to sandy silt (Possible fine sand)
Gr cl sa to gr sa si
Sand to silty sand
Gr sa cl to gr si cl **
Sandy clay to silty clay **
Sa si to sa cl
Silty clay to clay
Sa cl to si cl *
Silty sand to sandy silt
Silty clay to clay *
Sa si to cl si
Cl si to si cl
Clay to organic soil*
Silty clay to clay
Clay
Clay to organic soil
Sensitive fine grained soil
Fibrous organics
Organics to peat
STRATIGRAPHICS
CPT CORRELATION CHART
FOR SOIL BEHAVIOR TYPES
MIDWESTERN SOILS
Log Normalized Cone
3
2
1
0
1
2
3
4
5
6
7
8
9
10
11
12
Friction Ratio
* Over consolidated
** Heavily over consolidated or cemented
STRATIGRAPHICS

Figure A2

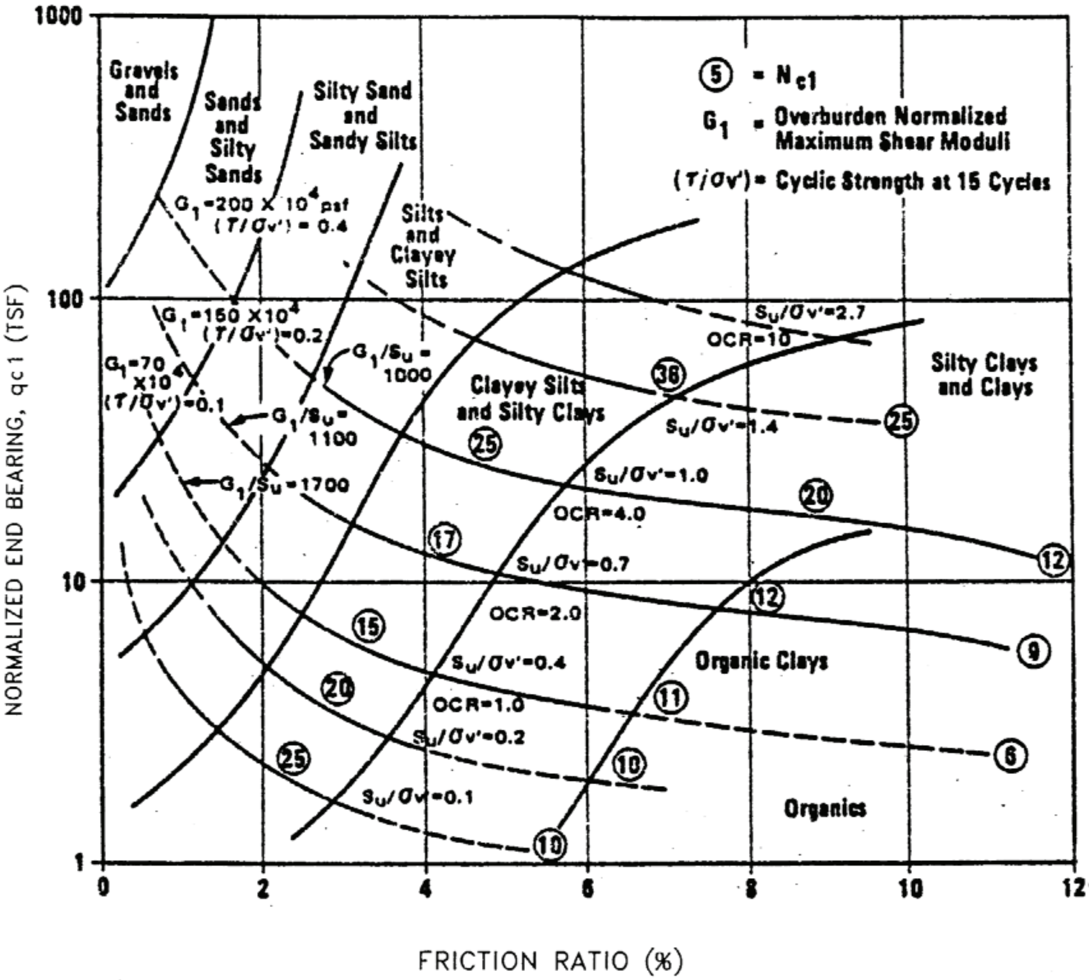


EXPANDED SOIL BEHAVIOR TYPE CLASSIFICATION CHART WITH EQUIVALENT OVERBURDEN NORMALIZED FRICTION ANGLE AND RELATIVE DENSITY TRENDS

After Douglas and Strutynsky, 1984

STRATIGRAPHICS

Figure A3

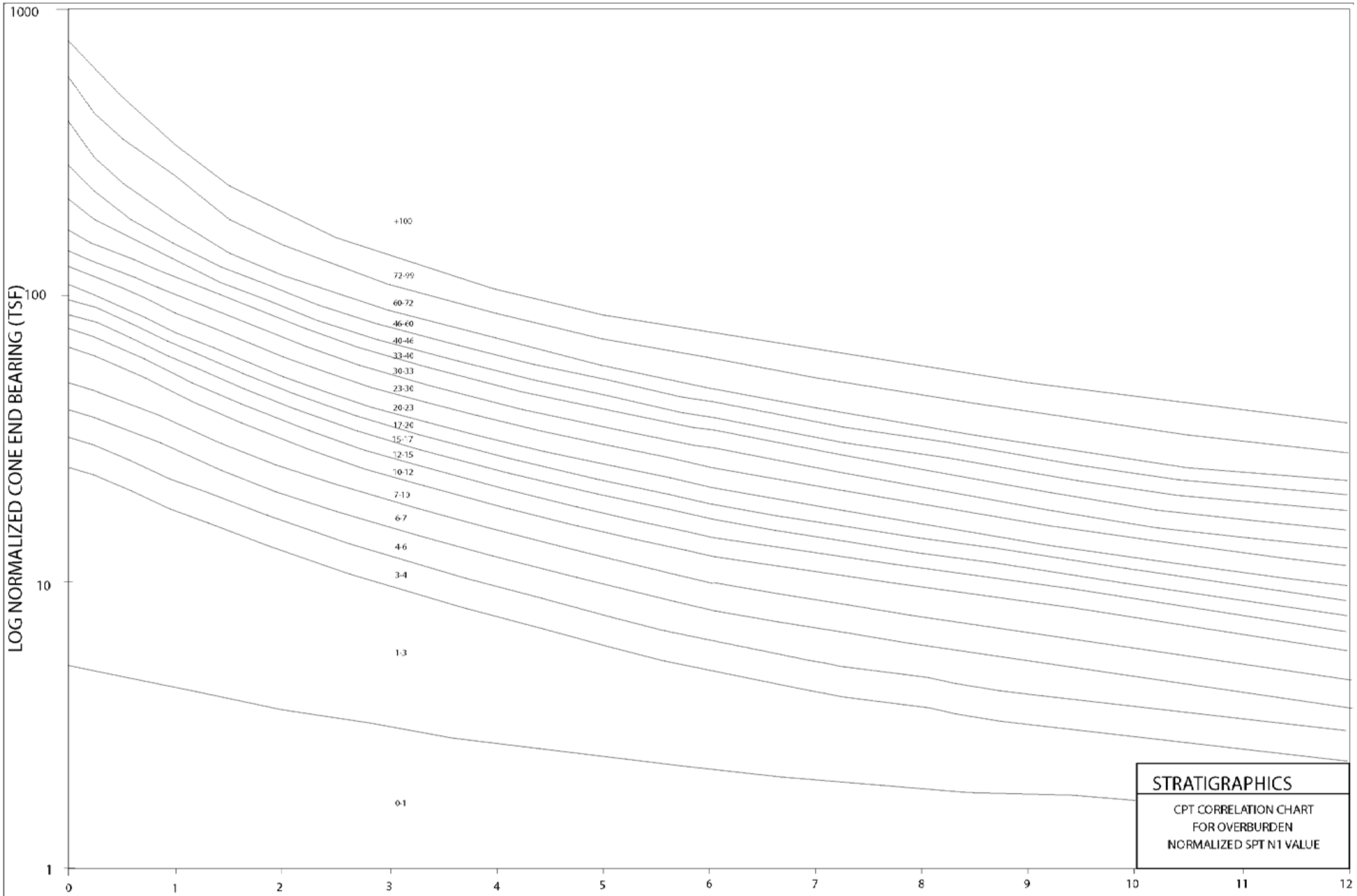


COMPOSITE TRENDS IN UNDRAINED SOIL PROPERTIES

After Douglas, Strutynsky, et. al., 1985

STRATIGRAPHICS

Figure A4



LOG NORMALIZED CONE END BEARING (TSF)
1000
100
10
1
FRICTION RATIO (%)
0
1
2
3
4
5
6
7
8
9
10
11
12
+100
72-99
60-72
46-60
40-46
33-40
30-33
23-30
20-23
17-20
15-17
12-15
10-12
7-10
6-7
4-6
3-4
1-3
0-1
STRATIGRAPHICS
CPT CORRELATION CHART
FOR OVERBURDEN
NORMALIZED SPT N1 VALUE

FIGURE A5

APPENDIX B

from Baligh, M.M. and J. Levadoux, "Pore Pressure Dissipation After Cone Penetration," Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1980.

6.2.4 Evaluation of c_h (probe)

At a given degree of consolidation, the predicted horizontal coefficient of consolidation c_h (probe) is obtained from the expression: c_h (probe) = R^2T/t
(6.2)
where R is the radius of the cone shaft, t is the measured time to reach this degree of consolidation; and T is the time factor. Table 5.1 provides values of T for different probe types at various degrees of consolidation.

An analytical method {equivalent to the graphical method described in Section 6.2.3} to check the validity of the prediction method consists of determining c_h at different dissipation stages, i.e., different u. Large differences between c_h at various degrees of consolidation indicate an inadequate initial distribution of excess pore pressure or significant coupling, or creep behavior.

The estimated values of c_h (probe) at 50% dissipation can be used in foundation problems involving horizontal water flow due to unloading or reloading of clays above the maximum past pressure. For problems involving vertical water flow in the overconsolidated range, the vertical coefficient of consolidation, c_v(probe), can be estimated from the expression: c_v (probe) = (k_v/k_h) c_h (probe)
(6.3)
where k_v and k_h are the vertical and horizontal coefficients of permeability, respectively. Reliable estimates of the in situ anisotropy of clays as expressed by the ratio k_h/k_v is difficult to determine in the laboratory because of the effects of sample size, sample disturbance, ... etc. and is the subject of controversy (Rowe, 1972; Casagrande and Poulos, 1969). In situ tests to determine k_h/k_v are almost nonexistent. Table 6.2 provides rough estimates of k_h/k_v for different clays.

6.2.5 Prediction of k_h (probe)

Approximate estimates of the horizontal coefficient of permeability, k_h (probe), can be obtained from the expression: k_h (probe) = $(g_w/2.3s_{vo})$ * RR(probe) * c_h (probe) (6.4)
where s_{vo} is the initial vertical effective stress (kg/cm^2); g_w is the unit weight of water (=10^{-3} kg/cm^3); and RR(probe) is the recompression ratio during early stages of consolidation (50% dissipation, say). Results in both the upper and lower Boston Blue Clays indicate that: the average RR(probe) =10^{-2}
(6.5)
and generally $0.5 * 10^{-2}$ < RR(probe) < $2 * 10^{-2}$ (6.6)

6.2.6 Prediction of c_v(NC)

For foundation clays consolidated in the normally consolidated range, estimates of the coefficients of consolidation can be obtained from c_h (probe) by means of the expressions:

c_h(NC) = (RR(probe)/CR) * c_h (probe) (6.7)

for horizontal water flow, and c_v(NC) = (RR(probe)/CR) * (k_v/k_h) * c_h(probe) (6.8)
for vertical water flow.

The compression of ratio CR is the average slope of the strain vs. log effective stress plot in the appropriate effective stress range expected during consolidation of the foundation clay. Values of CR should be obtained from good quality samples carefully tested in the laboratory. Table 6.2 provides rough estimates of CR based on empirical correlation with index properties of various clays.

Table 6.2 Empirical Correlation and Typical Properties of Clays

1. Compression Ratio CR (from Ladd, 1973)

$CR = C_c/1+e_o$ = slope of the strain vs. log stress curve

e_o = initial void ratio

c_c = virgin compression index = slope of e vs. log stress

w_L = liquid limit

w_N = natural water content

$c_c = 0.009\ (w_L\% - 10\%)$	Terzaghi and Peck (1967)
$C_c = 0.54\ (e_o - 0.35)$	Nishida (1958)
$C_c = 0.01$ to $0.15\ (w_N\%)$	MPMR (1958)
$C_c = 0.6\ (e_o - 1)$ for $e_o < 6$	
$C_c = 0.85\ (e_o - 2)$ for $6 < e_o < 14$	Kapp, (1966)

2. Anisotropic Permeability of Clays (from Ladd, 1976)

Nature of Clay	k_h/k_v
1. No evidence of layering	1.2 +- 0.2
2. Slight layering, e.g., sedimentary clays with occasional silt dustings to random lenses	2 to 5
3. Varved clays in northeastern U.S.	10 +/-5

APPENDIX C
APPLICATIONS OF SEISMIC WAVE VELOCITIES

Shear modulus G = (Vs**2)*d/g;
where: Vs is the measured shear wave velocity;
d is the soil unit weight; and
g is the acceleration of gravity.

Shear modulus G = E/(2*(1+u));
where: E is Young's modulus, and
u is Poisson's ratio.

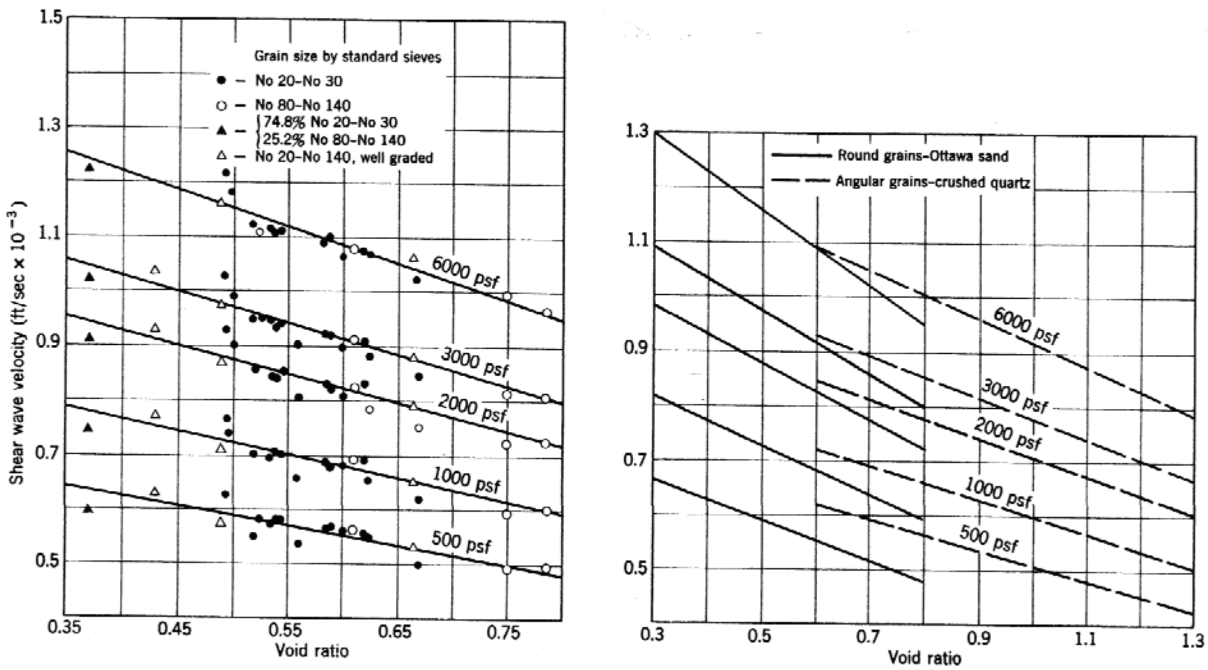


Fig. 12.10 Shear wave velocities through quartz sands (From Hardin and Richart, 1963).

μ	Soil type
0.4–0.5	Most clay soils
0.45–0.50	Saturated clay soils
0.3–0.4	Cohesionless—medium and dense
0.2–0.35	Cohesionless—loose to medium

Appendix C (continued)
from Mayne, P.W. And J.A. Schneider, "Evaluating Axial Drilled Shaft Response by Seismic Cone," Foundations & Ground Improvement, GSP 113, ASCE, Reston, VA, pp 655-669.

Small-Strain Modulus

Recent research outside of the U.S. has found that the small-strain stiffness from shear wave velocity (V_s) measurements applies to the initial static monotonic loading, as well as the dynamic loading of geomaterials (Burland, 1989; Tatsuoka & Shibuya, 1992; LoPresti et al., 1993). Thus, the original dynamic shear modulus (G_{dyn}) has been re-termed the maximum shear modulus, designated G_{max} or G_0, that provides an upper limit stiffness given by: $G_0 = \rho_T V_s^2$ where ρ_T = total mass density of the soil. This is a fundamental stiffness of all solids in civil engineering and can be measured in all soil types from colloids, clays, silts, sands, gravels, to boulders and fractured rocks. The corresponding equivalent elastic modulus is found from: $E_0 = 2G_0(1+\nu)$ where $\nu = 0.2$ is the approximate value of Poisson's ratio of geomaterials at small strains.

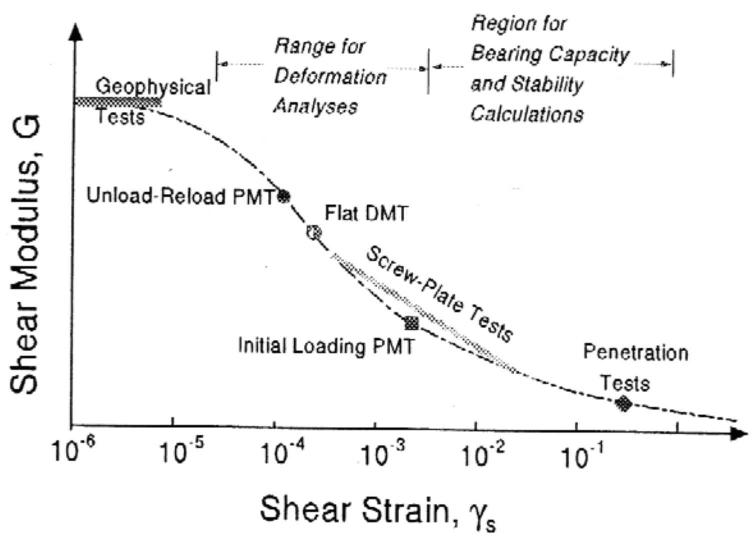


Figure 2. Variation of Shear Modulus with Strain Level and Relevance to In-Situ Tests.

The shear wave data are processed to obtain the initial stiffness using the following relationship for saturated soil mass density (Mayne, et al., 1999a).

$$\rho_{sat} \approx 1 + \frac{1}{0.614 + 58.7(\log z + 1.095)/V_s} \qquad (9)$$

where ρ_{sat} is in g/cc, depth z is in meters, and V_s in m/s. Note that dry density (and dry unit weights) can be evaluated from the saturated value from:

$$\rho_{dry} = \frac{G_s(\rho_{sat} - 1)}{G_s - 1} \qquad (10)$$

In the vadose zone with partial saturation, the total unit weight would fall between these two extremes. The derived parameters of mass density and initial elastic modulus with depth are presented in Figure 9.

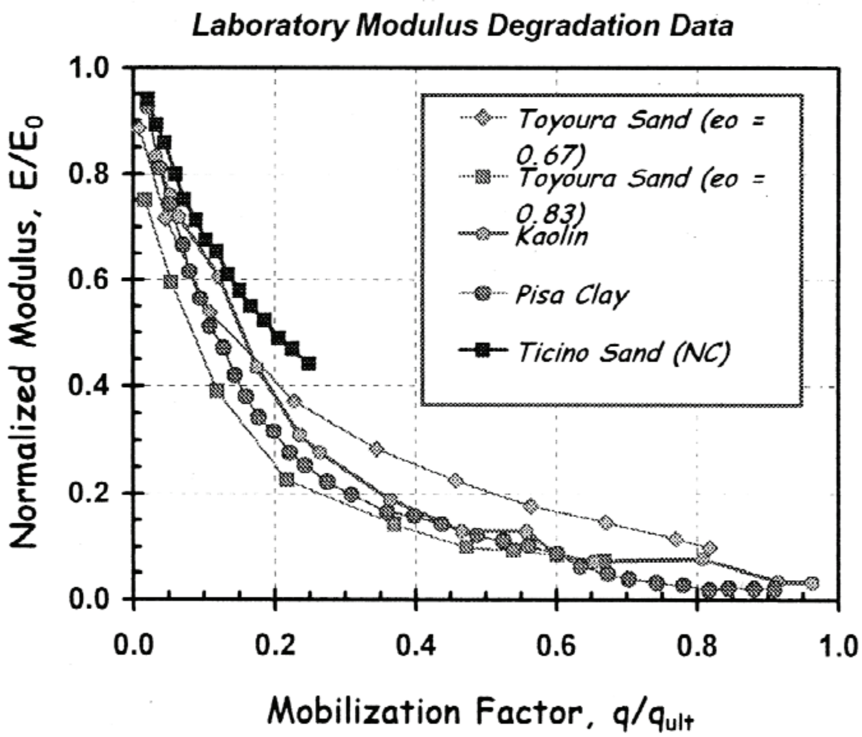


Figure 4. Modulus Degradation from Instrumented Laboratory Tests on Uncemented and Unstructured Geomaterials.

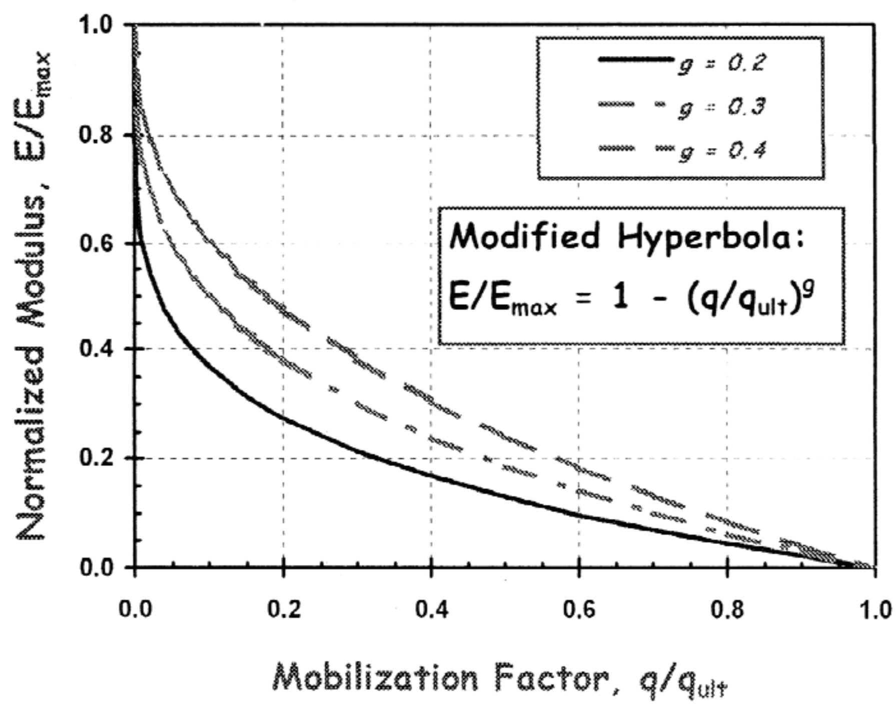


Figure 5. Modified Hyperbolas with g= 0.2, 0.3, and 0.4 to Illustrate Modulus Degradation Curves. Note: Mobilized stress level q/q_u = 1/FS.

Axial Capacity Determinations

The assessment of axial pile capacity ($Q_{ult} = Q_s + Q_b$) from CPT results is well-recognized (e.g., Robertson, et al. 1988; Poulos, 1989; Eslami & Fellenius, 1997). Of recent, Takesue, et al. (1998) offer a versatile direct CPT approach for side resistance of both drilled shafts and driven piles to obtain the pile side friction (f_p) in both clays and sands in terms of the measured f_s and excess porewater pressures (Δu_b) during piezocone penetration. Using measurements with a porous filter located at the cone shoulder:

For $\Delta u_b < 300$ kPa: then $f_p = f_s \cdot[(\Delta u_b/1250) + 0.76]$ (6a)

For $\Delta u_b > 300$ kPa: then $f_p = f_s \cdot[(\Delta u_b/200) - 0.50]$ (6b)

In clays, the pile tip or pier base resistance (q_b) will be fully mobilized and can be evaluated from the effective cone resistance (Eslami & Fellenius, 1997):

Clays: $q_b = q_t - u_b$ (7)

In sands, however, full mobilization of the base develops fairly slowly, depending on the relative movement (s) with respect to pile width (B). Recent work by Lee & Salgado (1999) gives:

Sands: $q_b \approx q_t \cdot [1.90 + \{0.62/(s/B)\}]^{-1}$ (8)

STRATIGRAPHICS

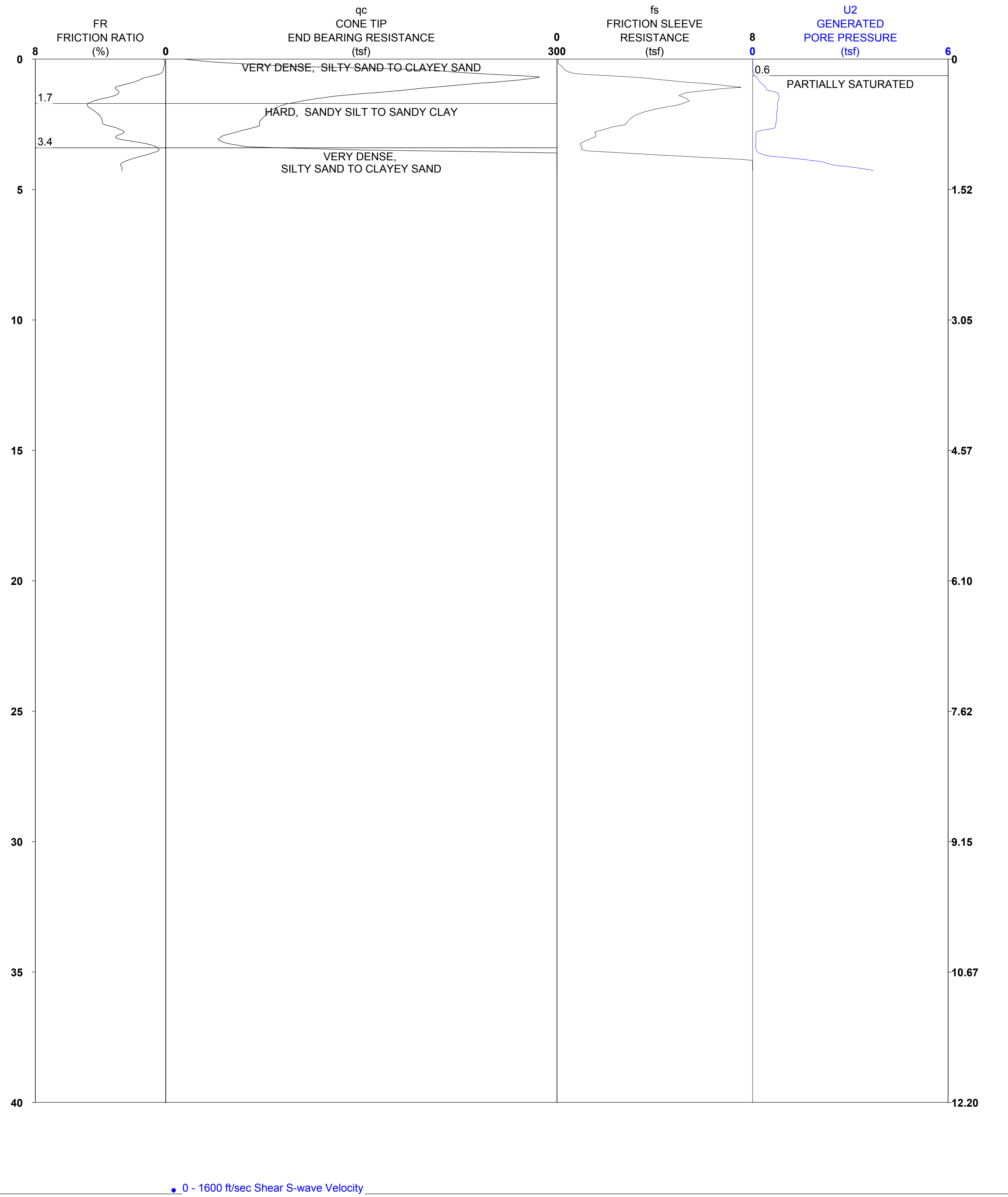
TABLE 1
SUMMARY OF CPT SOUNDINGS
Dynegy Vermillion Power Plant Ash Ponds
13-130-070

SOUNDING NUMBER	DATE PERFORMED	SOUNDING TYPE	SOUNDING DEPTH (feet)	COMMENTS	COORDINATES LATITUDE (dec. deg)	LONGITUDE (dec. deg)
CP-1301	07/24/13	CPTU	4.3	Lift ATV rig		
CP-1301a	07/24/13	CPTU	38.6	Offset 4 ft, coarse gravel at refusal		
CP-1302	07/24/13	CPTU	33.6	Coarse gravel at refusal		
CP-1303	07/24/13	CPTU	47.4	Coarse gravel at refusal		
CP-1304	07/24/13	CPTU	11.9	Lift ATV rig		
CP-1304a	07/24/13	CPTU	23.9	Lift ATV rig		
CP-1304b	07/24/13	CPTU	24.3	Lift ATV rig		
CP-1305	07/24/13	CPTU	57.7	Significant rod spring, extreme pullout force		
			241.7			

STRATIGRAPHICS
TABLE 2
SUMMARY OF CPTU DISSIPATION TESTS
Dynegy Vermillion Plant
13-130-070

SOUNDING NUMBER	DEPTH (ft)	EVALUATED SOIL TYPE AT DISSIPATION DEPTH	t50 (sec)	ESTIMATED SOIL HORIZONTAL HYDRAULIC CONDUCTIVITY kh (cm/sec)	ESTIMATED HORIZONTAL COEFFICIENT OF CONSOLIDATION IN OVERCONSOLIDATED RANGE* Ch(oc) (cm**2/sec)	MEASURED OR ESTIMATED POTENTIOMETRIC SURFACE AT TEST DEPTH (ft)	ESTIMATED EFFECTIVE STRESS (tsf)	EVALUATED RR PARAMETER
cp1301a	14.0	Silty clay to clay	40	4E-06	6E-01	11	0.75	0.01
cp1301a	15.6	Clayey silt to silty clay	9	2E-05	3E+00	11	0.79	0.01
cp1301a	18.9	Silty clay to clay	47	3E-06	5E-01	11	0.89	0.01
cp1301a	26.8	Sensitive fine grained soil	5.5	2E-05	5E+00	8	1.02	0.01
cp1301a	28.8	Sensitive fine grained soil	11	1E-05	2E+00	7.5	1.06	0.01
cp1301a	30.4	Sensitive fine grained soil	8.5	1E-05	3E+00	6.5	1.08	0.01
cp1302	9.2	Sandy clay to silty clay *	15	2E-04	2E+00	7.5	0.50	0.10
cp1302	10.8	Sandy clay to silty clay *	24	9E-05	1E+00	7.5	0.55	0.10
cp1302	12.4	Silty sand to sandy silt	24	1E-04	1E+00	7.5	0.59	0.15
cp1302	15.6	Sensitive fine grained soil	9	2E-05	3E+00	8	0.70	0.01
cp1302	18.8	Silty clay to clay	4.5	3E-05	6E+00	9	0.82	0.01
cp1302	19.9	Silty clay to clay	8	2E-05	3E+00	9	0.85	0.01
cp1302	22.4	Silty clay to clay	7.5	2E-05	3E+00	9	0.93	0.01
cp1302	23.3	Sensitive fine grained soil	8	2E-05	3E+00	9	0.95	0.01
cp1302	24.9	Silty clay to clay	5.5	2E-05	5E+00	9	1.00	0.01
cp1302	26.6	Sensitive fine grained soil	5.5	2E-05	5E+00	9	1.05	0.01
cp1302	28.2	Sensitive fine grained soil	25	4E-06	1E+00	9	1.09	0.01
cp1302	28.9	Silty clay to clay	131	8E-07	2E-01	9	1.11	0.01
cp1302	31.3	Silty clay to clay *	816	9E-08	3E-02	22	1.59	0.01
cp1302	33.1	Silty sand to sandy silt	7	2E-04	4E+00	22	1.64	0.20

CPTU LOG WITH LITHOLOGIC EVALUATION cp1301

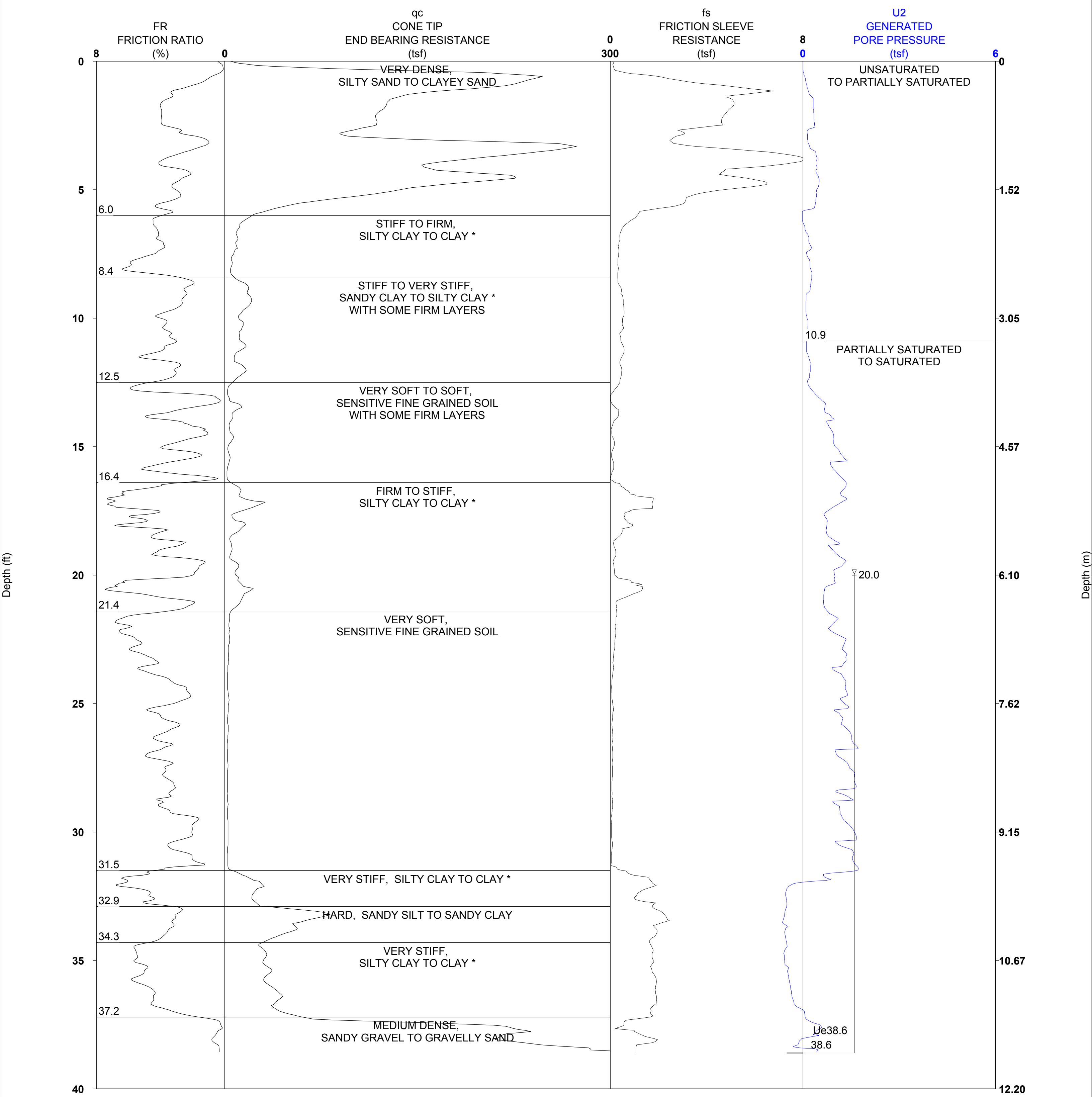


PROJECT NAME:Dynegy Vermillion Plant
PROJECT NUMBER:13-130-070

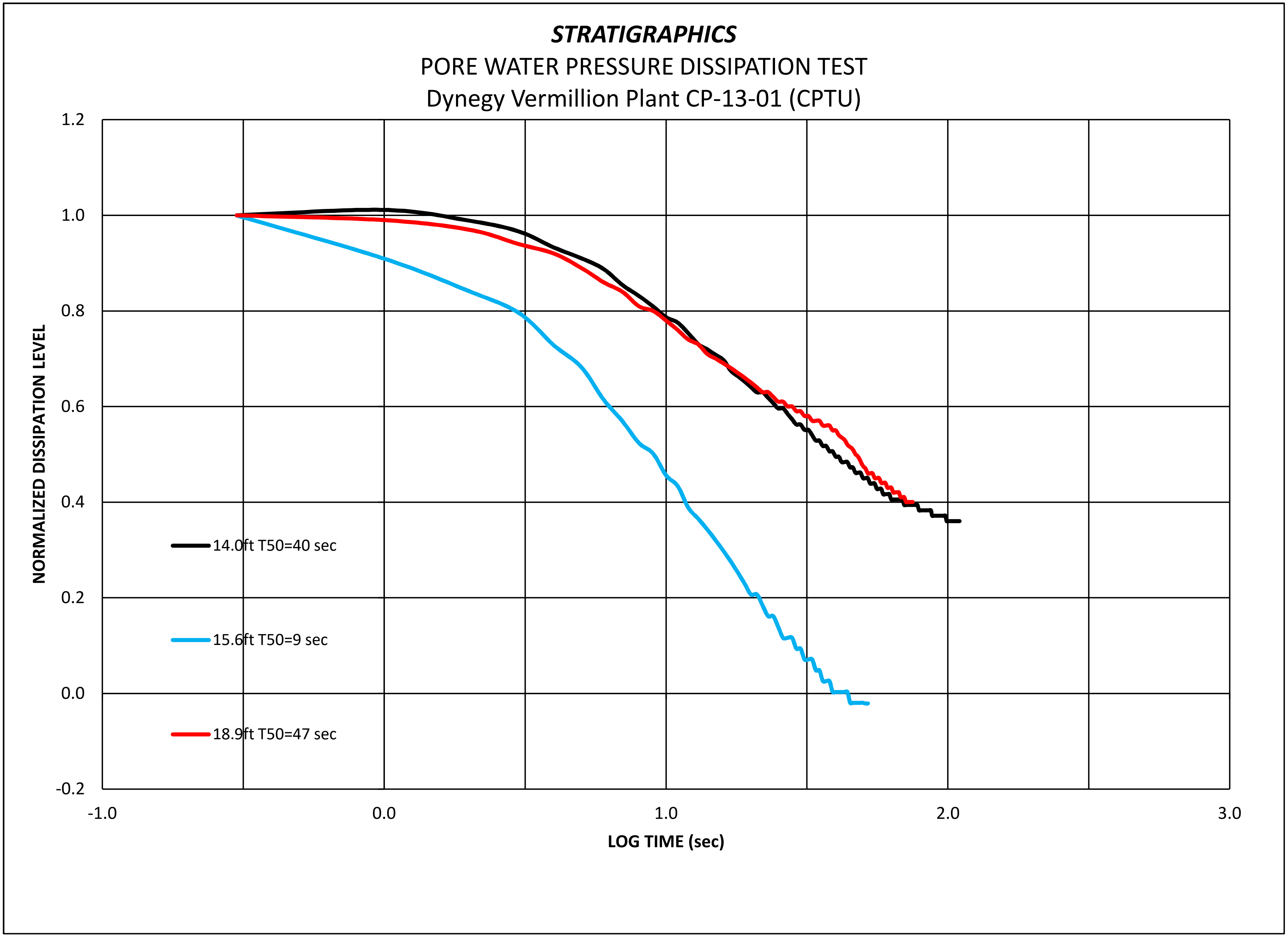
STRATIGRAPHICS

R1 DATE:7/24/2013 TIME:8:24 AM
SOUNDING NUMBER:CP-13-01 (CPTU)

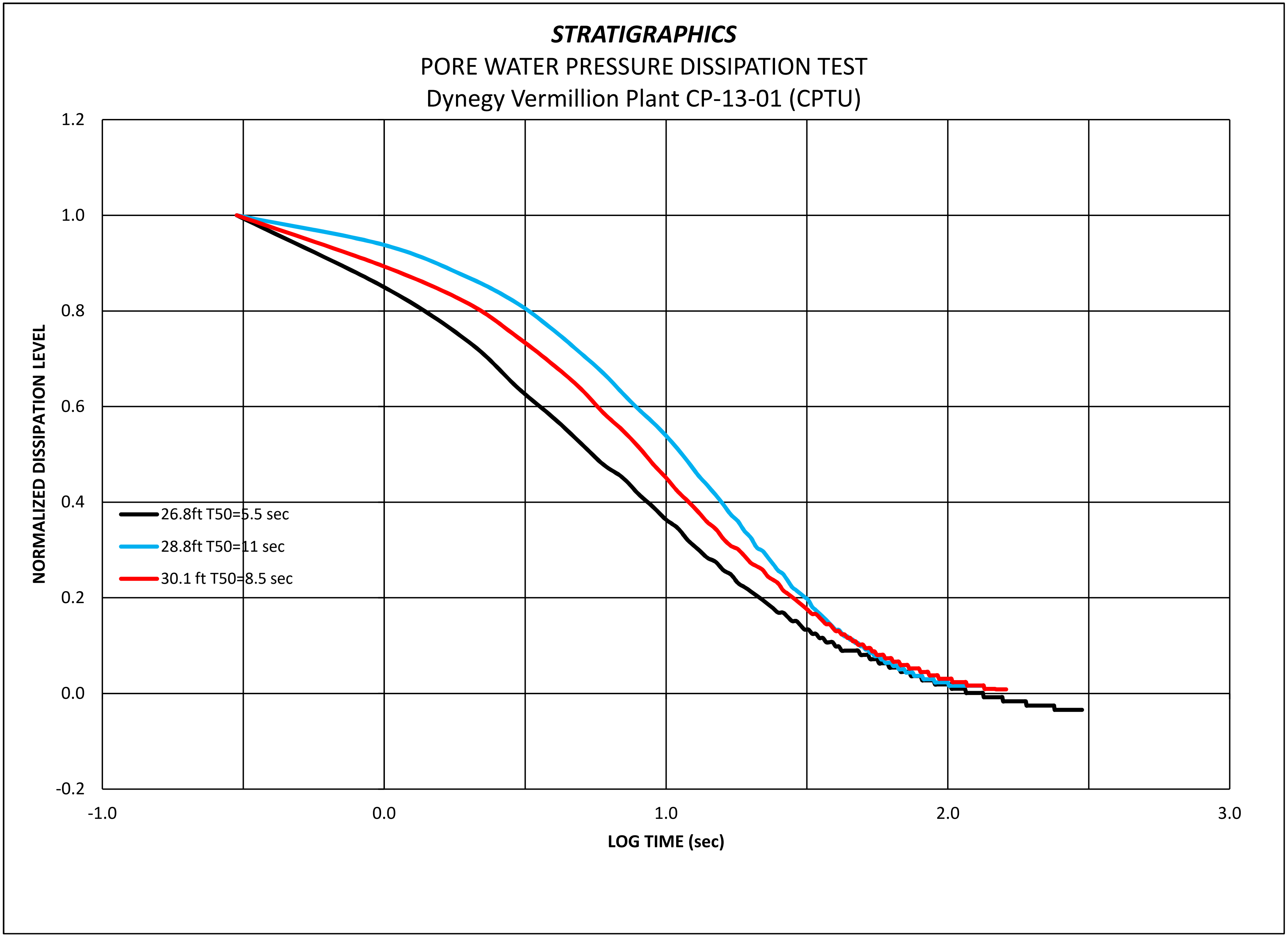
CPTU LOG WITH LITHOLOGIC EVALUATION cp1301a



• 0 - 1600 ft/sec Shear S-wave Velocity

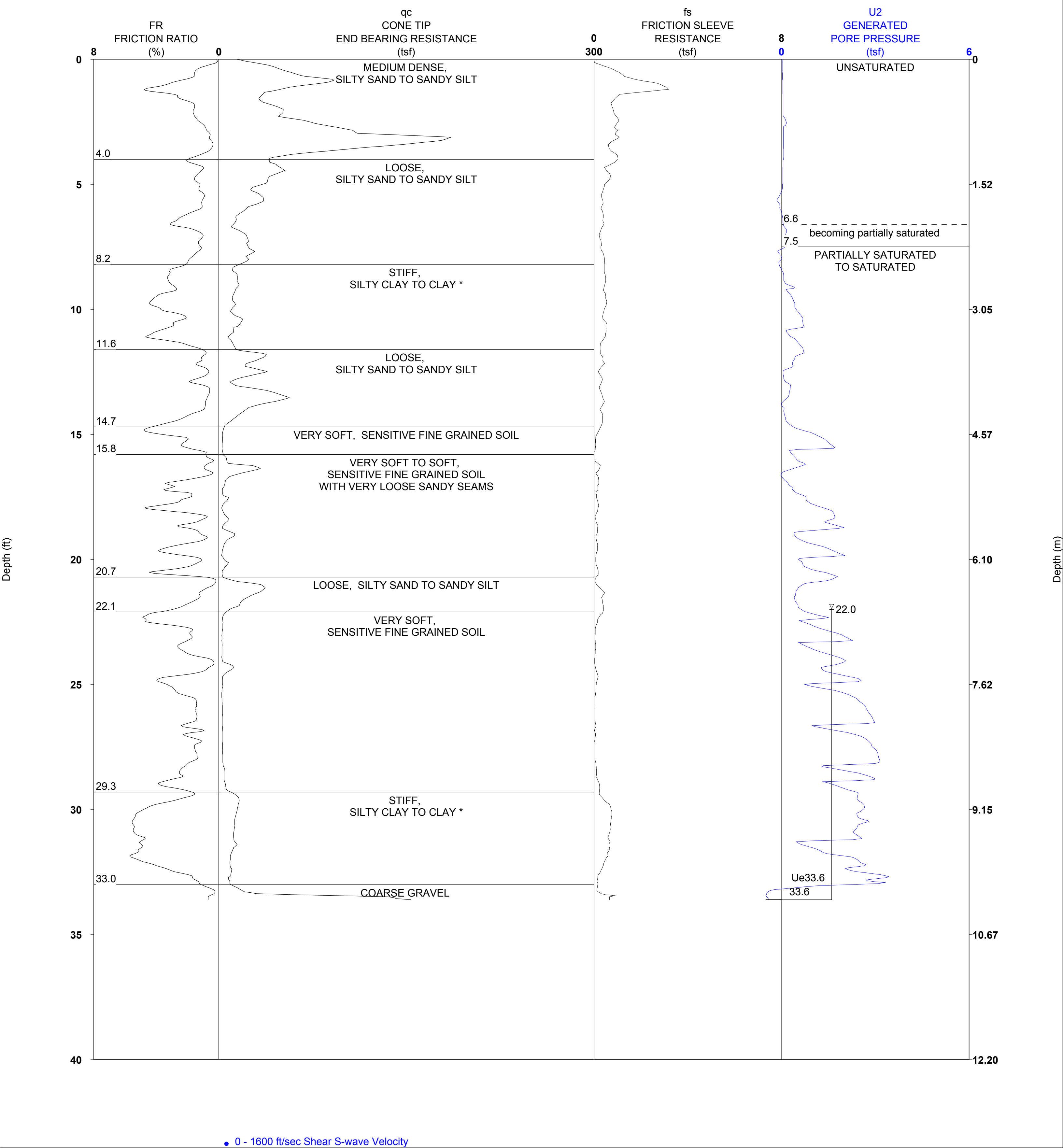


STRATIGRAPHICS
PORE WATER PRESSURE DISSIPATION TEST
Dynegy Vermillion Plant CP-13-01 (CPTU)
NORMALIZED DISSIPATION LEVEL
LOG TIME (sec)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-1.0
0.0
1.0
2.0
3.0
14.0ft T50=40 sec
15.6ft T50=9 sec
18.9ft T50=47 sec



STRATIGRAPHICS
PORE WATER PRESSURE DISSIPATION TEST
Dynegy Vermillion Plant CP-13-01 (CPTU)
NORMALIZED DISSIPATION LEVEL
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-1.0
0.0
1.0
2.0
3.0
LOG TIME (sec)
26.8ft T50=5.5 sec
28.8ft T50=11 sec
30.1 ft T50=8.5 sec

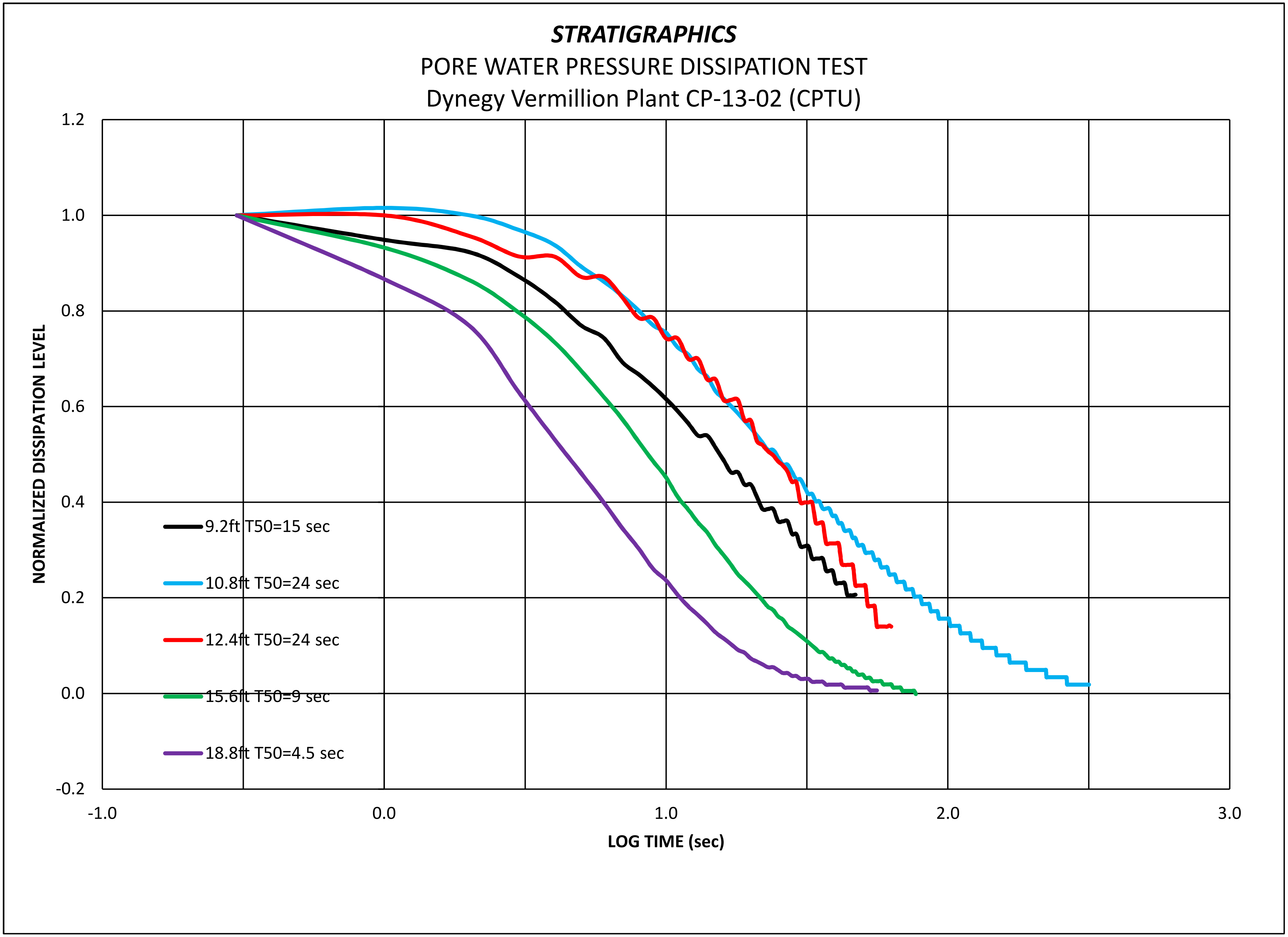
CPTU LOG WITH LITHOLOGIC EVALUATION cp1302



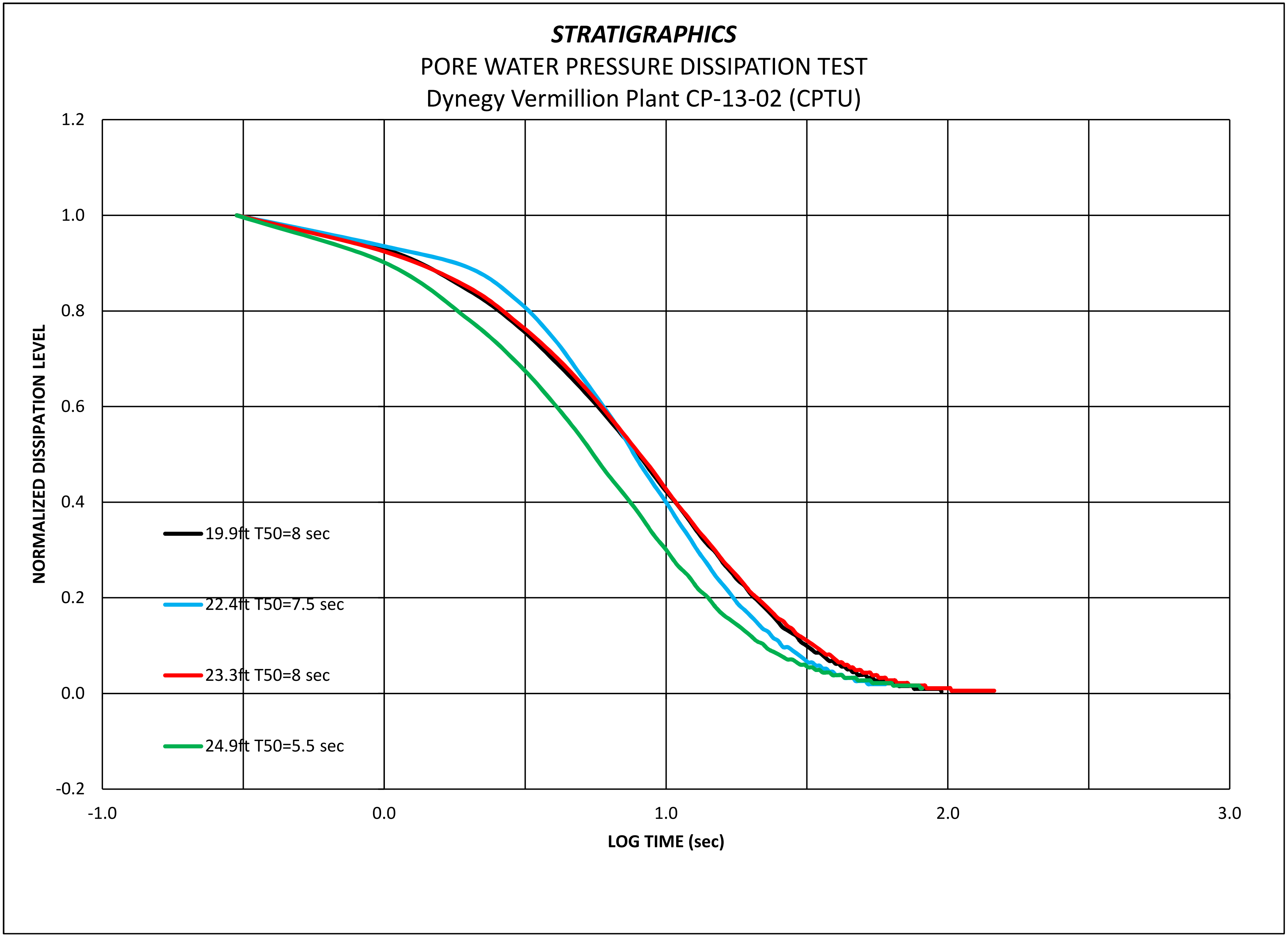
PROJECT NAME:Dynegy Vermillion Plant
PROJECT NUMBER:13-130-070

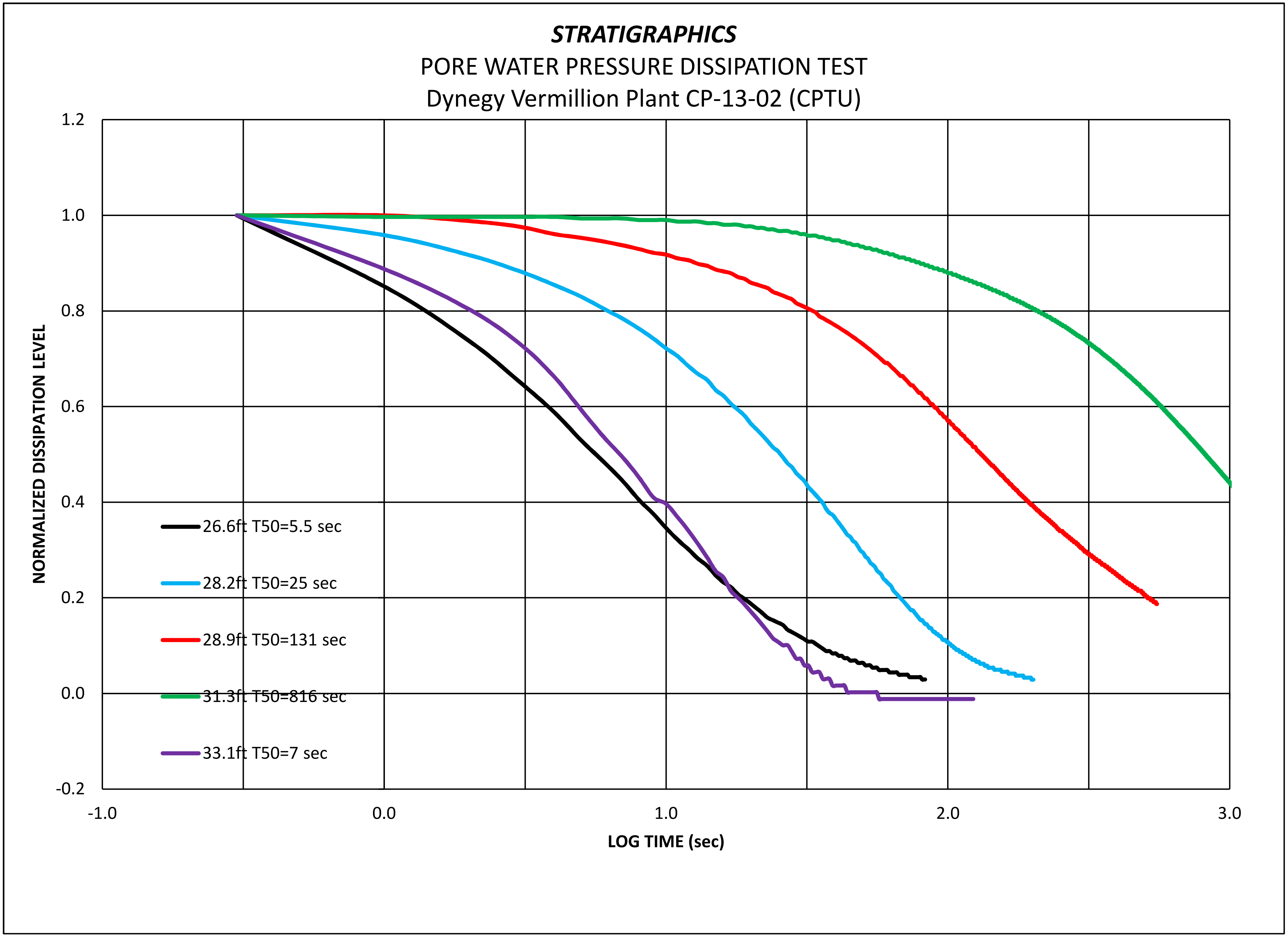
STRATIGRAPHICS

R1 DATE:7/24/2013 TIME:11:05 AM
SOUNDING NUMBER:CP-13-02 (CPTU)

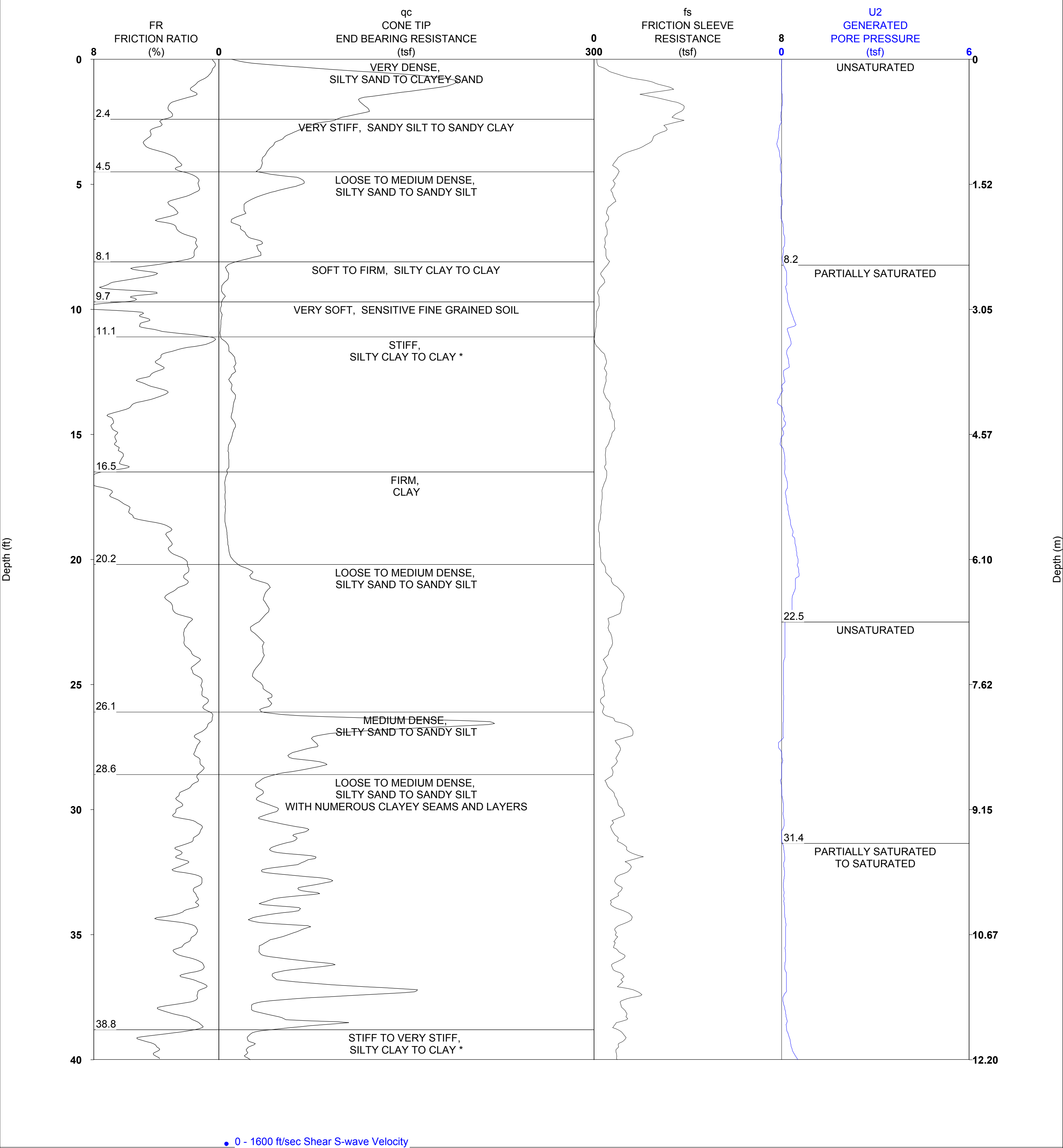


STRATIGRAPHICS
PORE WATER PRESSURE DISSIPATION TEST
Dynegy Vermillion Plant CP-13-02 (CPTU)
NORMALIZED DISSIPATION LEVEL
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-1.0
0.0
1.0
2.0
3.0
LOG TIME (sec)
9.2ft T50=15 sec
10.8ft T50=24 sec
12.4ft T50=24 sec
15.6ft T50=9 sec
18.8ft T50=4.5 sec


STRATIGRAPHICS
PORE WATER PRESSURE DISSIPATION TEST
Dynegy Vermillion Plant CP-13-02 (CPTU)
NORMALIZED DISSIPATION LEVEL
LOG TIME (sec)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-1.0
0.0
1.0
2.0
3.0
19.9ft T50=8 sec
22.4ft T50=7.5 sec
23.3ft T50=8 sec
24.9ft T50=5.5 sec


STRATIGRAPHICS
PORE WATER PRESSURE DISSIPATION TEST
Dynegy Vermillion Plant CP-13-02 (CPTU)
NORMALIZED DISSIPATION LEVEL
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-1.0
0.0
1.0
2.0
3.0
LOG TIME (sec)
26.6ft T50=5.5 sec
28.2ft T50=25 sec
28.9ft T50=131 sec
31.3ft T50=816 sec
33.1ft T50=7 sec

CPTU LOG WITH LITHOLOGIC EVALUATION cp1303

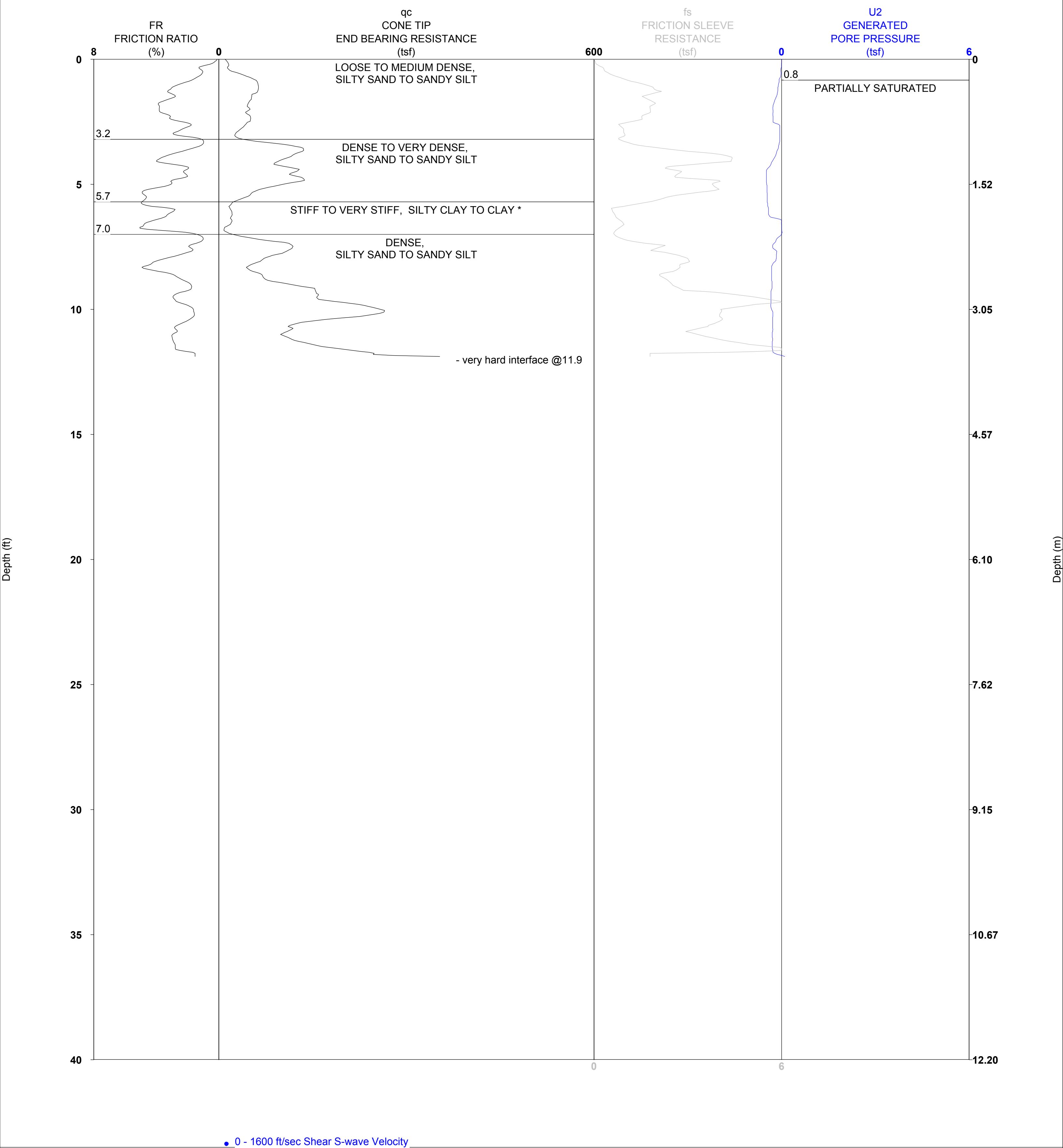


PROJECT NAME:Dynegy Vermillion Plant
PROJECT NUMBER:13-130-070

STRATIGRAPHICS

R1 DATE:7/24/2013 TIME:1:34 PM
SOUNDING NUMBER:CP-13-03 (CPTU)

CPTU LOG WITH LITHOLOGIC EVALUATION cp1304

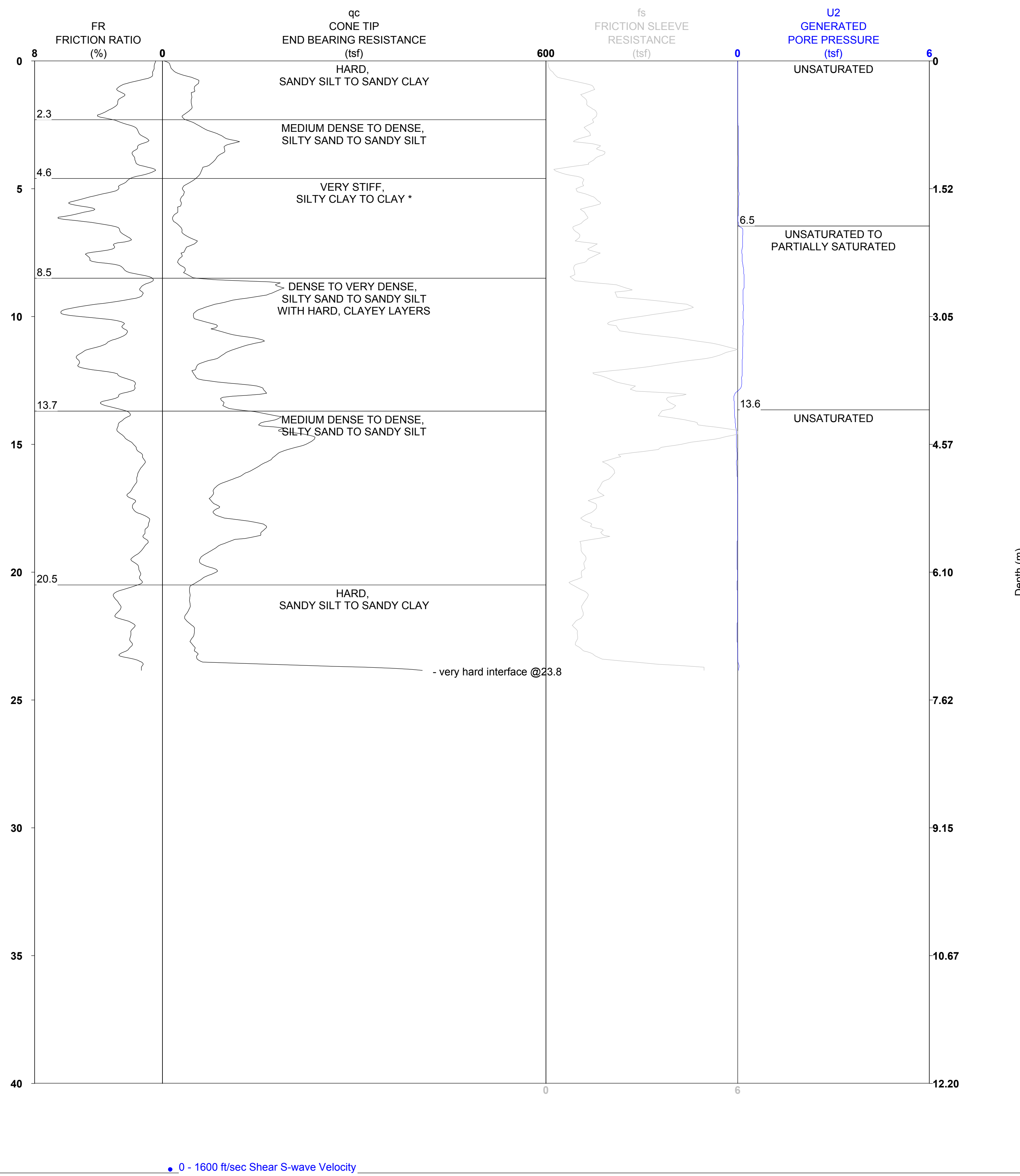


PROJECT NAME:Dynegy Vermillion Plant
PROJECT NUMBER:13-130-070

STRATIGRAPHICS

R1 DATE:7/24/2013 TIME:3:00 PM
SOUNDING NUMBER:CP-13-04 (CPTU)

CPTU LOG WITH LITHOLOGIC EVALUATION cp1304a

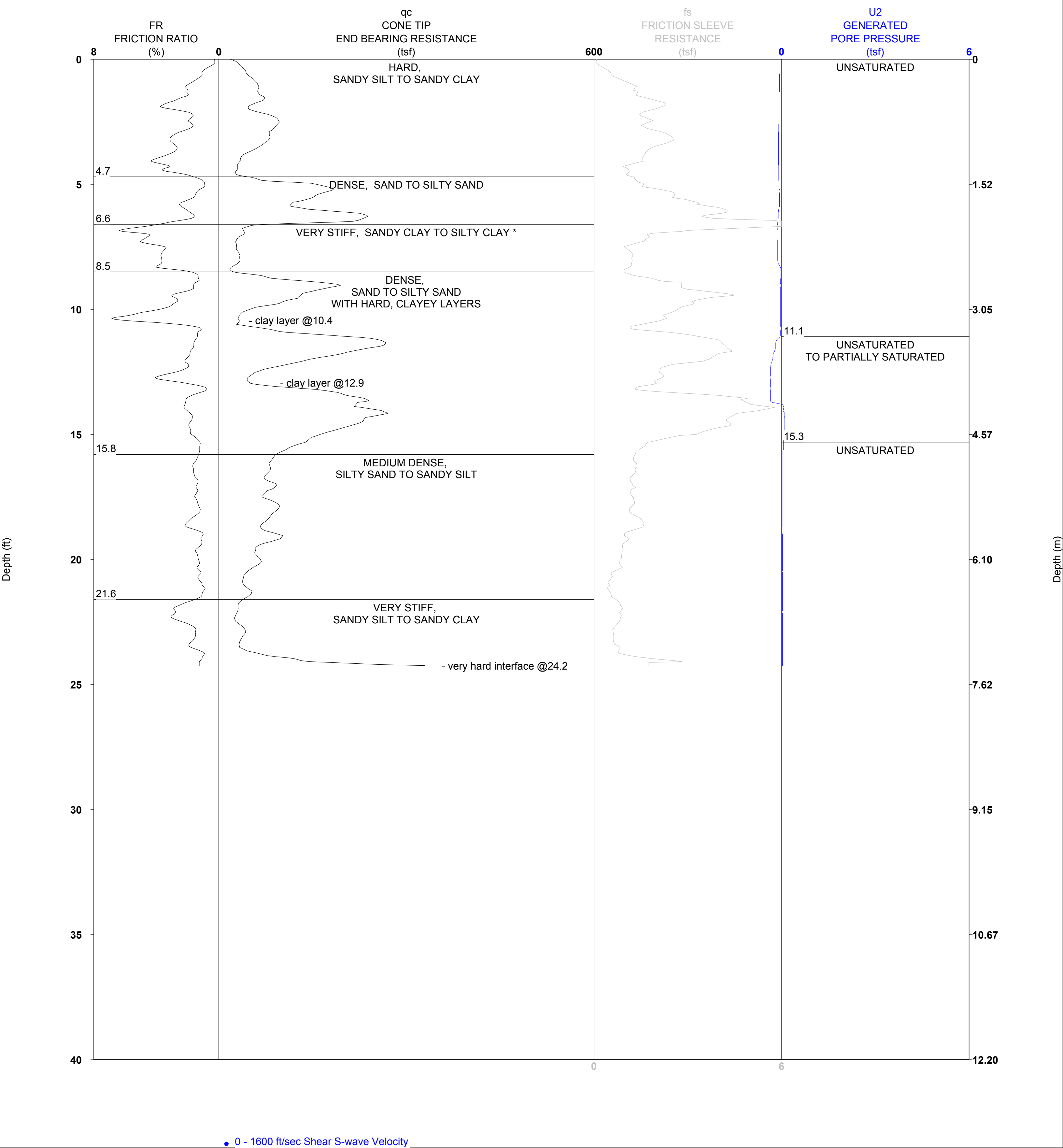


PROJECT NAME:Dynegy Vermillion Plant
PROJECT NUMBER:13-130-070

STRATIGRAPHICS

R1 DATE:7/24/2013 TIME:3:23 PM
SOUNDING NUMBER:CP-13-04a (CPTU)

CPTU LOG WITH LITHOLOGIC EVALUATION cp1304b

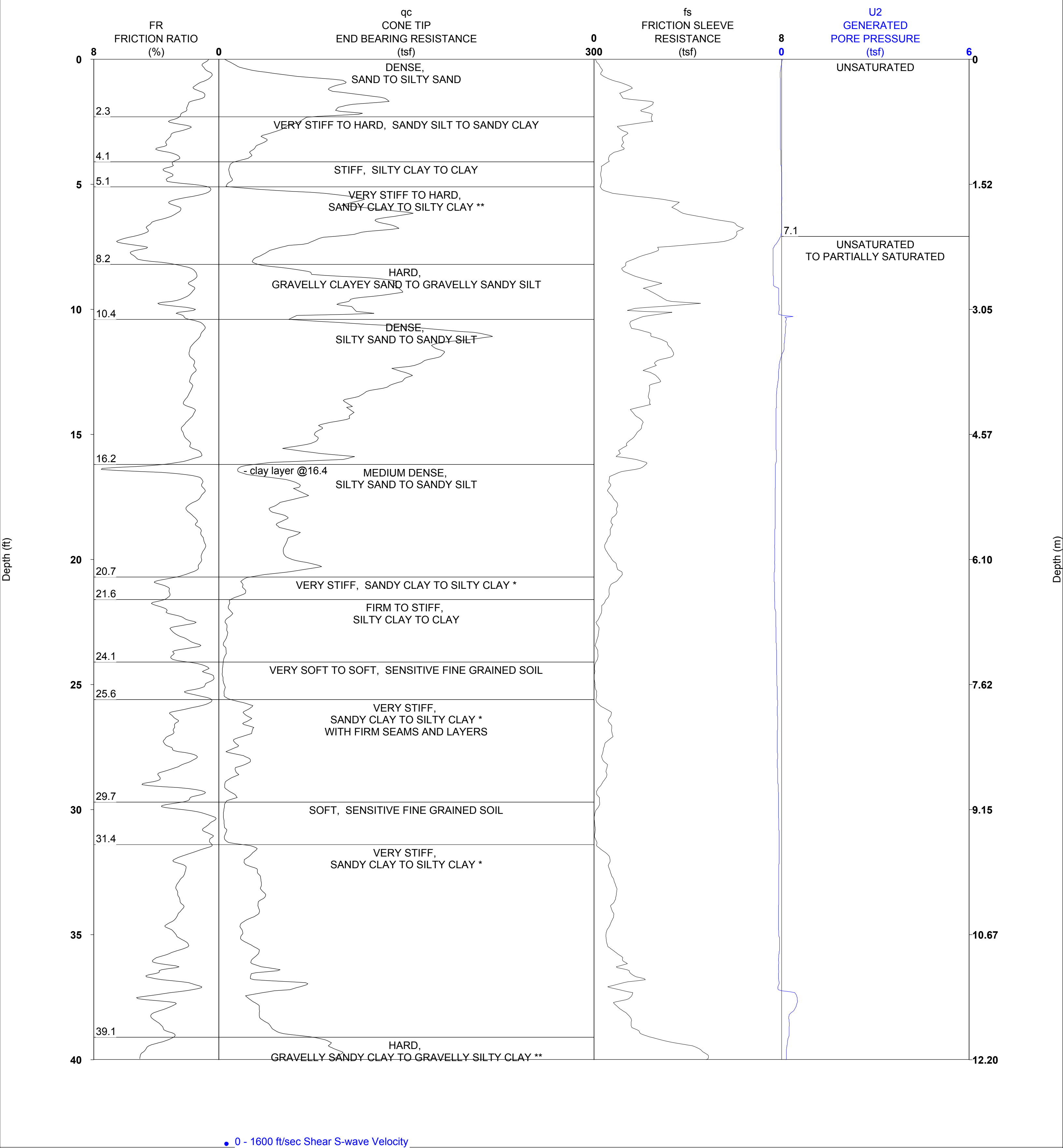


PROJECT NAME:Dynegy Vermillion Plant
PROJECT NUMBER:13-130-070

STRATIGRAPHICS

R1 DATE:7/24/2013 TIME:4:36 PM
SOUNDING NUMBER:CP-13-05 (CPTU)

CPTU LOG WITH LITHOLOGIC EVALUATION cp1305



PROJECT NAME:Dynegy Vermillion Plant
PROJECT NUMBER:13-130-070

STRATIGRAPHICS

R1 DATE:7/24/2013 TIME:4:36 PM
SOUNDING NUMBER:CP-13-05 (CPTU)

Laboratory Test Results
URS-St. Louis

URS Corporation #215629006
Dynegy Vermilion 2013
LABORATORY TEST DATA SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS						
			WATER CONTENT (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTIC INDEX (%)	USCS SYMB. (1)	SIEVE MINUS NO. 200	HYDRO. % MINUS 2µm
B-13-1	S-10	35.0-36.5	11.6						
B-13-1	S-11	40.0-41.5	12.2	24	12	12	CL		
B-13-2	S-4	7.5-9.0	14.4	22	16	6	CL-ML		
B-13-2	S-9	35.0-36.5	10.8					28.8	
B-13-2	S-10	45.0-46.5	9.6						
B-13-3	S-2	2.5-4.0	15.9	38	16	22	CL		
B-13-3	S-8	25.0-26.5	16.9					25.4	
B-13-3	S-9	30.0-31.5	17.0					6.4	
B-13-3	S-10	35.0-36.5	10.7	23	12	11	CL		
B-13-4	S-2	2.5-4.5	7.7						
B-13-4	S-3	5.0-7.0	13.7						
B-13-4	S-7	20.0-22.0	11.7	24	12	12	CL		
B-13-4	S-10	40.0-42.0	13.0					15.2	
B-13-5	S-3	5.0-6.5	17.2	35	17	18	CL		
B-13-5	S-4	7.5-9.0	17.6						
B-13-5	S-5	10.0-11.5	19.2						
B-13-5	S-7	20-21.5	17.5						
B-13-5	S-8	25.0-26.5	20.2						
B-13-5	S-11	40.0-41.5	12.4	22	11	11	CL		
B-13-6	S-2	2.5-4.0	13.7						
B-13-6	S-4	7.5-9.0	19.3						
B-13-6	S-3	5.0-6.5	16.5	33	16	16	CL		
B-13-6	S-5	10.0-11.5	17.6						
B-13-6	S-9	30.0-31.5	17.9						
B-13-6	S-11	40.0-41.5	11.4						
B-13-7	S-3	5.0-6.5	12.3						
B-13-7	S-5	10-11.5	27.0						
B-13-7	S-6	15.0-16.5	23.3					42.8	
B-13-8	S-6	15.0-16.5	21.5	39	18	20	CL		
B-13-8	S-11	40-41.5	17.3						
B-13-8	S-12	45.0-46.5	13.0						
B-13-9	S-2	2.5-4.0	9.6						
B-13-9	S-4	7.5-9.0	22.4						
B-13-9	S-6	15-16.5	22.7						
B-13-9	S-7	20.0-21.5	11.8						
B-13-9	S-12	45.0-46.5	20.9						
B-13-9	S-15	70-71.5	6.3						

Prepared by: BTH
Reviewed by: SAV
Date: 11/05/13

URS COrporation
1001 Highlands Plaza Drive West, Suite # 300
St. Louis, MO 63110

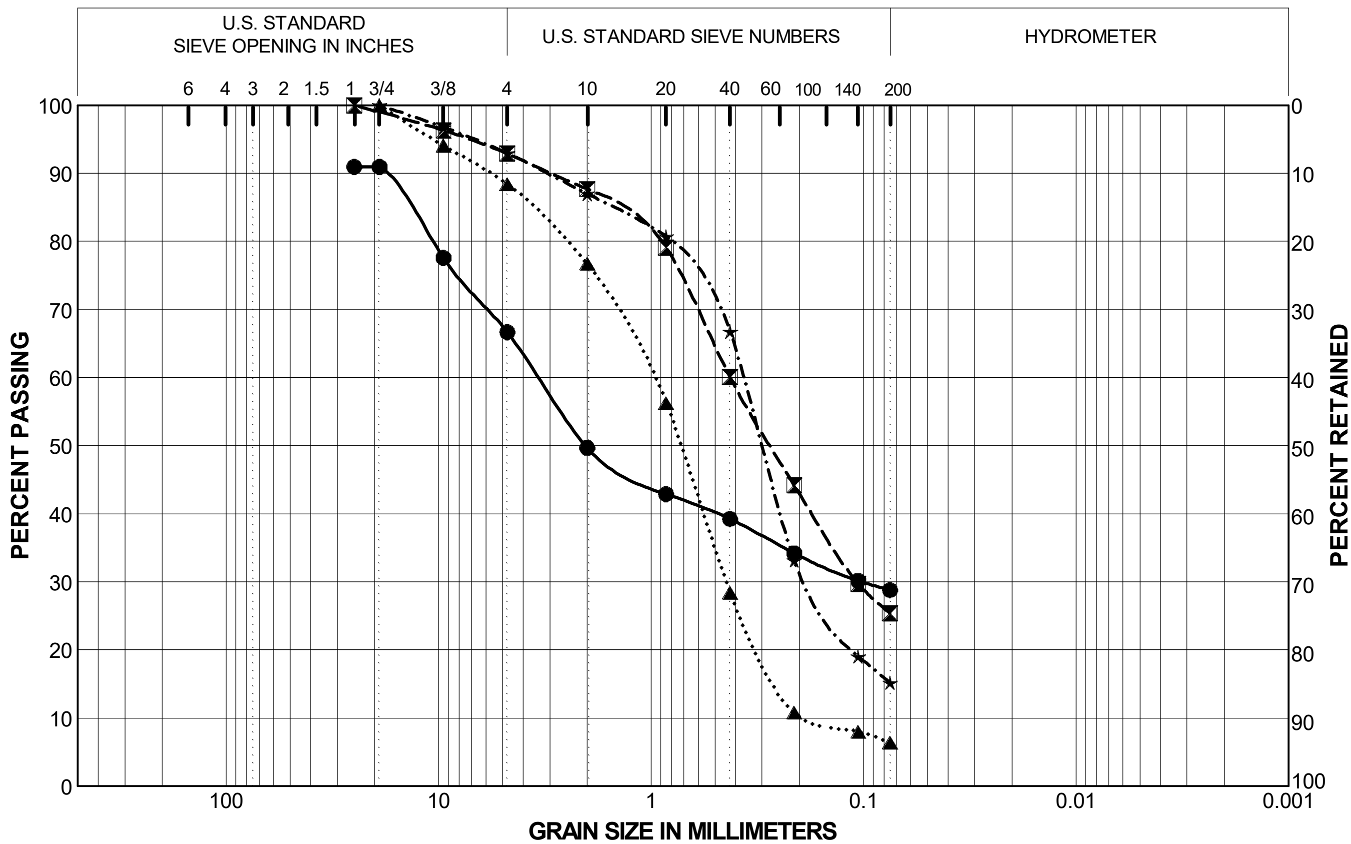
URS Corporation #215629006
Dynegy Vermilion 2013
LABORATORY TEST DATA SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS						
			WATER CONTENT (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTIC INDEX (%)	USCS SYMB. (1)	SIEVE MINUS NO. 200	HYDRO. % MINUS 2µm
B-13-10	S-2	2.5-4.5	12.4						
B-13-10	S-4	7.5-9.0	19.5	42	21	21	CL		
B-13-10	S-5	10.0-12.0	17.8						
B-13-10	S-6	12.5-14.0	21.1					35.7	
B-13-11	S-2	2.5-4.0	13.9						
B-13-11	S-14	55-56.5	22.8						
B-13-12	S-2	2.5-4.0	13.3						
B-13-12	S-3	5.0-6.5	17.5						
B-13-12	S-12	40.0-41.5	64.8					89.5	
B-13-12	S-14	50.0-51.5	19.7						
B-13-13	S-2	2.5-4.0	6.8	24	14	10	CL		
B-13-13	S-3	5.0-6.5	13.0						
B-13-13	S-5	10.0-11.5	10.4						
B-13-13	S-6	15.0-16.5	5.6					17.9	
B-13-13	S-13	50.0-51.5	19.1						
B-13-13	S-15	70.0-71.0	11.0					23.6	
B-13-14	S-2	2.5-4.0	16.8						
B-13-14	S-3	5.0-6.5	15.1						
B-13-14	S-6	15.0-16.5	8.9					8.5	
B-13-14	S-9	30.0-31.5	11.1	24	13	11	CL		
B-13-14	S-7	20.0-21.5	11.3	24	12	11	CL		
B-13-14	S-8	25.0-26.5	9.6						
B-13-14	S-11	40.0-41.5	19.0						
B-13-15	S-2	2.5-4.0	16.0						
B-13-15	S-5	10.0-11.5	38.3					96.7	
B-13-15	S-9	30.0-31.5	32.7					71.6	
B-13-15	S-13	50-51.5	78.5					93.4	
B-13-15	S-14	55.0-56.5	21.9						
B-13-15	S-17	75.0-76.5	11.3						
B-13-16	S-2	2.5-4.0	10.2						
B-13-16	S-3	5.0-6.5	14.8						
B-13-16	S-11	35-36.5	50.6					96.1	
B-13-16	S-15	55.0-56.5	17.3	29	17	12	CL		
B-13-17	S-3	5.0-6.5	19.4						
B-13-17	S-6	15.0-16.5	9.9						
B-13-17	S-7	20-21.5	10.0						
B-13-17	S-9	30.0-31.5	10.9						

Prepared by: BTH
Reviewed by: SAV
Date: 11/05/13

URS COrporation
1001 Highlands Plaza Drive West, Suite # 300
St. Louis, MO 63110

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	



Boring Number	Depth (feet)	Symbol	LL	PI	Classification
B-13-2	35.0	●			Brown and dark gray, Clayey Gravel
B-13-3	25.0	⧗			Brown, Silty Sand
B-13-3	30.0	▲			Brown, Sand with trace to some silt
B-13-4	40.0	★			Brown, Sand with trace silt

Project: Dynegy-Vermilion
Location: Danville, IL
Project Number: 21562906

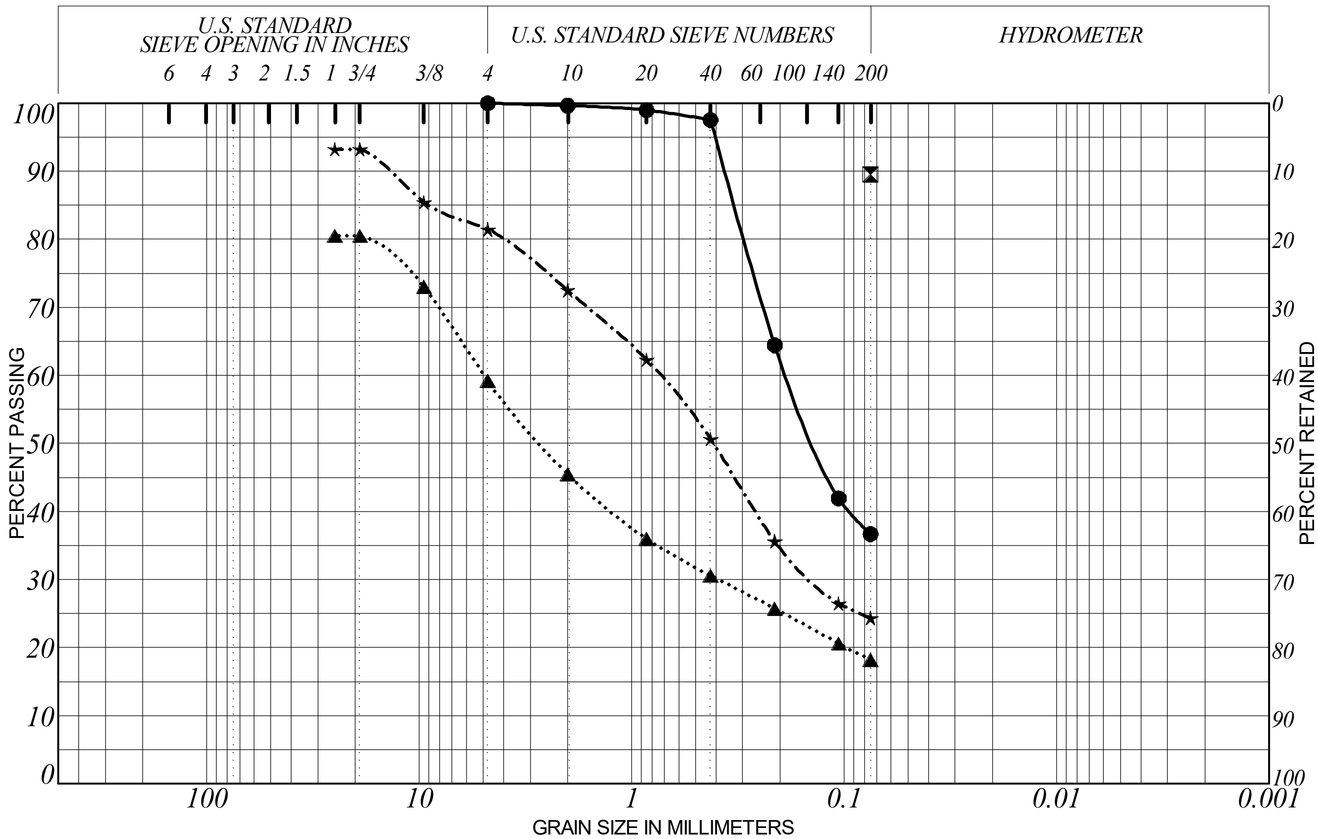
GRAIN SIZE DISTRIBUTION CURVES

Figure 1

11/6/13 SLSIEVES DYNERG-VERMILLION.GPJ

URS

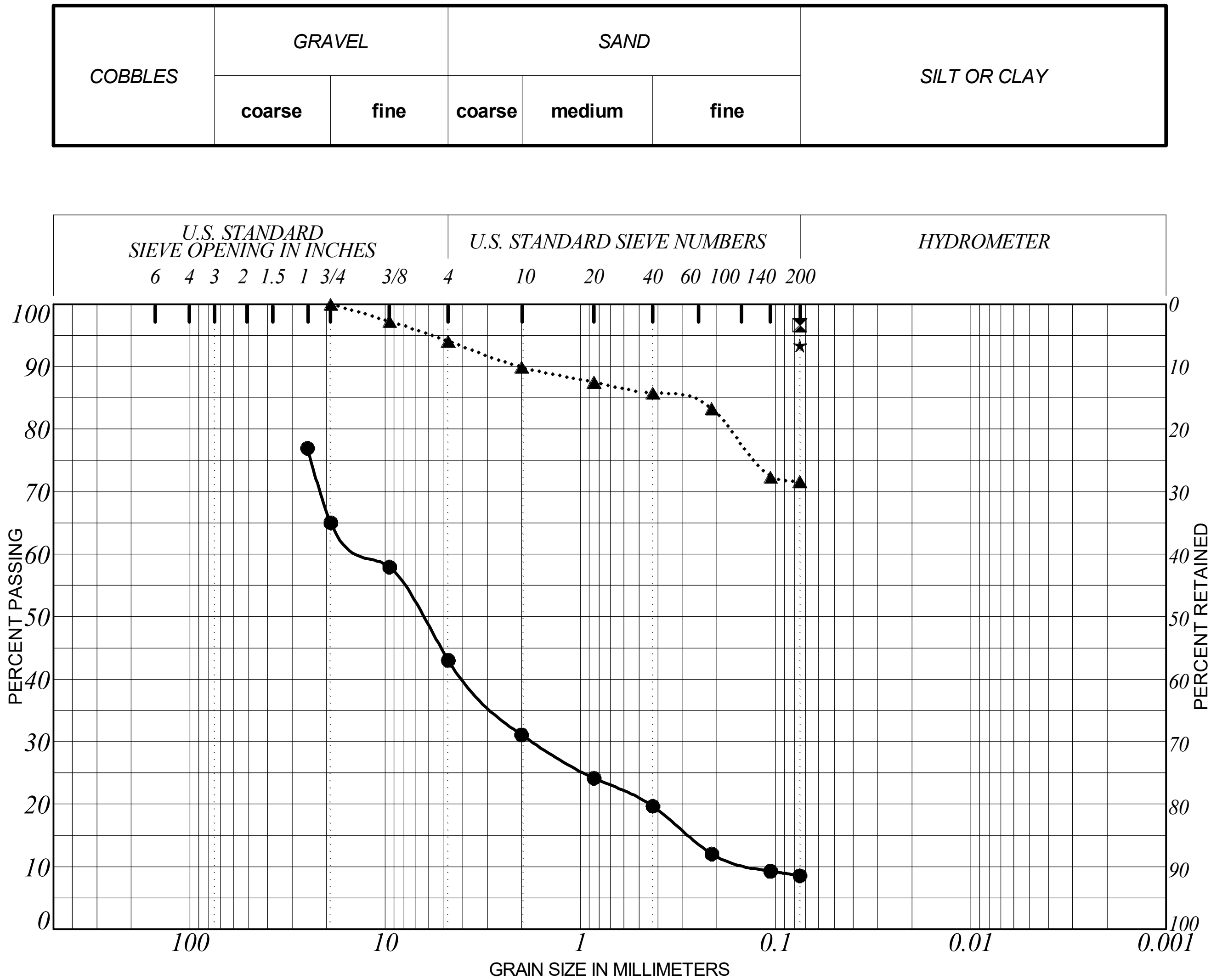
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	



Boring Number	Depth (feet)	Symbol	LL	PI	Classification
B-13-10	**12.5**	●			**Brown, Silty Sand**
B-13-12	**40.0**	⧗			**Brown and dark gray, Sandy Silt**
B-13-13	**15.0**	▲			**Ash with trace gravel**
B-13-13	**70.0**	★			**Silty Sand with trace gravel**

Project: Dynegy-Vermilion **Project Number:** *21562906*	GRAIN SIZE DISTRIBUTION CURVES	*Figure 1*

URS



Boring Number	Depth (feet)	Symbol	LL	PI	Classification
B-13-14	**15.0**	●			**Brown, Gravel with sand and trace silt**
B-13-15	**10.0**	⧗			**Dark brown gray, Silt with trace to some sand**
B-13-15	**30.0**	▲			**Dark gray, Silt with trace to some sand**
B-13-15	**50.0**	★			**Dark brown gray, Silt with trace to some sand**

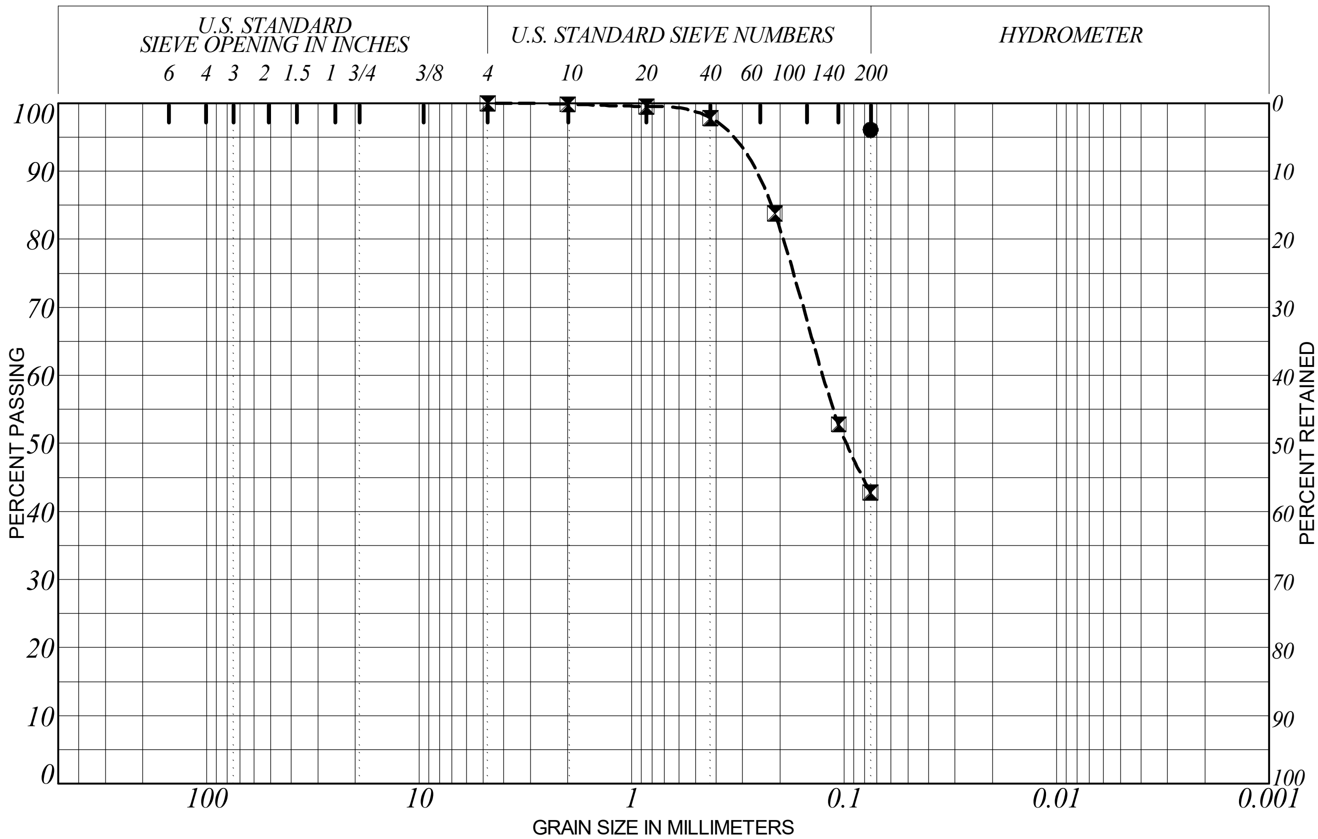
Project: Dynegy-Vermilion
Project Number: 21562906

GRAIN SIZE
DISTRIBUTION CURVES

Figure 2

URS

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	



Boring Number	Depth (feet)	Symbol	LL	PI	Classification
B-13-16	**35.0**	●			**Dark brown gray, Silt with trace to some sand**
B-13-7	**15.0**	⧗			**Brown, Sity Sand**

Project: Dynegy-Vermilion **Project Number:** *21562906*	GRAIN SIZE DISTRIBUTION CURVES	*Figure 3*

Laboratory Test Results
Terrasense

URS Corporation #21562906
Dynegy Vermillion 2013
LABORATORY TESTING DATA SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS: WATER CONTENT (%)	LIQUID LIMIT (-)	PLASTIC LIMIT (-)	PLAS. INDEX (-)	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 μm (%)	TOTAL UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	STRENGTH: Type Test @ STRESS (psi)	PEAK SHEAR STRESS (psi)	STRAIN @ PEAK STRESS (%)	CONSOLIDATION INITIAL CONDITIONS: VOID RATIO (-)	SATUR-ATION (%)	REMARKS / Test ID
B-13-1	SS-6	15-16.5	38.8				CL	97.7	8								
B-13-2	SS-7	20-21.5	17.8				SC	36.1	10								
B-13-2	SH-3	5-7								101.5							
B-13-2	SH-3A	5.4	34.9				FA	87.2	6	96.2	71.3	CID@5	7.5	7.9			TD409
B-13-2	SH-3	5.7	48.6														
B-13-2	SH-3B	5.95	39.7				FA			98.4	70.4				1.038	88	C13192
B-13-2	SH-3	6.25	31.0														
B-13-4	SS-5	10-12	17.1				SC	40.3	9								
B-13-5	SS-6	15-17								132.1							
B-13-5	SS-6A	15.25	17.8				CL			134.2	113.9	CID@5	11.2	15.7			TD410
B-13-5	SS-6B	15.75	17.5	36	16	20	CL			134.3	114.3	CID@10	14.4	15.5			TD411
B-13-5	SS-6C	16.25	16.5				CL			133.9	114.9	CID@15	28.4	14.3			TD412
B-13-6	SS-6	15-17								130.0							
B-13-6	SS-6A	15.4	16.3				CL			133.6	114.9	CIU@5	12.7	20.4			T3521
B-13-6	SS-6	15.7	18.6														
B-13-6	SS-6B	15.95	21.0	36	16	20	CL			132.4	109.5	CIU@10	9.0	20.2			T3522
B-13-6	SS-6	16.25	19.8														
B-13-6	SS-6C	16.5	18.4				CL			132.4	111.9	CIU@15	24.0	20.0			T3523
B-13-7	SS-2	2.5-4.5								125.5							
B-13-7	SS-2A	2.75	16.4				CL			130.8	112.4	CIU@2	8.2	20.2			T3524
B-13-7	SS-2B	3.25	14.1	28	14	14	CL			129.4	113.4	CIU@3	11.3	21.1			T3525
B-13-7	SS-2C	3.75	10.3				SM			130.3	118.1	CIU@4	69.5	14.5			T3526

Prepared by: JR
Reviewed by: GET
Date: 9/20/2013

URS Corporation #21562906
Dynegy Vermillion 2013
LABORATORY TESTING DATA SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS: WATER CONTENT (%)	LIQUID LIMIT (-)	PLASTIC LIMIT (-)	PLAS. INDEX (-)	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 μm (%)	TOTAL UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	STRENGTH: Type Test @ STRESS (psi)	PEAK SHEAR STRESS (psi)	STRAIN @ PEAK STRESS (%)	CONSOLIDATION INITIAL CONDITIONS: VOID RATIO (-)	SATUR-ATION (%)	REMARKS / Test ID
B-13-7	SS-4	7.5-9								117.8							
B-13-7	SS-4	8.0	16.8				FA										
B-13-7	SS-4B	8.25	16.7	27	15	12	CL/FA			125.9	107.9	UU@6	4.7	14.0			UU234b
B-13-8	SS-4	7.5-9.5								108.7							
B-13-8	SS-4	7.85	26.3														
B-13-8	SS-4A	8.1	34.8				FA			107.3	79.6	CID@5	6.8	8.8			TD413
B-13-8	SS-4	8.4	28.5														
B-13-8	SS-4B	8.65	28.0				CL/FA	78.9	6	114.3	89.3	CID@6	10.1	3.1			TD414
B-13-8	SS-9	30-32								103.9							
B-13-8	SS-9A	30.4	47.4				FA			102.1	69.3	UU@20	7.3	7.4			UU234c
B-13-8	SS-9	30.7	47.6														
B-13-8	SS-9B	30.95	44.2				FA	97.5	7	102.5	71.0				1.118	95	C13193
B-13-9	SS-3	5-7								128.5							
B-13-9	SS-3A	5.6	17.5				CL			132.6	112.9	CIU@4	12.5	20.4			T3527
B-13-9	SS-3	5.9	19.5														
B-13-9	SS-3B	6.15	19.6				CL	93.6	24	131.5	110.0	CIU@5	18.5	20.7			T3528
B-13-9	SS-8	25-27								99.0							
B-13-9	SS-8	25.45	40.3														
B-13-9	SS-8B	25.7	43.5				FA	98.9	8	103.5	72.1	UU@20	7.7	10.8			UU234a
B-13-9	SS-14	60-61.5	10.1				SM	12.8	1								

URS Corporation #21562906
Dynegy Vermillion 2013
LABORATORY TESTING DATA SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS: WATER CONTENT (%)	LIQUID LIMIT (-)	PLASTIC LIMIT (-)	PLAS. INDEX (-)	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 µm (%)	TOTAL UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	STRENGTH: Type Test @ STRESS (psi)	PEAK SHEAR STRESS (psi)	STRAIN @ PEAK STRESS (%)	CONSOLIDATION INITIAL CONDITIONS: VOID RATIO (-)	SATUR-ATION (%)	REMARKS / Test ID
B-13-11	SS-6	15-16.5	3.8				GM	13.7	2								
B-13-11	SS-10	35-36.5	53.3				MH	81.8	6								
B-13-11	SS-13	50-51.5	33.6				CL	90.4	5								
B-13-12	SS-5	10-11.5	6.7				GM	17.9	2								
B-13-13	SS-8	25-26.5	41.4				ML	79.3	5								
B-13-15	SS-3	5-7								124.4							
B-13-15	SS-3	5.9	14.9	33	16	17	SM/CL			133.2	115.9	CID@4	8.3	11.0			TD416
B-13-15	SS-6	15-17								88.6							
B-13-15	SS-6A	15.3	34.7				FA			105.0	77.9	CID@5	7.4	5.9			TD415
B-13-15	SS-6	15.65	27.4														
B-13-15	SS-6B	15.9	31.3				FA	94.0	3	105.9	80.6	CID@10	14.2	4.4			TD417
B-13-16	SS-16	60-61.5	29.1				SM	17.4	1								
B-13-17	SS-2	2.5-4.5								95.3							
B-13-17	SS-2A	2.85	27.1				SC/FA			107.8	84.8	CID@2	3.1	12.9			TD418
B-13-17	SS-2B	3.35	37.2	44	35	9	FA			93.3	68.0	CID@3	4.6	4.0			TD419
B-13-17	SS-2	3.65	36.8														
B-13-17	SS-2	3.9	36.6				FA			97.6	71.5	CID@4	8.8	2.1			TD420
B-13-17	SS-5	10-11.5	17.7				SM	17.2	3								

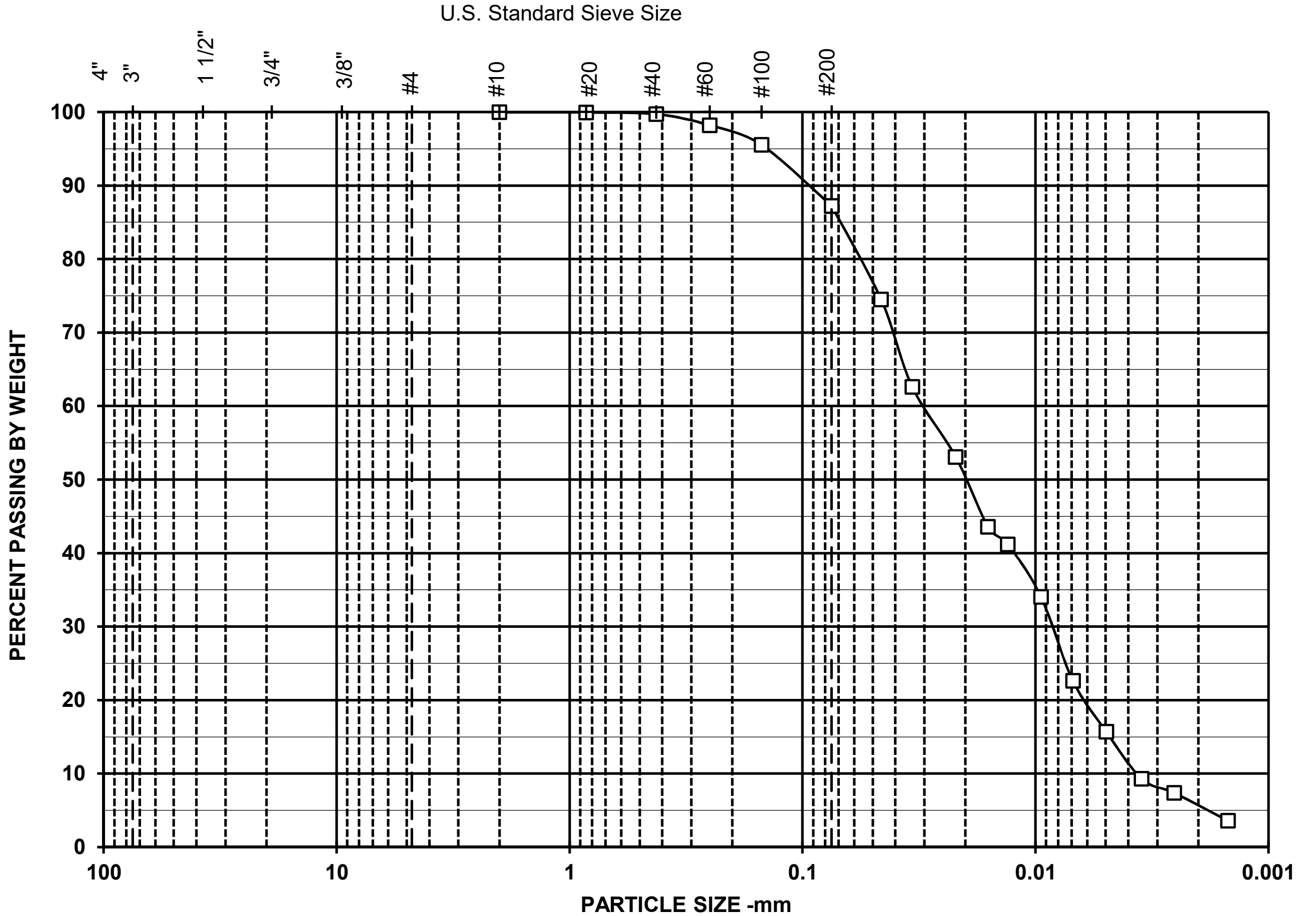
Note: (1) USCS symbol based on visual observation and Sieve and Atterberg limits reported. "FA" reported for Fly-Ash samples

Prepared by: JR
Reviewed by: GET
Date: 9/20/2013

TerraSense, LLC
45H Commerce Way
Totowa, NJ 07512

Project No.: T21562906
File: IndxAll.xls

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	B-13-2		
Sample	SH-3A		
Depth	5.4		
% +3"	0.0		
% Gravel	0.0		
% SAND	12.8		
%C SAND	0.0		
%M SAND	0.2		
%F SAND	12.5		
% FINES	87.2		
% -2μ	6		
D_{100} (mm)	4.75		
D_{60} (mm)	0.03		
D_{30} (mm)	0.01		
D_{10} (mm)			
Cc			
Cu			

Particle Size	PERCENT FINER		
(Sieve #)	□	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4			
10	100.0		
20	99.9		
40	99.7		
60	98.2		
100	95.5		
200	87.2		

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□					FA	Gray, Fly-Ash	8/26/2013
■							
○							

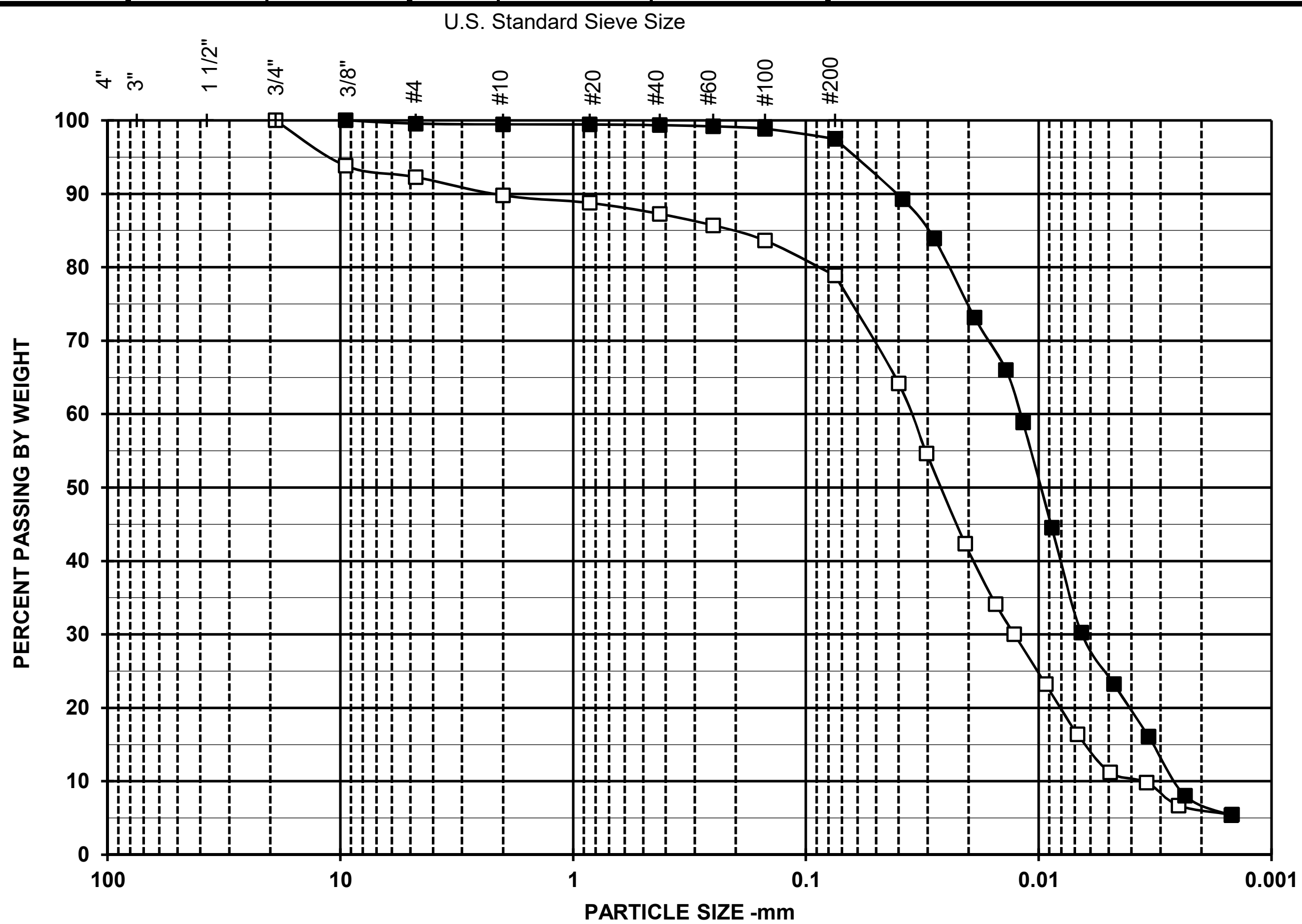
TerraSense, LLC	URS Corporation
T21562906	21562906

PARTICLE SIZE DISTRIBUTION
Dynegy Vermillion 2013

Analysis File: 3SV-MasterRev3

siev13-02.xls 9/20/2013

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	B-13-8	B-13-8	
Sample	SS-4	SS-9B	
Depth	8.65	30.95	
% +3"	0.0	0.0	
% Gravel	7.7	0.4	
% SAND	13.4	2.1	
%C SAND	2.5	0.1	
%M SAND	2.5	0.1	
%F SAND	8.4	1.9	
% FINES	78.9	97.5	
% -2μ	6	7	
D_{100} (mm)	19.00	9.50	
D_{60} (mm)	0.04	0.01	
D_{30} (mm)	0.01	0.01	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"	100.0		
3/8"	93.8	100.0	
4	92.3	99.6	
10	89.8	99.5	
20	88.8	99.4	
40	87.3	99.4	
60	85.7	99.2	
100	83.6	98.9	
200	78.9	97.5	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□					FA	Gray, Fly-Ash with clay	9/4/2013
■					FA	Gray, Fly-Ash	8/22/2013
○							

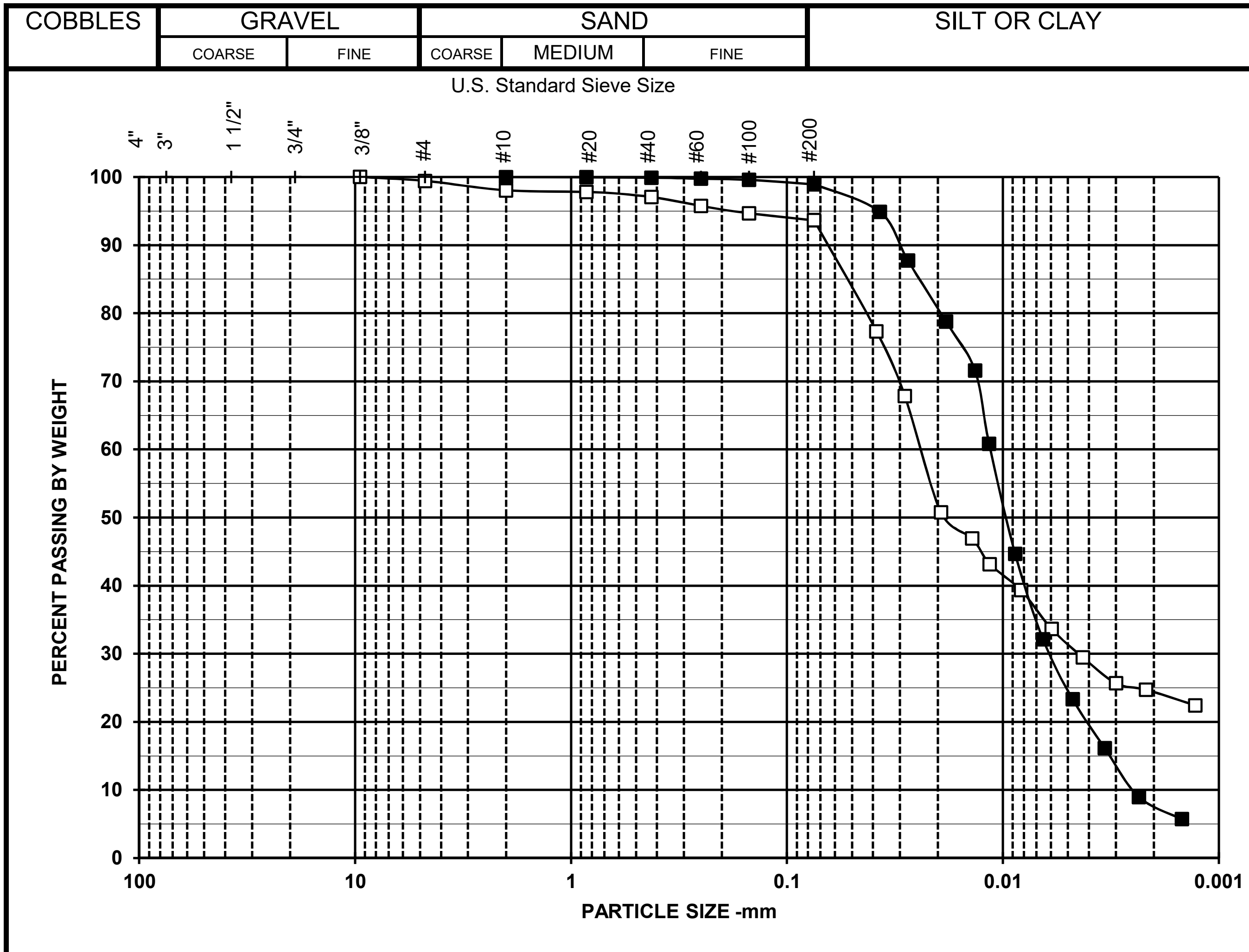
TerraSense, LLC	URS
T21562906	21562906

PARTICLE SIZE DISTRIBUTION

Dynegy Vermillion 2013

Analysis File: 3SV-MasterRev3

siev13-08.xls 9/20/2013



Symbol	□	■	○
Boring	B-13-9	B-13-9	
Sample	SH-3B	SS-8B	
Depth	6.15	25.7	
% +3"	0.0	0.0	
% Gravel	0.6	0.0	
% SAND	5.8	1.1	
%C SAND	1.4	0.0	
%M SAND	1.0	0.1	
%F SAND	3.4	1.0	
% FINES	93.6	98.9	
% -2μ	24	8	
D_{100} (mm)	9.50	4.75	
D_{60} (mm)	0.02	0.01	
D_{30} (mm)	0.00	0.01	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"	100.0		
4	99.4		
10	98.0	100.0	
20	97.8	100.0	
40	97.1	99.9	
60	95.7	99.8	
100	94.7	99.6	
200	93.6	98.9	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□					CL	Brown, Lean clay	8/26/2013
■					FA	Gray, Fly-Ash	8/22/2013
○							

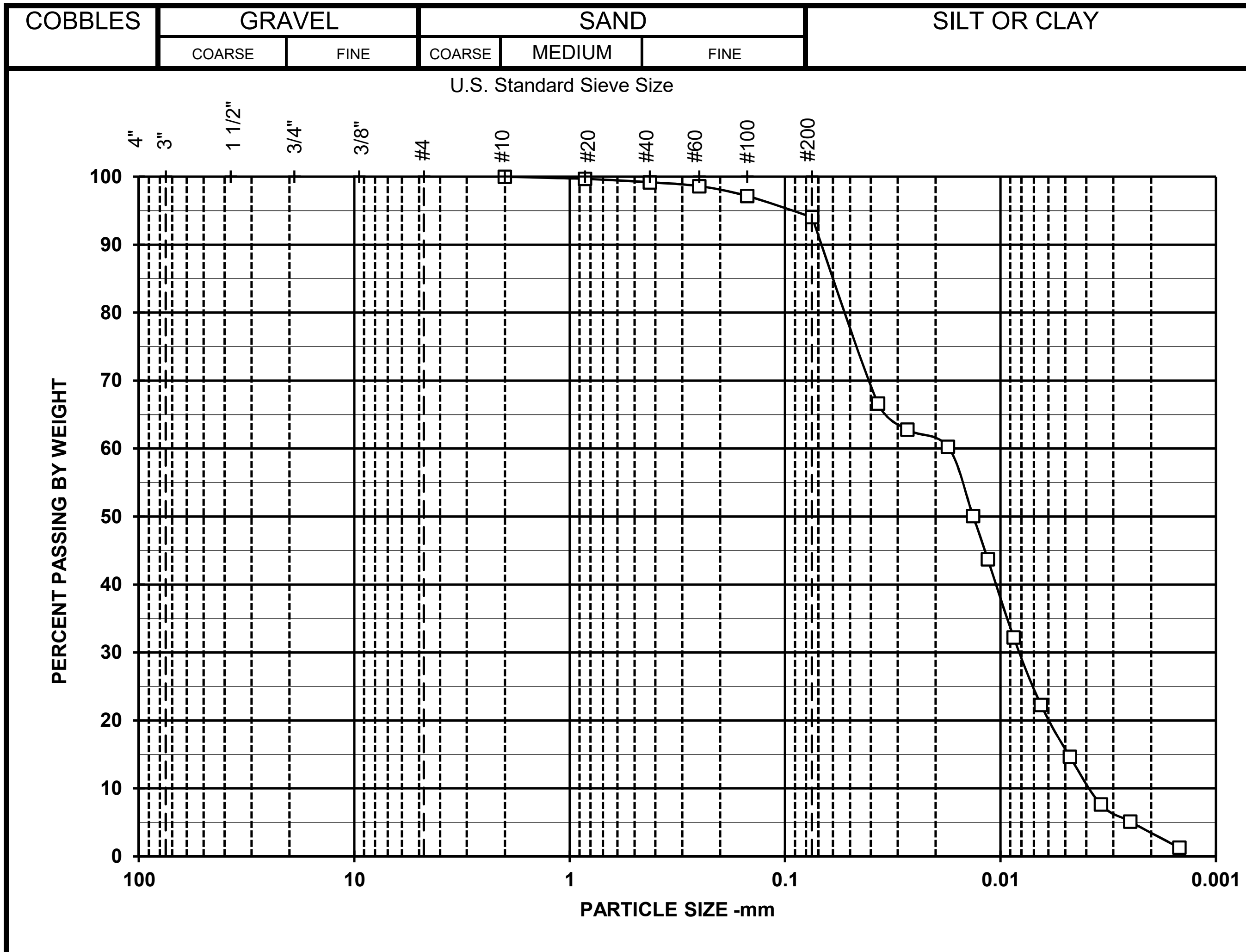
TerraSense, LLC	URS
T21562906	21562906

PARTICLE SIZE DISTRIBUTION

Dynegy Vermillion 2013

Analysis File: 3SV-MasterRev3

siev13-09.xls 9/20/2013



Symbol	□	■	○
Boring	B-13-15		
Sample	SS-6B		
Depth	15.9		
% +3"	0.0		
% Gravel	0.0		
% SAND	6.0		
%C SAND	0.0		
%M SAND	0.8		
%F SAND	5.1		
% FINES	94.0		
% -2µ	3		
D_{100} (mm)	4.75		
D_{60} (mm)	0.02		
D_{30} (mm)	0.01		
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4			
10	100.0		
20	99.7		
40	99.2		
60	98.6		
100	97.2		
200	94.0		

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□					FA	Gray, Fly-Ash	9/4/2013
■							
○							

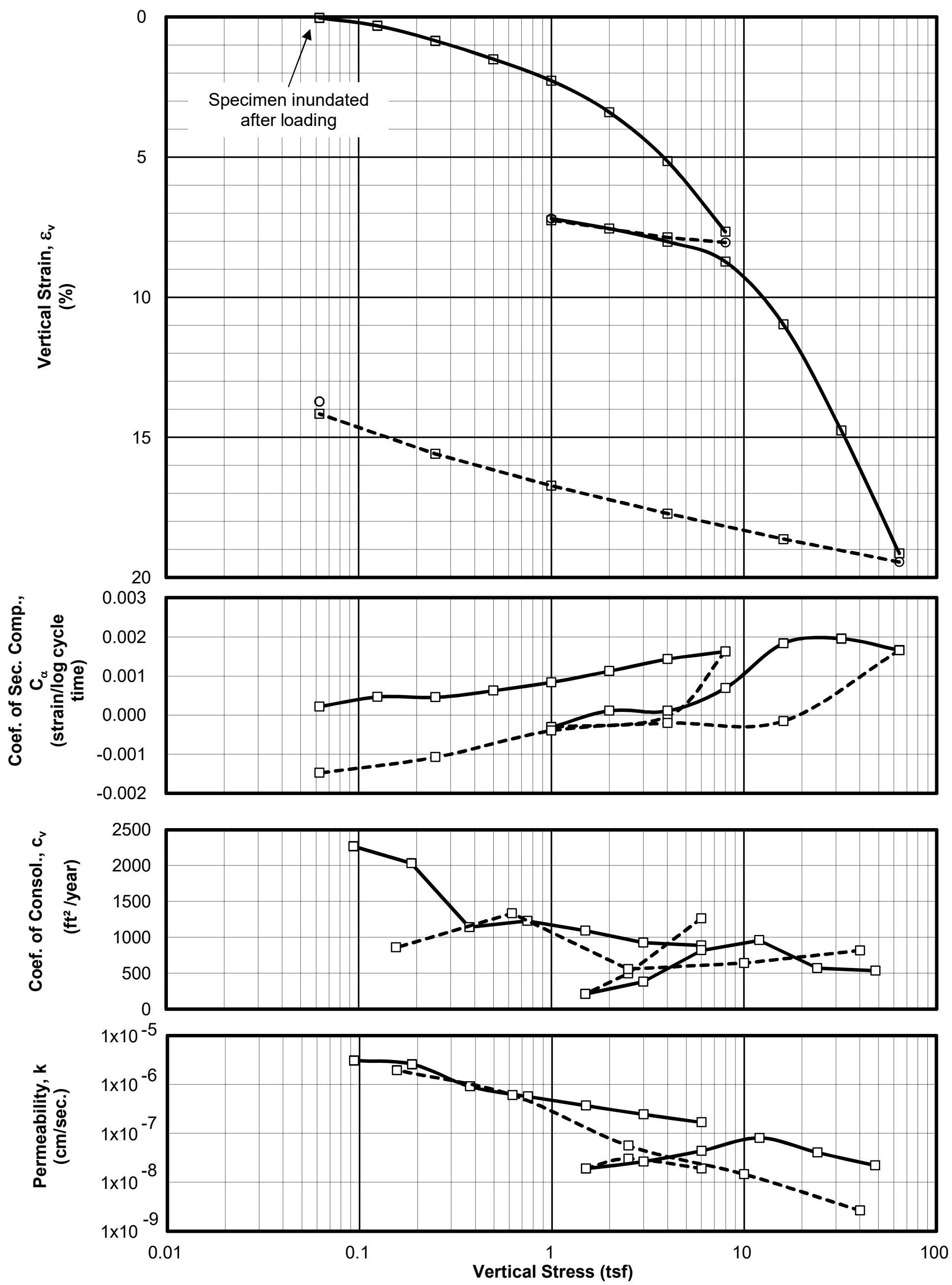
TerraSense, LLC	URS Corporation
T21562906	21562906

PARTICLE SIZE DISTRIBUTION

Dynegy Vermillion 2013

Analysis File: 3SV-MasterRev3

siev13-15.xls 9/20/2013



SAMPLE INFORMATION

Boring:	B-13-2
Sample:	SH-3B
Depth:	5.95 feet
Elevation:	
Type:	3-inch thin wall tube
Description:	FA, gray silt with sand (flyash)

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height:	0.61	inch
Diameter:	2.50	inch

Initial water content:	39.7	%
Initial total unit weight:	98.4	pcf
Initial dry unit weight:	70.4	pcf
Initial void ratio:	1.038	
Initial degree of saturation:	88	%
Final water content:	37.8	%
Final total unit weight:	105.7	pcf
Final dry unit weight:	76.7	pcf
Final void ratio:	0.873	
Final degree of saturation:	100	% (assumed specific gravity = 2.30)

TEST SUMMARY

Construction Method:	Casagrande (Log)
Estimated preconsolidation stress (tsf):	5.5 (Range: 5.2 to 7.9)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.136
Compression Index (void ratio per log cycle stress):	0.277
Swell Ratio (strain per log cycle stress):	0.010
Swell Index (void ratio per log cycle stress):	0.020
Recompression Ratio (strain per log cycle stress):	0.016
Recompression Index (void ratio per log cycle stress):	0.033
Remarks:	

LEGEND: □ End of primary o End of Stage ——— Loading - - - - - - Unloading

Test Date: 8/21/13 Tested By: CMJ Checked By: GET

URS Project No. 21562906	Dynegy Vermillion 2013	ONE DIMENSIONAL CONSOLIDATION TEST Boring: B-13-2 Depth: 5.95 feet
TerraSense, LLC	Project No. 21562906	September 2013

PROJECT:	Dynegy Vermillion 2013				
PROJECT NO.:	21562906	Initial height:	0.606 inch	Final height:	0.557 inch
BORING:	B-13-2	Initial water content:	39.7 %	Final water content:	37.8 %
SAMPLE:	SH-3B	Initial dry density:	70.4 pcf	Final dry density:	76.7 pcf
TEST:	C13192	Initial total density:	98.4 pcf	Final total density:	105.7 pcf
DEPTH, feet:	5.95	Initial saturation:	88 %	Final saturation:	100 %
BY:	CMJ	Initial void ratio:	1.038	Final void ratio:	0.873
TEST DATE:	8/21/2013			Final strain:	8.1 %

EQUIPMENT:

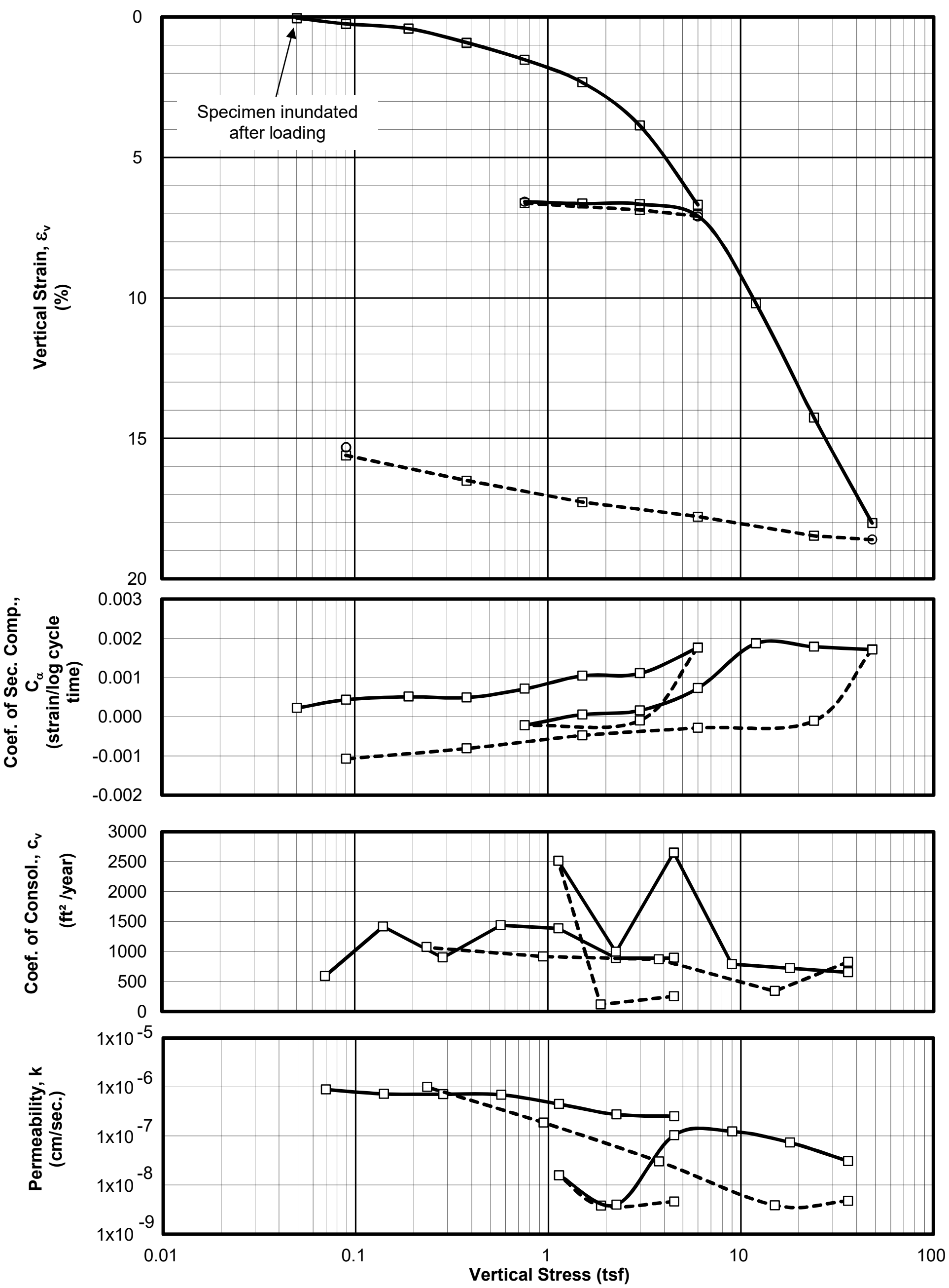
Load Frame No.: 2

Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: FA, gray silt with sand (flyash)

G	LL	PL	PI
2.3			

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft²/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.063	0.0002	0.039	1.038	0.056	1.037	71.12	0.0002	161.65	1.33E-08
2	0.125	0.0019	0.322	1.032	0.566	1.027	2268.70	0.0005	22.09	3.10E-06
3	0.250	0.0052	0.853	1.021	0.984	1.018	2031.30	0.0005	23.53	2.60E-06
4	0.500	0.0092	1.515	1.008	1.669	1.004	1140.89	0.0006	37.78	9.11E-07
5	1.00	0.0138	2.279	0.992	2.495	0.988	1228.54	0.0008	65.37	5.67E-07
6	2.00	0.0206	3.402	0.969	3.673	0.964	1092.02	0.0011	89.07	3.70E-07
7	4.00	0.0312	5.148	0.933	5.487	0.927	924.99	0.0014	114.53	2.44E-07
8	8.00	0.0465	7.665	0.882	8.048	0.874	884.12	0.0016	158.94	1.68E-07
9	4.00	0.0477	7.866	0.878	7.869	0.878	1264.84	0.0000	1992.83	1.91E-08
10	1.00	0.0440	7.257	0.890	7.194	0.892	495.27	-0.0003	492.97	3.03E-08
11	2.00	0.0458	7.558	0.884	7.567	0.884	209.88	0.0001	332.58	1.90E-08
12	4.00	0.0486	8.019	0.875	8.039	0.875	379.97	0.0001	433.21	2.65E-08
13	8.00	0.0529	8.732	0.860	8.892	0.857	817.36	0.0007	561.08	4.39E-08
14	16.0	0.0665	10.964	0.815	11.410	0.806	957.65	0.0018	358.52	8.06E-08
15	32.0	0.0894	14.755	0.738	15.167	0.729	569.16	0.0020	422.07	4.07E-08
16	64.0	0.1160	19.140	0.648	19.441	0.642	534.89	0.0017	729.68	2.21E-08
17	16.0	0.1129	18.626	0.659	18.515	0.661	815.98	-0.0002	9330.56	2.64E-09
18	4.00	0.1074	17.719	0.677	17.680	0.678	641.06	-0.0002	1324.11	1.46E-08
19	1.00	0.1014	16.721	0.698	16.635	0.699	557.32	-0.0004	300.53	5.59E-08
20	0.250	0.0945	15.590	0.721	15.262	0.727	1332.08	-0.0011	66.27	6.06E-07
21	0.063	0.0859	14.164	0.750	13.724	0.759	856.56	-0.0015	13.15	1.96E-06



SAMPLE INFORMATION

Boring: B-13-8
Sample: SS-9B
Depth: 30.95 feet
Elevation:
Type: 3-inch thin wall tube
Description: FA, light gray silt (flyash); crystalized formation noted

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height: 0.61 inch
Diameter: 2.50 inch

Initial water content: 44.2 %
Initial total unit weight: 102.5 pcf
Initial dry unit weight: 71.0 pcf
Initial void ratio: 1.118
Initial degree of saturation: 95 %

Final water content: 34.5 %
Final total unit weight: 110.6 pcf
Final dry unit weight: 82.2 pcf
Final void ratio: 0.831
Final degree of saturation: 100 % (assumed specific gravity = 2.41)

TEST SUMMARY

Construction Method: Casagrande (Log)
Estimated preconsolidation stress (tsf): 3.9 (Range: 3.4 to 4.1)
Estimated in situ effective overburden stress (tsf):
Compression Ratio (strain per log cycle stress): 0.130
Compression Index (void ratio per log cycle stress): 0.275
Swell Ratio (strain per log cycle stress): 0.004
Swell Index (void ratio per log cycle stress): 0.008
Recompression Ratio (strain per log cycle stress): 0.004
Recompression Index (void ratio per log cycle stress): 0.008
Remarks:

LEGEND: □ End of primary o End of Stage ——— Loading - - - - - - Unloading

Test Date: 8/22/13 Tested By: CMJ Checked By: GET

URS Project No. 21562906	Dynegy Vermillion 2013	ONE DIMENSIONAL CONSOLIDATION TEST Boring: B-13-8 Depth: 30.95 feet
TerraSense, LLC	Project No. T21562906	September 2013

PROJECT:	Dynegy Vermillion 2013				
PROJECT NO.:	T21562906	Initial height:	0.613 inch	Final height:	0.530 inch
BORING:	B-13-8	Initial water content:	44.2 %	Final water content:	34.5 %
SAMPLE:	SS-9B	Initial dry density:	71.0 pcf	Final dry density:	82.2 pcf
TEST:	C13193	Initial total density:	102.5 pcf	Final total density:	110.6 pcf
DEPTH, feet:	30.95	Initial saturation:	95 %	Final saturation:	100 %
BY:	CMJ	Initial void ratio:	1.118	Final void ratio:	0.831
TEST DATE:	8/22/2013			Final strain:	13.6 %

EQUIPMENT:

Load Frame No.: 1

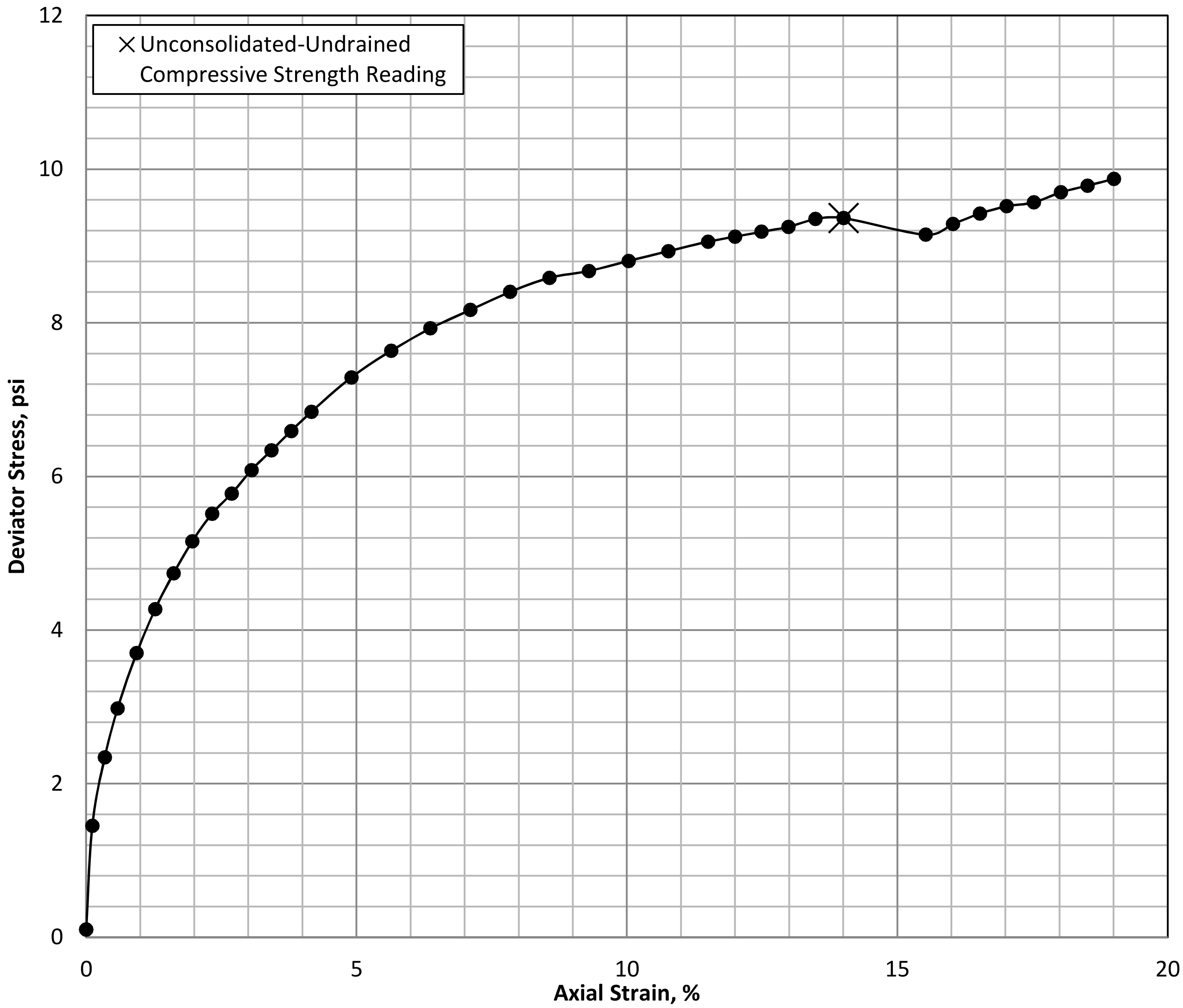
Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: FA, light gray silt (flyash); crystalized formation noted

G	LL	PL	PI
2.41			

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft²/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.050	0.0003	0.046	1.117	0.308	1.111	767.56	0.0002	109.73	2.11E-07
2	0.090	0.0015	0.247	1.113	0.342	1.111	588.72	0.0004	19.81	8.97E-07
3	0.190	0.0026	0.417	1.109	0.605	1.105	1414.53	0.0005	59.04	7.23E-07
4	0.380	0.0056	0.920	1.098	1.034	1.096	896.39	0.0005	37.78	7.16E-07
5	0.760	0.0094	1.529	1.085	1.708	1.082	1437.38	0.0007	62.38	6.95E-07
6	1.51	0.0143	2.334	1.068	2.599	1.063	1385.83	0.0010	93.22	4.49E-07
7	3.00	0.0237	3.866	1.036	4.115	1.031	889.31	0.0011	97.26	2.76E-07
8	6.00	0.0410	6.691	0.976	7.098	0.968	891.48	0.0018	106.17	2.53E-07
9	3.00	0.0422	6.874	0.972	6.859	0.973	249.61	-0.0001	1639.59	4.59E-09
10	0.760	0.0407	6.631	0.977	6.576	0.979	114.50	-0.0002	919.47	3.76E-09
11	1.51	0.0408	6.646	0.977	6.659	0.977	2513.85	0.0001	4812.91	1.58E-08
12	3.00	0.0409	6.666	0.977	6.706	0.976	991.67	0.0002	7581.65	3.95E-09
13	6.00	0.0433	7.054	0.968	7.284	0.964	2649.83	0.0007	772.21	1.04E-07
14	12.0	0.0625	10.194	0.902	10.626	0.893	788.30	0.0019	191.09	1.24E-07
15	24.0	0.0875	14.257	0.816	14.676	0.807	719.80	0.0018	295.36	7.35E-08
16	48.0	0.1105	18.010	0.736	18.600	0.724	650.19	0.0017	639.46	3.07E-08
17	24.0	0.1133	18.467	0.727	18.443	0.727	824.20	-0.0001	5250.70	4.74E-09
18	6.00	0.1091	17.787	0.741	17.732	0.742	337.70	-0.0003	2644.09	3.85E-09
19	1.51	0.1059	17.270	0.752	17.155	0.755	869.51	-0.0005	869.12	3.02E-08
20	0.380	0.1012	16.503	0.768	16.308	0.772	914.78	-0.0008	147.40	1.87E-07
21	0.090	0.0957	15.607	0.787	15.321	0.793	1070.47	-0.0011	32.36	9.98E-07

UNCONSOLIDATED-UNDRAINED COMPRESSIVE STRENGTH TEST, ASTM METHOD D2850



Specimen and Material Property Information

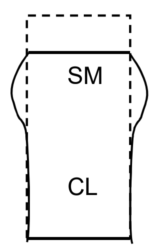
Sample Type: Intact tube sample

Description and/or Classification: CL, gray CLAY with gray silty sand Fly-Ash at top

Cell Pressure (psi)	Water Content (1) (%)	Wet Unit Weight (pcf)	Dry Unit Weight (1) (pcf)	Void Ratio (-)	Saturation (2) (%)	Length (inch)	Diameter (inch)	L/D (-)	LL/PL (-)	PI (-)	Specific Gravity (2) (-)
0 (Initial)	16.7	125.9	107.9	0.45	93.5	6.059	2.866	2.1	27	12	2.50
6.0	16.7	127.1	108.9	0.43	96.5	6.039	2.857	2.1	15		

Failure Summary

U-U Compressive Strength (psi)	U-U Shear Strength, s_u (psi)	Strain to to Peak (%)	Strain Rate (%/min)
9.36	4.68	14.0	0.72



FAILURE SKETCH

Remarks and Notes:

(1) Water Content determined after shear from partial specimen.

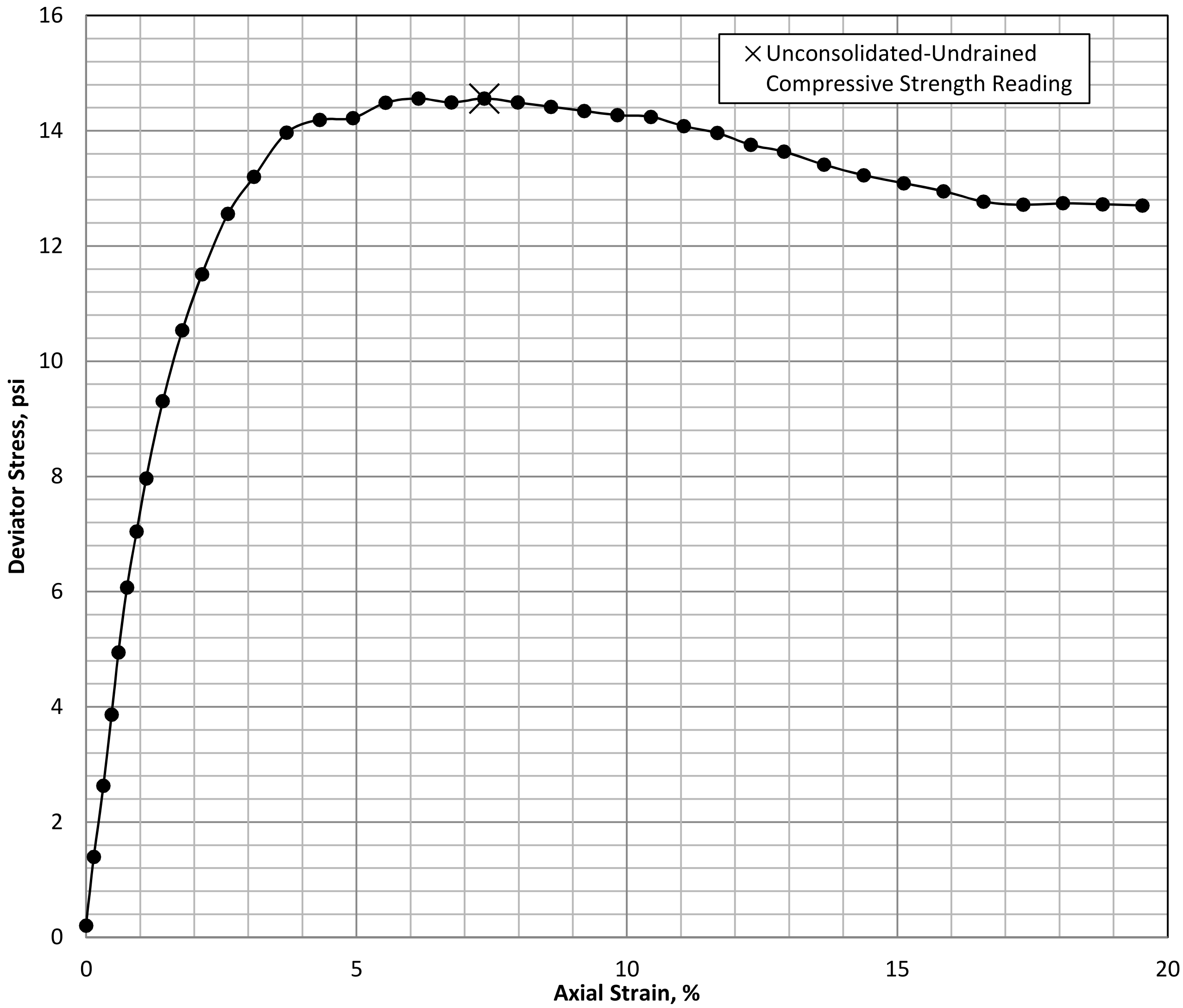
(2) Assumed specific gravity

Tested by: DT   Reviewed by: GET

Test Date: 8/22/2013

URS Corporation **Project # 21562906**	**Dynegy Vermillion 2013**	**UNCONSOLIDATED-UNDRAINED COMPRESSION TEST**
TerraSense, LLC **Project # T21562906**		**Boring: B-13-7 Sample: SS-4** **Section: B Depth: 8.25 ft.**

UNCONSOLIDATED-UNDRAINED COMPRESSIVE STRENGTH TEST, ASTM METHOD D2850



Specimen and Material Property Information

Sample Type: Intact tube sample

Description and/or Classification: FA, gray layered silty and sandy Fly-Ash

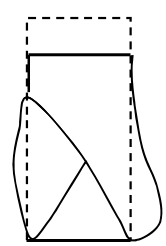
Cell Pressure (psi)	Water Content (%) (1)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf) (1)	Void Ratio (-)	Saturation (%) (2)	Length (inch)	Diameter (inch)	L/D (-)	LL/PL (-)	PI (-)	Specific Gravity (-) (2)
0 (Initial)	47.4	102.1	69.3	1.16	97.9	6.013	2.872	2.1			2.40
20.0	47.4	102.7	69.7	1.15	99.0	6.001	2.866	2.1			

Failure Summary

U-U Compressive Strength (psi)	U-U Shear Strength, s_u (psi)	Strain to to Peak (%)	Strain Rate (%/min)
14.6	7.3	7.4	0.73

Tested by: DT Reviewed by: GET

Test Date: 8/22/2013



FAILURE SKETCH

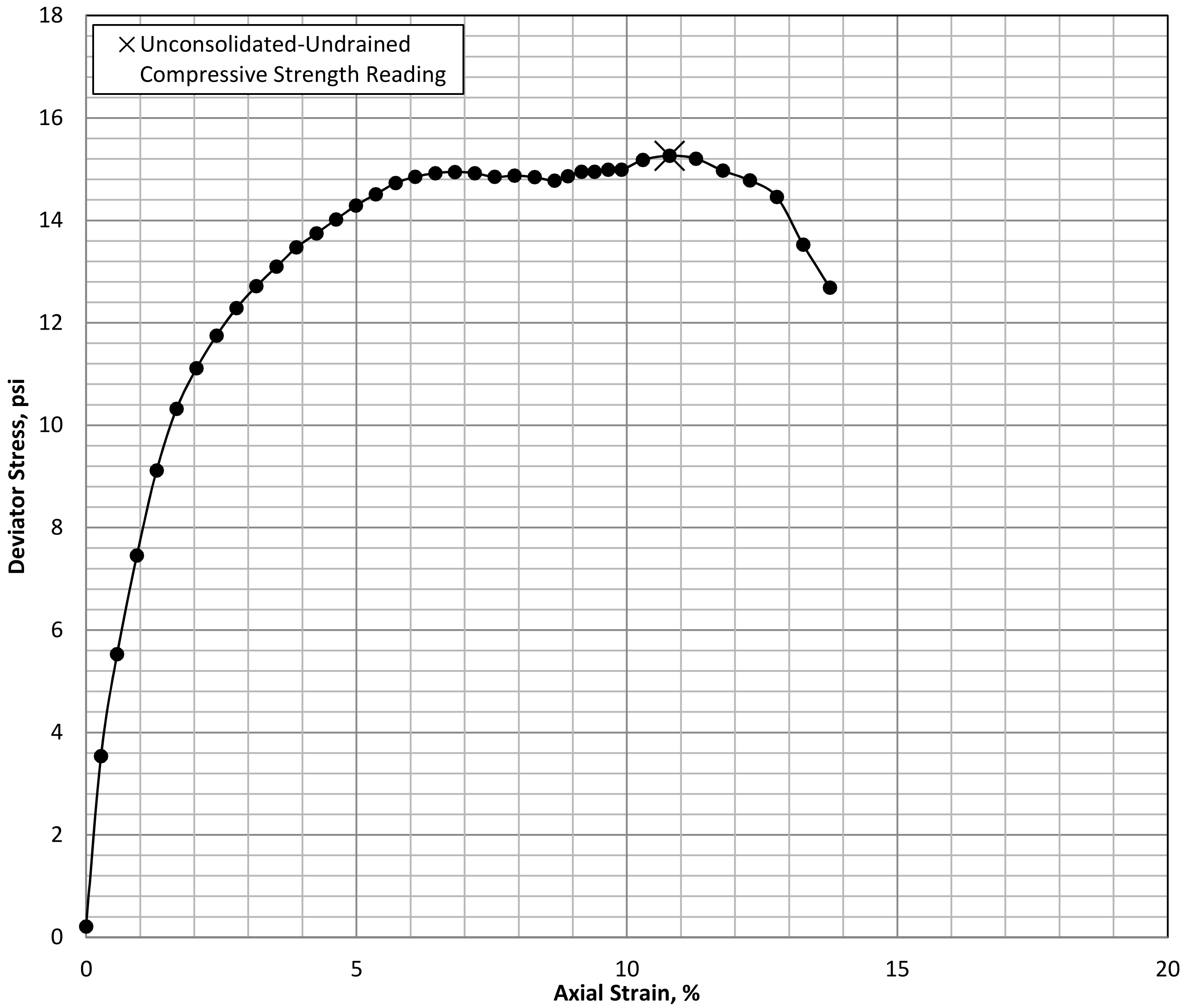
Remarks and Notes:

(1) Water Content determined after shear from partial specimen.

(2) Assumed specific gravity

URS Corporation Project # 21562906	**Dynegy Vermillion 2013**	**UNCONSOLIDATED-UNDRAINED COMPRESSION TEST**
TerraSense, LLC Project # T21562906		**Boring: B-13-8 Sample: SS-9 Section: A Depth: 30.4 ft.**

UNCONSOLIDATED-UNDRAINED COMPRESSIVE STRENGTH TEST, ASTM METHOD D2850



Specimen and Material Property Information

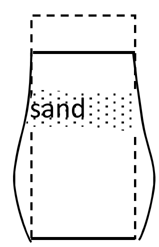
Sample Type: Intact tube sample

Description and/or Classification: FA, light gray silty Fly-Ash with sandy layers

Cell Pressure (psi)	Water [1] Content (%)	Wet Unit Weight (pcf)	Dry Unit [1] Weight (pcf)	Void Ratio (-)	Saturation[2] (%)	Length (inch)	Diameter (inch)	L/D (-)	LL/ PL (-)	PI (-)	Specific [2] Gravity (-)
0 (Initial)	43.5	103.5	72.1	1.08	97.0	6.001	2.859	2.1			2.40
20.0	43.5	105.1	73.2	1.05	100.0	5.969	2.843	2.1			

Failure Summary

U-U Compressive Strength (psi)	U-U Shear Strength, s_u (psi)	Strain to to Peak (%)	Strain Rate (%/min)
15.3	7.65	10.8	0.73



FAILURE SKETCH

Remarks and Notes:

(1) Water Content determined after shear from partial specimen.

(2) Assumed specific gravity

Tested by: DT

Reviewed by: GET

Test Date: 8/22/2013

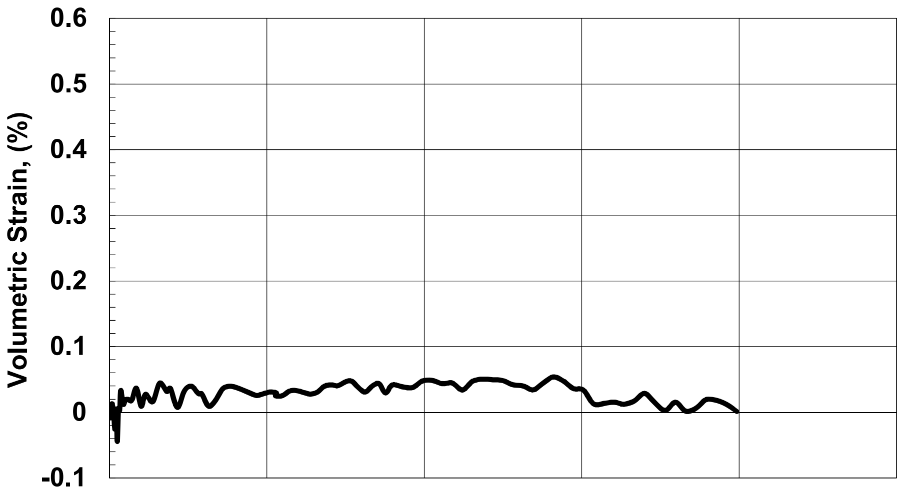
URS Corporation
Project # 21562906

TerraSense, LLC
Project # T21562906

Dynegy Vermillion 2013

UNCONSOLIDATED-UNDRAINED COMPRESSION TEST

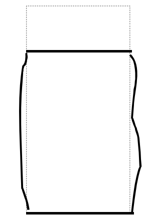
Boring: B-13-9 Sample: SS-8
Section: B Depth: 25.7 ft.



SAMPLE INFORMATION
Boring: B-13-2 Sample: SH-3A Depth: 5.4 ft
Type: Intact tube sample
Description: FA, light gray silt with sand (flyash), roots present

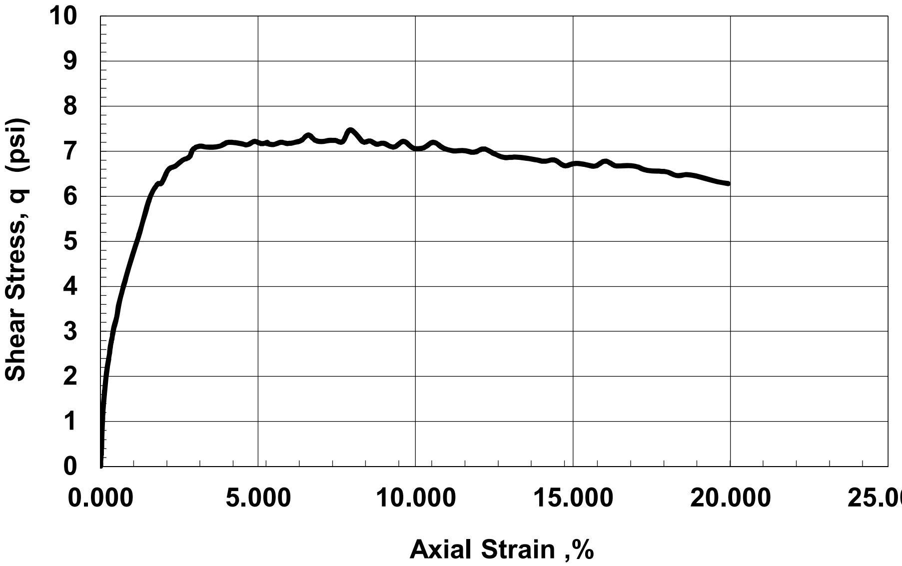
SPECIMEN INFORMATION (Initial)
Height: 6.03 inch Diameter: 2.87 inch Area: 6.49 in²
Water Content: 34.9 % Total Unit Weight: 96.2 pcf

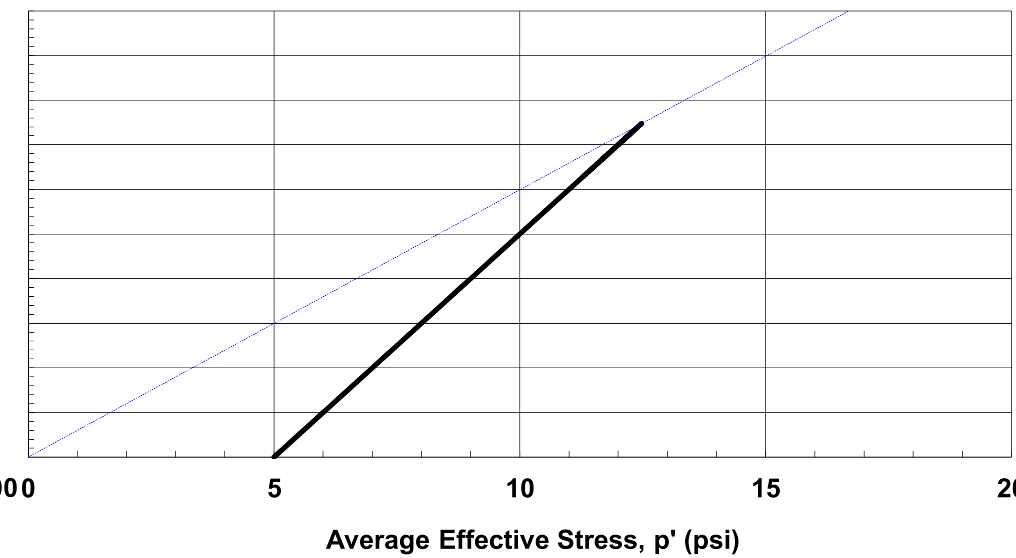
TEST SUMMARY
Consolidation Stresses: 5.00 psi vertical, 5.00 psi lateral
Water Content: 41.5 % Total Unit Weight: 104.0 pcf
B Coefficient: 99.4 Strain Rate: 0.018 %/min
Peak Shear Strength: 7.47 psi @ 7.9 % Strain
Peak Effective Friction Angle: 36.8°



Failure Sketch

REMARKS: Compression positive





Test by: D. Tso	Project No. T21562906	URS #21562906 Dynegy Vermillion 2013	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	
Checked by: G. Thomas	TerraSense, LLC		Boring:B-13-2 Sample: SH-3A Depth: 5.4ft	September-13

SUMMARY OF TRIAXIAL CID-C TESTS ON UNDISTURBED SPECIMENS

Series Test No	Boring No / Sample No.	Depth (ft)	w_o / w_c (%)	$\gamma_{t,o}$ / $\gamma_{t,c}$ (pcf)	$\gamma_{d,o}$ / $\gamma_{d,c}$ (pcf)	σ'_c (ksf) / OCR $\sigma'_{v,c}/\sigma'_{v,max}$	$\varepsilon_{a,c}$ / $\varepsilon_{v,c}$ (%)	B factor (%) / ε_{rate} (%/min)	ε_a (%)	$(\sigma_1 - \sigma_3)/2$ (psi)	$(\sigma'_1 + \sigma'_3)/2$ (psi)	σ'_1 / σ'_3	Vol. Strain ε_{vol} (%)	ϕ' for c'=0
									at Peak Deviator Stress / at Large Strain					
TD410	B-13-5	15.25	17.8	134.2	113.9	5.0	0.8	0.0	15.7	11.2	16.2	5.46	-0.34	43.7
	SS-6A		17.9	135.6	115.0	1.0	0.9	0.02	18.8	11.0	16.0	5.38	-0.58	43.4
TD411	B-13-5	15.75	17.5	134.3	114.3	10.0	0.4	99.2	15.5	14.4	24.4	3.87	0.32	36.1
	SS-6B		16.9	137.0	117.2	1.0	2.4	0.02	19.1	14.1	24.1	3.81	0.15	35.8
TD412	B-13-5	16.25	16.5	133.9	114.9	15.0	0.7	98.0	14.3	28.4	43.4	4.79	0.29	40.9
	SS-6C		16.9	137.0	117.3	1.0	2.0	0.02	19.8	27.3	42.3	4.65	0.04	40.2

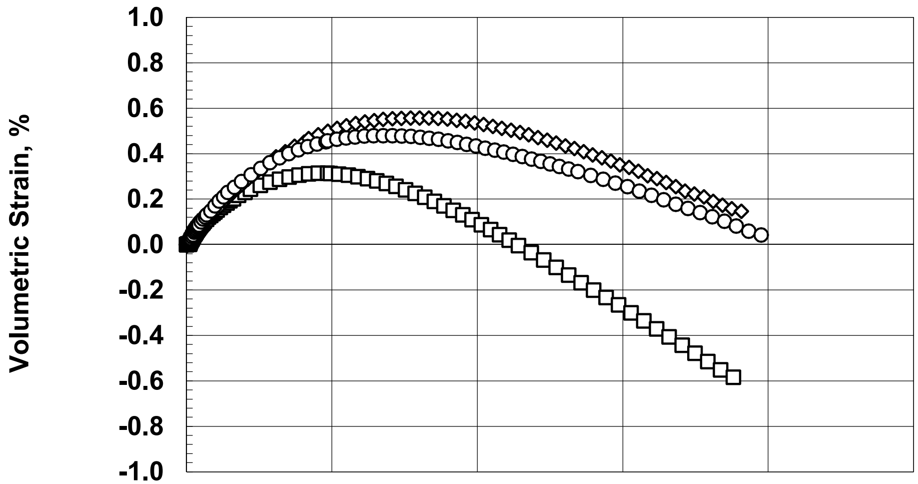
Test No	Description of Material Tested and Remarks
TD410	CL, brown lean clay
TD411	CL, brown lean clay
TD412	CL, gray clay

Strength Envelope Summary

Test Series	Failure Criteria	ϕ' (deg)	c' (psi)	α' (deg)	a' (psi)	Correlation Coefficient
1	1	40.1	0.000	32.8	0.000	--
	2	39.5	0.000	32.5	0.000	--

Failure Criteria: 1 - Peak Deviator Stress; 2 - Large Strain

Project No. T21562906	**URS Corporation #21562906** **Dynegy Vermillion 2013**	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	
TerraSense, LLC		B-13-5 SS-6 SUMMARY	September 2013

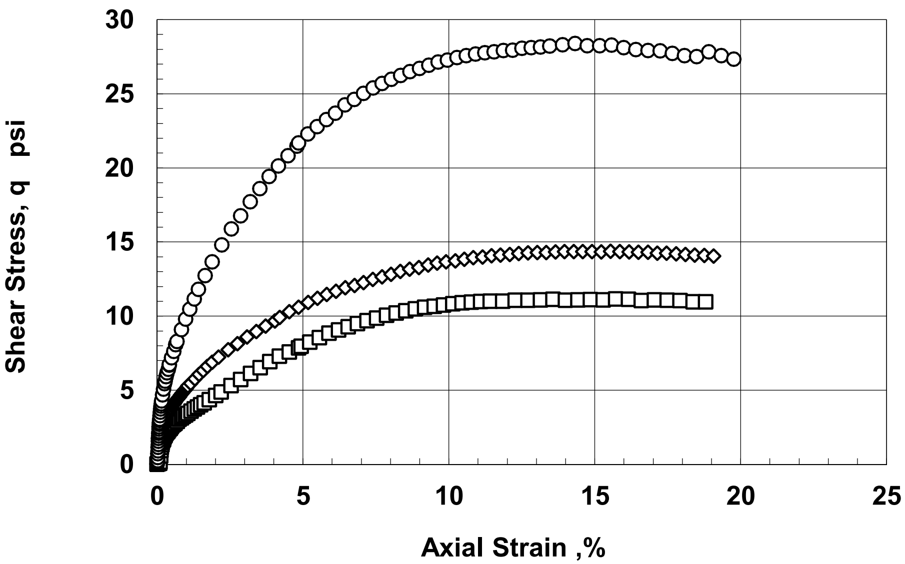


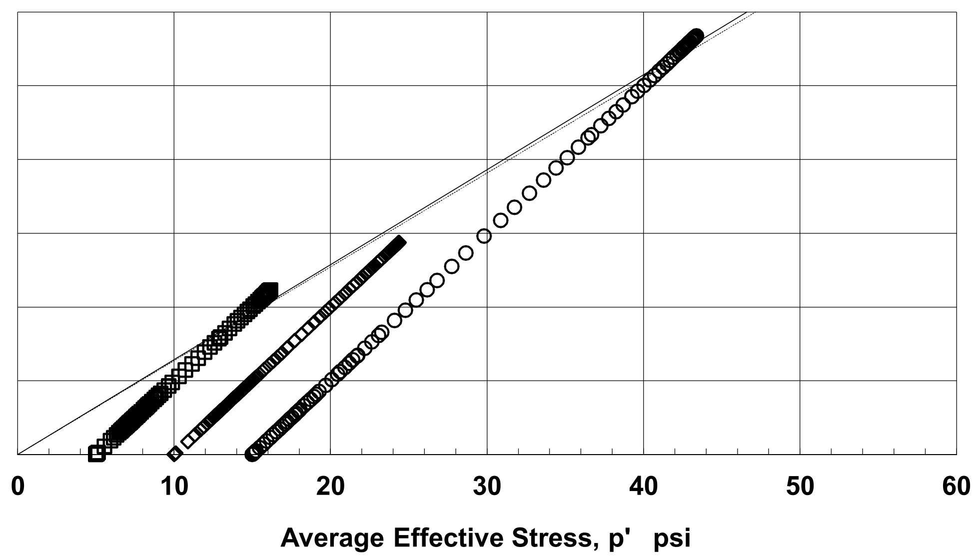
LEGEND AND SUMMARY INFORMATION

Symbol	Test	Boring	Sample	σ'_c (ksf)	w_c (%)	γ_{tc} (pcf)
□	TD410	B-13-5	15.25	5.0	17.9	135.6
◊	TD411	B-13-5	15.75	10.0	16.9	137.0
○	TD412	B-13-5	16.25	15.0	16.9	137.0

SERIES SUMMARY

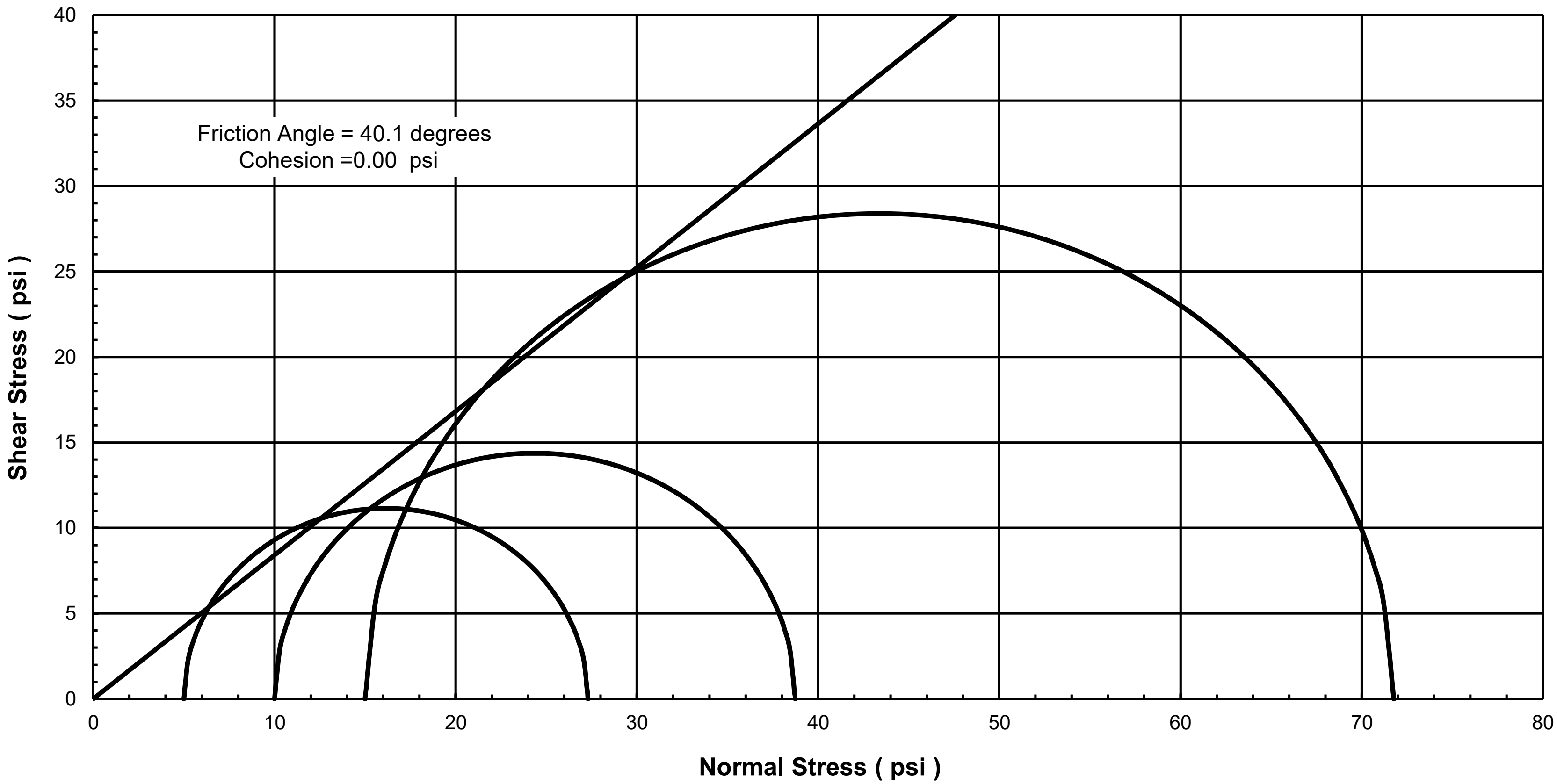
Notation	Failure Criteria	c' psi	Φ' (degrees)
————	Peak Deviator Stress	0.00	40.1
-----------	Large Strain	0.00	39.5



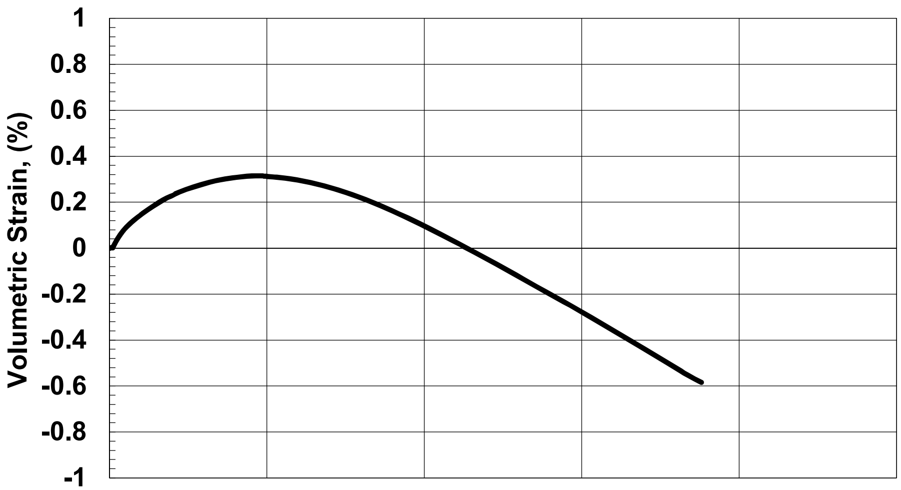


Project No. T21562906	**URS Corporation #21562906 Dynegy Vermillion 2013**	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	Figure 1
Prepared by: CMJ Checked by: G. Thomas	**TerraSense, LLC**	B-13-5 SS-6 SUMMARY	September 2013

Analysis File: CIDsum.xls (9/13)　　Cdsum1a.xlsx　　9/20/2013



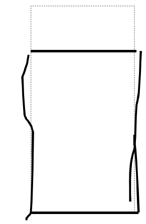
Project No. **T21562906**	**URS Corporation #21562906** **Dynegy Vermillion 2013**	**Mohr Circle at Peak** **CD Triaxial Tests**	**Figure** **2**
TerraSense, LLC		**B-13-5 SS-6 SUMMARY**	**September 2013**



SAMPLE INFORMATION
Boring: B-13-5 Sample: SS-6A Depth: 15.25 ft
Type: Intact tube sample
Description: CL, brown lean clay

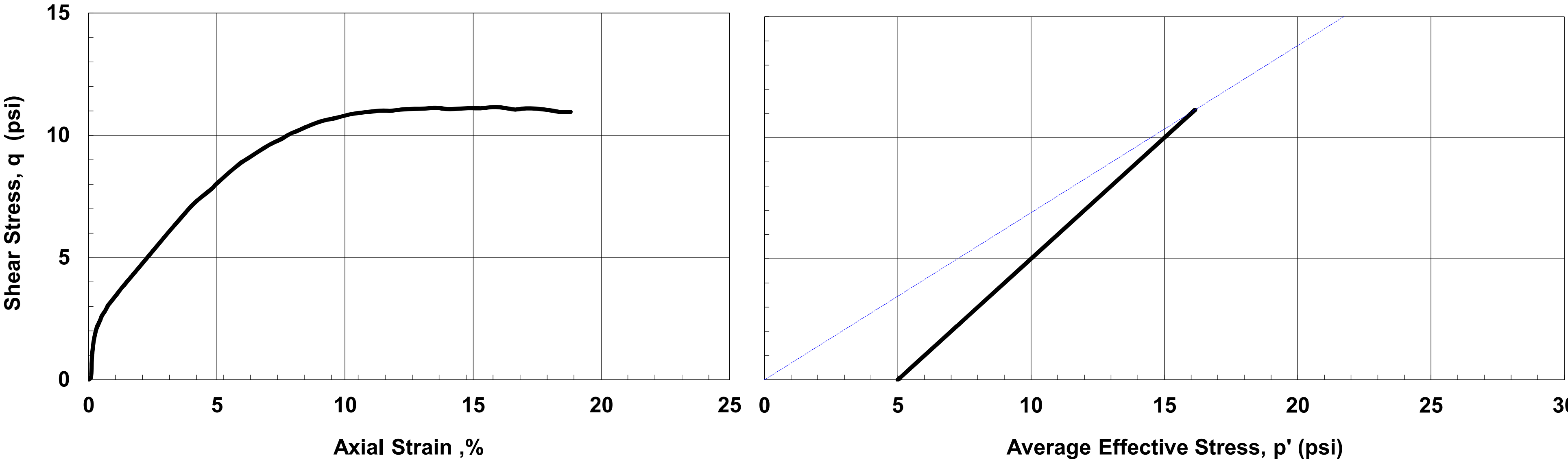
SPECIMEN INFORMATION (Initial)
Height: 6.03 inch Diameter: 2.85 inch Area: 6.39 in²
Water Content: 17.8 % Total Unit Weight: 134.2 pcf

TEST SUMMARY
Consolidation Stresses: 5.00 psi vertical, 5.00 psi lateral
Water Content: 17.9 % Total Unit Weight: 135.6 pcf
B Coefficient: Strain Rate: 0.018 %/min
Peak Shear Strength: 11.15 psi @ 15.7 % Strain
Peak Effective Friction Angle: 43.7°

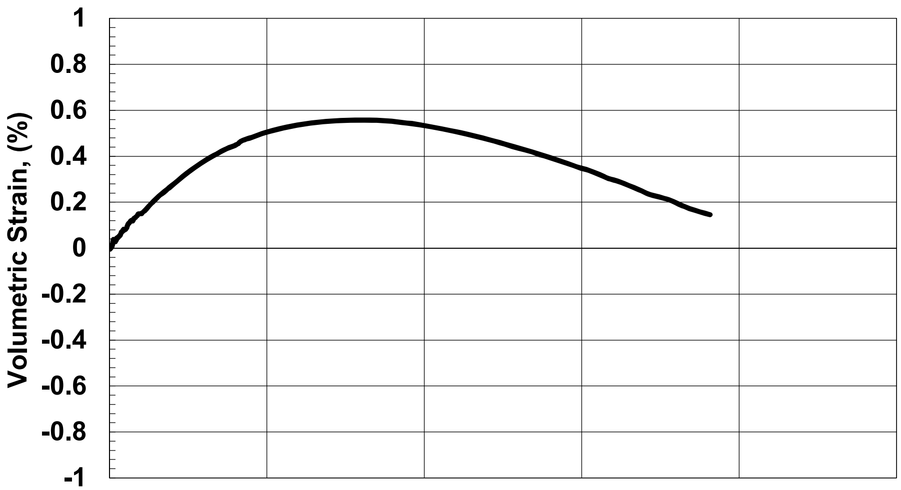


Failure Sketch

REMARKS: Compression positive



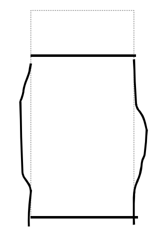
Test by: D. Tso	Project No. T21562906	URS #21562906 Dynegy Vermillion 2013	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	
Checked by: G. Thomas	**TerraSense, LLC**		Boring:B-13-5 Sample: SS-6A Depth: 15.25ft	September-13



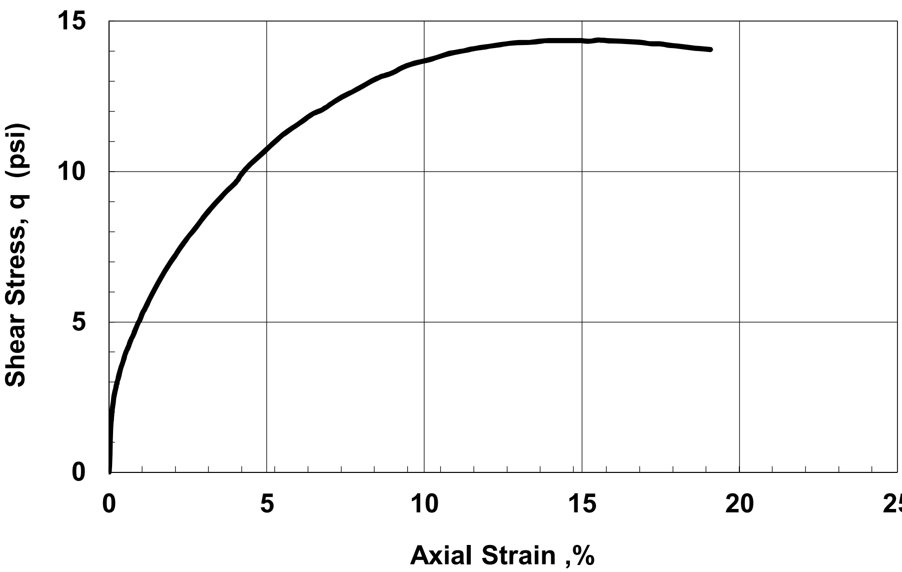
SAMPLE INFORMATION
Boring: B-13-5 Sample: SS-6B Depth: 15.75 ft
Type: Intact tube sample
Description: CL, brown lean clay
LL = 36 PL = 16 PI = 20

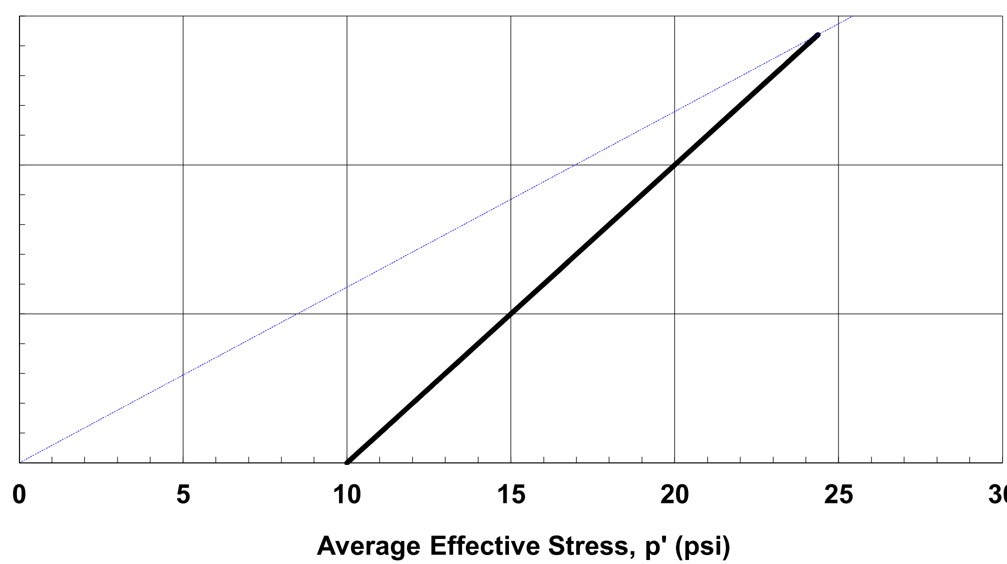
SPECIMEN INFORMATION (Initial)
Height: 6.04 inch Diameter: 2.87 inch Area: 6.45 in²
Water Content: 17.5 % Total Unit Weight: 134.3 pcf

TEST SUMMARY
Consolidation Stresses: 10.00 psi vertical, 10.00 psi lateral
Water Content: 16.9 % Total Unit Weight: 137.0 pcf
B Coefficient: 99.2 Strain Rate: 0.018 %/min
Peak Shear Strength: 14.37 psi @ 15.5 % Strain
Peak Effective Friction Angle: 36.1°


Failure Sketch

REMARKS: Compression positive





Test by: D. Tso	Project No. T21562906	URS #21562906 Dynegy Vermillion 2013	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	
Checked by: G. Thomas	TerraSense, LLC		Boring:B-13-5 Sample: SS-6B Depth: 15.75ft	September-13

SAMPLE INFORMATION

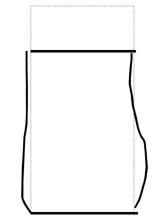
Boring: B-13-5 Sample: SS-6C Depth: 16.25 ft
Type: Intact tube sample
Description: CL, gray clay

SPECIMEN INFORMATION (Initial)

Height: 6.03 inch Diameter: 2.85 inch Area: 6.39 in²
Water Content: 16.5 % Total Unit Weight: 133.9 pcf

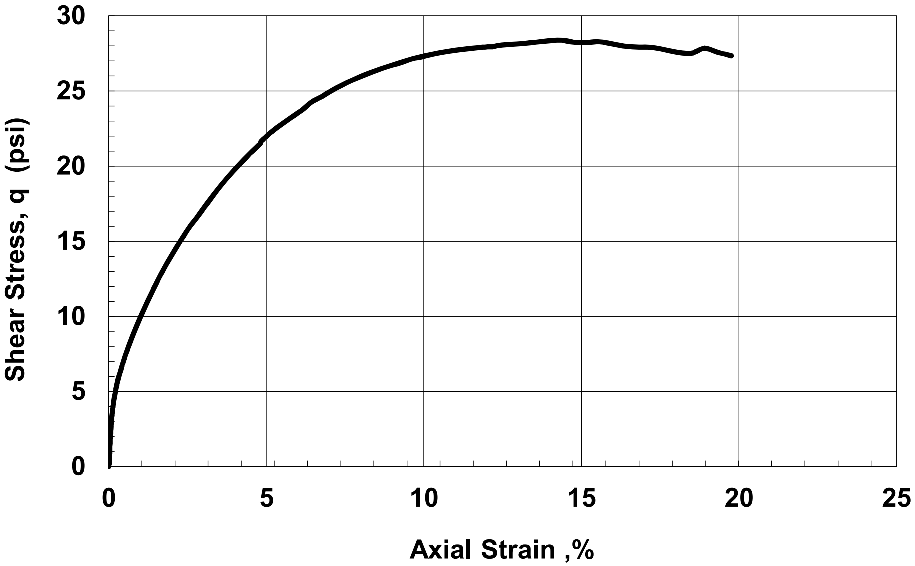
TEST SUMMARY

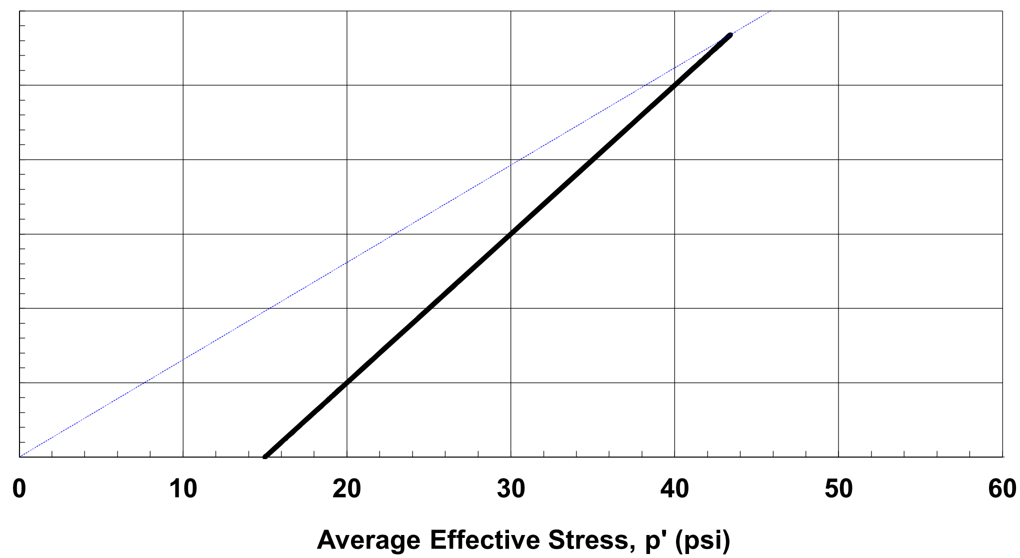
Consolidation Stresses: 15.00 psi vertical, 15.00 psi lateral
Water Content: 16.9 % Total Unit Weight: 137.0 pcf
B Coefficient: 98 Strain Rate: 0.018 %/min
Peak Shear Strength: 28.39 psi @ 14.3 % Strain
Peak Effective Friction Angle: 40.9°



Failure Sketch

REMARKS: Compression positive





Test by: D. Tso	Project No. T21562906	URS #21562906 Dynegy Vermillion 2013	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	
Checked by: G. Thomas	TerraSense, LLC		Boring:B-13-5 Sample: SS-6C Depth: 16.25ft	September-13

SUMMARY FOR STATIC CIU' TRIAXIAL TESTS SPECIMENS

Test No	Boring No	Sample Section No	Depth / Elev (ft)	USCS Group Symbol / Gs	w_o / w_c (%)	$\gamma_{t,o}$ / $\gamma_{t,c}$ (pcf)	$\gamma_{d,o}$ / $\gamma_{d,c}$ (pcf)	$\sigma'_{c,max}$ (psi) / OCR	$\sigma'_{v,c}$ (psi) / $K_c = \frac{\sigma'_{v,c}}{\sigma'_{h,c}}$	$\varepsilon_{a,c}$ / $\varepsilon_{v,c}$ (%)	B factor (%) / ε_{rate} (%/hr)	at Peak Deviator Stress / at Peak Obliquity: ε_a (%)	$\frac{\sigma_1 - \sigma_3}{2}$ (psi)	$\frac{\sigma'_1 + \sigma'_3}{2}$ (psi)	σ'_1 / σ'_3	A factor	ϕ' for c'=0
T3521	B-13-6	SS-6A	15.4	CL	16.3	133.6	114.9	5.00	5.00	1.0	97	20.4	12.65	23.73	3.28	-0.240	32.2
				(2.80)	17.0	138.5	118.3	1.0	1.00	2.9	1.1	3.7	5.41	8.21	4.85	0.203	41.2
T3522	B-13-6	SS-6B	15.95	CL	21.0	132.4	109.5	10.0	10.0	0.7	98.5	20.2	8.96	17.46	3.11	0.083	30.9
				(2.80)	20.4	133.9	111.2	1.0	1.00	1.6	1.1	3.1	5.94	9.89	4.01	0.510	36.9
T3523	B-13-6	SS-6C	16.5	CL	18.4	132.4	111.9	15.0	15.0	0.8	99.2	20.0	23.99	45.59	3.22	-0.138	31.8
				(2.78)	18.5	135.8	114.6	1.0	1.00	2.4	1.1	2.0	10.95	16.96	4.64	0.411	40.2

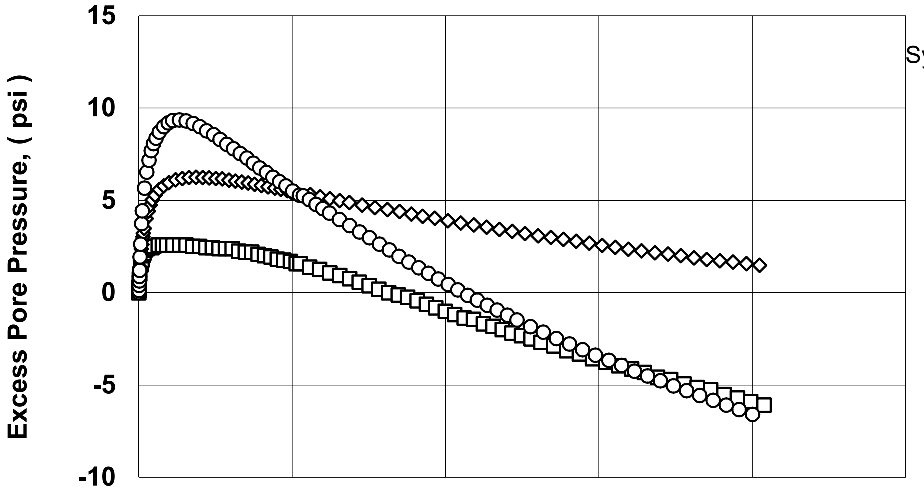
Test No	Description of Material Tested and Remarks
T3521	CL, brown lean clay
T3522	CL, brown lean clay
T3523	CL, brown lean clay; bottom gray silty clay

Strength Envelope Summary

Test Series	Failure Criteria	ϕ' (deg)	c' (psi)	α' (deg)	a' (psi)	Correlation Coefficient
1	1	31.7	0.000	27.8	0.000	--
	2	39.6	0.000	32.5	0.000	--

Failure Criteria: 1 - Peak Deviator Stress; 2 - Peak Obliquity

Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements B-13-6 SS-6 SUMMARY	August 2013
	TerraSense, LLC		

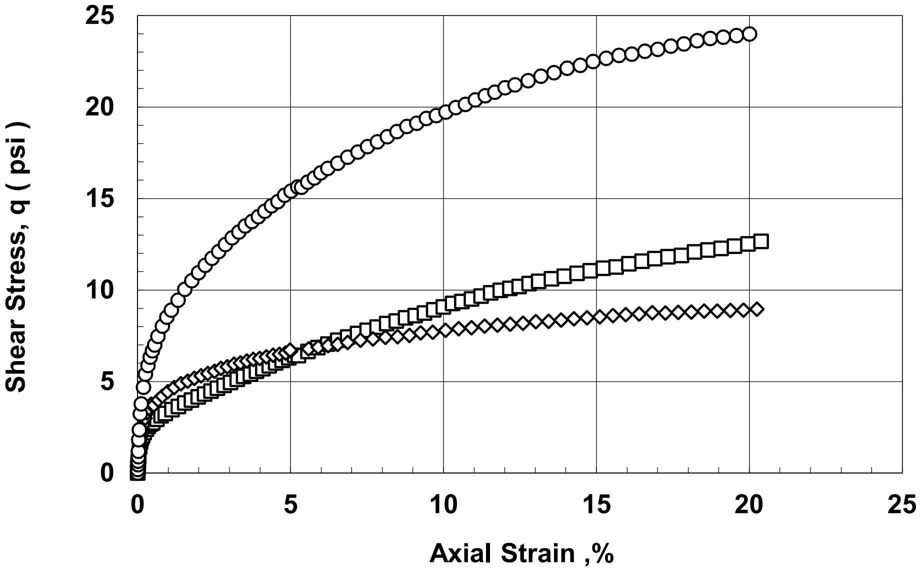


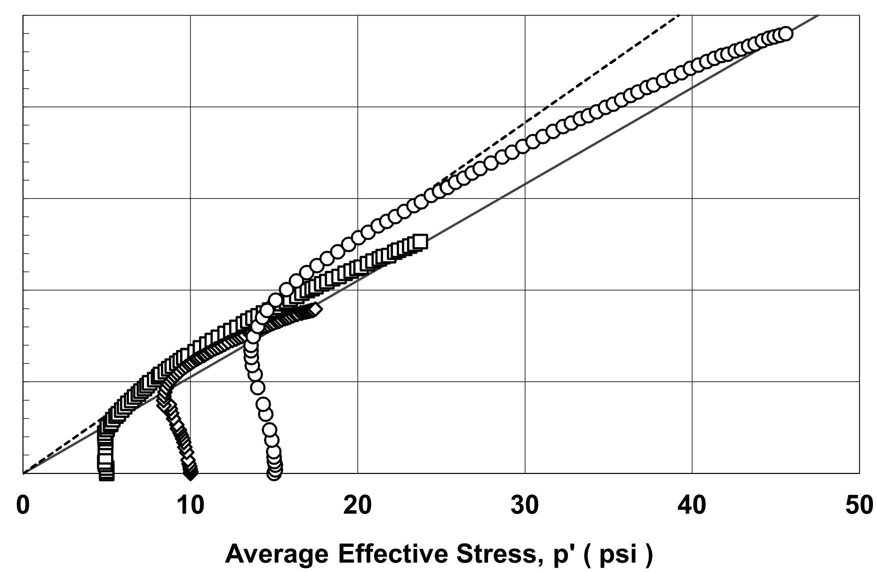
LEGEND AND SUMMARY INFORMATION

Symbol	Test	Boring	Sample	Depth (ft)	w_o (%)	γ_{to} (pcf)	σ'_c (psi)
□	T3521	B-13-6	SS-6A	15.4	16.3	133.6	5.00
◊	T3522	B-13-6	SS-6B	16.0	21.0	132.4	10.00
○	T3523	B-13-6	SS-6C	16.5	18.4	132.4	15.00

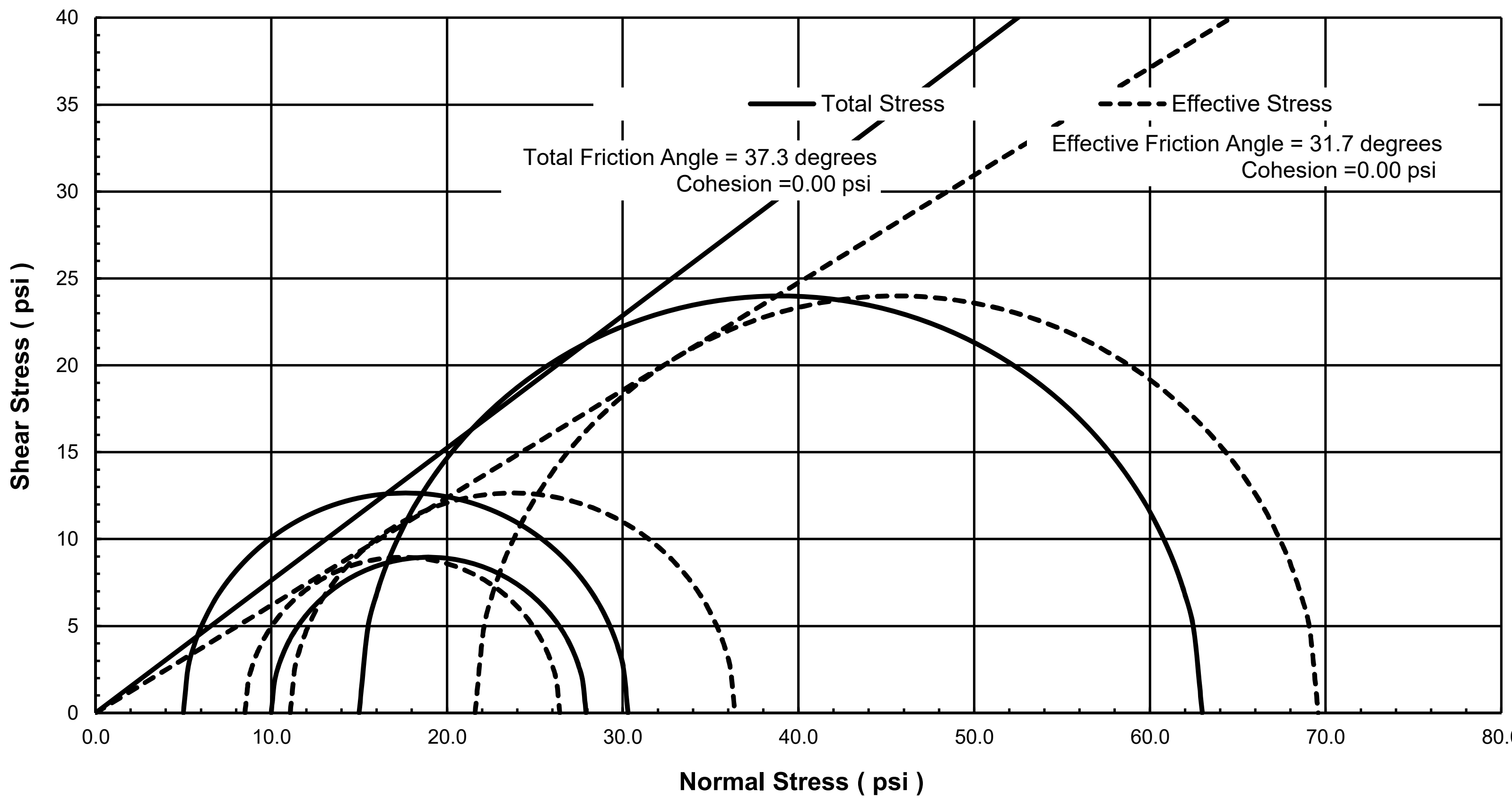
SERIES SUMMARY

Notation	Failure Criteria	c' (psi)	Φ' (degrees)
———	Peak Deviator Stress	0.00	31.7
·······	Peak Obliquity	0.00	39.6





Project No. T21562906	**URS Corporation #21562906 Dynegy Vermillion 2013**	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements B-13-6 SS-6 SUMMARY	Figure 1
Prepared by: CMJ	**TerraSense, LLC**		August 2013
Checked by: G. Thomas			



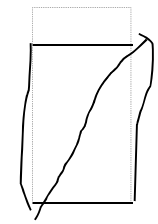
Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	Mohr Circles of Total and Effective Stresses at Peak	Figure 2
TerraSense, LLC		CIU' Triaxial Test B-13-6 SS-6 SUMMARY	August 2013

SAMPLE INFORMATION

Boring: B-13-6 Sample: SS-6A Depth: 15.4ft
Type: Intact tube sample
Description: CL, brown lean clay

SPECIMEN INFORMATION (Initial)

Height: 6.03 inch Diameter: 2.88 inch Area: 6.50 in²
Water Content: 16.3 % Total Unit Weight: 133.6 pcf

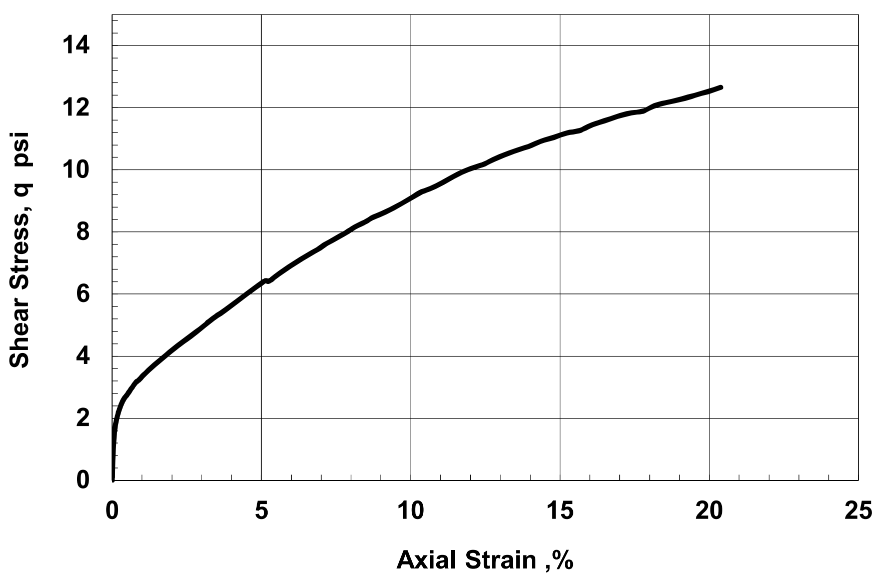


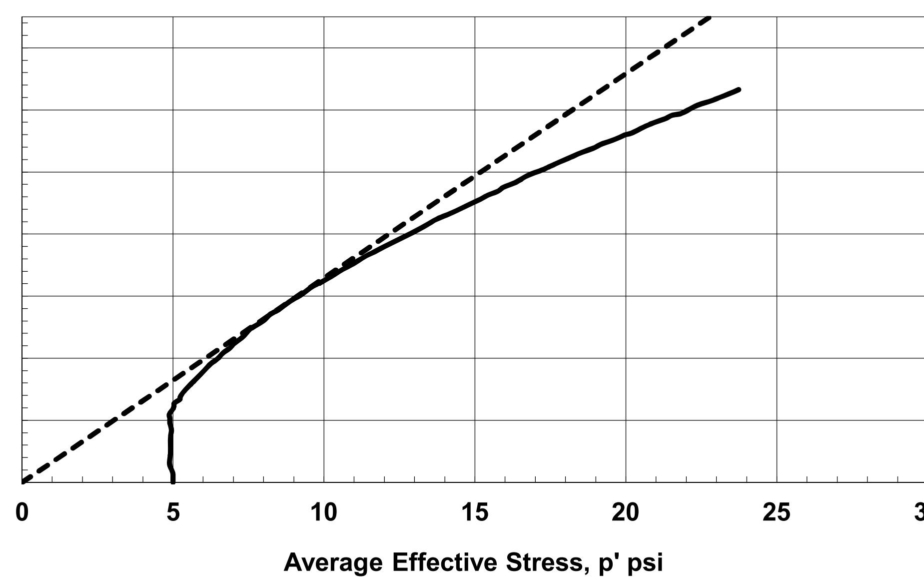
Failure Sketch

TEST SUMMARY

Consolidation Stresses: 5.00 psi vertical, 5.00 psi lateral
Water Content: 17.0 % Total Unit Weight: 138.5 pcf
B Coefficient: 97 Strain Rate: 0.018 %/min
Peak Shear Strength: 12.65 psi @ 20.4 % Strain
Peak Effective Friction Angle: 41.2°

REMARKS:





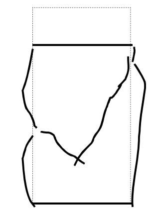
Test by: DT	Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements Boring: B-13-6 Sample: SS-6A	
Checked by: GET	TerraSense, LLC			September-13

SAMPLE INFORMATION

Boring: B-13-6 Sample: SS-6B Depth: 15.95ft
Type: Intact tube sample
Description: CL, brown lean clay
LL = 36 PL = 16 PI = 20

SPECIMEN INFORMATION (Initial)

Height: 6.02 inch Diameter: 2.87 inch Area: 6.48 in²
Water Content: 21.0 % Total Unit Weight: 132.4 pcf

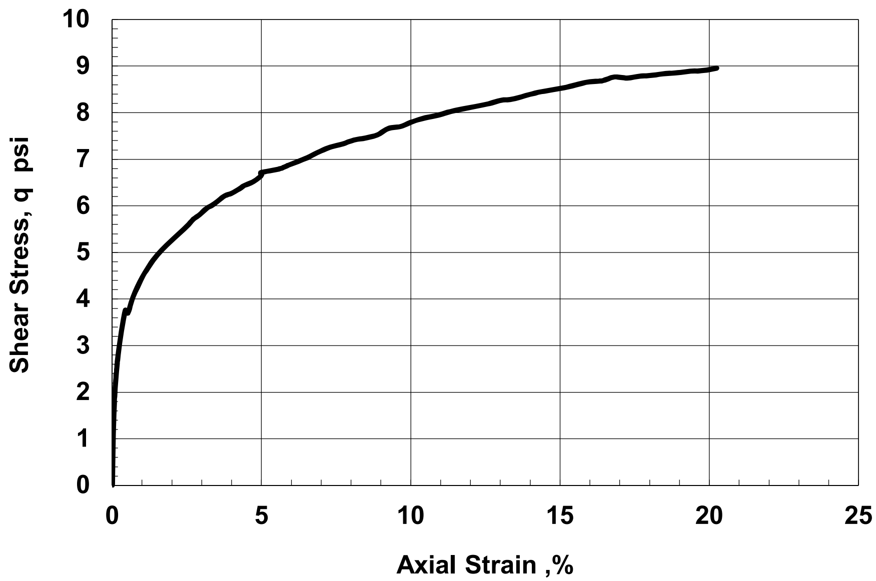


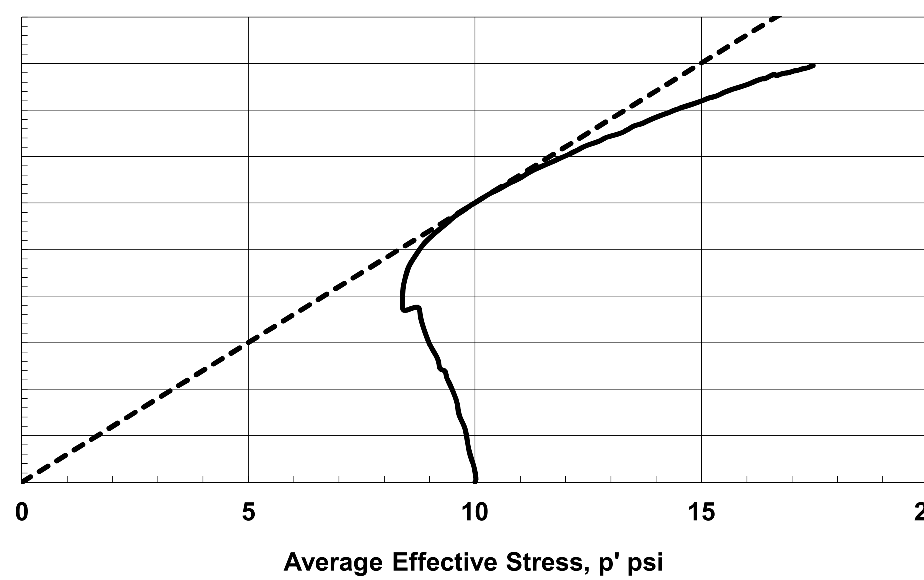
Failure Sketch

TEST SUMMARY

Consolidation Stresses: 10.00 psi vertical, 10.00 psi lateral
Water Content: 20.4 % Total Unit Weight: 133.9 pcf
B Coefficient: 98.5 Strain Rate: 0.018 %/min
Peak Shear Strength: 8.96 psi @ 20.2 % Strain
Peak Effective Friction Angle: 36.9°

REMARKS:

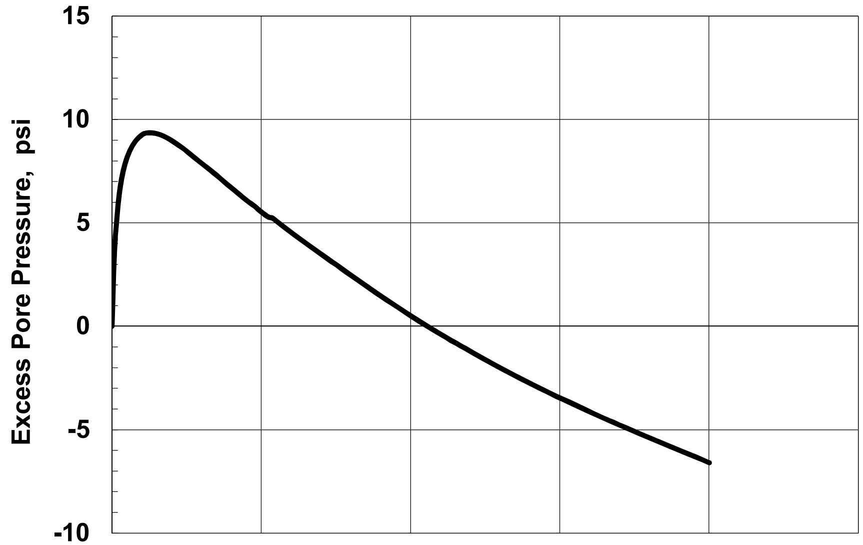




Test by: DT

Checked by: GET

Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements Boring: B-13-6 Sample: SS-6B	September-13
TerraSense, LLC			



SAMPLE INFORMATION

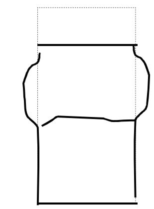
Boring: B-13-6 Sample: SS-6C Depth: 16.5ft
Type: Intact tube sample
Description: CL, brown lean clay; bottom gray silty clay

SPECIMEN INFORMATION (Initial)

Height: 6.03 inch Diameter: 2.88 inch Area: 6.51 in²
Water Content: 18.4 % Total Unit Weight: 132.4 pcf

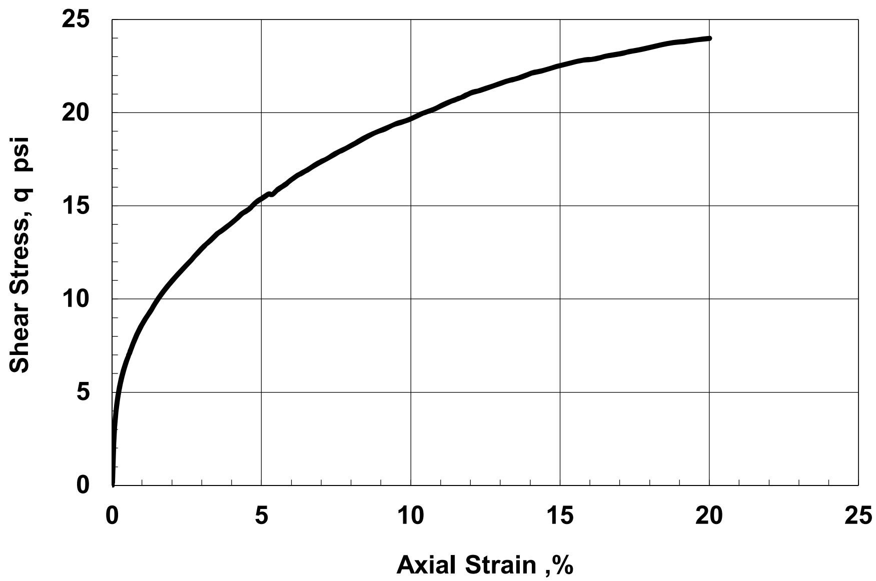
TEST SUMMARY

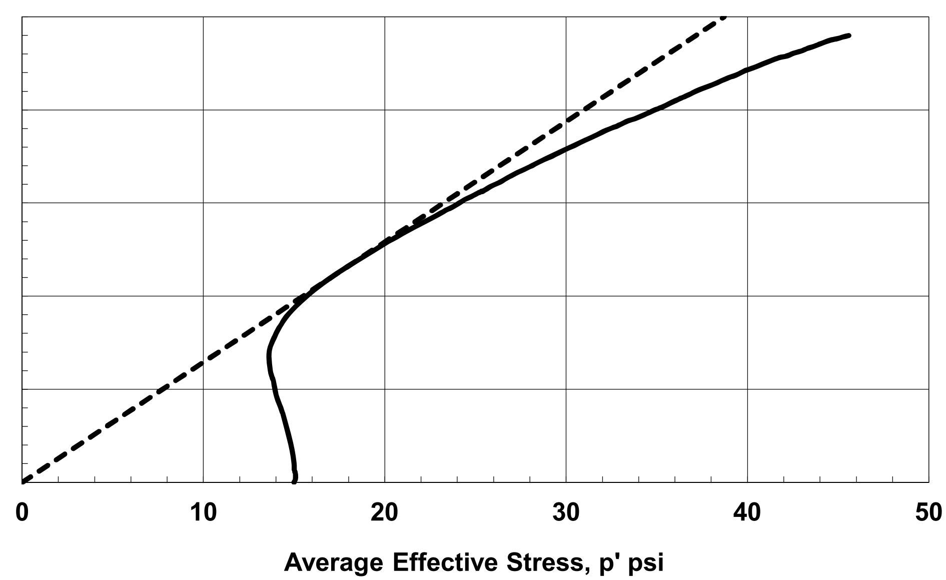
Consolidation Stresses: 15.00 psi vertical, 15.00 psi lateral
Water Content: 18.5 % Total Unit Weight: 135.8 pcf
B Coefficient: 99.2 Strain Rate: 0.018 %/min
Peak Shear Strength: 23.99 psi @ 20.0 % Strain
Peak Effective Friction Angle: 40.2°



Failure Sketch

REMARKS:





Test by: DT	Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: B-13-6 Sample: SS-6C	September-13

SUMMARY FOR STATIC CIU' TRIAXIAL TESTS SPECIMENS

Test No	Boring No	Sample Section No	Depth / Elev (ft)	USCS Group Symbol / Gs	w_o / w_c (%)	$\gamma_{t,o}$ / $\gamma_{t,c}$ (pcf)	$\gamma_{d,o}$ / $\gamma_{d,c}$ (pcf)	$\sigma'_{c,max}$ (psi) / OCR	$\sigma'_{v,c}$ (psi) / $K_c = \sigma'_{v,c}/\sigma'_{h,c}$	$\varepsilon_{a,c}$ / $\varepsilon_{v,c}$ (%)	B factor (%) / ε_{rate} (%/hr)	at Peak Deviator Stress / at Peak Obliquity: ε_a (%)	$\frac{\sigma_1 - \sigma_3}{2}$ (psi)	$\frac{\sigma'_1 + \sigma'_3}{2}$ (psi)	σ'_1 / σ'_3	A factor	ϕ' for c'=0
T3524	B-13-7	SS-2A	2.75	CL	16.4	130.8	112.4	2.00	2.00	0.9		20.2	8.16	14.25	3.68	-0.251	34.9
				(2.75)	17.6	136.1	115.7	1.00	1.00	2.9	1.0	1.8	2.66	3.78	5.78	0.166	44.8
T3525	B-13-7	SS-2B	3.25	CL	14.1	129.4	113.4	3.00	3.00	0.4		21.1	11.31	22.09	3.10	-0.344	30.8
				(2.72)	17.5	135.1	114.9	1.00	1.00	1.3	1.1	3.6	5.24	8.87	3.89	-0.060	36.2
T3526	B-13-7	SS-2C	3.75	SM	10.3	130.3	118.1	4.00	4.00	0.9		14.5	69.47	121.52	3.67	-0.346	34.9
				(2.70)	14.3	139.0	121.6	1.00	1.00	2.9	1.1	2.3	13.26	19.26	5.42	-0.076	43.5

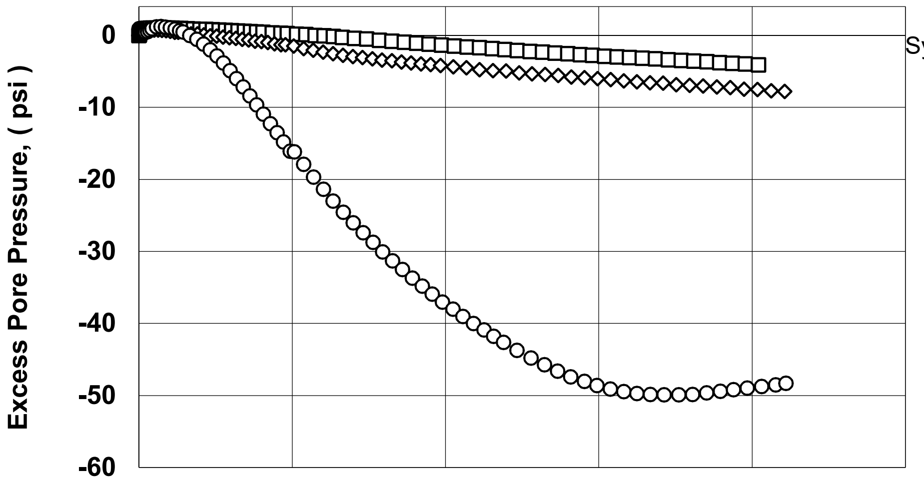
Test No	Description of Material Tested and Remarks
T3524	CL, light gray lean clay
T3525	CL, brown lean clay
T3526	SM, brown silty sand

Strength Envelope Summary

Test Series	Failure Criteria	ϕ' (deg)	c' (psi)	α' (deg)	a' (psi)	Correlation Coefficient
1	1	23.7	2.652	21.9	2.428	1.000
	2	30.5	0.868	26.9	0.748	1.000
	Failure Envelope for clay samples only					

Failure Criteria: 1 - Peak Deviator Stress; 2 - Peak Obliquity

Project No. T21562906	**URS Corporation #21562906** **Dynegy Vermillion 2013**	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements B-13-7 SS-2 SUMMARY	August 2013
TerraSense, LLC			



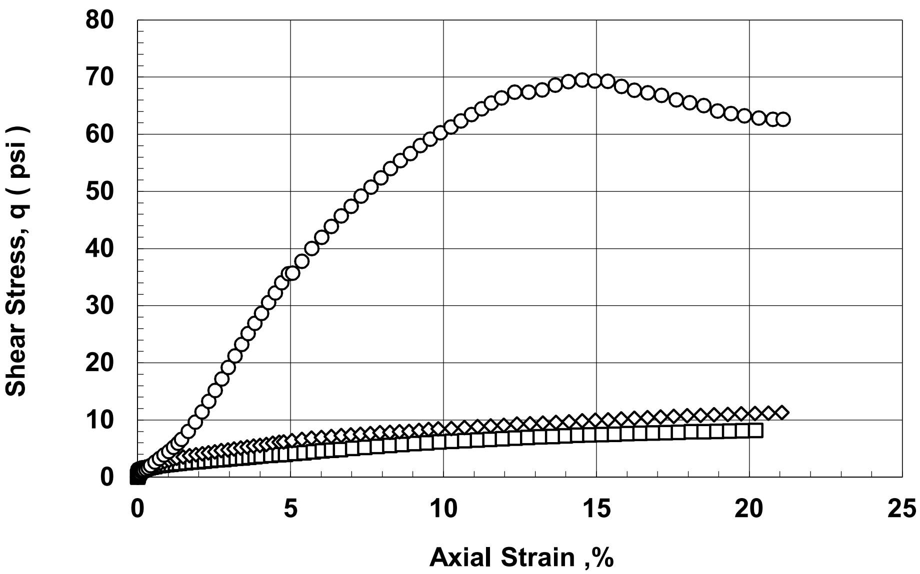
LEGEND AND SUMMARY INFORMATION

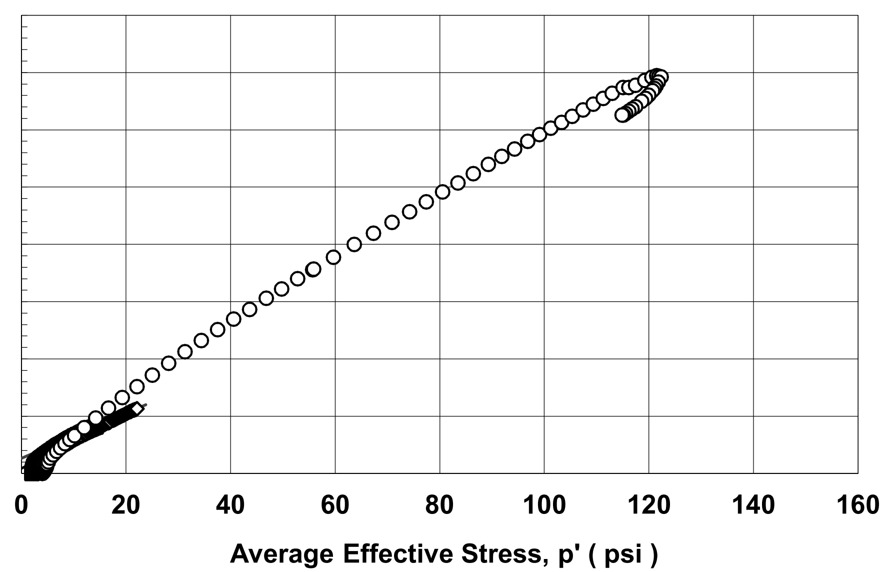
Symbol	Test	Boring	Sample	Depth (ft)	w_o (%)	γ_{to} (pcf)	σ'_c (psi)
□	T3524	B-13-7	SS-2A	2.8	16.4	130.8	2.00
◊	T3525	B-13-7	SS-2B	3.3	14.1	129.4	3.00
○	T3526	B-13-7	SS-2C	3.8	10.3	130.3	4.00

SERIES SUMMARY

Notation	Failure Criteria	c' (psi)	Φ' (degrees)
———	Peak Deviator Stress	2.65	23.7
········	Peak Obliquity	0.87	30.5

Failure Envelope for clay samples only

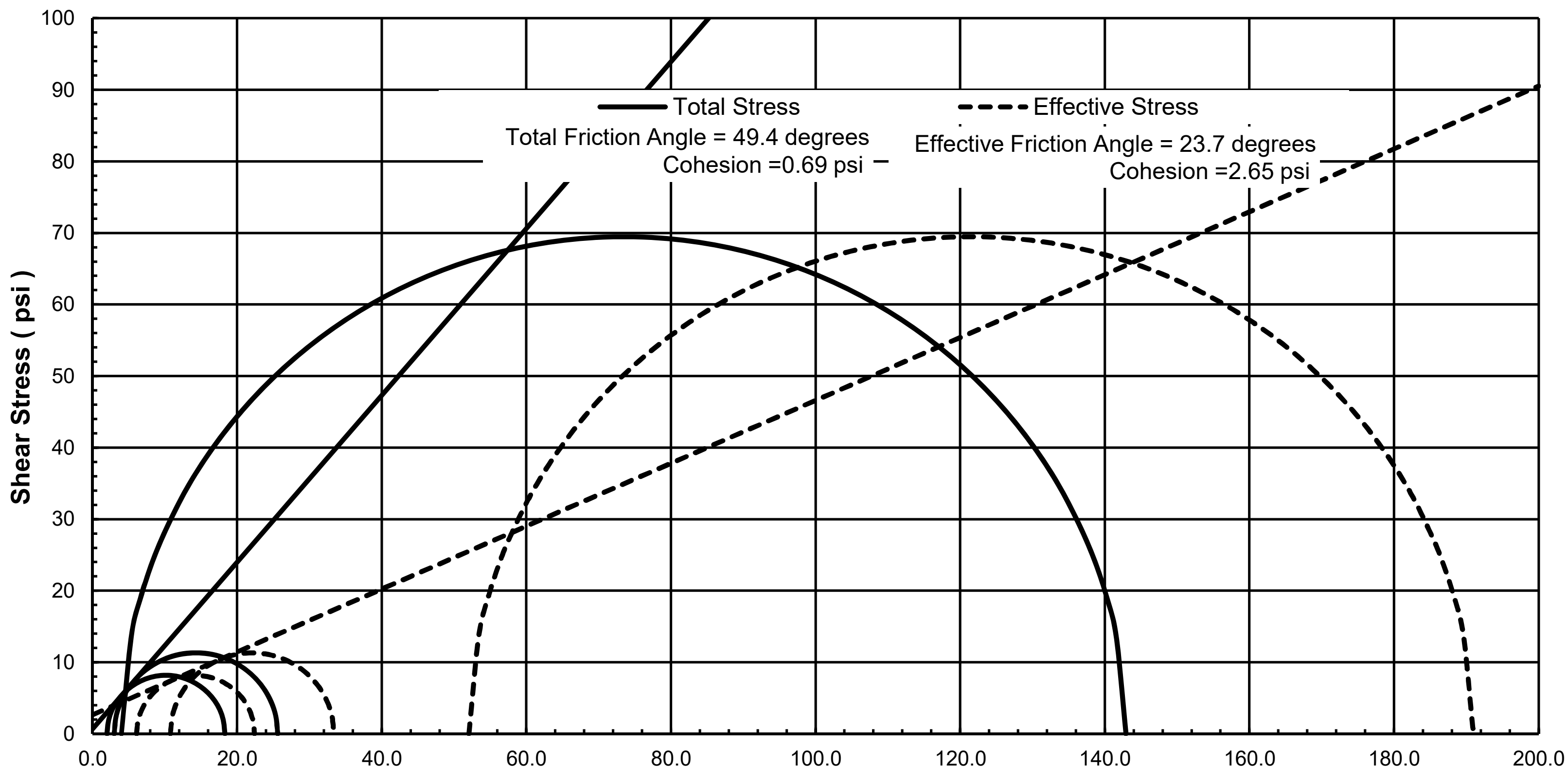




Prepared by:	CMJ	Project No. T21562906	**URS Corporation #21562906 Dynegy Vermillion 2013**	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements B-13-7 SS-2 SUMMARY	Figure 1
Checked by:	G. Thomas	**TerraSense, LLC**			August 2013

GSI Analysis File: Cu'sum3v4

9/20/2013 Test: Ciu1b.xlsx



Failure Envelope for clay samples only

Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	Mohr Circles of Total and Effective Stresses at Peak CIU' Triaxial Test	Figure 2
TerraSense, LLC		B-13-7 SS-2 SUMMARY	August 2013

Analysis File: Cu'sum3v4.xls Ciu1b.xlsx 9/20/2013

SAMPLE INFORMATION

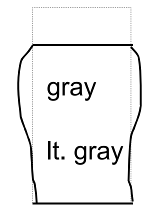
Boring: B-13-7 Sample: SS-2A Depth: 2.75ft
Type: Intact tube sample
Description: CL, light gray lean clay

SPECIMEN INFORMATION (Initial)

Height: 6.04 inch Diameter: 2.87 inch Area: 6.46 in²
Water Content: 16.4 % Total Unit Weight: 130.8 pcf

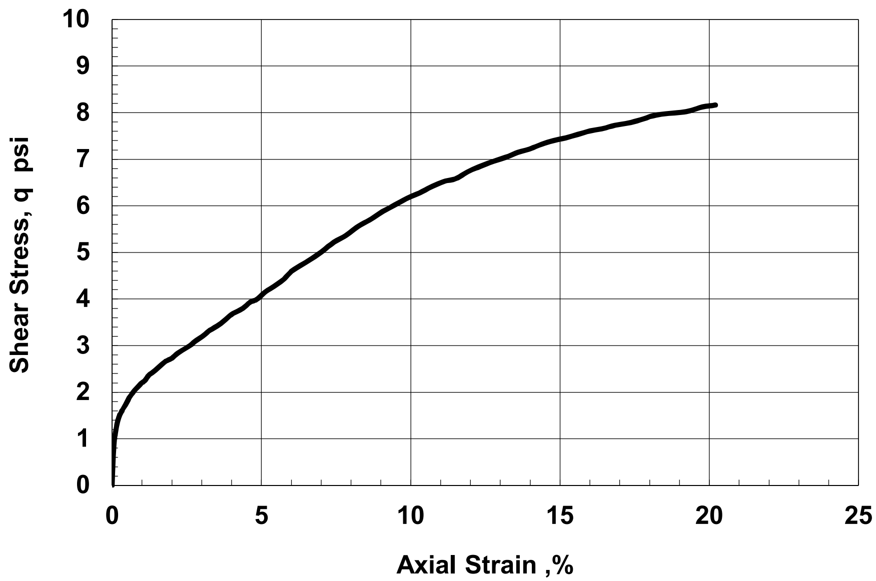
TEST SUMMARY

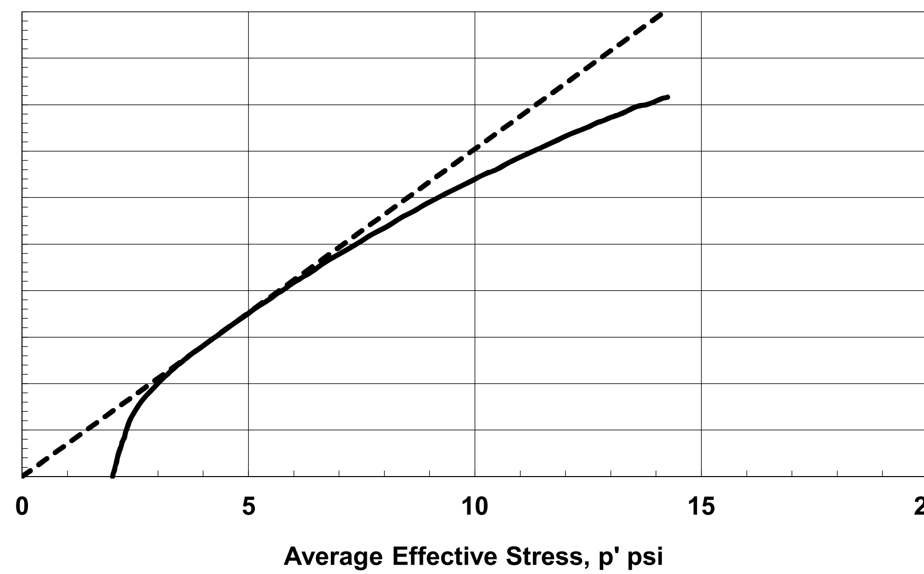
Consolidation Stresses: 2.00 psi vertical, 2.00 psi lateral
Water Content: 17.6 % Total Unit Weight: 136.1 pcf
B Coefficient: Strain Rate: 0.017 %/min
Peak Shear Strength: 8.16 psi @ 20.2 % Strain
Peak Effective Friction Angle: 44.8°



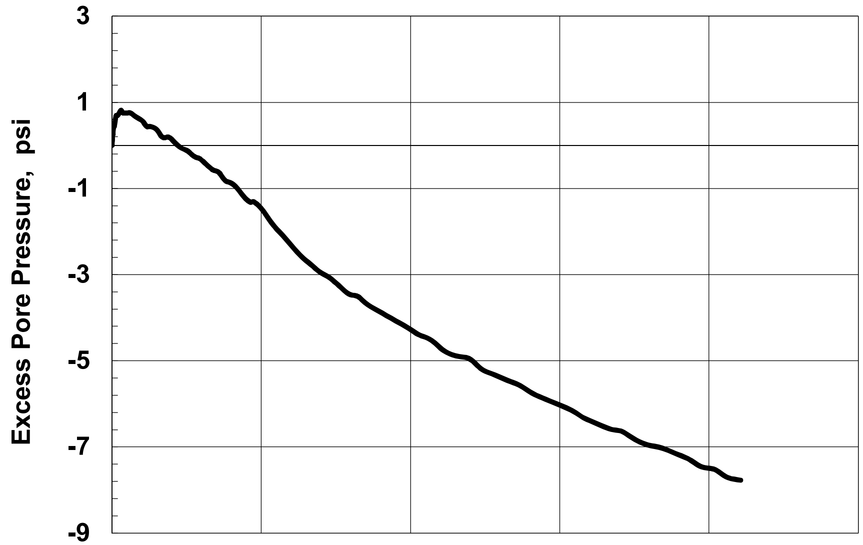
Failure
Sketch

REMARKS:





Test by: DT	Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: B-13-7 Sample: SS-2A	September-13

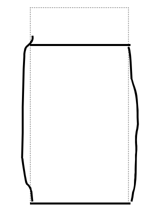


SAMPLE INFORMATION

Boring: B-13-7 Sample: SS-2B Depth: 3.25ft
Type: Intact tube sample
Description: CL, brown lean clay
LL = 28 PL = 14 PI = 14

SPECIMEN INFORMATION (Initial)

Height: 5.79 inch Diameter: 2.87 inch Area: 6.46 in²
Water Content: 14.1 % Total Unit Weight: 129.4 pcf

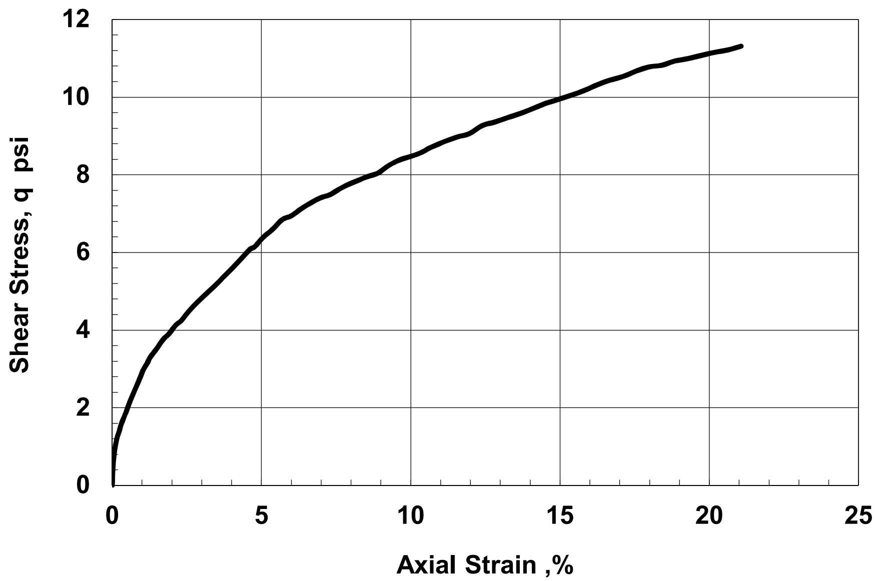


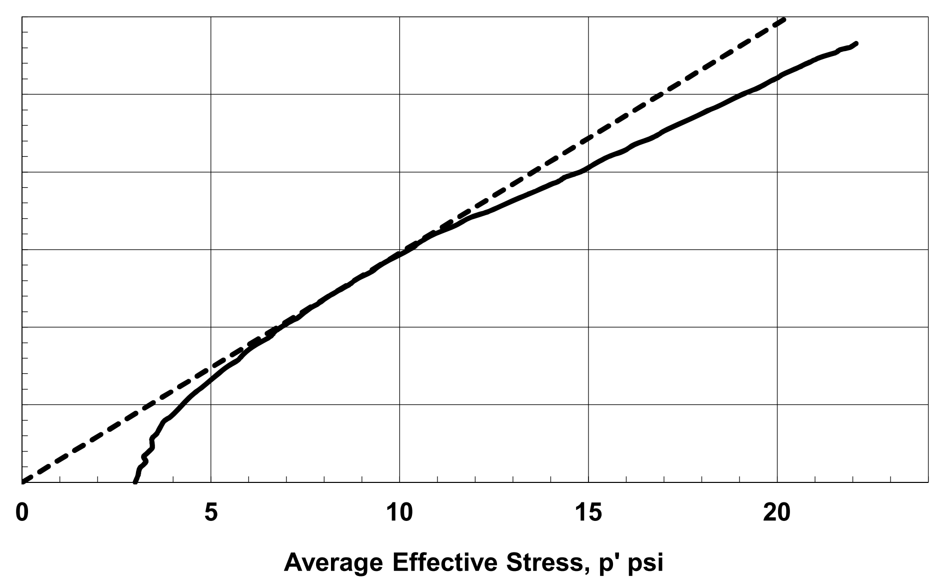
Failure Sketch

TEST SUMMARY

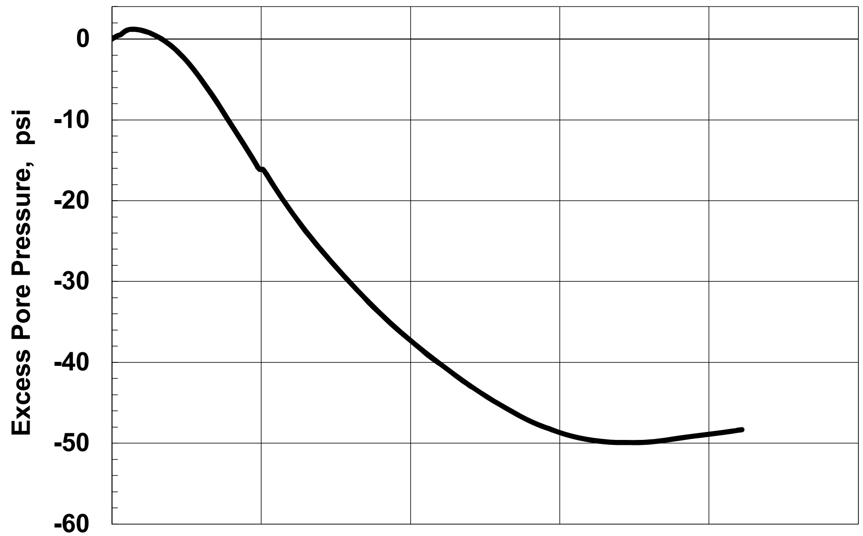
Consolidation Stresses: 3.00 psi vertical, 3.00 psi lateral
Water Content: 17.5 % Total Unit Weight: 135.1 pcf
B Coefficient: Strain Rate: 0.018 %/min
Peak Shear Strength: 11.31 psi @ 21.1 % Strain
Peak Effective Friction Angle: 36.2°

REMARKS:





Test by: DT	Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements Boring: B-13-7 Sample: SS-2B	
Checked by: GET	TerraSense, LLC			September-13



SAMPLE INFORMATION

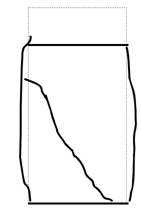
Boring: B-13-7 Sample: SS-2C Depth: 3.75ft
Type: Intact tube sample
Description: SM, brown silty sand

SPECIMEN INFORMATION (Initial)

Height: 5.91 inch Diameter: 2.87 inch Area: 6.47 in²
Water Content: 10.3 % Total Unit Weight: 130.3 pcf

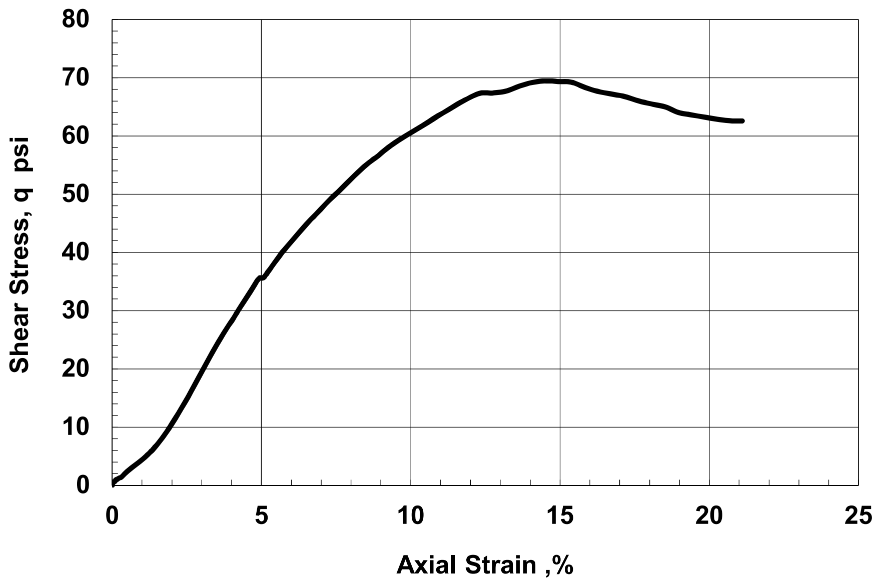
TEST SUMMARY

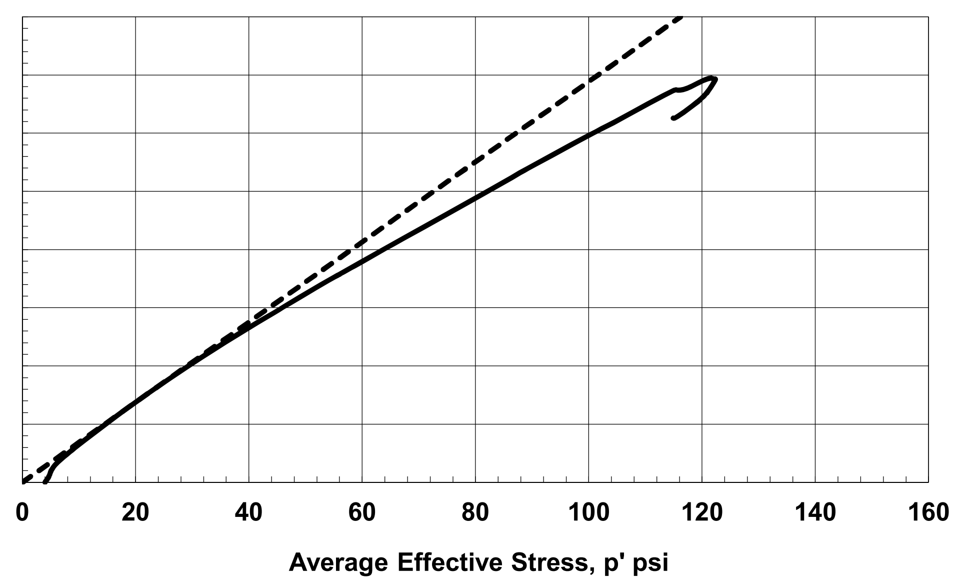
Consolidation Stresses: 4.00 psi vertical, 4.00 psi lateral
Water Content: 14.3 % Total Unit Weight: 139.0 pcf
B Coefficient: Strain Rate: 0.018 %/min
Peak Shear Strength: 69.47 psi @ 14.5 % Strain
Peak Effective Friction Angle: 43.5°



Failure
Sketch

REMARKS:





Test by: DT	Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements Boring: B-13-7 Sample: SS-2C
Checked by: GET	TerraSense, LLC		September-13

SUMMARY OF TRIAXIAL CID-C TESTS ON UNDISTURBED SPECIMENS

Series Test No	Boring No / Sample No.	Depth (ft)	w_o / w_c (%)	$\gamma_{t,o}$ / $\gamma_{t,c}$ (pcf)	$\gamma_{d,o}$ / $\gamma_{d,c}$ (pcf)	σ'_c (ksf) / OCR $\frac{\sigma'_{v,c}}{\sigma'_{v,max}}$	$\varepsilon_{a,c}$ / $\varepsilon_{v,c}$ (%)	B factor (%) / ε_{rate} (%/min)	at Peak Deviator Stress / at Large Strain: ε_a (%)	$\frac{\sigma_1 - \sigma_3}{2}$ (psi)	$\frac{\sigma'_1 + \sigma'_3}{2}$ (psi)	σ'_1 / σ'_3	Vol. Strain ε_{vol} (%)	ϕ' for c'=0
TD413	B-13-8	8.1	34.8	107.3	79.6	5.0	0.4	0.0	8.8	6.8	11.8	3.72	0.32	35.2
	SS-4A		35.9	117.4	86.4	1.0	7.9	0.02	18.9	6.3	11.3	3.51	0.06	33.8
TD414	B-13-8	8.65	28.0	114.3	89.3	6.0	0.6	0.0	3.1	10.1	16.1	4.38	-0.13	38.9
	SS-4B		29.6	117.8	90.9	1.0	1.8	0.02	20.3	8.4	14.4	3.81	-1.45	35.7

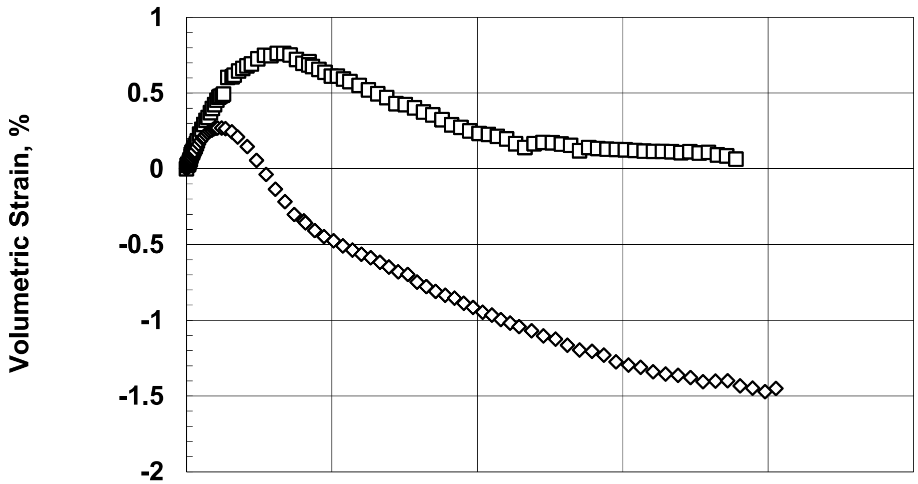
Test No	Description of Material Tested and Remarks
TD413	FA, gray silt with sand (Fly-Ash)
TD414	CL/FA, dark brown clay with silt and sand layer (Fly-Ash layer)

Strength Envelope Summary

Test Series	Failure Criteria	ϕ' (deg)	c' (psi)	α' (deg)	a' (psi)	Correlation Coefficient
1	1	37.6	0.000	31.4	0.000	--
	2	35.0	0.000	29.8	0.000	--

Failure Criteria: 1 - Peak Deviator Stress
2 - Large Strain

Project No. T21562906	**URS Corporation #21562906** **Dynegy Vermillion 2013**	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	
TerraSense, LLC		B-13-8 SS-4 SUMMARY	September 2013

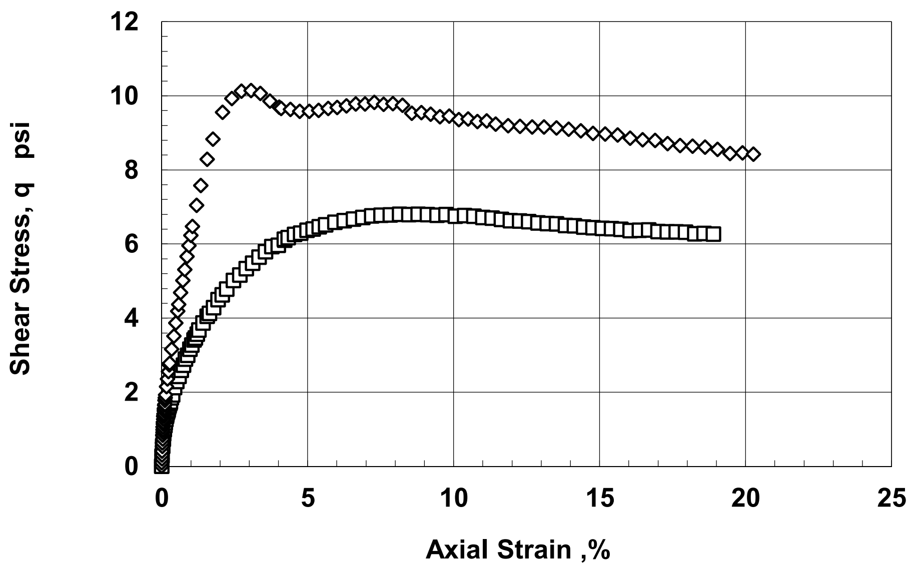


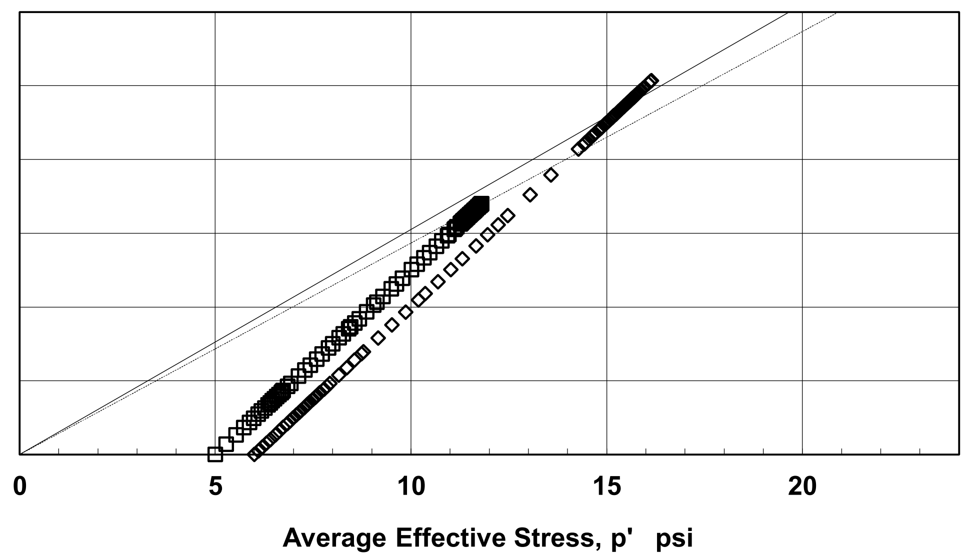
LEGEND AND SUMMARY INFORMATION

Symbol	Test	Boring	Sample	σ'$_c$ (ksf)	w_c (%)	γ_{tc} (pcf)
□	TD413	B-13-8	8.1	5.0	35.9	117.4
◊	TD414	B-13-8	8.65	6.0	29.6	117.8
○	0	0	0	0.0	0.0	0.0

SERIES SUMMARY

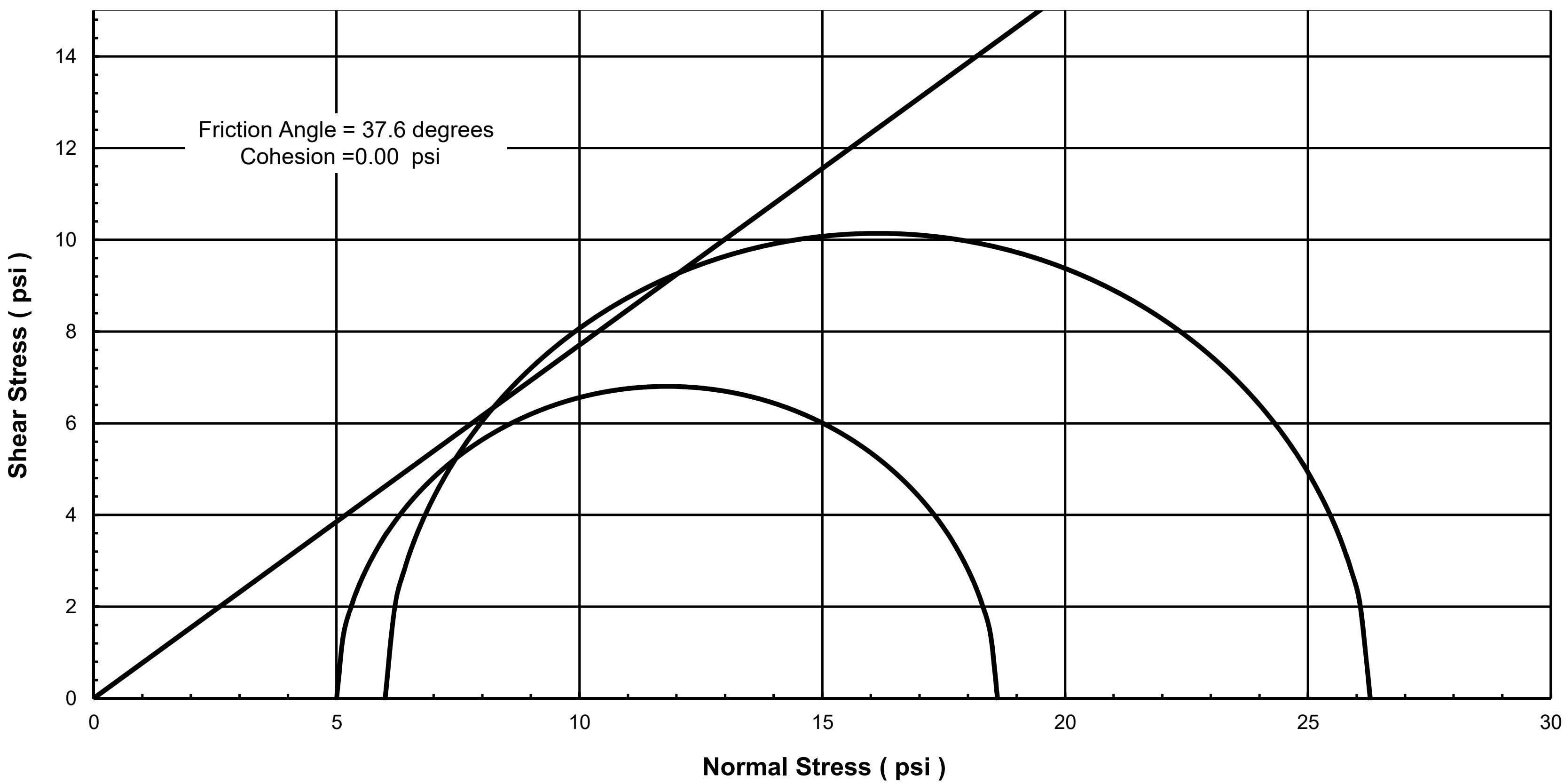
Notation	Failure Criteria	c' psi	Φ' (degrees)
————	Peak Deviator Stress	0.00	37.6
-----------	Large Strain	0.00	35.0





Prepared by: CMJ Checked by: G. Thomas	Project No. T21562906	**URS Corporation #21562906** **Dynegy Vermillion 2013**	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION B-13-8 SS-4 SUMMARY	Figure 1 September 2013
	TerraSense, LLC			

Analysis File: CIDsum.xls (9/13) Cdsum1b.xlsx 9/20/2013



Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	Mohr Circle at Peak CD Triaxial Tests	Figure 2
TerraSense, LLC		B-13-8 SS-4 SUMMARY	September 2013

SAMPLE INFORMATION

Boring: B-13-8 Sample: SS-4A Depth: 8.1 ft

Type: Intact tube sample

Description: FA, gray silt with sand (Fly-Ash)

SPECIMEN INFORMATION (Initial)

Height: 6.01 inch Diameter: 2.82 inch Area: 6.26 in²

Water Content: 34.8 % Total Unit Weight: 107.3 pcf

TEST SUMMARY

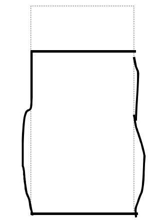
Consolidation Stresses: 5.00 psi vertical, 5.00 psi lateral

Water Content: 35.9 % Total Unit Weight: 117.4 pcf

B Coefficient: Strain Rate: 0.018 %/min

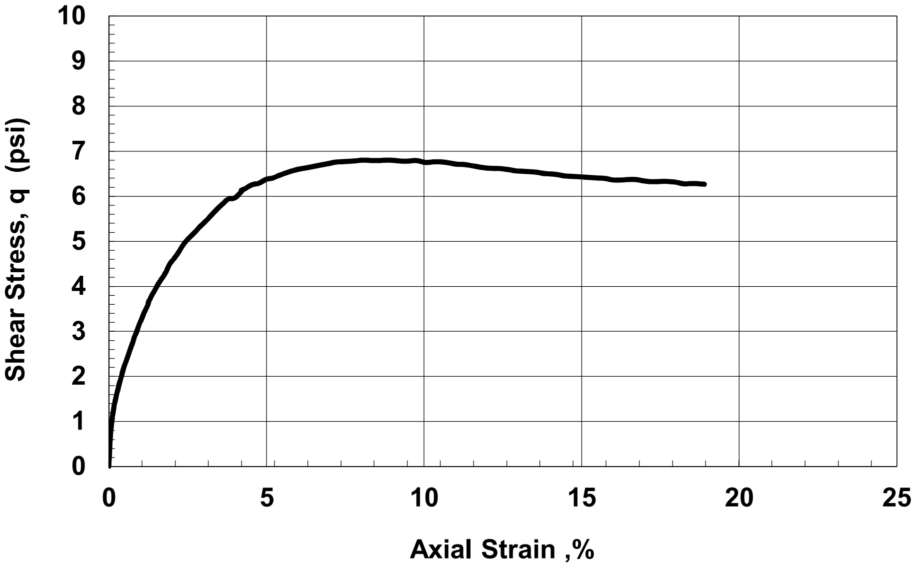
Peak Shear Strength: 6.80 psi @ 8.8 % Strain

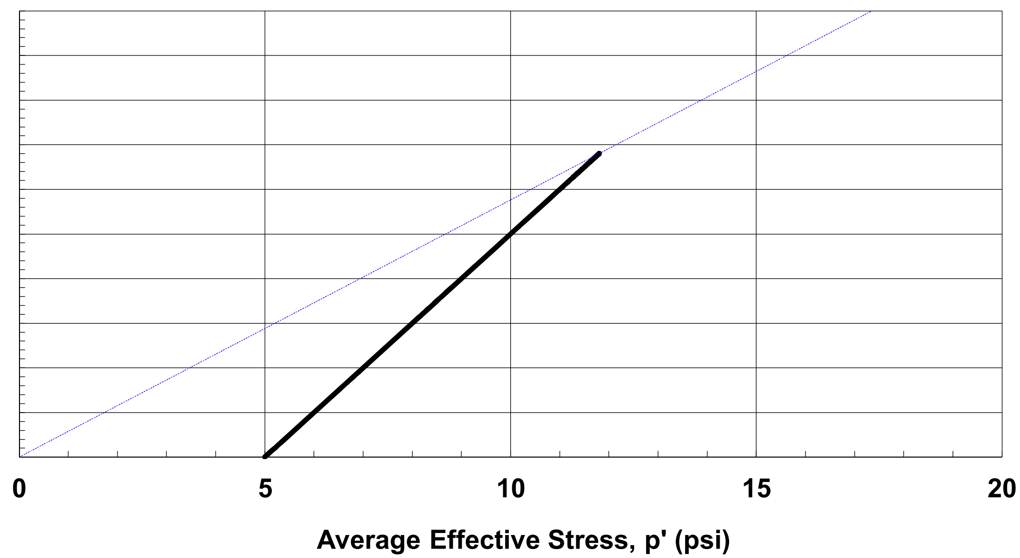
Peak Effective Friction Angle: 35.2°



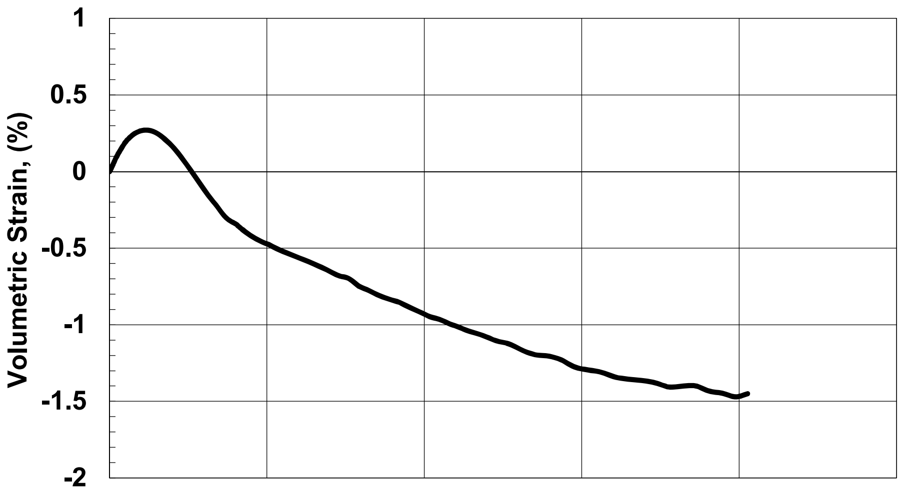
Failure Sketch

REMARKS: Compression positive





Test by: D. Tso	Project No. T21562906	URS #21562906 Dynegy Vermillion 2013	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	
Checked by: G. Thomas	TerraSense, LLC		Boring:B-13-8 Sample: SS-4A Depth: 8.1ft	September-13



SAMPLE INFORMATION

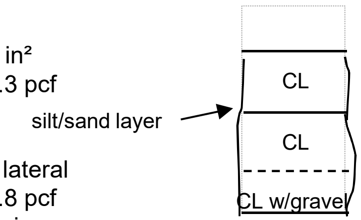
Boring: B-13-8 Sample: SS-4B Depth: 8.65 ft
Type: Intact tube sample
Description: CL/FA, dark brown clay with silt and sand layer (Fly-Ash layer)

SPECIMEN INFORMATION (Initial)

Height: 6.02 inch Diameter: 2.86 inch Area: 6.41 in²
Water Content: 28.0 % Total Unit Weight: 114.3 pcf

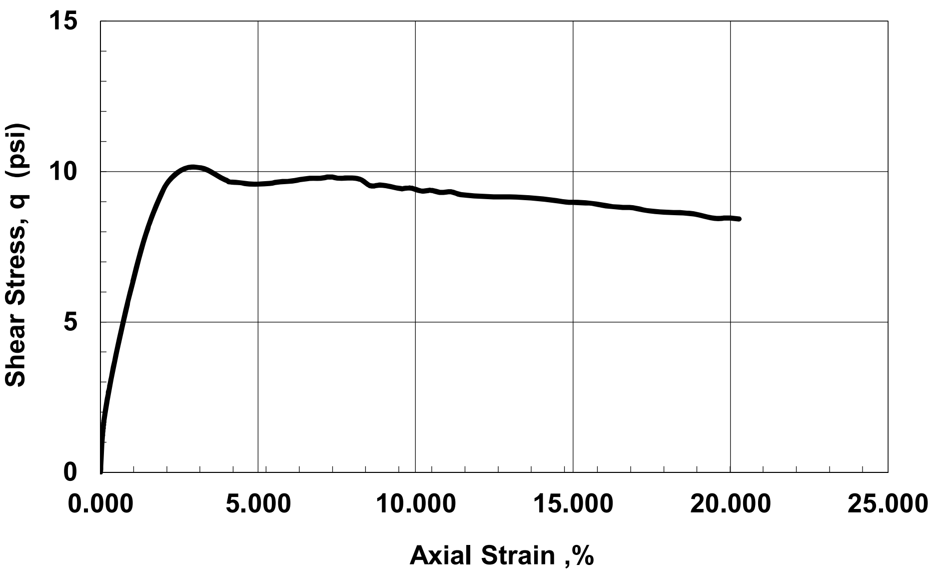
TEST SUMMARY

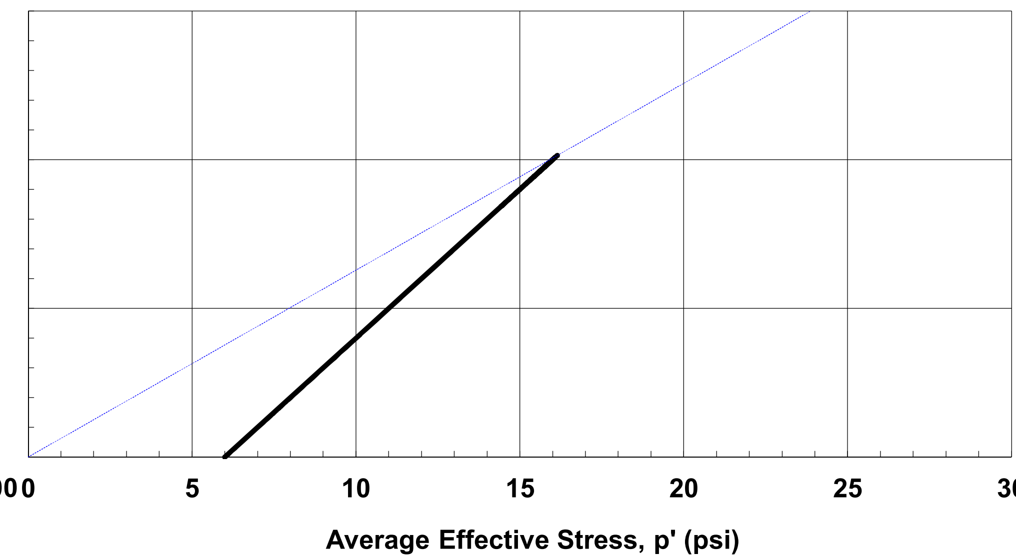
Consolidation Stresses: 6.00 psi vertical, 6.00 psi lateral
Water Content: 29.6 % Total Unit Weight: 117.8 pcf
B Coefficient: Strain Rate: 0.018 %/min
Peak Shear Strength: 10.14 psi @ 3.1 % Strain
Peak Effective Friction Angle: 38.9°



Failure Sketch

REMARKS: Compression positive





Test by: D. Tso	Project No. T21562906	URS #21562906 Dynegy Vermillion 2013	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION
Checked by: G. Thomas	**TerraSense, LLC**		Boring:B-13-8 Sample: SS-4B Depth: 8.65ft / September-13

SUMMARY FOR STATIC CIU' TRIAXIAL TESTS SPECIMENS

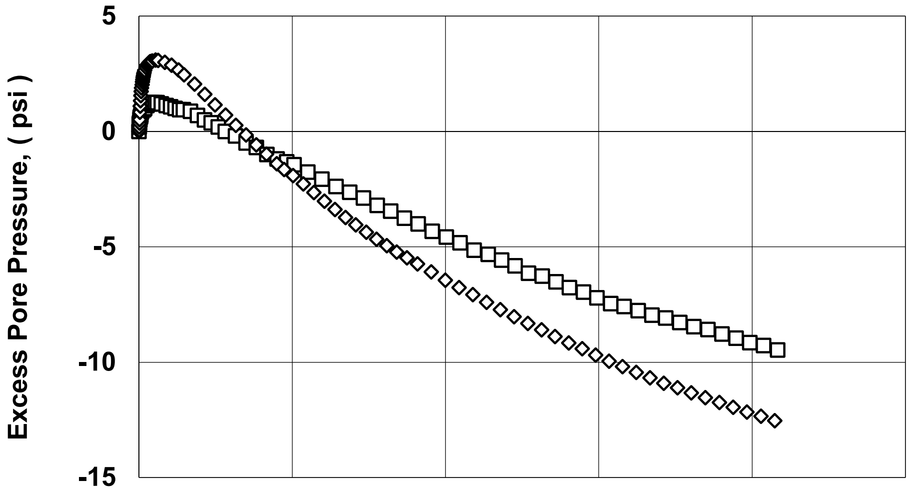
Test No	Boring No	Sample Section No	Depth / Elev (ft)	USCS Group Symbol / Gs	w_o / w_c (%)	$\gamma_{t,o}$ / $\gamma_{t,c}$ (pcf)	$\gamma_{d,o}$ / $\gamma_{d,c}$ (pcf)	$\sigma'_{c,max}$ (psi) / OCR	$\sigma'_{v,c}$ (psi) / $K_c = \frac{\sigma'_{v,c}}{\sigma'_{h,c}}$	$\varepsilon_{a,c}$ / $\varepsilon_{v,c}$ (%)	B factor (%) / ε_{rate} (%/hr)	at Peak Deviator Stress / at Peak Obliquity: ε_a (%)	$\frac{\sigma_1 - \sigma_3}{2}$ (psi)	$\frac{\sigma'_1 + \sigma'_3}{2}$ (psi)	σ'_1 / σ'_3	A factor	ϕ' for c'=0
T3527	B-13-9	SS-3A	5.6	CL	17.5	132.6	112.9	4.00	4.00	0.5		20.4	12.53	25.81	2.89	-0.370	29.0
				(2.79)	18.6	136.0	114.6	1.0	1.00	1.5	1.1	1.7	5.59	8.71	4.58	0.078	39.9
T3528	B-13-9	SS-3B	6.15	CL	19.6	131.5	110.0	5.00	5.00	0.1		20.7	18.51	36.05	3.11	-0.339	30.9
				(2.79)	20.2	133.9	111.4	1.0	1.00	1.3	1.1	1.3	6.34	8.68	6.41	0.210	46.9

Test No	Description of Material Tested and Remarks
T3527	CL, brown lean clay
T3528	CL, brown lean clay

Strength Envelope Summary						
Test Series	Failure Criteria	ϕ' (deg)	c' (psi)	α' (deg)	a' (psi)	Correlation Coefficient
1	1	30.3	0.000	26.8	0.000	--
	2	43.3	0.000	34.4	0.000	--

Failure Criteria: 1 - Peak Deviator Stress; 2 - Peak Obliquity

Project No. T21562906	**URS Corporation #21562906** **Dynegy Vermillion 2013**	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements B-13-9 SS-3 SUMMARY	
TerraSense, LLC			**September 2013**

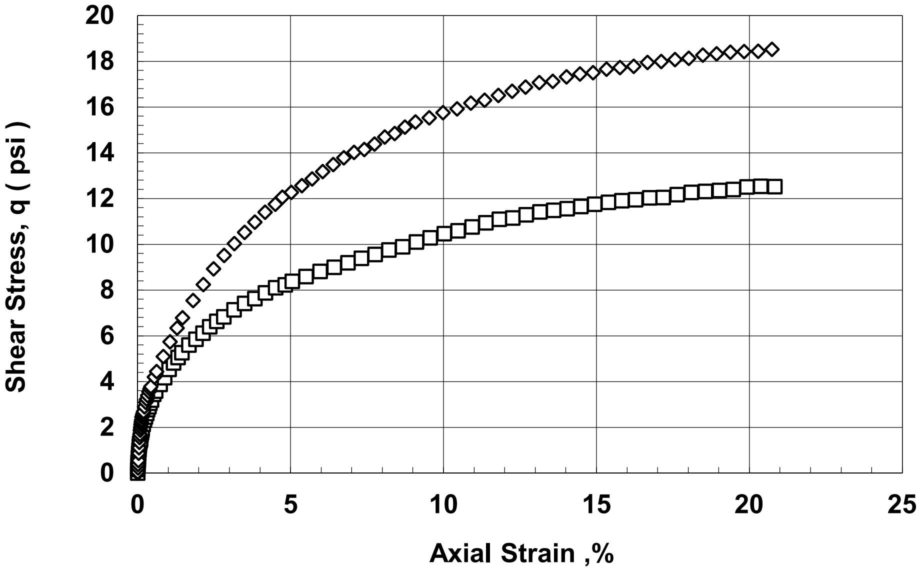


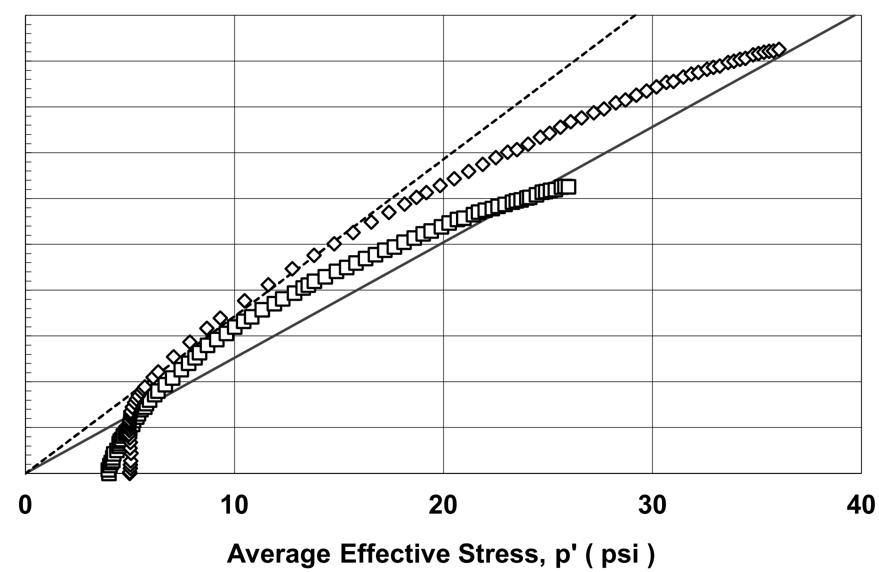
LEGEND AND SUMMARY INFORMATION

Symbol	Test	Boring	Sample	Depth (ft)	w_o (%)	γ_{to} (pcf)	σ'_c (psi)
□	T3527	B-13-9	SS-3A	5.6	17.5	132.6	4.00
◊	T3528	B-13-9	SS-3B	6.2	19.6	131.5	5.00

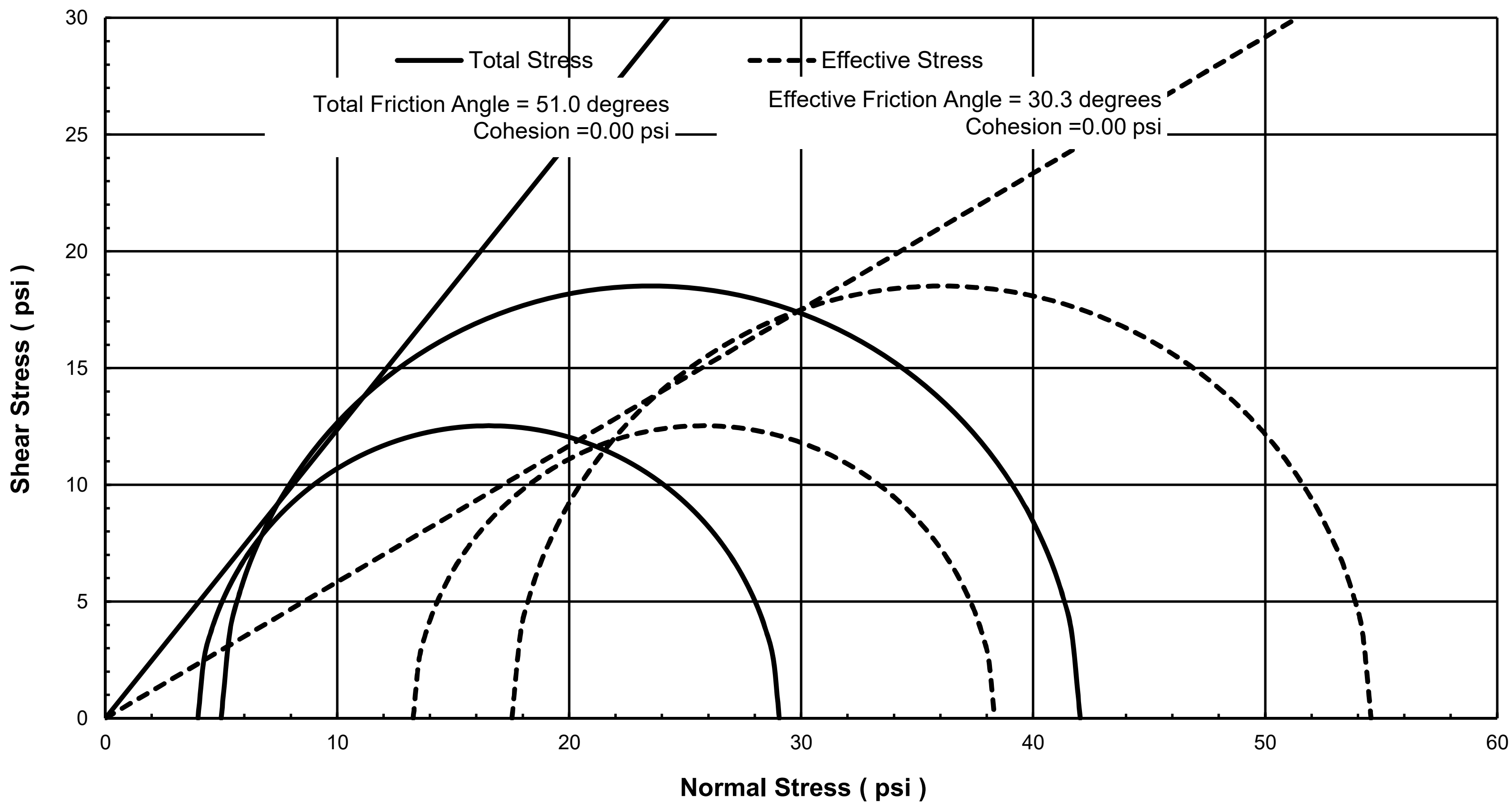
SERIES SUMMARY

Notation	Failure Criteria	c' (psi)	Φ' (degrees)
——	Peak Deviator Stress	0.00	30.3
······	Peak Obliquity	0.00	43.3

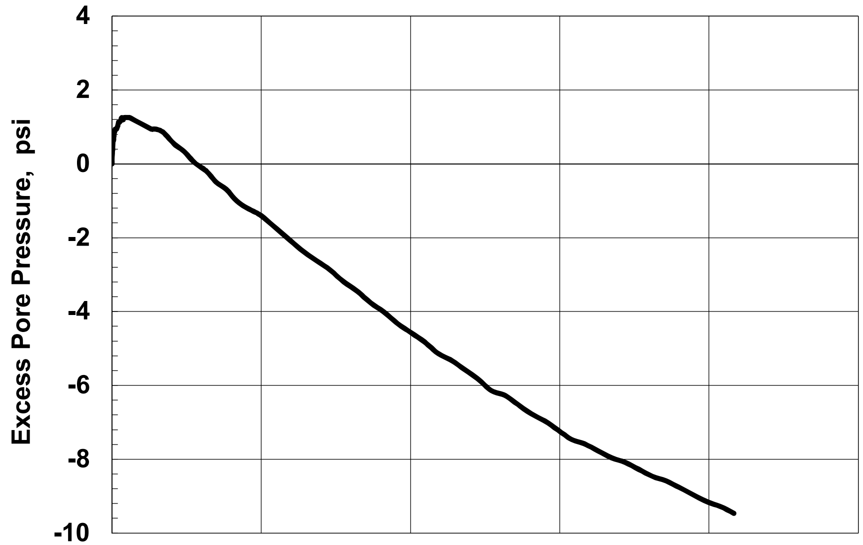




Project No. T21562906	**URS Corporation #21562906** **Dynegy Vermillion 2013**	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements B-13-9 SS-3 SUMMARY	Figure 1
Prepared by: C. Jordan Checked by: G. Thomas	**TerraSense, LLC**		September 2013



Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	Mohr Circles of Total and Effective Stresses at Peak CIU' Triaxial Test	Figure 2
TerraSense, LLC		B-13-9 SS-3 SUMMARY	September 2013



SAMPLE INFORMATION

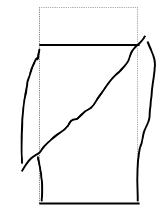
Boring: B-13-9 Sample: SS-3A Depth: 5.6ft
Type: Intact tube sample
Description: CL, brown lean clay

SPECIMEN INFORMATION (Initial)

Height: 6.03 inch Diameter: 2.88 inch Area: 6.50 in²
Water Content: 17.5 % Total Unit Weight: 132.6 pcf

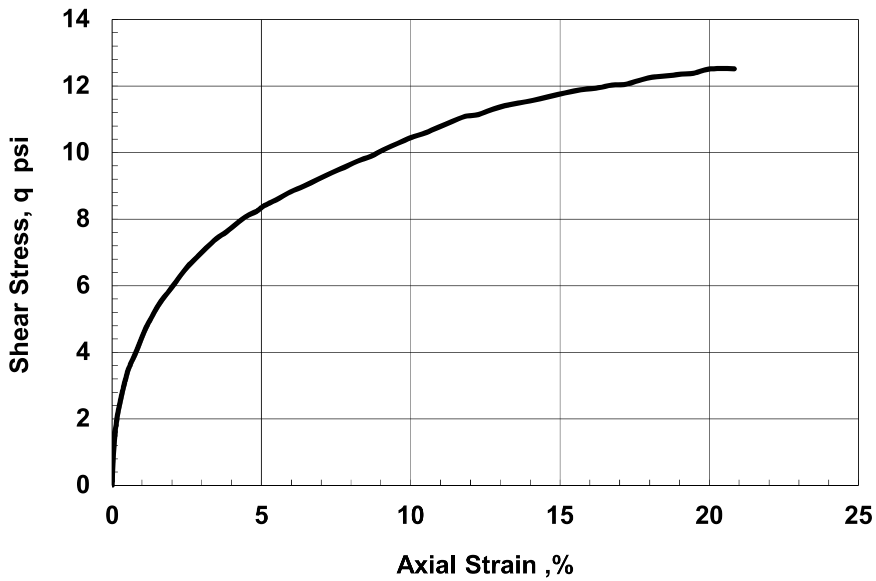
TEST SUMMARY

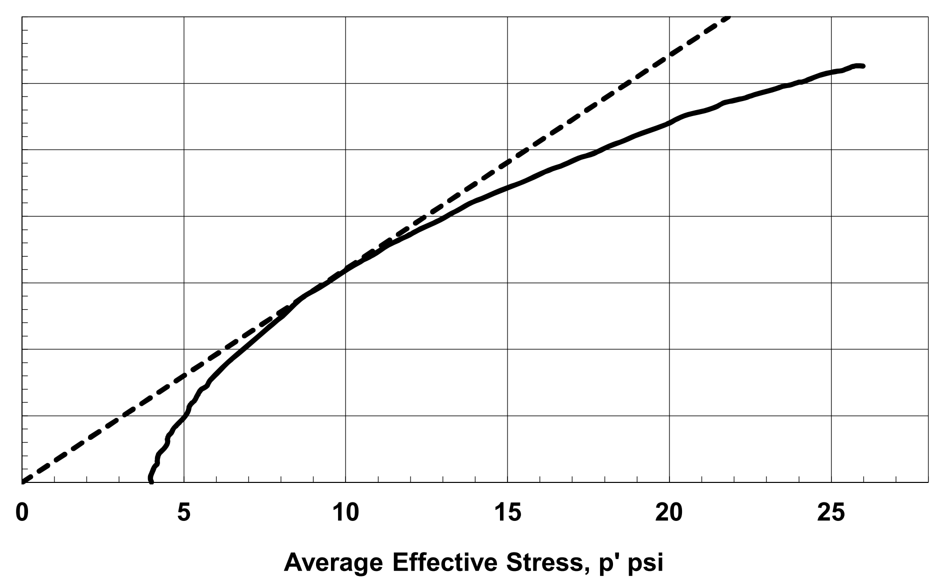
Consolidation Stresses: 4.00 psi vertical, 4.00 psi lateral
Water Content: 18.6 % Total Unit Weight: 136.0 pcf
B Coefficient: Strain Rate: 0.019 %/min
Peak Shear Strength: 12.53 psi @ 20.4 % Strain
Peak Effective Friction Angle: 39.9°



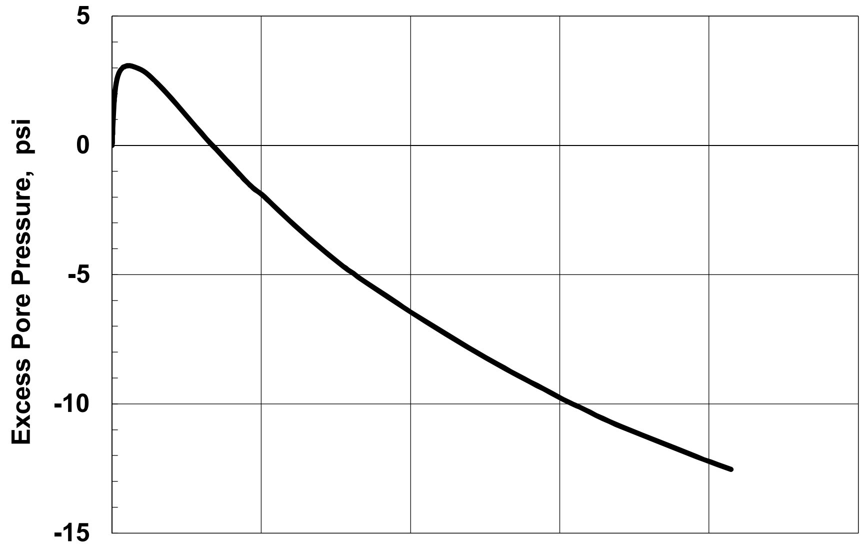
Failure Sketch

REMARKS:





Test by: DT	Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: B-13-9 Sample: SS-3A	September-13

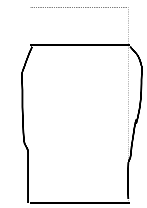


SAMPLE INFORMATION

Boring: B-13-9 Sample: SS-3B Depth: 6.15ft
Type: Intact tube sample
Description: CL, brown lean clay

SPECIMEN INFORMATION (Initial)

Height: 6.03 inch Diameter: 2.88 inch Area: 6.51 in²
Water Content: 19.6 % Total Unit Weight: 131.5 pcf

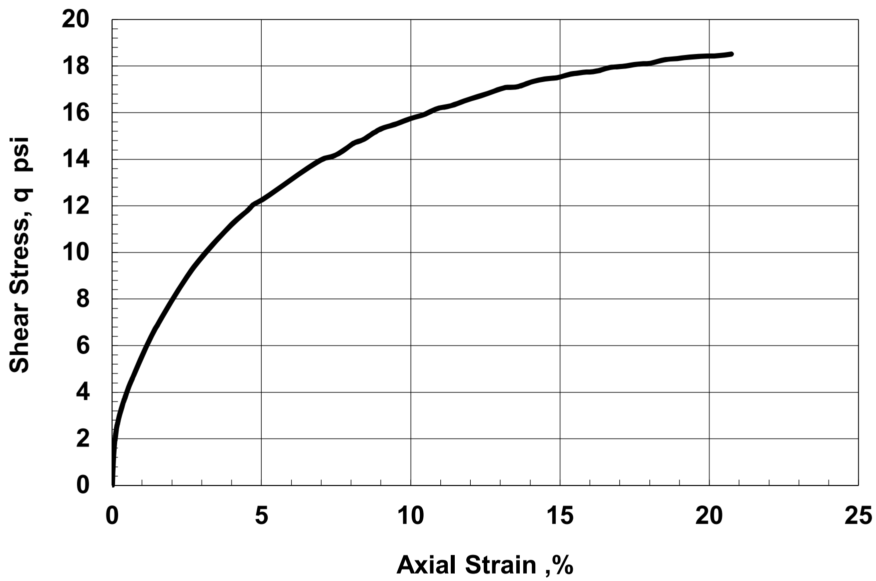


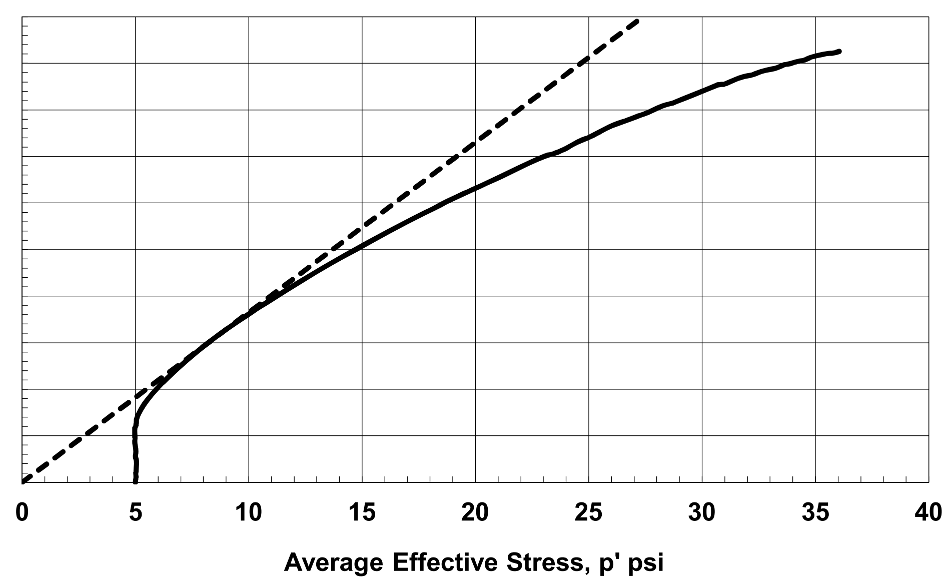
Failure Sketch

TEST SUMMARY

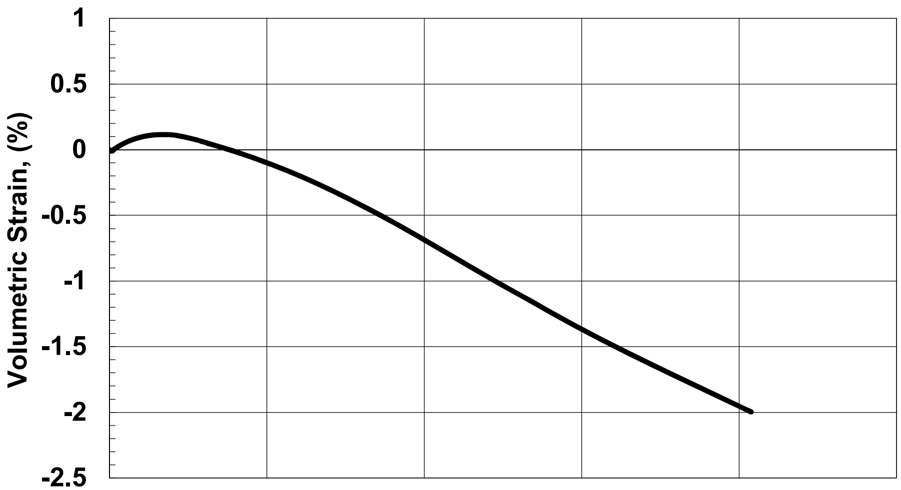
Consolidation Stresses: 5.00 psi vertical, 5.00 psi lateral
Water Content: 20.2 % Total Unit Weight: 133.9 pcf
B Coefficient: Strain Rate: 0.019 %/min
Peak Shear Strength: 18.51 psi @ 20.7 % Strain
Peak Effective Friction Angle: 46.9°

REMARKS:





Test by: DT	Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements
Checked by: GET	TerraSense, LLC		Boring: B-13-9 Sample: SS-3B
			September-13



SAMPLE INFORMATION

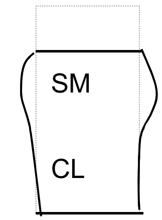
Boring: B-13-15 Sample: SS-3A Depth: 5.9 ft
Type: Intact tube sample
Description: SM/CL, Top: brown silty c-f sand; Bot.: gray clay
LL = 33 PL = 16 PI = 17

SPECIMEN INFORMATION (Initial)

Height: 6.04 inch Diameter: 2.85 inch Area: 6.40 in²
Water Content: 14.9 % Total Unit Weight: 133.2 pcf

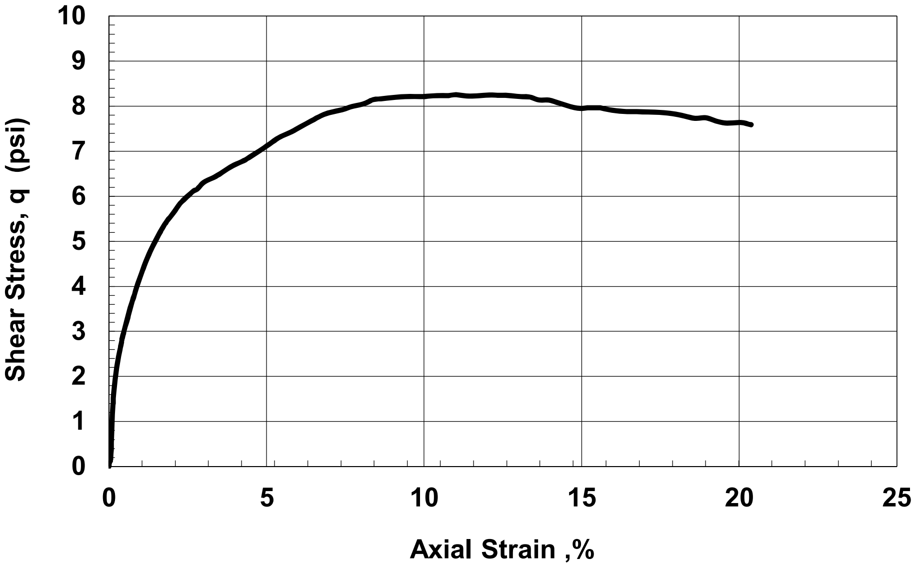
TEST SUMMARY

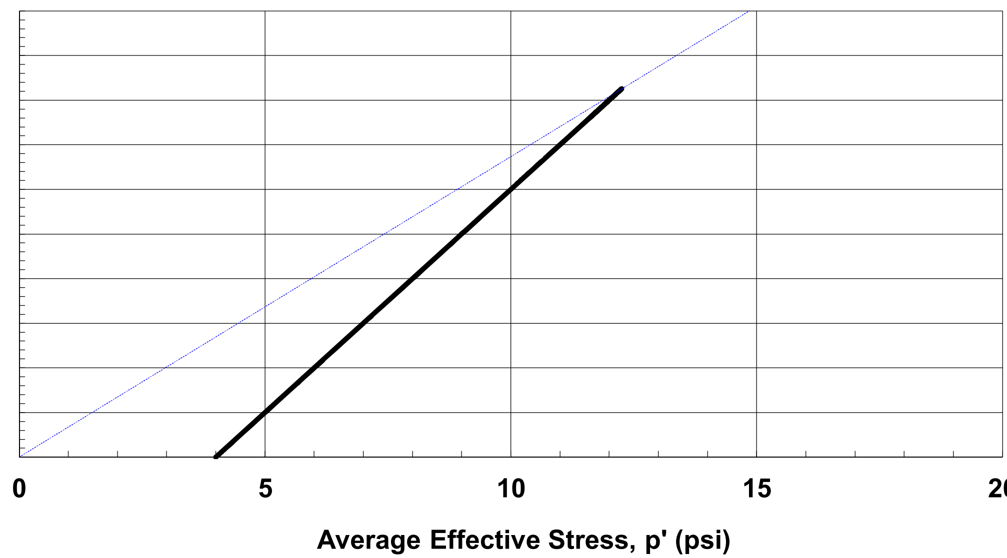
Consolidation Stresses: 4.00 psi vertical, 4.00 psi lateral
Water Content: 16.6 % Total Unit Weight: 137.5 pcf
B Coefficient: Strain Rate: 0.018 %/min
Peak Shear Strength: 8.25 psi @ 11.0 % Strain
Peak Effective Friction Angle: 42.3°



Failure Sketch

REMARKS: Compression positive





Test by: D. Tso

Checked by: G. Thomas

Project No. T21562906	URS #21562906 Dynegy Vermillion 2013	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	
	TerraSense, LLC	Boring:B-13-15 Sample: SS-3A Depth: 5.9ft	September-13

SUMMARY OF TRIAXIAL CID-C TESTS ON UNDISTURBED SPECIMENS

Series Test No	Boring No / Sample No.	Depth (ft)	w_o / w_c (%)	$\gamma_{t,o}$ / $\gamma_{t,c}$ (pcf)	$\gamma_{d,o}$ / $\gamma_{d,c}$ (pcf)	σ'_c (ksf) / OCR $\frac{\sigma'_{v,c}}{\sigma'_{v,max}}$	$\varepsilon_{a,c}$ / $\varepsilon_{v,c}$ (%)	B factor (%) / ε_{rate} (%/min)	at Peak Deviator Stress / at Large Strain: ε_a (%)	$\frac{\sigma_1 - \sigma_3}{2}$ (psi)	$\frac{\sigma'_1 + \sigma'_3}{2}$ (psi)	σ'_1 / σ'_3	Vol. Strain ε_{vol} (%)	ϕ' for c'=0
TD415	B-13-15	15.3	34.7	105.0	77.9	5.0	0.8	0.0	5.9	7.4	12.4	3.94	-0.03	36.5
	SS-6A		35.7	108.5	79.9	1.0	2.5	0.02	19.2	6.4	11.4	3.54	-0.96	34.0
TD417	B-13-15	15.9	31.3	105.9	80.6	10.0	1.2	98.5	4.4	14.2	24.2	3.84	-0.18	35.9
	SS-6B		33.8	111.4	83.2	1.0	3.1	0.02	19.2	11.1	21.1	3.23	-0.75	31.8

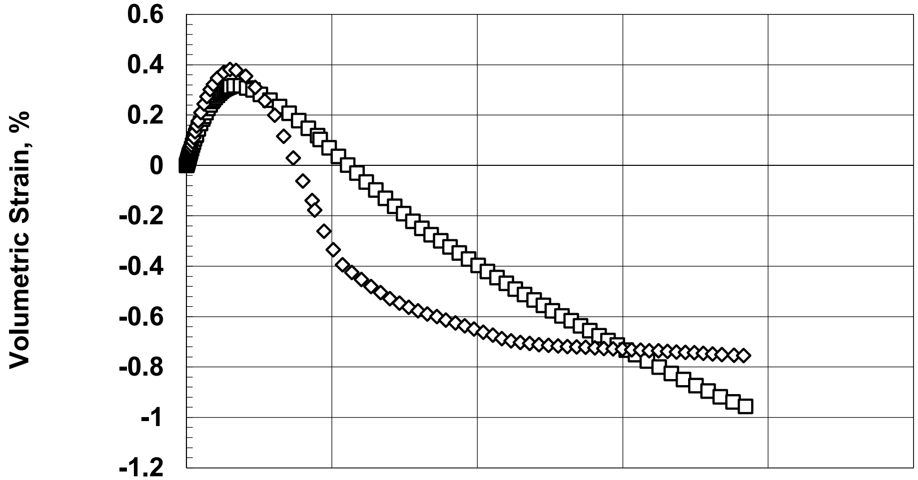
Test No	Description of Material Tested and Remarks
TD415	FA, gray silt with sand (Fly-Ash)
TD417	FA, gray silt with sand (Fly-Ash)

Strength Envelope Summary

Test Series	Failure Criteria	ϕ' (deg)	c' (psi)	α' (deg)	a' (psi)	Correlation Coefficient
1	1	35.3	0.274	30.0	0.224	1.000
	2	29.3	0.131	26.1	0.114	1.000

Failure Criteria: 1 - Peak Deviator Stress; 2 - Large Strain

Project No. T21562906	**URS Corporation #21562906** **Dynegy Vermillion 2013**	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION B-13-15 SS-6 SUMMARY	September 2013
	TerraSense, LLC		

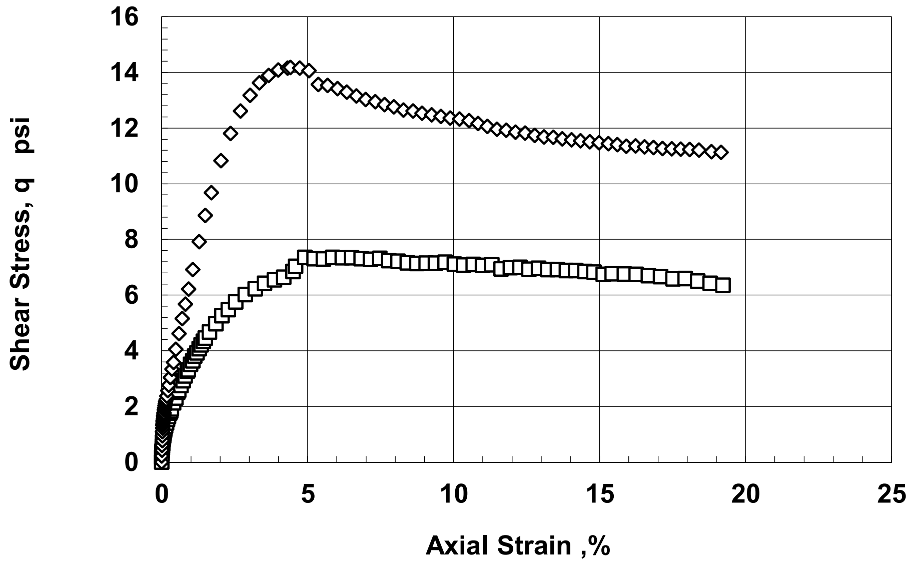


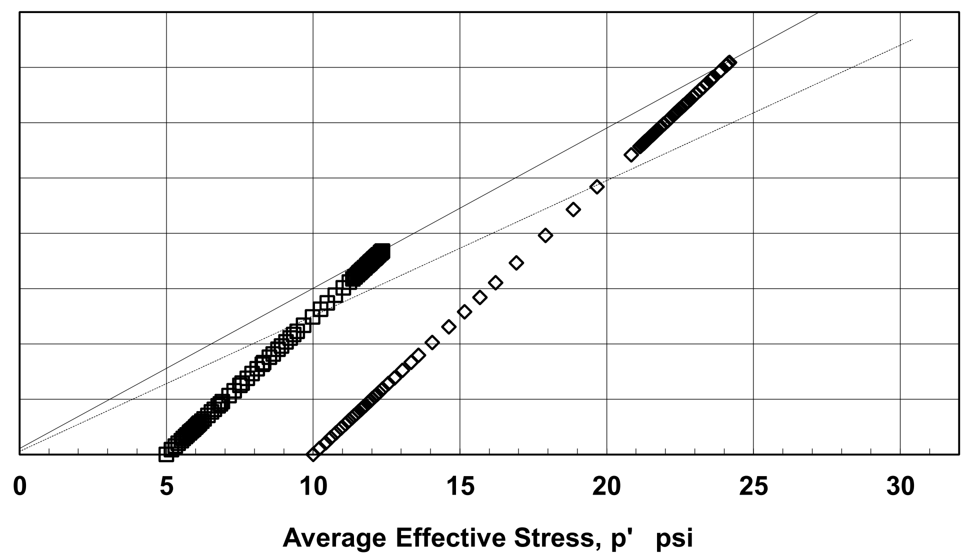
LEGEND AND SUMMARY INFORMATION

Symbol	Test	Boring	Sample	σ'_c (ksf)	w_c (%)	γ_{tc} (pcf)
□	TD415	B-13-15	15.3	5.0	35.7	108.5
◊	TD417	B-13-15	15.9	10.0	33.8	111.4
○	0	0	0	0.0	0.0	0.0

SERIES SUMMARY

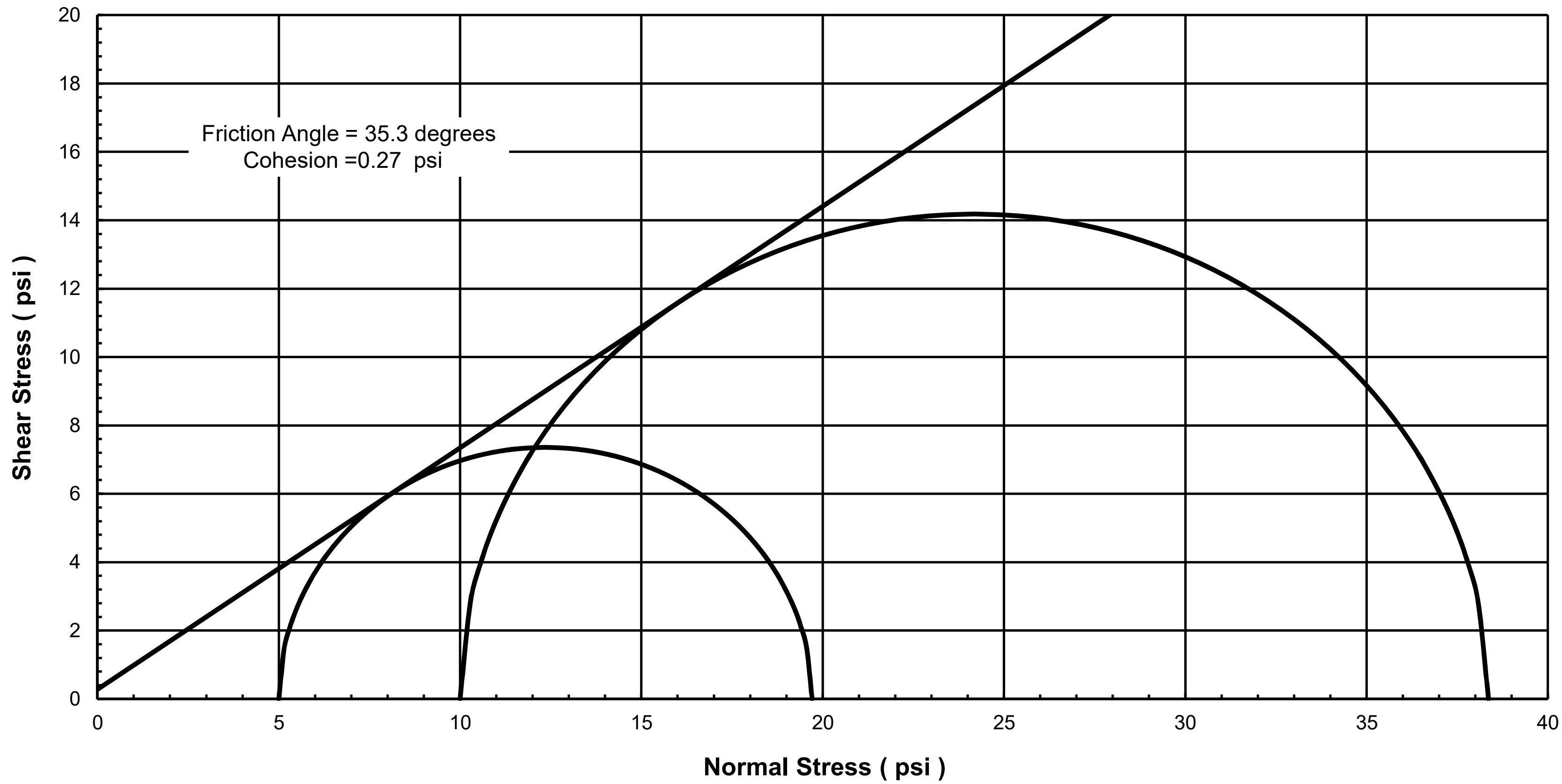
Notation	Failure Criteria	c' psi	Φ' (degrees)
————	Peak Deviator Stress	0.27	35.3
-----------	Large Strain	0.13	29.3





Project No. T21562906	**URS Corporation #21562906** **Dynegy Vermillion 2013**	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	Figure 1
	TerraSense, LLC	B-13-15 SS-6 SUMMARY	September 2013

Prepared by: CMJ
Checked by: G. Thomas

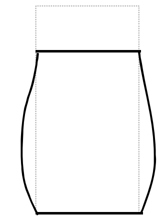


Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	Mohr Circle at Peak CD Triaxial Tests	Figure 2
TerraSense, LLC		B-13-15 SS-6 SUMMARY	September 2013

SAMPLE INFORMATION
Boring: B-13-15 Sample: SS-6A Depth: 15.3 ft
Type: Intact tube sample
Description: FA, gray silt with sand (Fly-Ash)

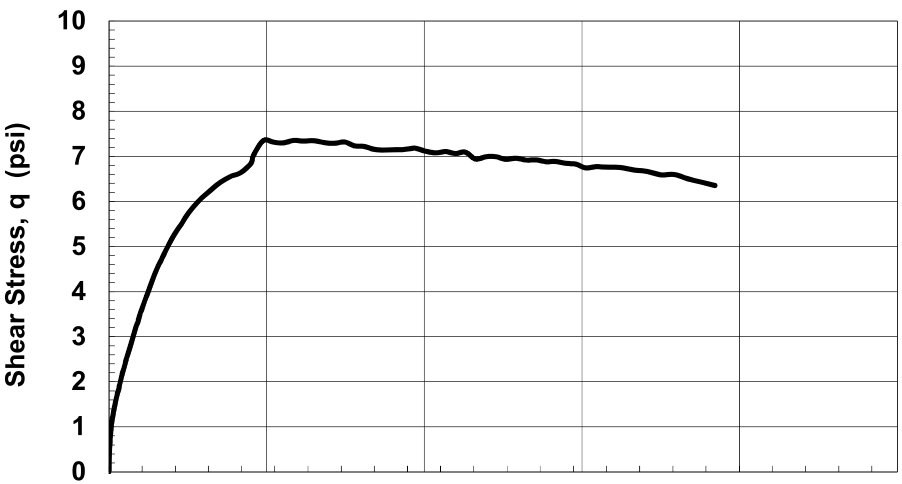
SPECIMEN INFORMATION (Initial)
Height: 6.01 inch Diameter: 2.82 inch Area: 6.24 in²
Water Content: 34.7 % Total Unit Weight: 105.0 pcf

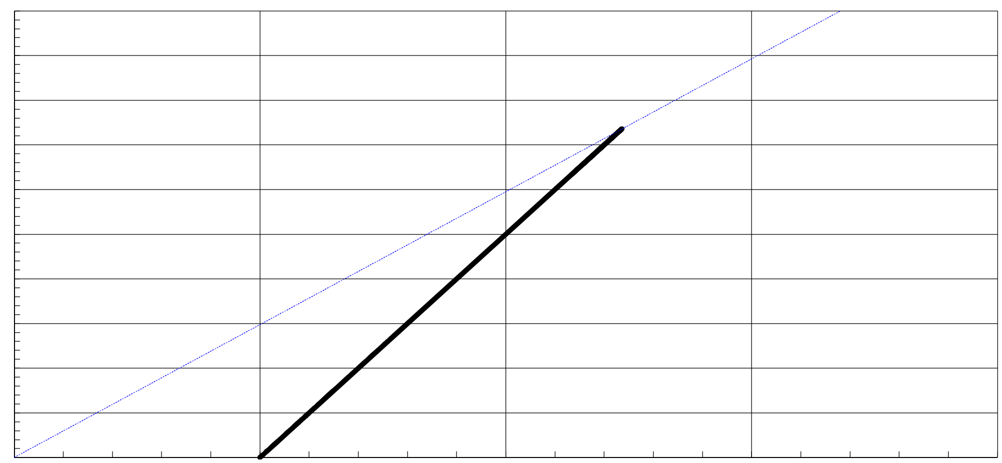
TEST SUMMARY
Consolidation Stresses: 5.00 psi vertical, 5.00 psi lateral
Water Content: 35.7 % Total Unit Weight: 108.5 pcf
B Coefficient: Strain Rate: 0.018 %/min
Peak Shear Strength: 7.36 psi @ 5.9 % Strain
Peak Effective Friction Angle: 36.5°



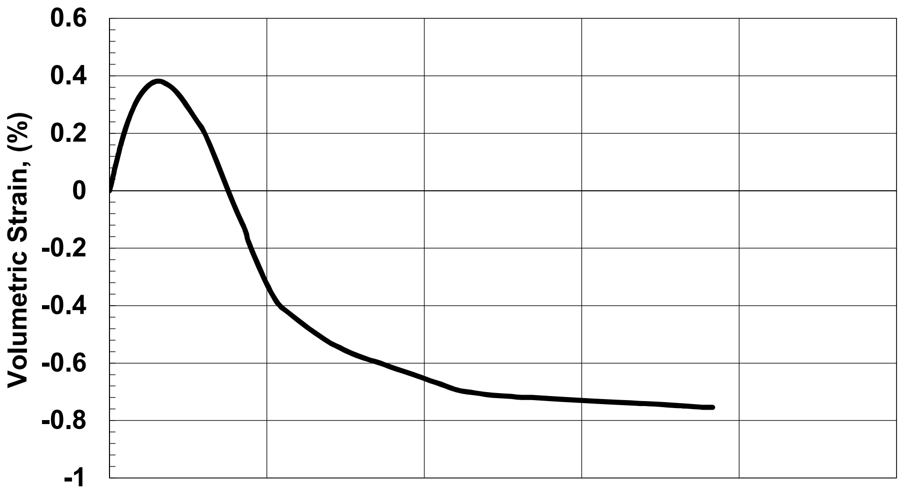
Failure
Sketch

REMARKS: Compression positive





Test by: D. Tso	Project No. T21562906	URS #21562906 Dynegy Vermillion 2013	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	
Checked by: G. Thomas	**TerraSense, LLC**		Boring:B-13-15 Sample: SS-6A Depth: 15.3ft	September-13



SAMPLE INFORMATION

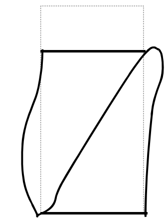
Boring: B-13-15 Sample: SS-6B Depth: 15.9 ft
Type: Intact tube sample
Description: FA, gray silt with sand (Fly-Ash)

SPECIMEN INFORMATION (Initial)

Height: 5.98 inch Diameter: 2.84 inch Area: 6.33 in²
Water Content: 31.3 % Total Unit Weight: 105.9 pcf

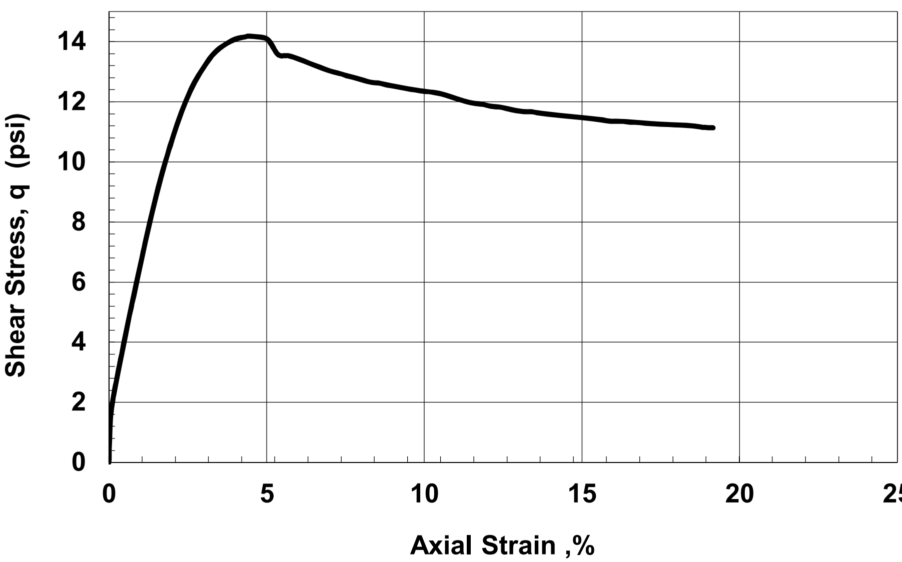
TEST SUMMARY

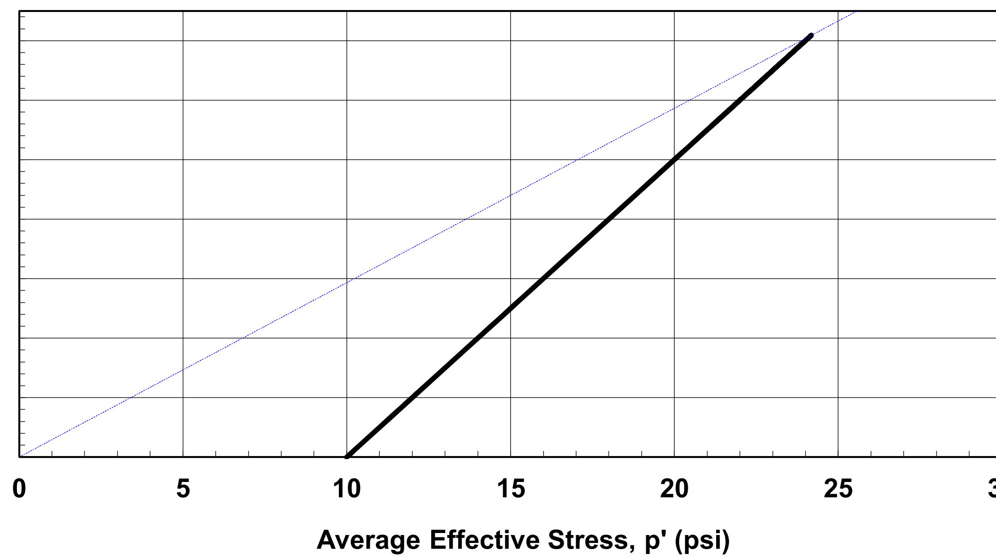
Consolidation Stresses: 10.00 psi vertical, 10.00 psi lateral
Water Content: 33.8 % Total Unit Weight: 111.4 pcf
B Coefficient: 98.5 Strain Rate: 0.018 %/min
Peak Shear Strength: 14.18 psi @ 4.4 % Strain
Peak Effective Friction Angle: 35.9°



Failure Sketch

REMARKS: Compression positive





Test by: D. Tso

Checked by: G. Thomas

Project No. T21562906	URS #21562906 Dynegy Vermillion 2013	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	
TerraSense, LLC		Boring:B-13-15 Sample: SS-6B Depth: 15.9ft	September-13

SUMMARY OF TRIAXIAL CID-C TESTS ON UNDISTURBED SPECIMENS

Series Test No	Boring No / Sample No.	Depth (ft)	w_o / w_c (%)	$\gamma_{t,o}$ / $\gamma_{t,c}$ (pcf)	$\gamma_{d,o}$ / $\gamma_{d,c}$ (pcf)	σ'_c (ksf) / OCR $\frac{\sigma'_{v,c}}{\sigma'_{v,max}}$	$\varepsilon_{a,c}$ / $\varepsilon_{v,c}$ (%)	B factor (%) / ε_{rate} (%/min)	at Peak Deviator Stress / at Large Strain ε_a (%)	$\frac{\sigma_1 - \sigma_3}{2}$ (psi)	$\frac{\sigma'_1 + \sigma'_3}{2}$ (psi)	σ'_1 / σ'_3	Vol. Strain ε_{vol} (%)	ϕ' for c'=0
TD418	B-13-17	2.85	27.1	107.8	84.8	2.0	0.3	98.5	12.9	3.1	5.1	4.08	0.24	37.3
	SS-2A		34.8	115.3	85.6	1.0	0.9	0.02	21.4	2.9	4.9	3.89	-0.16	36.2
TD419	B-13-17	3.35	37.2	93.3	68.0	3.0	0.5	0.0	4.0	4.6	7.6	4.05	-0.11	37.1
	SS-2B		49.6	103.3	69.0	1.0	1.4	0.02	20.6	3.9	6.9	3.59	-0.66	34.4
TD420	B-13-17	3.9	36.6	97.6	71.5	4.0	0.7	0.0	2.1	8.8	12.8	5.42	-0.39	43.5
	SS-2C		45.7	106.5	73.1	1.0	2.3	0.02	19.5	6.6	10.6	4.32	-2.38	38.6

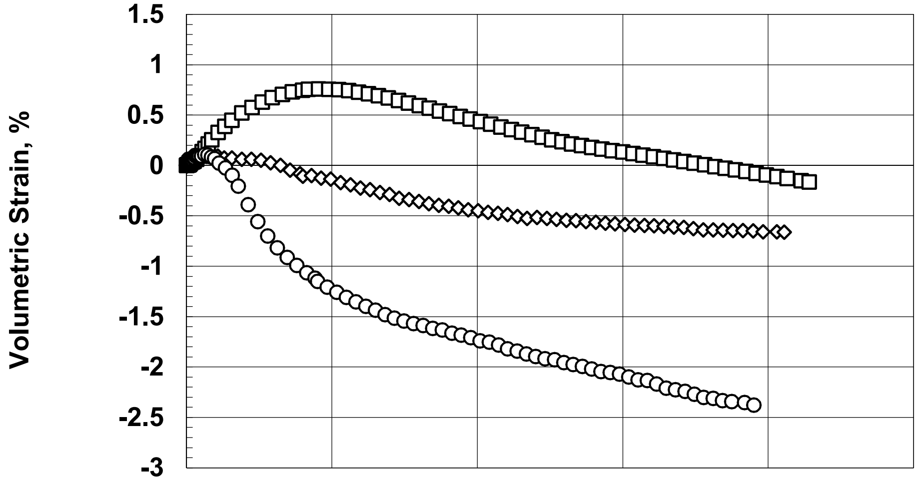
Test No	Description of Material Tested and Remarks
TD418	SC/FA, Top: brown clayey f. sand; Bot: gray silt with sand (Fly-Ash)
TD419	FA, gray silt with sand (Fly-Ash)
TD420	FA, gray silt with sand (Fly-Ash)

Strength Envelope Summary

Test Series	Failure Criteria	ϕ' (deg)	c' (psi)	α' (deg)	a' (psi)	Correlation Coefficient
1	1	41.3	0.000	33.4	0.000	--
	2	37.2	0.000	31.1	0.000	--

Failure Criteria: 1 - Peak Deviator Stress
2 - Large Strain

Project No. T21562906	**URS Corporation #21562906** **Dynegy Vermillion 2013**	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	
TerraSense, LLC		B-13-17 SS-2 SUMMARY	September 2013

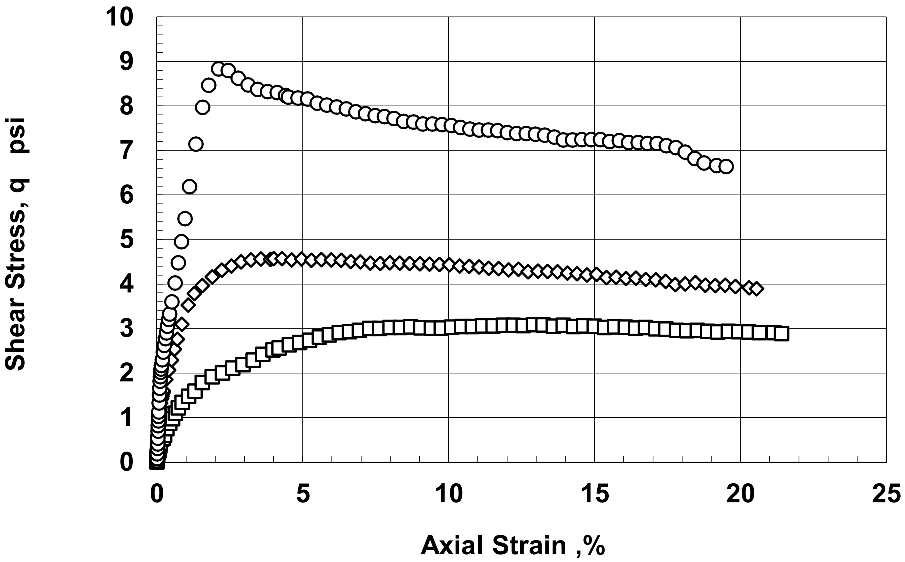


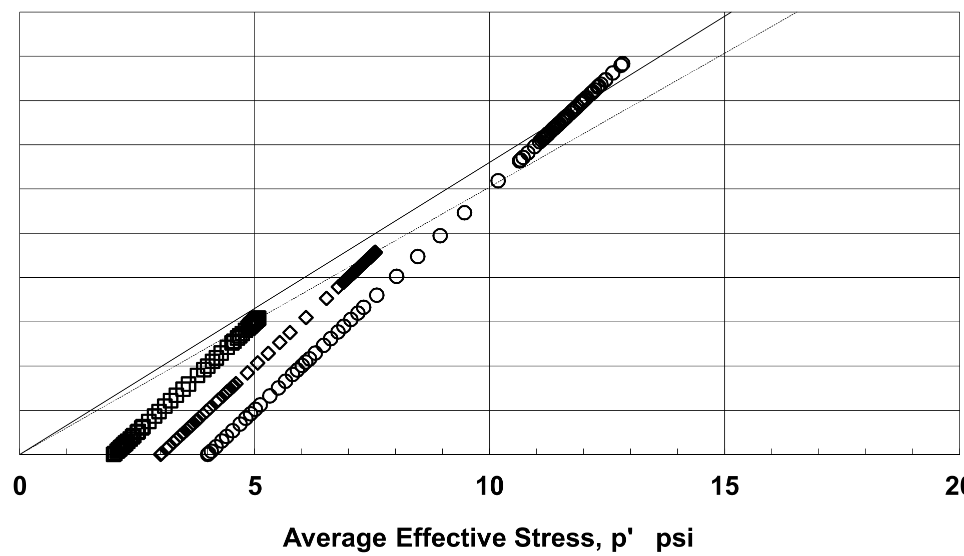
LEGEND AND SUMMARY INFORMATION

Symbol	Test	Boring	Sample	σ'c (ksf)	wc (%)	γtc (pcf)
□	TD418	B-13-17	2.85	2.0	34.8	115.3
◊	TD419	B-13-17	3.35	3.0	49.6	103.3
○	TD420	B-13-17	3.9	4.0	45.7	106.5

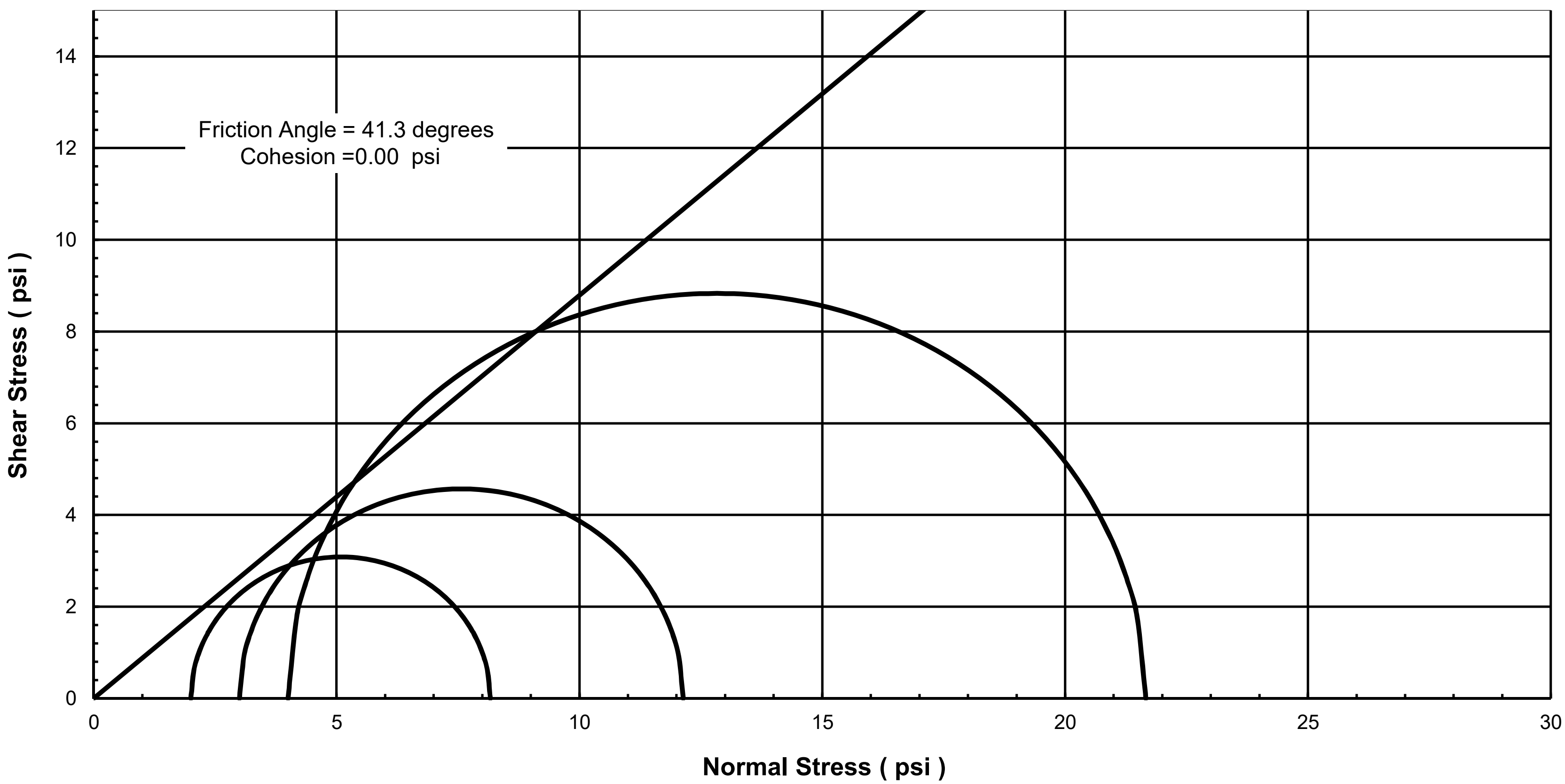
SERIES SUMMARY

Notation	Failure Criteria	c' psi	Φ' (degrees)
————	Peak Deviator Stress	0.00	41.3
-----------	Large Strain	0.00	37.2

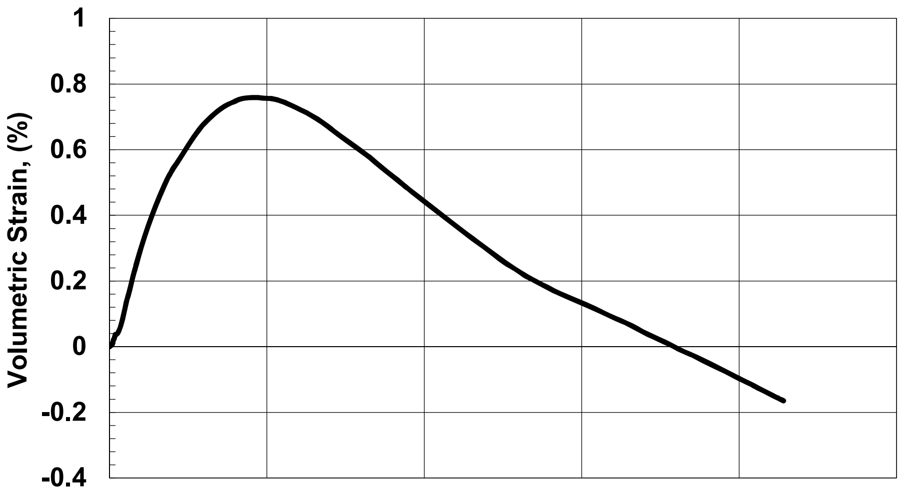




Prepared by: CMJ Checked by: G. Thomas	Project No. T21562906	**URS Corporation #21562906** **Dynegy Vermillion 2013**	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION B-13-17 SS-2 SUMMARY	Figure 1 September 2013
	TerraSense, LLC			



Project No. T21562906	URS Corporation #21562906 Dynegy Vermillion 2013	Mohr Circle at Peak CD Triaxial Tests	Figure 2
TerraSense, LLC		B-13-17 SS-2 SUMMARY	September 2013

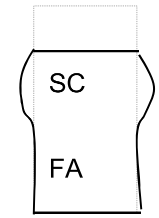


SAMPLE INFORMATION

Boring: B-13-17 Sample: SS-2A Depth: 2.85 ft
Type: Intact tube sample
Description: SC/FA, Top: brown clayey f. sand; Bot: gray silt with sand (Fly-Ash)

SPECIMEN INFORMATION (Initial)

Height: 5.76 inch Diameter: 2.86 inch Area: 6.41 in²
Water Content: 27.1 % Total Unit Weight: 107.8 pcf

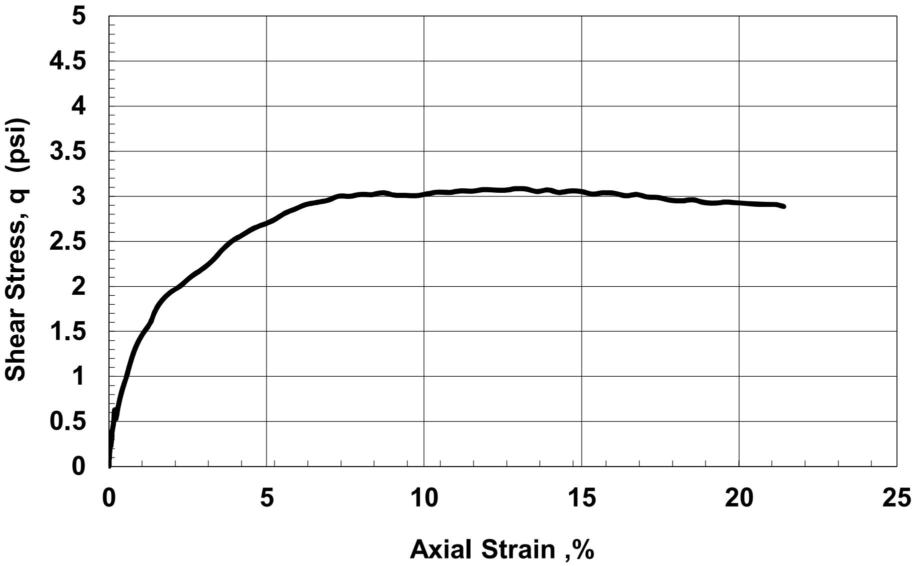


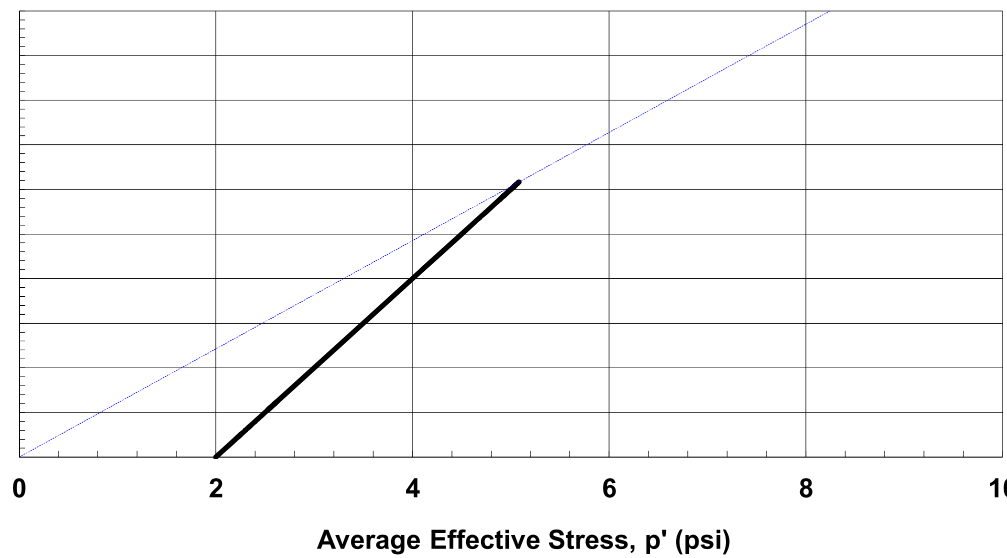
TEST SUMMARY

Consolidation Stresses: 2.00 psi vertical, 2.00 psi lateral
Water Content: 34.8 % Total Unit Weight: 115.3 pcf
B Coefficient: 98.5 Strain Rate: 0.019 %/min
Peak Shear Strength: 3.08 psi @ 12.9 % Strain
Peak Effective Friction Angle: 37.3°

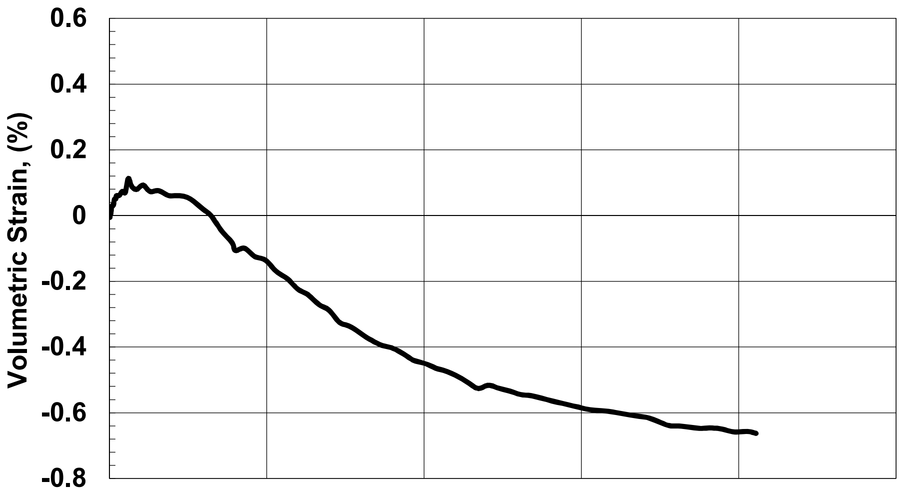
Failure Sketch

REMARKS: Compression positive





Test by: D. Tso	Project No. T21562906	URS #21562906 Dynegy Vermillion 2013	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	
Checked by: G. Thomas	**TerraSense, LLC**		Boring:B-13-17 Sample: SS-2A Depth: 2.85ft	September-13



SAMPLE INFORMATION

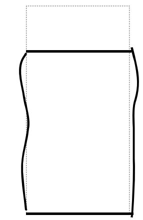
Boring: B-13-17 Sample: SS-2B Depth: 3.35 ft
Type: Intact tube sample
Description: FA, gray silt with sand (Fly-Ash)
LL = 44 PL = 35 PI = 9

SPECIMEN INFORMATION (Initial)

Height: 6.00 inch Diameter: 2.87 inch Area: 6.47 in²
Water Content: 37.2 % Total Unit Weight: 93.3 pcf

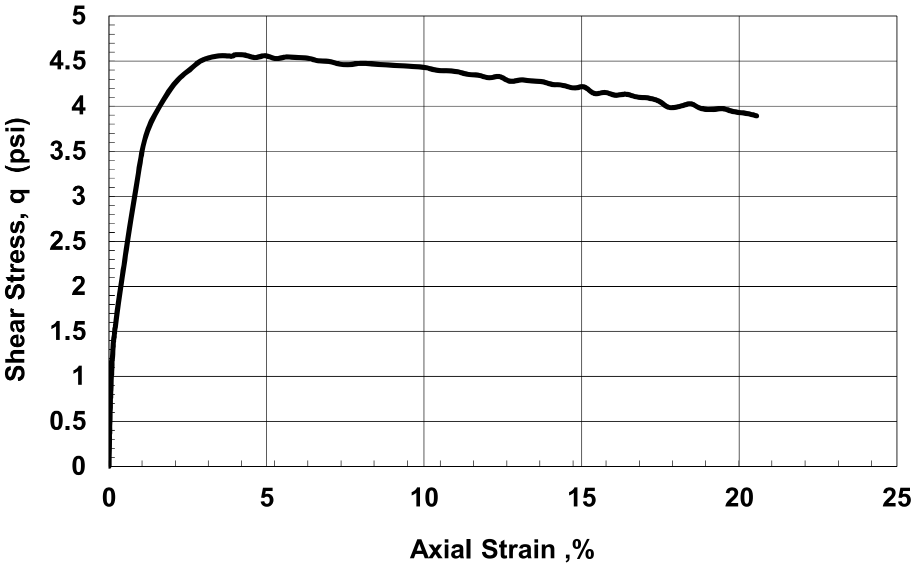
TEST SUMMARY

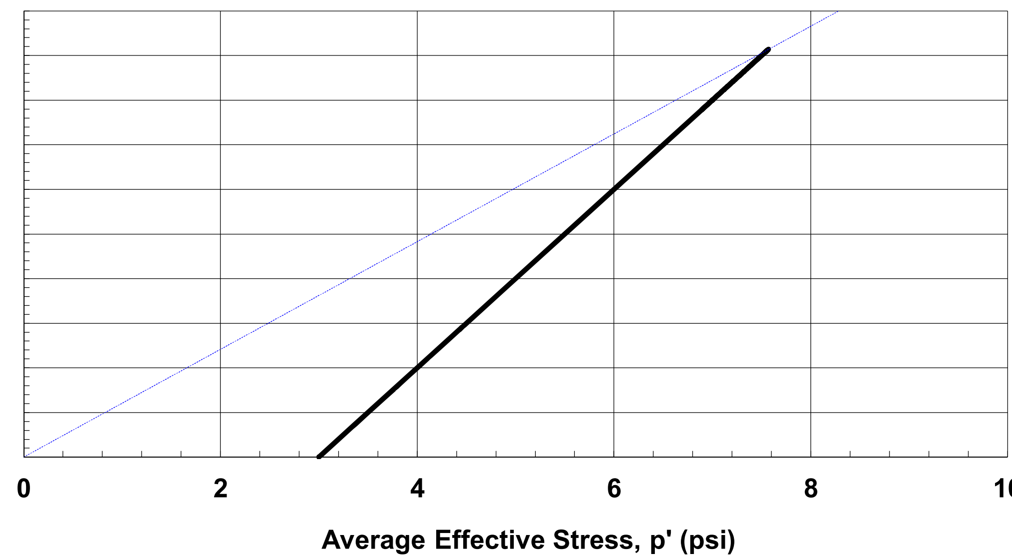
Consolidation Stresses: 3.00 psi vertical, 3.00 psi lateral
Water Content: 49.6 % Total Unit Weight: 103.3 pcf
B Coefficient: Strain Rate: 0.019 %/min
Peak Shear Strength: 4.57 psi @ 4.0 % Strain
Peak Effective Friction Angle: 37.1°



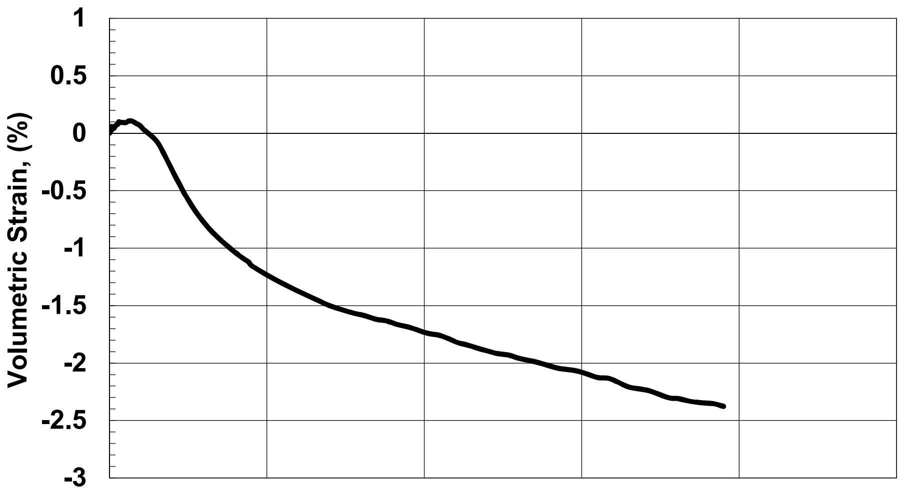
Failure
Sketch

REMARKS: Compression positive





Test by: D. Tso	Project No. T21562906	URS #21562906 Dynegy Vermillion 2013	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	
Checked by: G. Thomas	**TerraSense, LLC**		Boring:B-13-17 Sample: SS-2B Depth: 3.35ft	September-13



SAMPLE INFORMATION

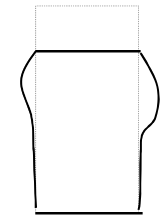
Boring: B-13-17 Sample: SS-2C Depth: 3.9 ft
Type: Intact tube sample
Description: FA, gray silt with sand (Fly-Ash)

SPECIMEN INFORMATION (Initial)

Height: 5.90 inch Diameter: 2.87 inch Area: 6.48 in²
Water Content: 36.6 % Total Unit Weight: 97.6 pcf

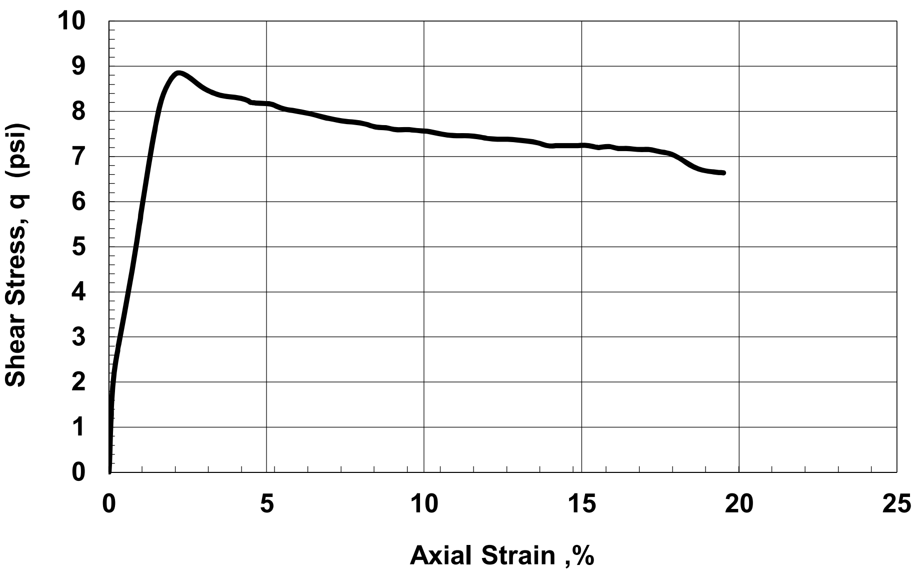
TEST SUMMARY

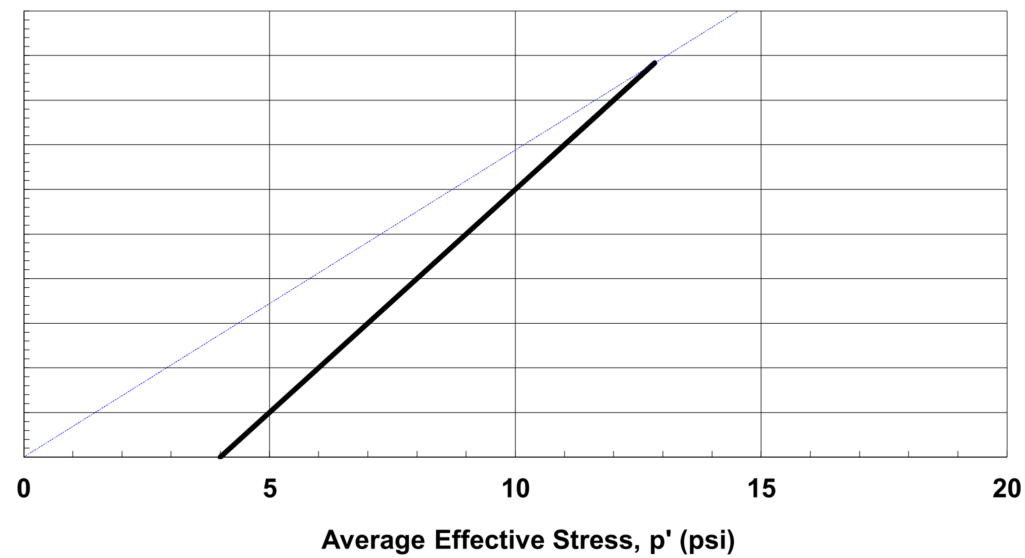
Consolidation Stresses: 4.00 psi vertical, 4.00 psi lateral
Water Content: 45.7 % Total Unit Weight: 106.5 pcf
B Coefficient: Strain Rate: 0.018 %/min
Peak Shear Strength: 8.83 psi @ 2.1 % Strain
Peak Effective Friction Angle: 43.5°



Failure Sketch

REMARKS: Compression positive



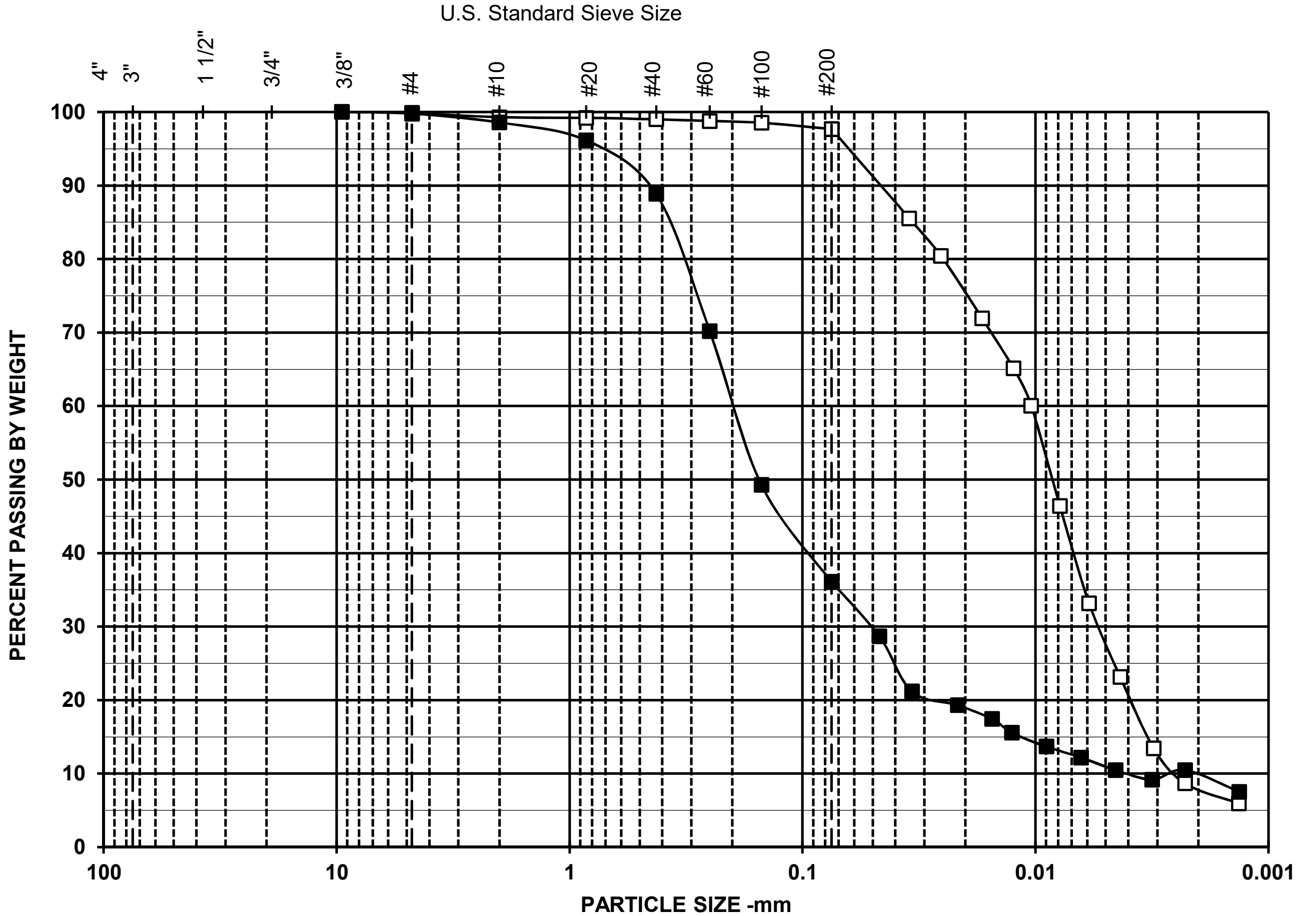


Test by: D. Tso

Checked by: G. Thomas

Project No. T21562906	URS #21562906 Dynegy Vermillion 2013	CONSOLIDATED DRAINED TRIAXIAL COMPRESSION	
TerraSense, LLC		Boring:B-13-17 Sample: SS-2C Depth: 3.9ft	September-13

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	B-13-1	B-13-2	
Sample	SS-6	SS-7	
Depth	15-16.5	20-21.5	
% +3"	0.0	0.0	
% Gravel	0.1	0.2	
% SAND	2.2	63.7	
%C SAND	0.6	1.2	
%M SAND	0.3	9.7	
%F SAND	1.3	52.8	
% FINES	97.7	36.1	
% -2μ	8	10	
D_{100} (mm)	9.50	9.50	
D_{60} (mm)	0.01	0.20	
D_{30} (mm)	0.01	0.05	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"	100.0	100.0	
4	99.9	99.8	
10	99.3	98.6	
20	99.2	96.2	
40	99.0	88.9	
60	98.8	70.2	
100	98.5	49.3	
200	97.7	36.1	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	38.8				CL	Gray, Lean clay	8/26/2013
■	17.8				SC	Gray, Clayey sand	8/26/2013
○							

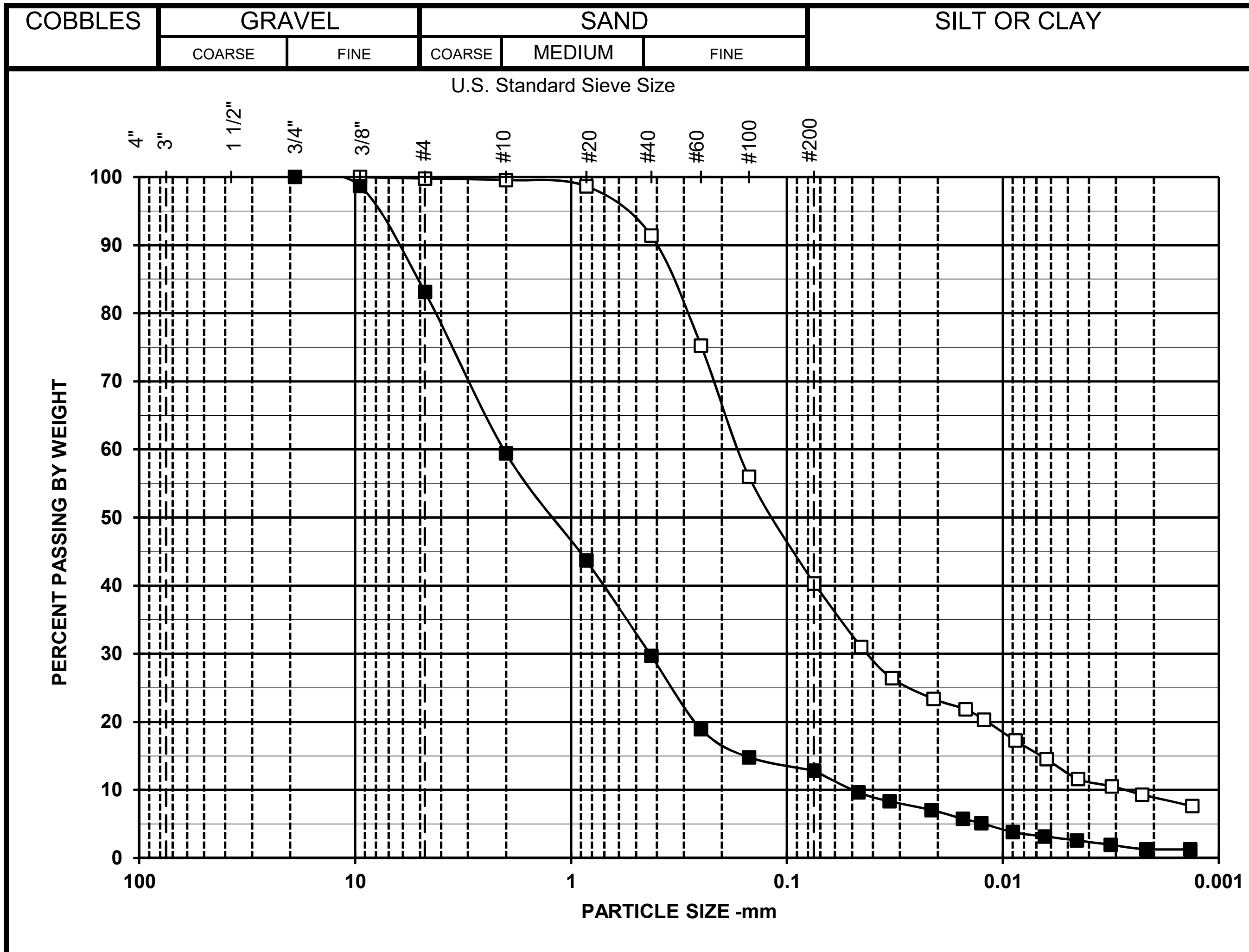
TerraSense, LLC	URS
T21562906	21562906

PARTICLE SIZE DISTRIBUTION

Dynegy Vermillion 2013

Analysis File: 3SV-MasterRev3

siev2a.xls 9/20/2013



Symbol	□	■	○
Boring	B-13-4	B-13-9	
Sample	SS-5	SS-14	
Depth	10-12	60-61.5	
% +3"	0.0	0.0	
% Gravel	0.2	16.9	
% SAND	59.5	70.3	
%C SAND	0.2	23.7	
%M SAND	8.2	29.7	
%F SAND	51.1	16.8	
% FINES	40.3	12.8	
% -2μ	9	1	
D_{100} (mm)	9.50	19.00	
D_{60} (mm)	0.17	2.07	
D_{30} (mm)	0.04	0.43	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"		100.0	
3/8"	100.0	98.7	
4	99.8	83.1	
10	99.6	59.4	
20	98.6	43.7	
40	91.4	29.7	
60	75.2	18.9	
100	56.0	14.8	
200	40.3	12.8	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	17.1				SC	Brown, Clayey sand	8/26/2013
■	10.1				SM	Brown, Silty sand with gravel	8/25/2013
○							

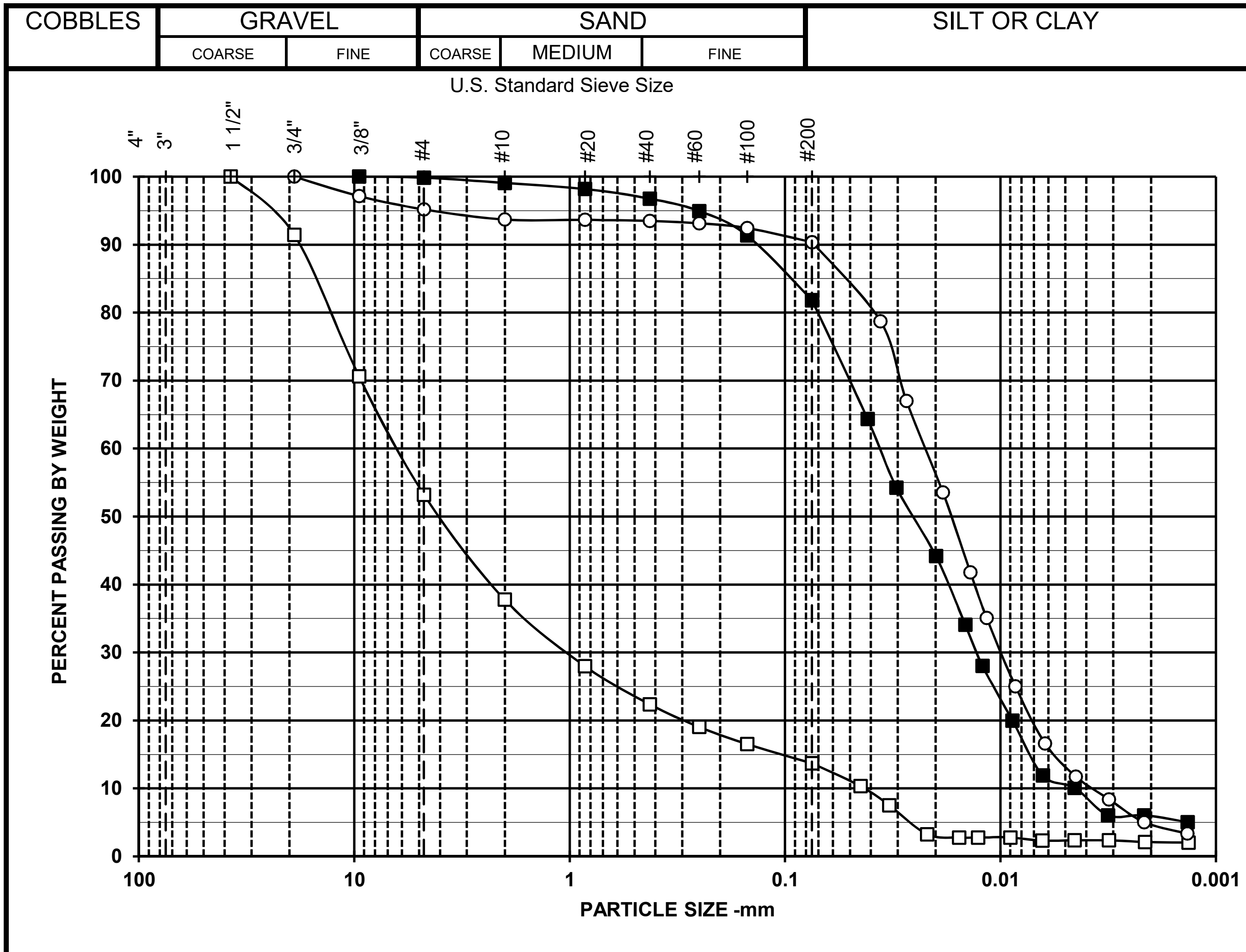
TerraSense, LLC	URS
T21562906	21562906

PARTICLE SIZE DISTRIBUTION

Dynegy Vermillion 2013

Analysis File: 3SV-MasterRev3

siev2b.xls 9/20/2013



Symbol	□	■	○
Boring	B-13-11	B-13-11	B-13-11
Sample	SS-6	SS-10	SS-13
Depth	15-16.5	35-36.5	50-51.5
% +3"	0.0	0.0	0.0
% Gravel	46.8	0.1	4.8
% SAND	39.5	18.1	4.8
%C SAND	15.5	0.8	1.5
%M SAND	15.4	2.3	0.2
%F SAND	8.7	14.9	3.1
% FINES	13.7	81.8	90.4
% -2μ	2	6	5
D_{100} (mm)	37.50	9.50	19.00
D_{60} (mm)	6.60	0.04	0.02
D_{30} (mm)	1.09	0.01	0.01
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"	100.0		
3/4"	91.4		100.0
3/8"	70.6	100.0	97.1
4	53.2	99.9	95.2
10	37.8	99.1	93.7
20	28.0	98.2	93.6
40	22.4	96.8	93.5
60	19.0	94.9	93.1
100	16.5	91.3	92.4
200	13.7	81.8	90.4

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	3.8				GM	Black, Silty gravel with sand	8/25/2013
■	53.3				MH	Gray, Elastic silt with sand	8/25/2013
○	33.6				CL	Black, Lean clay	8/25/2013

TerraSense, LLC	**URS**
T21562906	21562906

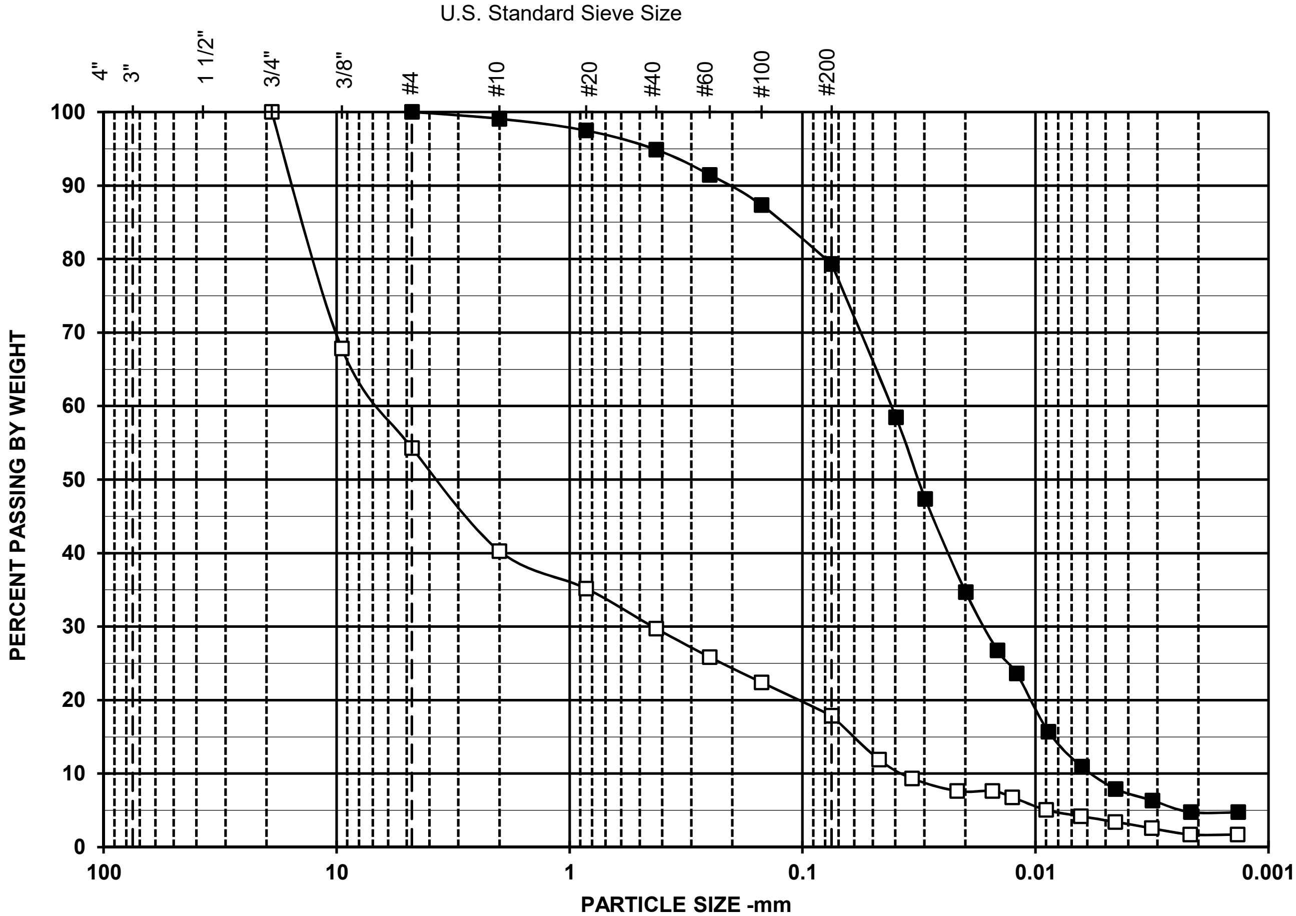
PARTICLE SIZE DISTRIBUTION

Dynegy Vermillion 2013

Analysis File: 3SV-MasterRev3

siev2c.xls 9/20/2013

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	B-13-12	B-13-13	
Sample	SS-5	SS-8	
Depth	10-11.5	25-26.5	
% +3"	0.0	0.0	
% Gravel	45.7	0.0	
% SAND	36.4	20.7	
%C SAND	14.0	0.9	
%M SAND	10.5	4.2	
%F SAND	11.8	15.5	
% FINES	17.9	79.3	
% -2μ	2	5	
D_{100} (mm)	19.00	4.75	
D_{60} (mm)	6.75	0.04	
D_{30} (mm)	0.45	0.02	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"	100.0		
3/8"	67.9		
4	54.3	100.0	
10	40.3	99.1	
20	35.2	97.5	
40	29.7	94.9	
60	25.8	91.5	
100	22.4	87.3	
200	17.9	79.3	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	6.7				GM	Black, Silty gravel with sand	8/25/2013
■	41.4				ML	Gray, Silt with sand	8/25/2013
○							

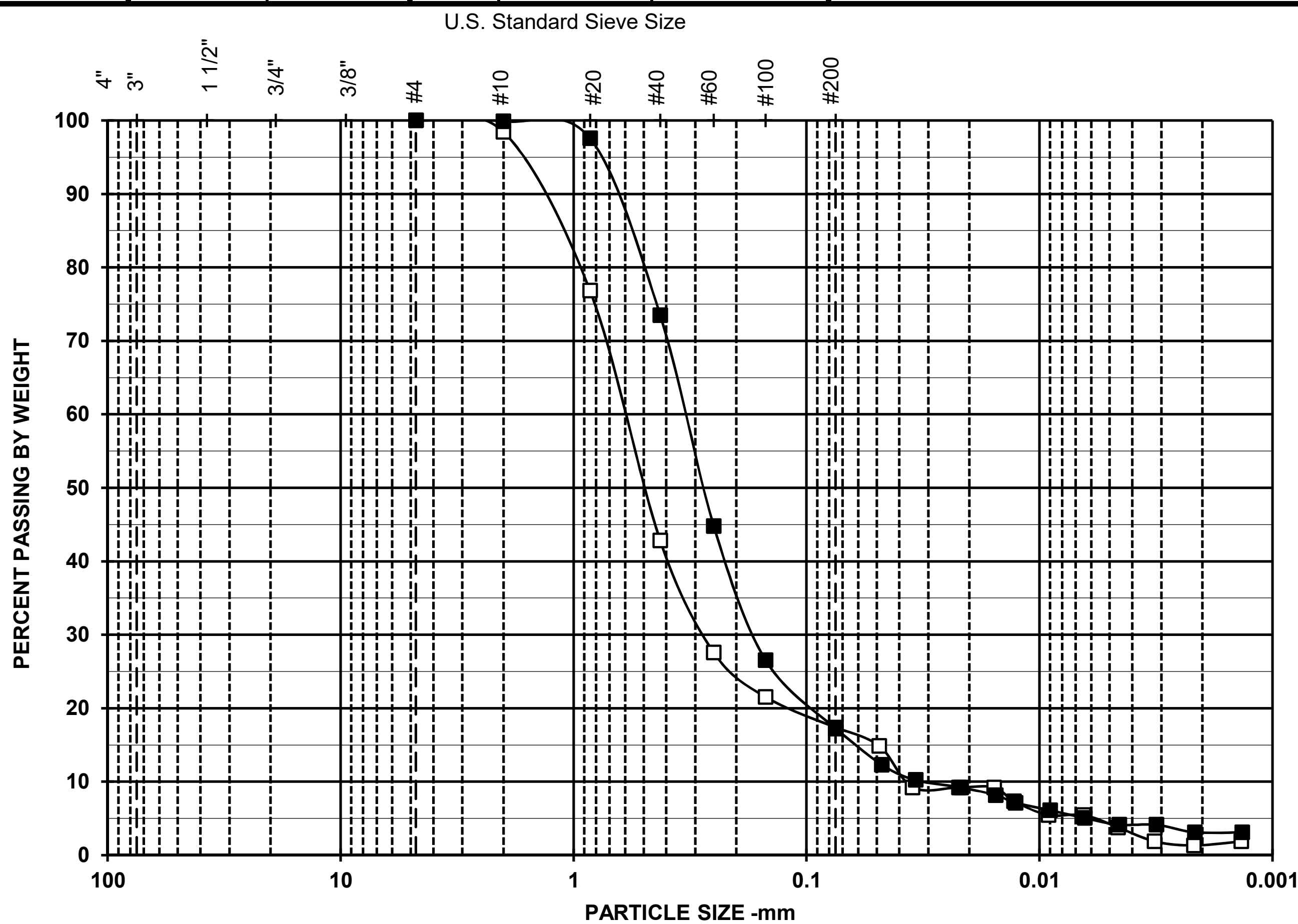
TerraSense, LLC	URS
T21562906	21562906

PARTICLE SIZE DISTRIBUTION
Dynegy Vermillion 2013

Analysis File: 3SV-MasterRev3

siev2d.xls 9/20/2013

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	B-13-16	B-13-17	
Sample	SS-16	SS-5	
Depth	60-61.5	10-11.5	
% +3"	0.0	0.0	
% Gravel	0.0	0.0	
% SAND	82.6	82.8	
%C SAND	1.6	0.1	
%M SAND	55.6	26.4	
%F SAND	25.5	56.3	
% FINES	17.4	17.2	
% -2μ	1	3	
D_{100} (mm)	4.75	4.75	
D_{60} (mm)	0.64	0.34	
D_{30} (mm)	0.28	0.17	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4	100.0	100.0	
10	98.4	99.9	
20	76.8	97.6	
40	42.8	73.5	
60	27.6	44.8	
100	21.5	26.6	
200	17.4	17.2	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	29.1				SM	Brown, Silty sand	8/28/2013
■	17.7				SM	Gray, Silty sand	8/25/2013
○							

TerraSense, LLC	**URS**
T21562906	21562906

PARTICLE SIZE DISTRIBUTION

Dynegy Vermillion 2013

Analysis File: 3SV-MasterRev3

siev2e.xls 9/20/2013

KELRON GEOTECHNICAL DATA

Table 6. Geotechnical Analysis Summary of Ash Pond Deposits
Hydrogeology and Groundwater Quality of the North Ash Pond System and Old East Ash Pond
Vermilion Power Station, Oakwood, Illinois

Geoprobe Location	Sample Depth BGS (feet)	USCS Soil Classification	Moisture Content (%)	Dry Bulk Density (pcf)	Hydraulic Conductivity (cm/sec)	Range of Hydraulic Gradient	Specific Gravity	Calculation from Soil-Mass Relationships Total Porosity (%)	Water Filled Porosity (%)	Air Filled Porosity (%)
North Ash Pond System										
VP-1	10 - 12	ASH - SILT with Sand (ML), Sand fine grained, very dark gray	41.0	73.3	1.7E-04	0.1 - 1.9	2.55	54.0	48.2	5.8
VP-2	5 - 7	ASH - SILT (ML), trace fine Sand, dark olive-brown	31.0	79.8	9.6E-05	0.1 - 2.8	2.68	52.3	39.6	12.7
		Average Value*	**36.0**	**76.6**	**1.3E-04**	**- -**	**2.62**	**53.2**	**43.9**	**9.3**
Old East Ash Pond										
VP-4	8 - 10	ASH - SILT (ML), trace fine sand, dark gray	42.4	70.2	6.2E-05	0.1 - 2.5	2.30	51.1	47.7	3.4
VP-4	18 - 20	ASH - SILT with Sand (ML), dark gray	31.1	81.8	1.3E-05	0.8 - 2.1	2.58	49.2	40.8	8.4
VP-5	13 - 15	ASH - Sandy SILT (ML), Sand fine grained, dark gray	29.2	71.1	4.8E-05	0.6 - 2.1	2.53	55.0	33.3	21.7
		Average Value*	**34.2**	**74.4**	**3.4E-05**	**- -**	**2.47**	**51.8**	**40.6**	**11.2**

Notes:
All geotechnical data obtained from Shively Geotechnical Report dated July 11, 2011 (Appendix X).
USCS Soil Classification based on both visual, and particle size analysis with sieve and hydrometer.
***** Hydraulic conductivity is calculated as geometric mean and not an average.
BGS below ground surface
cm/sec centimeters per second
pcf pounds per cubic foot
% percent

Shively Geotechnical
A Division of Environmental Operations, Inc.

July 11, 2011
Project No. 6451

Stuart Cravens
Kelron Environmental
1213 Dorchester Drive
Champaign, Illinois 61821

Subject: Geotechnical Laboratory Testing
HIR – North and Old East Ash Pond Systems
Vermilion Power Station
Oakwood, Illinois

Dear Mr. Cravens:

Please find the attached results of laboratory testing performed on samples provided to Shively Geotechnical, a Division of Environmental Operations. Samples were taken from the Vermilion Power Station project by others and were submitted to our laboratory for various testing. Assignments for the testing were initiated by Stuart Cravens of Kelron Environmental.

Testing was performed in accordance with the following American Society for Testing and Materials (ASTM) test procedures:

D 422	Particle-Size Analysis of Soils
D 854	Specific Gravity of Soils
D 2216	Water (Moisture) Content of Soil and Rock by Mass
D 2487	Classification of Soils (Unified Soil Classification System)
D 5084	Hydraulic Conductivity Using a Flexible Wall Permeameter
D 7263	Determination of Density (Unit Weight) of Soil Specimens

Porosity was calculated using soil-mass relationships. Tables are enclosed with test results, as well as the porosity calculation worksheets. Particle size analysis can be found on the enclosed Grain Size Distribution curves.

We appreciate the opportunity to be of service to Kelron Environmental and to Dynegy, Inc. Please let us know if you have any questions or if we can be of further assistance.

Sincerely,

Shively Geotechnical,
a Division of Environmental Operations, Inc.

Janet M. May

Janet M. May
Laboratory Services Manager

Attachments

SUMMARY OF LABORATORY TEST RESULTS

VERMILION POWER STATION
HIR - NORTH AND OLD EAST ASH POND SYSTEMS
OAKWOOD, ILLINOIS

Boring Number	Sample Depth (Feet)	Moisture Content, %	USCS Classification
VP-1	10.0-12.0	41.0	ASH - SILT with Sand (ML) - Sand Fine Grained, Very Dark Gray
VP-1	24.0-25.0	15.3	SAND with Silt (SM) - Fine Grained, Olive-Brown
VP-2	5.0-7.0	31.0	ASH - SILT (ML) - Trace Fine Sand, Dark Olive-Brown
VP-2	29.0-30.0	19.3	Silty SAND (SM) - Fine Grained, Dark Olive-Brown
VP-2	45.0-46.0	12.6	Sandy Lean CLAY (CL) - Trace Gravel, Very Dark Gray-Brown
VP-3	34.5-35.0	32.4	Lean to Fat CLAY (CL/CH) - Medium to High Plasticity, Very Dark Gray
VP-4	8.0-10.0	42.4	ASH – SILT (ML) - Trace Fine Sand, Dark Gray
VP-4	18.0-20.0	31.1	ASH – SILT with Sand (ML) - Dark Gray
VP-4	44.0-45.0	22.6	Lean to Fat CLAY (CL/CH) - Trace Fine Sand, Medium to High Plasticity, Very Dark Gray-Brown
VP-4	48.0-48.5	25.8	Lean to Fat CLAY (CL/CH) - Medium to High Plasticity, Gray-Brown
VP-4	50.0-50.5	11.9	SAND with Gravel (SP) - Sand Medium to Coarse Grained, Dark Gray-Brown
VP-4	52.5-53.0	13.5	SAND with Silt (SP-SM) - Fine Grained, Dark Gray
VP-4	59.0-60.0	8.1	Clayey SAND (SC) - Fine to Medium Grained, Trace Gravel, Dark Gray
VP-5	13.0-15.0	29.2	ASH – Sandy SILT (ML) - Sand Fine Grained, Dark Gray

USCS – Unified Soil Classification System

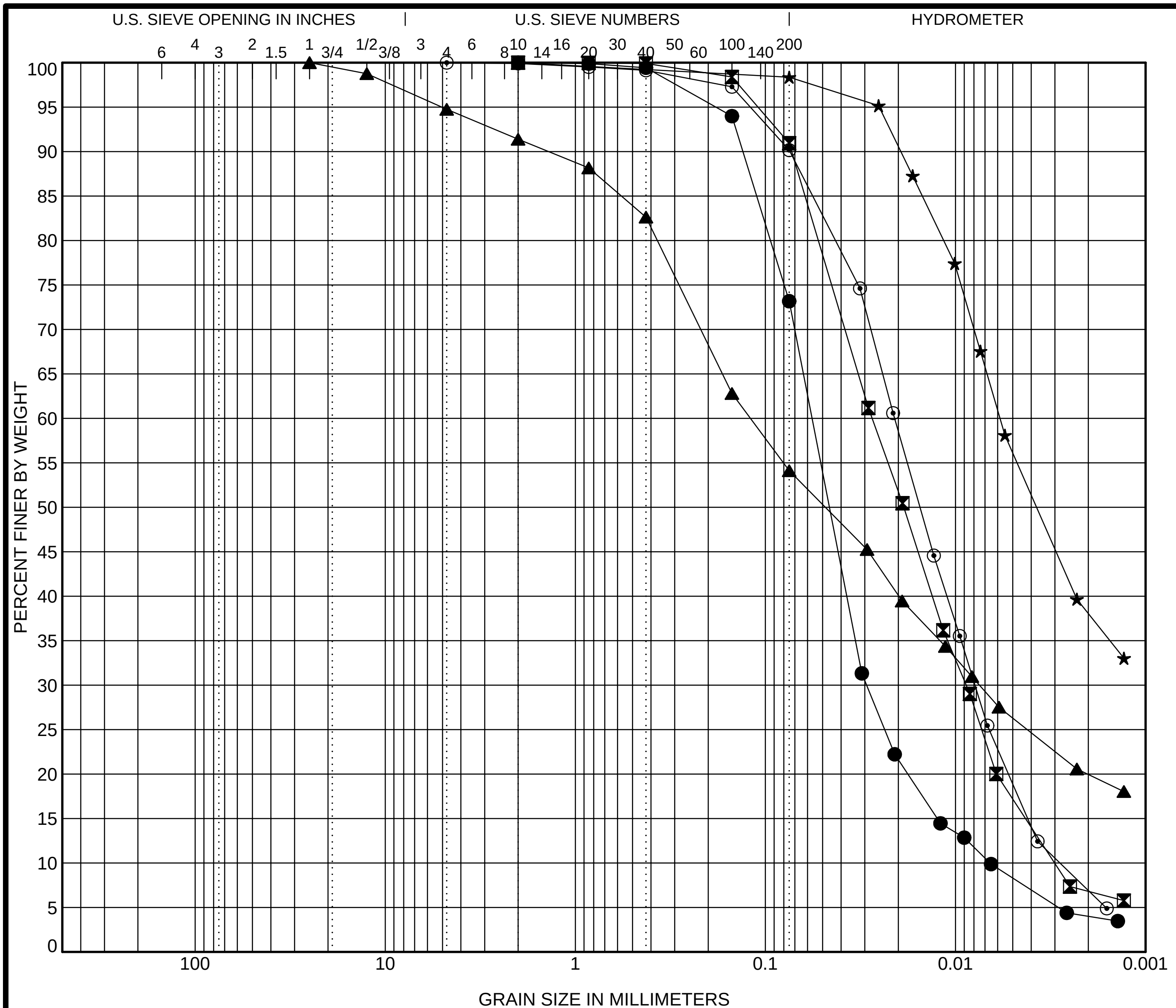
SUMMARY OF LABORATORY TEST RESULTS

VERMILION POWER STATION
HIR - NORTH AND OLD EAST ASH POND SYSTEMS
OAKWOOD, ILLINOIS
(Continued)

		ASTM D 2216	ASTM D 6023	ASTM D 5084	
Boring Number	Sample Depth (Feet)	Moisture Content, %	Dry Bulk Density, (pcf)	Hydraulic Conductivity, cm/sec	Range of Hydraulic Gradient
VP-1	10.0-12.0	41.0	73.3	1.7×10^{-4}	0.1-1.9
VP-2	5.0-7.0	31.0	79.8	9.6×10^{-5}	0.1-2.8
VP-4	8.0-10.0	42.4	70.2	6.2×10^{-5}	0.1-2.5
VP-4	18.0-20.0	31.1	81.8	1.3×10^{-5}	0.8-2.1
VP-5	13.0-15.0	29.2	71.1	4.8×10^{-5}	0.6-2.1

		ASTM D 854	Calculation from Soil-Mass Relationships		
Boring Number	Sample Depth (Feet)	Specific Gravity	Total Porosity, (%)	Water Filled Porosity, (%)	Air Filled Porosity, (%)
VP-1	10.0-12.0	2.55	54.0	48.2	5.8
VP-2	5.0-7.0	2.68	52.3	39.6	12.7
VP-4	8.0-10.0	2.30	51.1	47.7	3.4
VP-4	18.0-20.0	2.58	49.2	40.8	8.4
VP-5	13.0-15.0	2.53	55.0	33.3	21.7

% - Percent
cm/sec - Centimeters per Second
pcf - Pounds per Cubic Foot



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**VP-1**	**10.0-12.0 Feet**	**SILT, with Sand (ML)**				**2.30**	**8.63**
⧗	**VP-2**	**5.0-7.0 Feet**	**SILT (ML)**				**0.93**	**9.11**
▲	**VP-2**	**45.0-46.0 Feet**	**Sandy Lean CLAY (CL)**					
★	**VP-3**	**34.5-35.0 Feet**	**Lean to Fat CLAY (CL/CH)**					
⊙	**VP-4**	**8.0-10.0 Feet**	**SILT (ML)**				**1.06**	**7.41**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**VP-1**	**10.0-12.0 Feet**	**2**	**0.057**	**0.029**	**0.007**	**0.0**	**26.8**	**64.9**	**8.3**
⧗	**VP-2**	**5.0-7.0 Feet**	**2**	**0.027**	**0.009**	**0.003**	**0.0**	**9.1**	**73.8**	**17.2**
▲	**VP-2**	**45.0-46.0 Feet**	**25**	**0.12**	**0.007**		**5.2**	**40.6**	**27.8**	**26.3**
★	**VP-3**	**34.5-35.0 Feet**	**2**	**0.006**			**0.0**	**1.6**	**42.3**	**56.1**
⊙	**VP-4**	**8.0-10.0 Feet**	**4.75**	**0.021**	**0.008**	**0.003**	**0.0**	**9.8**	**71.3**	**18.9**

Shively Geotechnical
A Division of Environmental Operations, Inc.

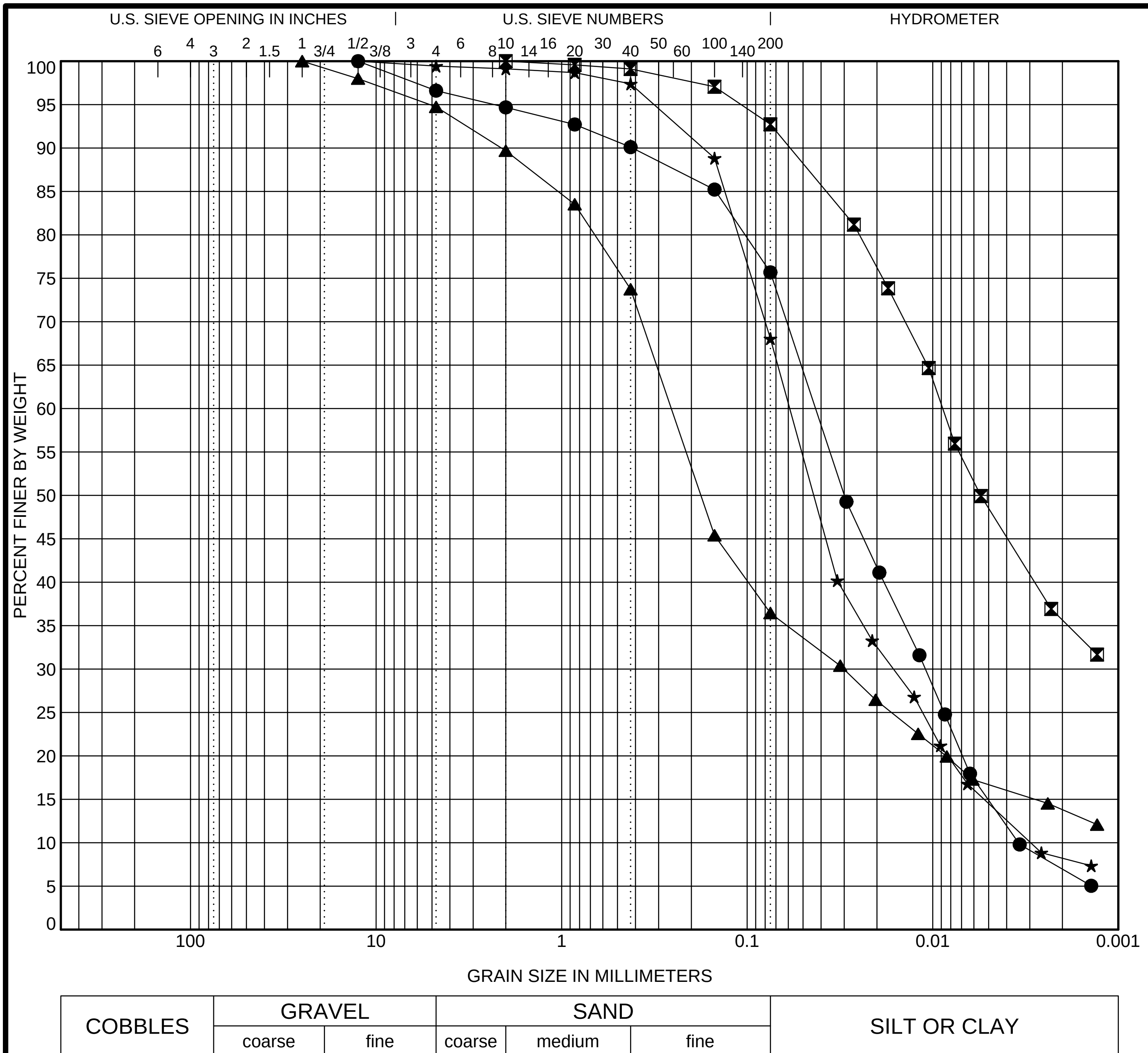
Missouri (314) 241-0900
Illinois (618) 398-1414

GRAIN SIZE DISTRIBUTION

Project Number: 6451

Project: HIR - North and Old East Ash Pond Systems

Location: Oakwood, Illinois



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**VP-4**	**18.0-20.0 Feet**	**SILT, with Sand (ML)**				**0.81**	**12.41**
⧗	**VP-4**	**44.0-45.0 Feet**	**Lean to Fat CLAY (CL/CH)**					
▲	**VP-4**	**59.0-60.0 Feet**	**Clayey SAND (SC)**					
★	**VP-5**	**13.0-15.0 Feet**	**Sandy SILT (ML)**				**1.52**	**19.87**

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**VP-4**	**18.0-20.0 Feet**	**12.5**	**0.043**	**0.011**	**0.003**	**3.4**	**20.9**	**60.8**	**14.9**
⧗	**VP-4**	**44.0-45.0 Feet**	**2**	**0.009**			**0.0**	**7.3**	**44.2**	**48.5**
▲	**VP-4**	**59.0-60.0 Feet**	**25**	**0.257**	**0.03**		**5.3**	**58.3**	**19.8**	**16.7**
★	**VP-5**	**13.0-15.0 Feet**	**12.5**	**0.059**	**0.016**	**0.003**	**0.6**	**31.4**	**53.5**	**14.5**

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GRAIN SIZE DISTRIBUTION

Project Number: 6451

Project: HIR - North and Old East Ash Pond Systems

Location: Oakwood, Illinois

HYDRAULIC CONDUCTIVITY TEST DATA
(ASTM D 5084)

JOB NO.:	6451			WET UNIT WEIGHT, pcf:	103.3		
SAMPLE ID:	ST-VP-1			**DRY UNIT WEIGHT, pcf:**	**73.3**		
DEPTH:	10.0-12.0						
SPECIMEN:							
				INITIAL MOISTURE CONTENT		FINAL MOISTURE CONTENT	
LENGTH, in.:	3.937	LENGTH, cm:	10.000	WET WT SPLE+TARE	421.02	WET WT SPLE+TARE	417.49
DIAMETER, in.:	1.870	DIAMETER, cm	4.750	DRY WT SPLE+TARE	335.70	DRY WT SPLE+TARE	335.70
WET WT., gms.:	293.34			TARE WEIGHT	127.68	TARE WEIGHT	127.68
AREA, sq.in.:	2.746	AREA, sq cm:	17.719	**% MOISTURE**	41.0	% MOISTURE	39.3

B VALUE (before Permeation): 96% Cell / Back Pressure, psi: 53 / 50

HEAD (PSI)	DATE (YR,MO,DY)	TIME (HR,MN,SC)	TEMP ºC	ELAPSED MINUTES	BOTTOM BURETTE	TOP BURETTE	Q (CC)	K CM/SEC	HYDRAULIC GRADIENT	HYDRAULIC HEAD
0.0	28-Jun-11	08:42 AM	24.1	0	4.57	23.69			1.91	19.12
0.0	28-Jun-11	08:52 AM	24.1	10	7.66	20.56	3.09	1.9E-04	1.29	12.90
0.0	28-Jun-11	09:53 AM	23.7	61	13.49	14.76	5.83	1.9E-04	0.13	1.27
0.0	28-Jun-11	12:12 PM	24.2	0	6.70	24.15			1.75	17.45
0.0	28-Jun-11	12:54 PM	24.1	42	13.63	17.17	6.93	1.9E-04	0.35	3.54
0.0	28-Jun-11	01:26 PM	24.4	32	14.90	15.93	1.27	1.9E-04	0.10	1.03
0.0	28-Jun-11	01:27 PM	24.4	0	8.86	23.83			1.50	14.97
0.0	28-Jun-11	01:47 PM	24.4	20	12.58	19.61	3.72	1.9E-04	0.70	7.03
0.0	28-Jun-11	02:26 PM	24.5	39	15.29	16.91	2.71	1.9E-04	0.16	1.62
0.0	29-Jun-11	08:00 AM	24.1	0	9.98	24.51			1.45	14.53
0.0	29-Jun-11	08:53 AM	24.4	53	16.33	18.15	6.35	1.9E-04	0.18	1.82

Average Temp. = 24.2

AVERAGE K = 1.9E-04
Corrected K for 20ºC = 1.7E-04

Shively Geotechnical,
a Division of Environmental Operations, Inc.

HYDRAULIC CONDUCTIVITY TEST DATA
(ASTM D 5084)

JOB NO.:	6451			WET UNIT WEIGHT, pcf:	104.5		
SAMPLE ID:	ST-VP-2			**DRY UNIT WEIGHT, pcf:**	**79.8**		
DEPTH:	5.0-7.0						
SPECIMEN:							
				INITIAL MOISTURE CONTENT		FINAL MOISTURE CONTENT	
LENGTH, in.:	2.630	LENGTH, cm:	6.680	WET WT SPLE+TARE	326.63	WET WT SPLE+TARE	333.02
DIAMETER, in.:	1.859	DIAMETER, cm	4.722	DRY WT SPLE+TARE	280.27	DRY WT SPLE+TARE	280.27
WET WT., gms.:	195.87			TARE WEIGHT	130.76	TARE WEIGHT	130.76
AREA, sq.in.:	2.714	AREA, sq cm:	17.511	**% MOISTURE**	31.0	% MOISTURE	35.3

B VALUE (before Permeation): 96%   Cell / Back Pressure, psi: 53 / 50

HEAD (PSI)	DATE (YR,MO,DY)	TIME (HR,MN,SC)	TEMP ºC	ELAPSED MINUTES	BOTTOM BURETTE	TOP BURETTE	Q (CC)	K CM/SEC	HYDRAULIC GRADIENT	HYDRAULIC HEAD
0.0	28-Jun-11	01:01 PM	23.8	0	5.73	24.44			2.80	18.71
0.0	28-Jun-11	01:22 PM	24.1	21	10.27	19.44	4.54	1.1E-04	1.37	9.17
0.0	28-Jun-11	01:48 PM	24.5	26	12.90	16.84	2.63	1.1E-04	0.59	3.94
0.0	28-Jun-11	02:34 PM	23.9	46	14.43	15.34	1.53	1.1E-04	0.14	0.91
0.0	28-Jun-11	07:56 AM	24.6	0	7.42	24.04			2.49	16.62
0.0	28-Jun-11	08:53 AM	24.5	57	14.36	17.12	6.94	1.1E-04	0.41	2.76

Average Temp. = 24.3

AVERAGE K = 1.1E-04
Corrected K for 20ºC = 9.6E-05

HYDRAULIC CONDUCTIVITY TEST DATA
(ASTM D 5084)

JOB NO.:	6451			WET UNIT WEIGHT, pcf:	100.0		
SAMPLE ID:	ST-VP-4			**DRY UNIT WEIGHT, pcf:**	**70.2**		
DEPTH:	8.0-10.0						
SPECIMEN:							
				INITIAL MOISTURE CONTENT		FINAL MOISTURE CONTENT	
LENGTH, in.:	3.464	LENGTH, cm:	8.799	WET WT SPLE+TARE	363.58	WET WT SPLE+TARE	366.87
DIAMETER, in.:	1.869	DIAMETER, cm	4.747	DRY WT SPLE+TARE	289.31	DRY WT SPLE+TARE	289.31
WET WT., gms.:	249.39			TARE WEIGHT	114.19	TARE WEIGHT	114.19
AREA, sq.in.:	2.744	AREA, sq cm:	17.700	**% MOISTURE**	42.4	% MOISTURE	44.3

B VALUE (before Permeation): 97%   Cell / Back Pressure, psi: 53 / 50

HEAD (PSI)	DATE (YR,MO,DY)	TIME (HR,MN,SC)	TEMP ºC	ELAPSED MINUTES	BOTTOM BURETTE	TOP BURETTE	Q (CC)	K CM/SEC	HYDRAULIC GRADIENT	HYDRAULIC HEAD
0.0	30-Jun-11	11:01 AM	23.5	0	2.16	23.93			2.47	21.77
0.0	30-Jun-11	11:10 AM	23.5	9	3.63	22.35	1.47	7.3E-05	2.13	18.72
0.0	30-Jun-11	11:46 AM	23.9	36	7.49	18.50	3.86	6.4E-05	1.25	11.01
0.0	30-Jun-11	01:45 PM	24.1	119	12.03	13.89	4.54	6.5E-05	0.21	1.86
0.0	30-Jun-11	02:34 PM	24.1	49	12.52	13.37	0.49	7.0E-05	0.10	0.85

Average Temp. = 23.9

AVERAGE K = 6.8E-05
Corrected K for 20ºC = 6.2E-05

HYDRAULIC CONDUCTIVITY TEST DATA
(ASTM D 5084)

JOB NO.:	6451			WET UNIT WEIGHT, pcf:	107.3		
SAMPLE ID:	ST-VP-4			**DRY UNIT WEIGHT, pcf:**	**81.8**		
DEPTH:	18.0-20.0						
SPECIMEN:							
				INITIAL MOISTURE CONTENT		FINAL MOISTURE CONTENT	
LENGTH, in.:	3.486	LENGTH, cm:	8.854	WET WT SPLE+TARE	383.76	WET WT SPLE+TARE	385.59
DIAMETER, in.:	1.868	DIAMETER, cm	4.745	DRY WT SPLE+TARE	319.91	DRY WT SPLE+TARE	319.91
WET WT., gms.:	269.05			TARE WEIGHT	114.71	TARE WEIGHT	114.71
AREA, sq.in.:	2.741	AREA, sq cm:	17.681	**% MOISTURE**	31.1	% MOISTURE	32.0

B VALUE (before Permeation): 96%   Cell / Back Pressure, psi: 53 / 50

HEAD (PSI)	DATE (YR,MO,DY)	TIME (HR,MN,SC)	TEMP ºC	ELAPSED MINUTES	BOTTOM BURETTE	TOP BURETTE	Q (CC)	K CM/SEC	HYDRAULIC GRADIENT	HYDRAULIC HEAD
0.0	30-Jun-11	11:10 AM	23.8	0	6.20	24.50			2.07	18.30
0.0	30-Jun-11	11:46 AM	24.1	36	7.19	23.33	0.99	1.5E-05	1.82	16.14
0.0	30-Jun-11	01:45 PM	24.0	119	9.79	20.77	2.60	1.4E-05	1.24	10.98
0.0	30-Jun-11	02:34 PM	23.5	49	10.57	19.98	0.78	1.4E-05	1.06	9.41
0.0	30-Jun-11	04:06 PM	23.5	92	11.78	18.77	1.21	1.4E-05	0.79	6.99

Average Temp. = 23.8

AVERAGE K = 1.4E-05
Corrected K for 20ºC = 1.3E-05

HYDRAULIC CONDUCTIVITY TEST DATA
(ASTM D 5084)

JOB NO.:	6451			WET UNIT WEIGHT, pcf:	91.9				
SAMPLE ID:	ST-VP-5			**DRY UNIT WEIGHT, pcf:**	**71.1**				
DEPTH:	13.0-15.0								
SPECIMEN:									
				INITIAL MOISTURE CONTENT		FINAL MOISTURE CONTENT			
LENGTH, in.:	3.024	LENGTH, cm:	7.681	WET WT SPLE+TARE	330.70	WET WT SPLE+TARE	352.73		
DIAMETER, in.:	1.874	DIAMETER, cm	4.760	DRY WT SPLE+TARE	285.18	DRY WT SPLE+TARE	285.18		
WET WT., gms.:	201.28			TARE WEIGHT	129.42	TARE WEIGHT	129.42		
AREA, sq.in.:	2.758	AREA, sq cm:	17.795	**% MOISTURE**	29.2	% MOISTURE	43.4		

B VALUE (before Permeation): 96%   Cell / Back Pressure, psi: 53 / 50

HEAD (PSI)	DATE (YR,MO,DY)	TIME (HR,MN,SC)	TEMP ºC	ELAPSED MINUTES	BOTTOM BURETTE	TOP BURETTE	Q (CC)	K CM/SEC	HYDRAULIC GRADIENT	HYDRAULIC HEAD
0.0	28-Jun-11	01:01 PM	23.7	0	8.10	24.40			2.12	16.30
0.0	28-Jun-11	01:22 PM	24.1	21	10.40	22.18	2.30	5.8E-05	1.53	11.78
0.0	28-Jun-11	01:48 PM	24.4	26	12.23	20.33	1.83	5.4E-05	1.05	8.10
0.0	28-Jun-11	02:34 PM	23.7	46	14.11	18.50	1.88	5.0E-05	0.57	4.39
0.0	28-Jun-11	07:56 AM	24.2	0	9.52	23.90			1.87	14.38
0.0	28-Jun-11	08:53 AM	24.2	57	13.43	19.95	3.91	5.2E-05	0.85	6.52

Average Temp. = 24.1

AVERAGE K = 5.2E-05

Corrected K for 20ºC = 4.8E-05

Shively Geotechnical,
a Division of Environmental Operations, Inc.

Va = Volume of air
Vw = Volume of water
Vv = Volume of voids
Vd - Volume of dry soil
V = Total volume
Ma = Mass of air (=0)
Mw = Mass of water
Md = Mass of dry soil
M = Total mass

	Volume		Mass
Volume of Voids	Va	AIR	Ma=0
	Vw	WATER	Mw
	Vd	SOIL	Md
	V	Total	M

Project No.:	6451	
Sample ID:	ST-VP-1	
Depth (Feet):	10.0 - 12.0	
Height	3.937	(in)
Diameter	1.870	(in)
Weight	293.34	(g)
Volume	177.19	(cc)
Bulk Density, Wet	1.656	(g/cc)
Bulk Density, Dry - ASTM D 2937	**1.174**	**(g/cc)**
Wet + Tare	421.02	(gms)
Dry + Tare	335.70	(gms)
Tare	127.68	(gms)
Water Content - ASTM D 2216	**41.0**	**(%)**
Gravimetric Water Content	**0.410**	**(g/g)**
Volumetric Water Content	**0.482**	**(cc/cc)**

Volume of Voids	Volume (cc)		Mass (gms)
95.61	10.29	AIR	0.00
	85.32	WATER	85.32
	81.58	SOIL	208.02
	177.19	Total	293.34

Specific Gravity - ASTM D 854 = 2.55 (g/cc)

Total Porosity (n) = Vv/V = 0.540 (cc/cc)

Water Filled Porosity (n) = Vw/V = 0.482 (cc/cc)

Air Filled Porosity (n) = Va/V = 0.058 (cc/cc)

Project No.:	6451	
Sample ID:	ST-VP-2	
Depth (Feet):	5.0 - 7.0	
Height	2.630	(in)
Diameter	1.859	(in)
Weight	195.87	(g)
Volume	116.98	(cc)
Bulk Density, Wet	1.674	(g/cc)
Bulk Density, Dry - ASTM D 2937	**1.278**	**(g/cc)**
Wet + Tare	326.63	(gms)
Dry + Tare	280.27	(gms)
Tare	130.76	(gms)
Water Content - ASTM D 2216	**31.0**	**(%)**
Gravimetric Water Content	**0.310**	**(g/g)**
Volumetric Water Content	**0.396**	**(cc/cc)**

Volume of Voids	Volume (cc)		Mass (gms)
61.19	14.83	AIR	0.00
	46.36	WATER	46.36
	55.79	SOIL	149.51
	116.98	Total	195.87

Specific Gravity - ASTM D 854 = 2.68 (g/cc)

Total Porosity (n) = Vv/V = 0.523 (cc/cc)

Water Filled Porosity (n) = Vw/V = 0.396 (cc/cc)

Air Filled Porosity (n) = Va/V = 0.127 (cc/cc)

NOTE: Values not representative of effective porosity.

Va = Volume of air
Vw = Volume of water
Vv = Volume of voids
Vd - Volume of dry soil
V = Total volume
Ma = Mass of air (=0)
Mw = Mass of water
Md = Mass of dry soil
M = Total mass

	Volume		Mass
Volume of Voids	Va	AIR	Ma=0
	Vw	WATER	Mw
	Vd	SOIL	Md
	V	Total	M

			Volume (cc)		Mass (gms)
Project No.:	6451				
Sample ID:	ST-VP-4				
Depth (Feet):	8.0 - 10.0		5.33	AIR	0.00
		79.60			
Height	3.464 (in)		74.27	WATER	74.27
Diameter	1.869 (in)				
Weight	249.39 (g)		76.14	SOIL	175.12
Volume	155.74 (cc)				
			155.74	Total	249.39
Bulk Density, Wet	1.601 (g/cc)				
Bulk Density, Dry - ASTM D 2937	**1.124 (g/cc)**				
Wet + Tare	363.58 (gms)				
Dry + Tare	289.31 (gms)				
Tare	114.19 (gms)				
Water Content - ASTM D 2216	**42.4 (%)**				
Gravimetric Water Content	**0.424 (g/g)**				
Volumetric Water Content	**0.477 (cc/cc)**				

Specific Gravity - ASTM D 854 = 2.30 (g/cc)

Total Porosity (n) = Vv/V = 0.511 (cc/cc)

Water Filled Porosity (n) = Vw/V = 0.477 (cc/cc)

Air Filled Porosity (n) = Va/V = 0.034 (cc/cc)

			Volume (cc)		Mass (gms)
Project No.:	6451				
Sample ID:	ST-VP-4				
Depth (Feet):	18.0 - 20.0		13.17	AIR	0.00
		77.02			
Height	3.486 (in)		63.85	WATER	63.85
Diameter	1.868 (in)				
Weight	269.05 (g)		79.53	SOIL	205.20
Volume	156.56 (cc)				
			156.56	Total	269.05
Bulk Density, Wet	1.719 (g/cc)				
Bulk Density, Dry - ASTM D 2937	**1.311 (g/cc)**				
Wet + Tare	383.76 (gms)				
Dry + Tare	319.91 (gms)				
Tare	114.71 (gms)				
Water Content - ASTM D 2216	**31.1 (%)**				
Gravimetric Water Content	**0.311 (g/g)**				
Volumetric Water Content	**0.408 (cc/cc)**				

Specific Gravity - ASTM D 854 = 2.58 (g/cc)

Total Porosity (n) = Vv/V = 0.492 (cc/cc)

Water Filled Porosity (n) = Vw/V = 0.408 (cc/cc)

Air Filled Porosity (n) = Va/V = 0.084 (cc/cc)

NOTE: Values not representative of effective porosity.

07/06/11 POROSITY CALCULATION WORKSHEET 6451

Va = Volume of air
Vw = Volume of water
Vv = Volume of voids
Vd - Volume of dry soil
V = Total volume
Ma = Mass of air (=0)
Mw = Mass of water
Md = Mass of dry soil
M = Total mass

	Volume		Mass
Volume of Voids	Va	AIR	Ma=0
	Vw	WATER	Mw
	Vd	SOIL	Md
	V	Total	M

Project No.:	6451	
Sample ID:	ST-VP-5	
Depth (Feet):	13.0 - 15.0	
Height	3.024	(in)
Diameter	1.874	(in)
Weight	201.28	(g)
Volume	136.68	(cc)
Bulk Density, Wet	1.473	(g/cc)
Bulk Density, Dry - ASTM D 2937	**1.140**	**(g/cc)**
Wet + Tare	330.70	(gms)
Dry + Tare	285.18	(gms)
Tare	129.42	(gms)
Water Content - ASTM D 2216	**29.2**	**(%)**
Gravimetric Water Content	**0.292**	**(g/g)**
Volumetric Water Content	**0.333**	**(cc/cc)**

	Volume (cc)		Mass (gms)
	29.60	AIR	0.00
75.12	45.52	WATER	45.52
	61.57	SOIL	155.76
	136.68	Total	201.28

Specific Gravity - ASTM D 854 = 2.53 (g/cc)

Total Porosity (n) = Vv/V = 0.550 (cc/cc)

Water Filled Porosity (n) = Vw/V = 0.333 (cc/cc)

Air Filled Porosity (n) = Va/V = 0.217 (cc/cc)

NOTE: Values not representative of effective porosity.

6451

SOIL/SEDIMENT/SLUDGE SAMPLING DATA

Serial No. SSSSD

Project Name HIR – North and Old East Ash Pond Systems Project No. 46115 / 46116

Project Manager Stuart Cravens, Kelron Environmental Phase.Task No.

Client Company Dynegy, Inc.

Site Name Vermilion Power Station

Site Address

Sampling Method
- ☒ Shelby Tube (ST)
- ☐ Split Spoon (SS)
- ☒ Macrocore (MC)
- ☐ Other

Reason For Collection
- ☐ Lab Analysis
- ☐ On-Site Headspace
- ☐ Geotechnical Lab
- ☐ Other

Portable Screening Instrument Used ☒ None

Type	Manufacturer	Model
☐ PID (Lamp____eV)		
☐ FID		
☐ CGI		

Sample No.	Location	Date Collected	Sample Type ST	SS	MC	Requested Analysis 1	Requested Analysis 2	Requested Analysis 3
VP2 (5-7)		6-21-11	X			X		
VP1 (10-12)		6-21-11	X			X		
VP4 (8-10)		6-22-11	X			X		
VP4 (18-20)		6-22-11	X			X		
VP5 (13-15)		6-23-11	X			X		
VP1 (24-25')	~~[illegible]~~	6-21-11			X		X	~~[illegible]~~
VP2 (29-30')		6-21-11			X		X	
VP2 (45-46')		6-21-11			X		X	X (S/H)
VP4 (44-45')		6-22-11			X		X	X (S/H)
VP4 (48-48.5)		6-22-11			X		X	
VP4 (50-50.5)		6-22-11			X		X	
VP4 (52.5-53)		6-22-11			X		X	
VP4 (59-60')		6-22-11			X		X	X (S/H)
VP3 (34.5-35')		~~[illegible]~~ 6-21-11			X		X	X (S/H)

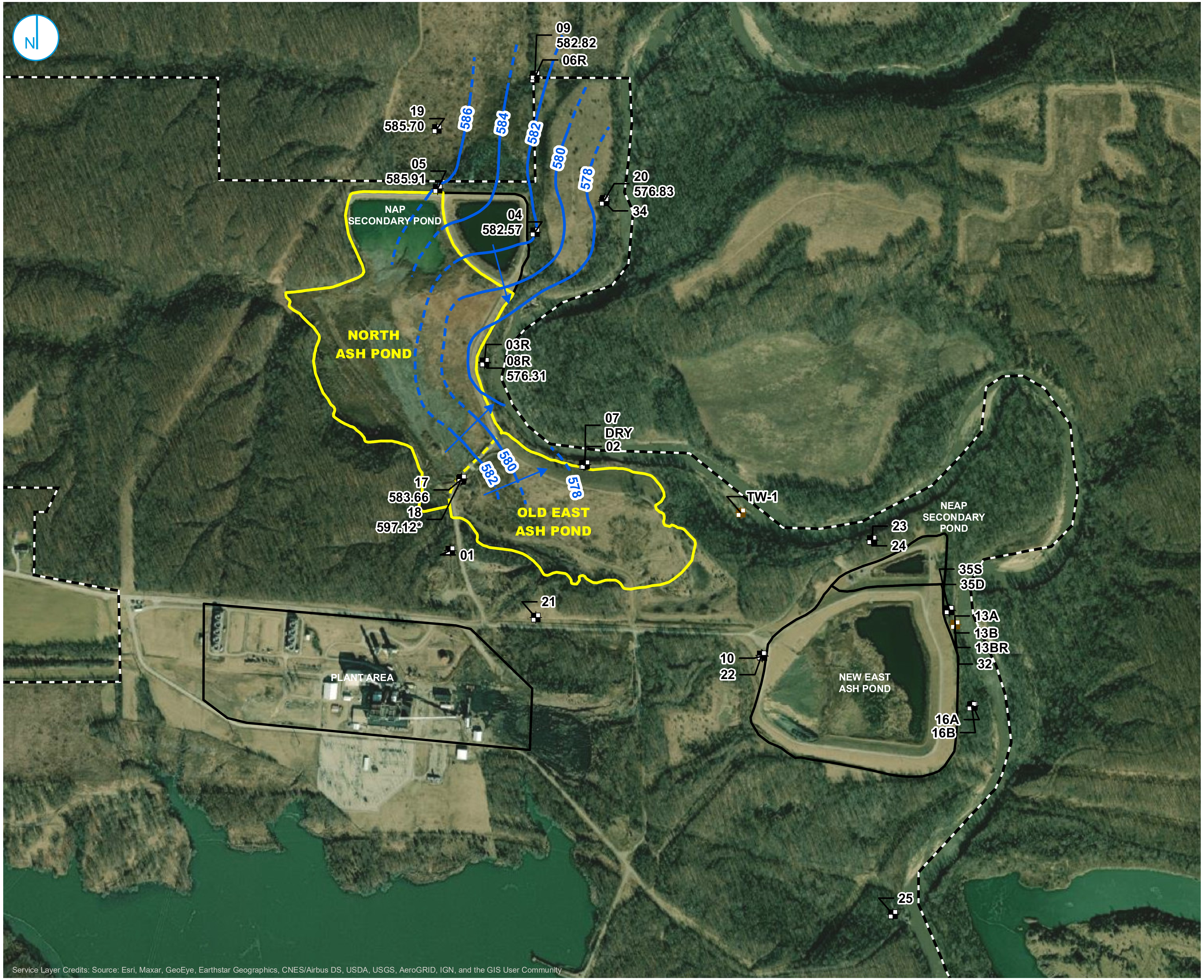
Chain-of-Custody Form Number

Comments 1 = Mositure, Unit Wt, Spec Grav, Sieve/Hydrometer, Hydraulic Conductivity, Volum Porosity Calc

2 = Visual Classification 3 = Sieve/Hydrometer or Sieve only

Signature [signature] Date 6/23/11 Reviewer ______ Date ______

APPENDIX D
GROUNDWATER ELEVATIONS AND CONTOUR MAPS (2017-2018)



Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure D-1_MGU Contours 1709.mxd

PROJECT: 169000XXXX | DATED: 10/18/2021 | DESIGNER: STOLZSD

MONITORING WELL LOCATION
ABANDONED MONITORING WELL LOCATION
DESTROYED MONITORING WELL LOCATION
GROUNDWATER ELEVATION CONTOUR (2-FT INTERVAL)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 300 600
Feet

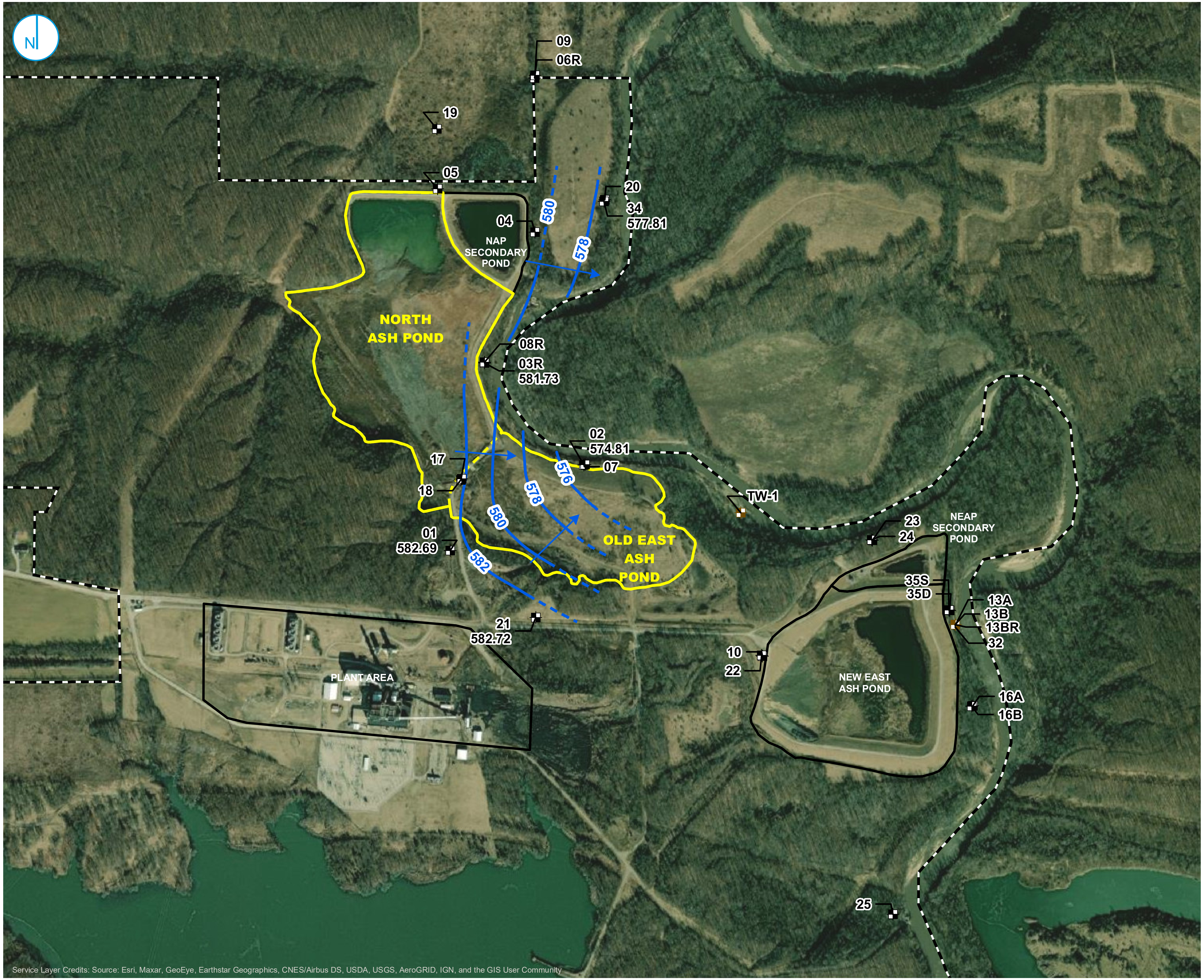
POTENTIOMETRIC SURFACE ELEVATION CONTOUR MAP MIDDLE GROUNDWATER UNIT SEPTEMBER 2017

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE D-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure D-2_LUGU Contours 1709.mxd

PROJECT: 169000XXXX | DATED: 10/18/2021 | DESIGNER: STOLZSD

MONITORING WELL LOCATION
ABANDONED MONITORING WELL LOCATION
DESTROYED MONITORING WELL LOCATION
GROUNDWATER ELEVATION CONTOUR (2-FT INTERVAL)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 300 600
Feet

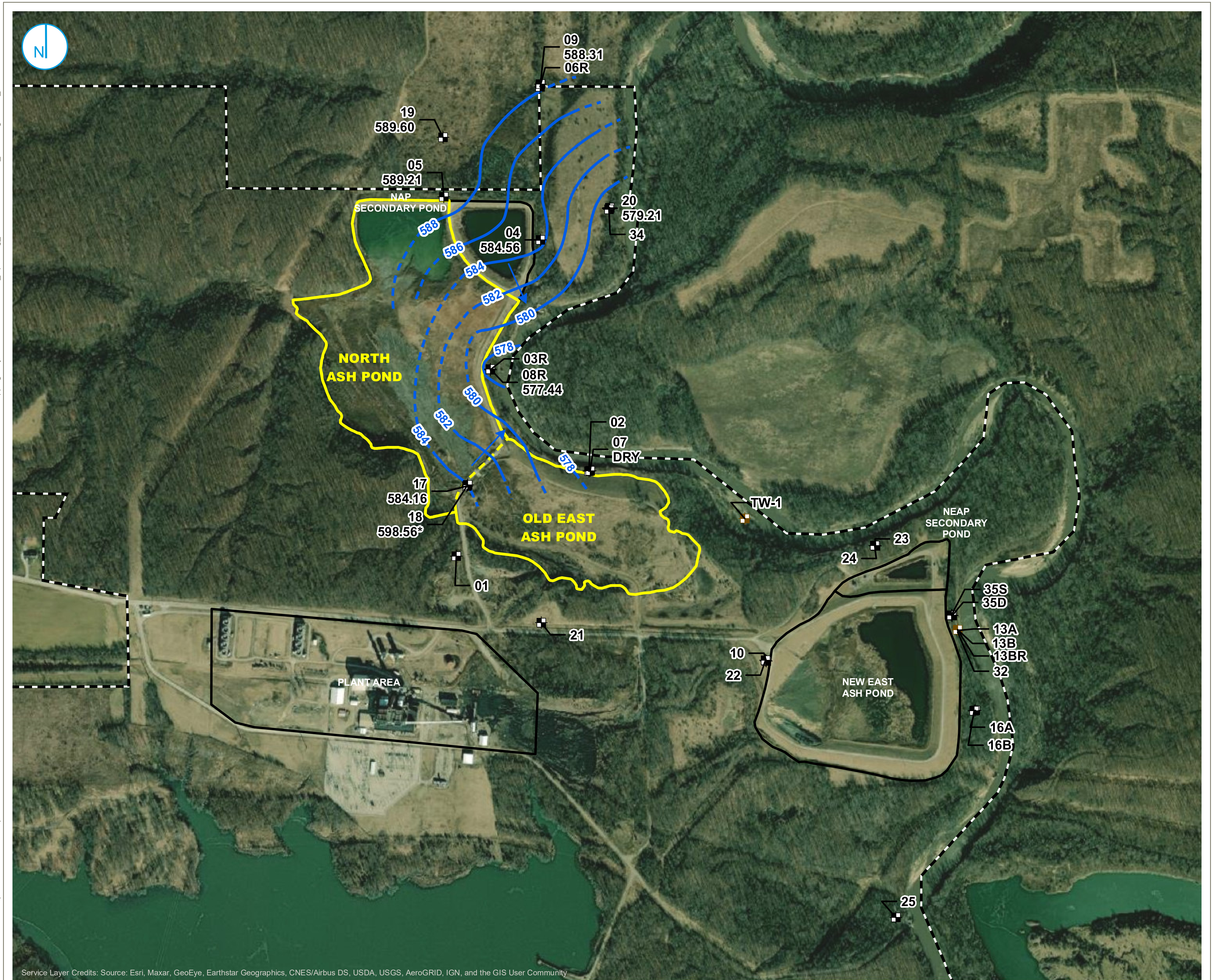
POTENTIOMETRIC SURFACE ELEVATION CONTOUR MAP LOWER AND UPLAND GROUNDWATER UNIT SEPTEMBER 2017

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE D-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure D-3_MGU Contours 1803.mxd

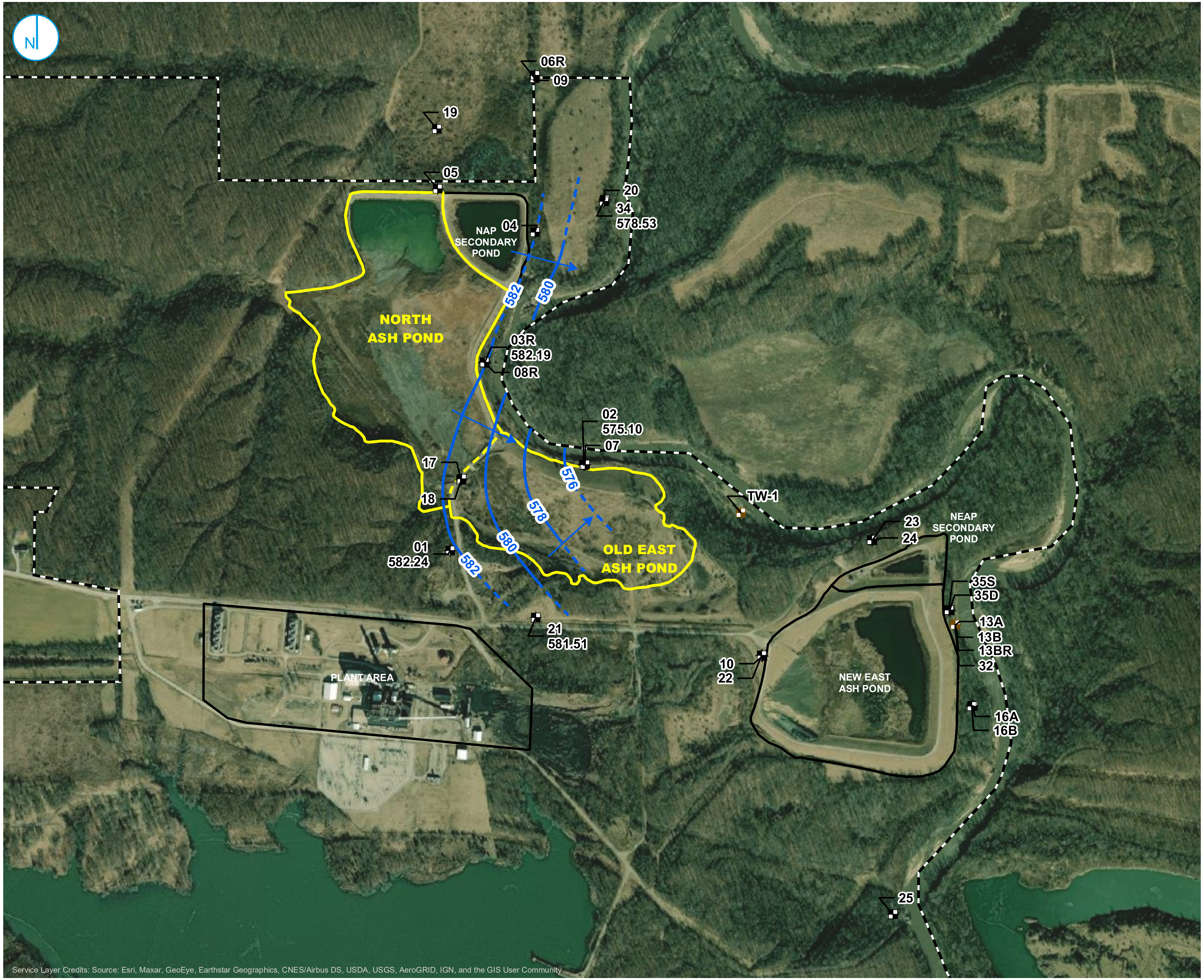
PROJECT: 169000XXXX | DATED: 10/18/2021 | DESIGNER: STOLZSD

POTENTIOMETRIC SURFACE ELEVATION CONTOUR MAP MIDDLE GROUNDWATER UNIT MARCH 2018

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE D-3

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.



MONITORING WELL LOCATION
ABANDONED MONITORING WELL LOCATION
DESTROYED MONITORING WELL LOCATION
GROUNDWATER ELEVATION CONTOUR (2-FT INTERVAL)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 300 600
Feet

POTENTIOMETRIC SURFACE ELEVATION CONTOUR MAP LOWER AND UPLAND GROUNDWATER UNIT MARCH 2018

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE D-4

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure D-4_LUGU Contours 1803.mxd

PROJECT: 169000XXXX | DATED: 10/18/2021 | DESIGNER: STOLZSD

TABLE D-1. GROUNDWATER ELEVATION RESULTS

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
01	07/13/2017	583.94
01	09/13/2017	582.69
01	11/08/2017	582.21
01	01/24/2018	581.94
01	03/22/2018	582.24
01	05/09/2018	582.86
01	03/29/2021	582.64
01	03/31/2021	582.64
01	04/12/2021	582.31
01	04/19/2021	582.31
01	05/10/2021	584.04
01	05/11/2021	584.04
01	06/04/2021	582.81
01	06/16/2021	582.29
01	07/05/2021	582.99
01	07/07/2021	582.99
01	07/26/2021	583.10
01	08/16/2021	582.64
02	07/13/2017	575.40
02	09/14/2017	574.81
02	11/08/2017	575.16
02	01/24/2018	575.81
02	03/22/2018	575.10
02	05/09/2018	575.53
02	03/29/2021	577.05
02	03/31/2021	577.05
02	04/12/2021	575.13
02	04/21/2021	575.13
02	05/10/2021	577.31
02	05/12/2021	577.31
02	06/03/2021	575.65
02	06/17/2021	574.67
02	07/08/2021	575.97
02	07/27/2021	575.77
02	08/16/2021	576.16
02	08/17/2021	576.16
03R	07/13/2017	582.80
03R	09/14/2017	581.73
03R	11/08/2017	581.19
03R	01/24/2018	584.40
03R	03/22/2018	582.19
03R	05/09/2018	582.87
03R	03/29/2021	582.64
03R	03/30/2021	582.64
03R	04/12/2021	582.44

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
03R	04/21/2021	582.44
03R	05/10/2021	582.84
03R	05/11/2021	582.84
03R	06/02/2021	582.58
03R	06/16/2021	582.26
03R	07/07/2021	583.23
03R	07/26/2021	583.01
03R	08/16/2021	582.69
04	07/13/2017	583.51
04	09/13/2017	582.57
04	11/08/2017	583.38
04	01/24/2018	584.15
04	03/22/2018	584.56
04	05/09/2018	584.55
04	03/29/2021	584.61
04	03/30/2021	584.61
04	04/12/2021	584.20
04	04/19/2021	584.20
04	05/10/2021	584.65
04	06/02/2021	583.71
04	06/16/2021	583.33
04	07/07/2021	584.18
04	07/26/2021	583.75
04	08/16/2021	582.87
05	07/13/2017	588.75
05	09/14/2017	585.91
05	11/08/2017	588.33
05	01/24/2018	589.26
05	03/22/2018	589.21
05	05/09/2018	589.39
05	03/29/2021	589.05
05	03/30/2021	590.15
05	04/12/2021	588.83
05	04/21/2021	588.83
05	05/10/2021	589.27
05	05/11/2021	589.27
05	06/02/2021	588.60
05	06/16/2021	588.24
05	07/07/2021	588.66
05	07/26/2021	588.60
05	08/16/2021	588.07
06R	07/13/2017	584.85
06R	09/13/2017	582.64
06R	11/08/2017	582.98
06R	01/24/2018	587.28

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
06R	03/22/2018	588.31
06R	05/09/2018	588.48
06R	03/29/2021	588.49
06R	04/12/2021	588.28
06R	05/10/2021	588.45
06R	07/05/2021	588.72
06R	07/07/2021	588.72
06R	07/26/2021	585.78
06R	08/16/2021	584.87
07R	05/10/2021	578.96
07R	05/12/2021	578.96
07R	06/03/2021	578.75
07R	06/17/2021	578.75
07R	07/08/2021	579.42
07R	07/27/2021	579.31
07R	08/16/2021	579.27
07R	08/17/2021	579.27
08R	07/13/2017	577.41
08R	09/14/2017	576.31
08R	11/08/2017	576.46
08R	01/24/2018	577.37
08R	03/22/2018	577.44
08R	05/09/2018	577.67
08R	03/29/2021	579.30
08R	03/30/2021	579.30
08R	04/12/2021	577.23
08R	04/21/2021	577.23
08R	05/10/2021	580.35
08R	05/11/2021	580.35
08R	06/02/2021	577.32
08R	06/16/2021	576.96
08R	07/07/2021	577.89
08R	07/26/2021	577.67
08R	08/16/2021	577.90
09	07/12/2017	584.98
09	09/13/2017	582.82
09	11/08/2017	583.14
09	01/24/2018	587.25
09	03/22/2018	588.31
09	05/09/2018	588.51
10	07/12/2017	609.21
10	09/14/2017	608.15
10	11/08/2017	607.34
10	01/24/2018	607.10
10	03/22/2018	608.26

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
10	05/09/2018	609.97
17	07/12/2017	584.67
17	09/13/2017	583.66
17	11/08/2017	583.56
17	01/24/2018	584.23
17	03/22/2018	584.16
17	05/09/2018	584.83
17	03/29/2021	586.83
17	03/31/2021	586.83
17	04/12/2021	584.37
17	04/20/2021	584.37
17	05/10/2021	587.12
17	05/11/2021	587.12
17	06/02/2021	584.31
17	06/16/2021	584.49
17	07/05/2021	585.79
17	07/07/2021	585.79
17	07/26/2021	585.70
17	08/16/2021	585.41
18	07/12/2017	599.35
18	09/13/2017	597.12
18	11/08/2017	596.02
18	01/24/2018	595.02
18	03/22/2018	598.56
18	05/09/2018	599.89
18	03/29/2021	598.24
18	04/12/2021	598.39
18	04/20/2021	598.39
18	05/10/2021	598.49
18	05/11/2021	598.49
18	06/02/2021	598.67
18	06/16/2021	597.99
18	07/05/2021	600.59
18	07/07/2021	600.59
18	07/26/2021	599.82
18	08/16/2021	598.81
19	07/13/2017	588.73
19	09/13/2017	585.70
19	11/08/2017	587.16
19	01/24/2018	589.55
19	03/22/2018	589.60
20	07/13/2017	577.99
20	09/13/2017	576.83
20	11/08/2017	577.24
20	01/24/2018	577.94

RAMBOLL

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
20	03/22/2018	579.21
20	05/09/2018	579.09
20	03/29/2021	580.29
20	03/30/2021	580.29
20	04/12/2021	579.00
20	04/19/2021	579.00
20	05/10/2021	579.19
20	06/02/2021	578.56
20	06/16/2021	578.21
20	07/07/2021	580.62
20	07/26/2021	578.92
20	08/16/2021	578.54
21	07/13/2017	583.21
21	09/13/2017	582.72
21	11/08/2017	581.67
21	01/24/2018	581.36
21	03/22/2018	581.51
21	05/09/2018	582.45
21	03/29/2021	581.21
21	03/31/2021	581.21
21	04/12/2021	581.56
21	04/20/2021	581.56
21	05/10/2021	578.93
21	05/11/2021	578.93
21	06/03/2021	581.82
21	06/16/2021	581.60
21	07/08/2021	582.11
21	07/27/2021	582.08
21	08/16/2021	582.21
21	08/17/2021	582.21
34	07/13/2017	578.40
34	09/13/2017	577.81
34	11/08/2017	577.95
34	01/24/2018	577.37
34	03/22/2018	578.53
34	05/09/2018	578.97
34	03/29/2021	579.94
34	03/30/2021	579.94
34	04/12/2021	578.63
34	04/19/2021	578.63
34	05/10/2021	579.35
34	06/02/2021	579.00
34	06/16/2021	578.54
34	07/07/2021	579.86
34	07/26/2021	579.03

RAMBOLL

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
34	08/16/2021	579.15
36	03/29/2021	578.56
36	03/31/2021	578.56
36	04/12/2021	575.98
36	04/20/2021	575.98
36	05/10/2021	579.19
36	05/11/2021	579.19
36	06/02/2021	576.25
36	06/16/2021	575.96
36	07/07/2021	576.76
36	07/26/2021	576.47
36	08/16/2021	576.97
37	03/29/2021	582.59
37	03/31/2021	582.59
37	04/12/2021	582.33
37	04/21/2021	582.33
37	05/10/2021	582.68
37	05/11/2021	582.68
37	06/02/2021	582.48
37	06/16/2021	582.12
37	07/07/2021	583.02
37	07/26/2021	581.83
37	08/16/2021	582.51
38	03/29/2021	588.59
38	03/30/2021	588.59
38	04/12/2021	588.38
38	04/19/2021	588.38
38	05/10/2021	588.64
38	05/11/2021	588.64
38	06/02/2021	587.48
38	06/16/2021	586.20
38	07/07/2021	588.06
38	07/26/2021	586.94
38	08/16/2021	585.00
40	03/29/2021	578.50
40	03/31/2021	578.50
40	04/12/2021	577.82
40	04/21/2021	577.82
40	05/10/2021	578.51
40	05/12/2021	578.51
40	06/03/2021	577.85
40	06/17/2021	577.76
40	07/08/2021	578.71
40	07/27/2021	578.36
40	08/16/2021	578.40

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
40	08/17/2021	578.40
41	03/29/2021	581.86
41	03/30/2021	581.86
41	04/12/2021	581.45
41	04/20/2021	581.45
41	05/10/2021	581.64
41	06/02/2021	581.74
41	06/16/2021	581.35
41	07/07/2021	582.38
41	07/26/2021	581.97
41	08/16/2021	581.66
42	03/29/2021	583.45
42	03/31/2021	583.45
42	04/12/2021	583.36
42	04/19/2021	583.36
42	05/10/2021	583.59
42	05/11/2021	583.59
42	06/03/2021	583.48
42	06/16/2021	583.08
42	07/07/2021	584.10
42	07/26/2021	583.92
42	08/16/2021	583.51
42	08/17/2021	583.51
43	03/29/2021	593.41
43	03/31/2021	593.41
43	04/12/2021	592.29
43	04/20/2021	592.29
43	05/10/2021	592.18
43	05/11/2021	592.18
43	06/02/2021	592.42
43	06/16/2021	592.19
43	07/07/2021	592.54
43	07/26/2021	592.69
43	08/16/2021	592.44
43	08/17/2021	592.44
44	03/29/2021	591.97
44	03/31/2021	591.97
44	04/12/2021	593.85
44	04/20/2021	593.85
44	05/10/2021	593.85
44	05/11/2021	593.85
44	06/02/2021	593.86
44	06/16/2021	593.59
44	07/07/2021	594.09
44	07/26/2021	594.06

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
44	08/16/2021	593.61
44	08/17/2021	593.61
101	03/29/2021	598.10
101	04/01/2021	598.10
101	04/12/2021	598.50
101	04/20/2021	598.50
101	05/10/2021	591.20
101	05/12/2021	591.20
101	06/18/2021	598.35
101	07/08/2021	598.37
101	07/27/2021	598.17
101	07/28/2021	598.25
101	08/16/2021	598.23
101	08/18/2021	598.23
102	03/29/2021	466.05
102	04/01/2021	466.05
102	04/12/2021	466.29
102	04/20/2021	466.29
102	05/10/2021	450.10
102	05/12/2021	455.10
102	06/18/2021	466.01
102	07/05/2021	466.46
102	07/07/2021	466.46
102	07/26/2021	467.55
102	08/16/2021	466.04
102	08/18/2021	466.04
103	03/29/2021	583.18
103	04/02/2021	583.18
103	04/12/2021	583.21
103	04/20/2021	583.21
103	05/10/2021	583.27
103	05/12/2021	583.27
103	06/18/2021	583.07
103	07/05/2021	583.63
103	07/07/2021	583.63
103	07/26/2021	583.63
103	08/16/2021	583.30
103	08/18/2021	583.30
104	03/29/2021	580.51
104	04/01/2021	580.51
104	04/12/2021	580.61
104	04/20/2021	580.61
104	05/10/2021	570.93
104	05/12/2021	565.93
104	06/17/2021	580.49

RAMBOLL

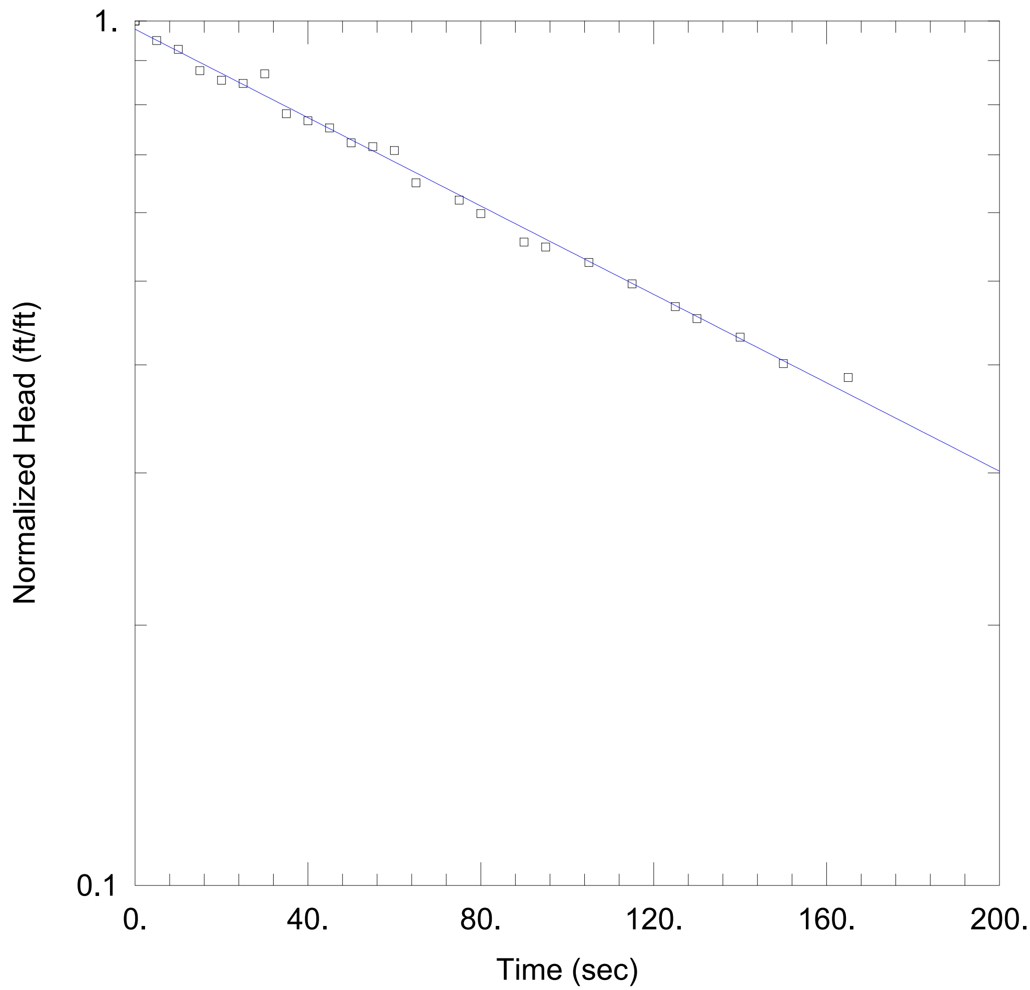
TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
VERMILION POWER PLANT
NORTH ASH POND SYSTEM & OLD EAST ASH POND
OAKWOOD, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
104	07/08/2021	582.12
104	07/27/2021	580.97
104	08/16/2021	579.68
104	08/18/2021	579.68
105	03/29/2021	585.61
105	04/02/2021	585.61
105	04/12/2021	585.94
105	04/20/2021	585.94
105	05/10/2021	585.60
105	05/11/2021	585.60
105	06/04/2021	587.78
105	06/17/2021	585.85
105	07/05/2021	588.54
105	07/07/2021	588.54
105	07/26/2021	586.07
105	08/16/2021	586.00
105	08/18/2021	586.00
ND3	03/29/2021	598.16
ND3	03/31/2021	598.16
ND3	04/12/2021	598.81
ND3	04/21/2021	598.81
ND3	05/10/2021	598.86
ND3	05/11/2021	598.86
ND3	06/03/2021	599.50
ND3	06/16/2021	598.14
ND3	07/05/2021	600.85
ND3	07/07/2021	600.85
ND3	07/26/2021	600.99
ND3	07/28/2021	600.69
ND3	08/16/2021	599.36
ND3	08/17/2021	599.36
OED1	06/03/2021	588.53
OED1	06/16/2021	589.31
OED1	07/08/2021	589.82
OED1	07/27/2021	590.56
OED1	08/16/2021	591.70
OED1	08/17/2021	591.70
SG01	03/29/2021	680.76
SG01	04/12/2021	680.50
SG01	05/10/2021	680.82
SG01	07/05/2021	680.77
SG01	07/08/2021	680.77
SG01	07/26/2021	681.07
SG01	08/16/2021	679.67

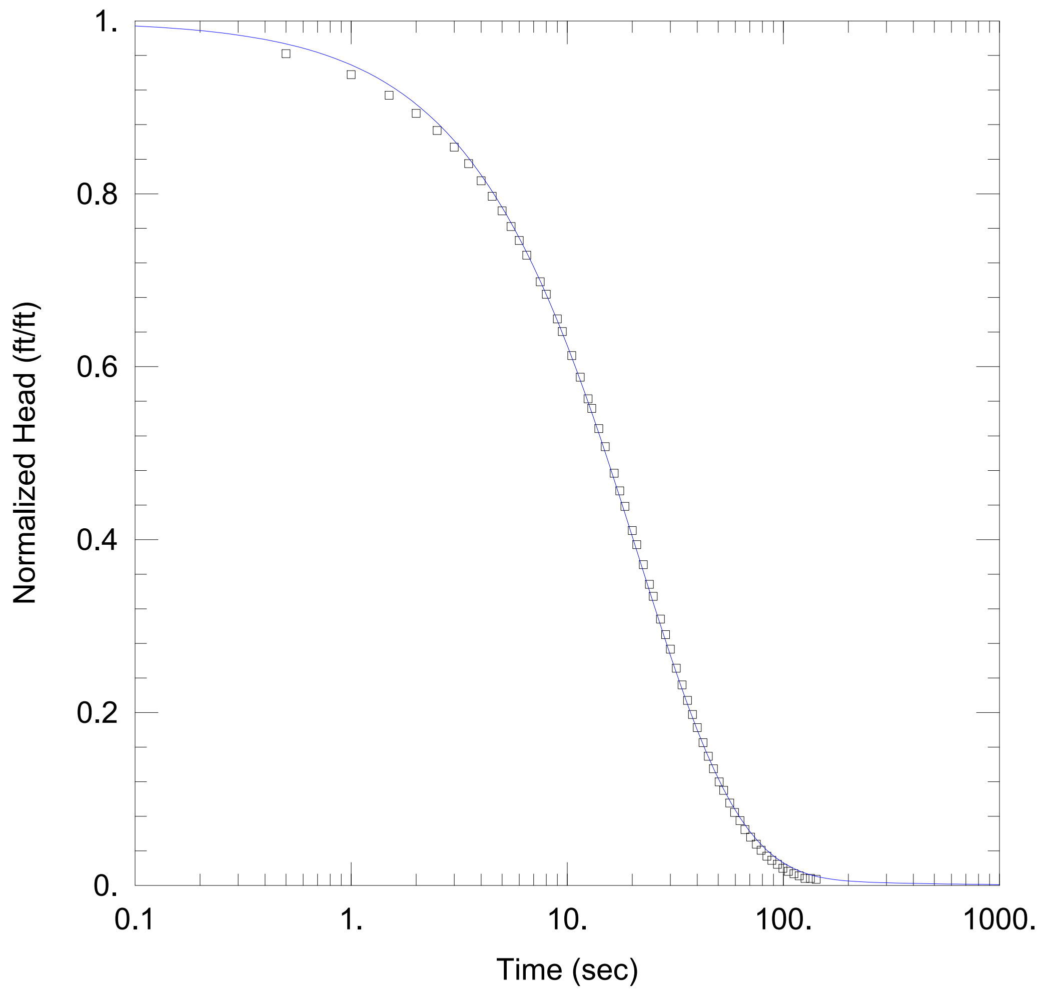
Notes:
ft NAVD88 = feet relative to the North American Vertical Datum 1988, GEOID 12A

generated 10/05/2021, 4:09:40 PM CDT

APPENDIX E
FIELD HYDRAULIC CONDUCTIVITY TEST DATA



02 FH1	
PROJECT INFORMATION	
Company: Ramboll	
Client: Dynegy Midwest Generation, LLC	
Location: Vermilion Power Plant	
Test Date: 4/15/2021	
AQUIFER DATA	
Saturated Thickness: 12.5 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (02)	
Initial Displacement: 1.37 ft	Static Water Column Height: 24.1 ft
Total Well Penetration Depth: 12.2 ft	Screen Length: 9.6 ft
Casing Radius: 0.086 ft	Well Radius: 0.42 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 0.000165 cm/sec	y0 = 1.34 ft



03R RH2

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Well: 03R
Test Date: 4/14/2021

AQUIFER DATA

Saturated Thickness: 10. ft

WELL DATA (03R)

Initial Displacement: 1.72 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.083 ft

Static Water Column Height: 31.7 ft
Screen Length: 5. ft
Well Radius: 0.34 ft

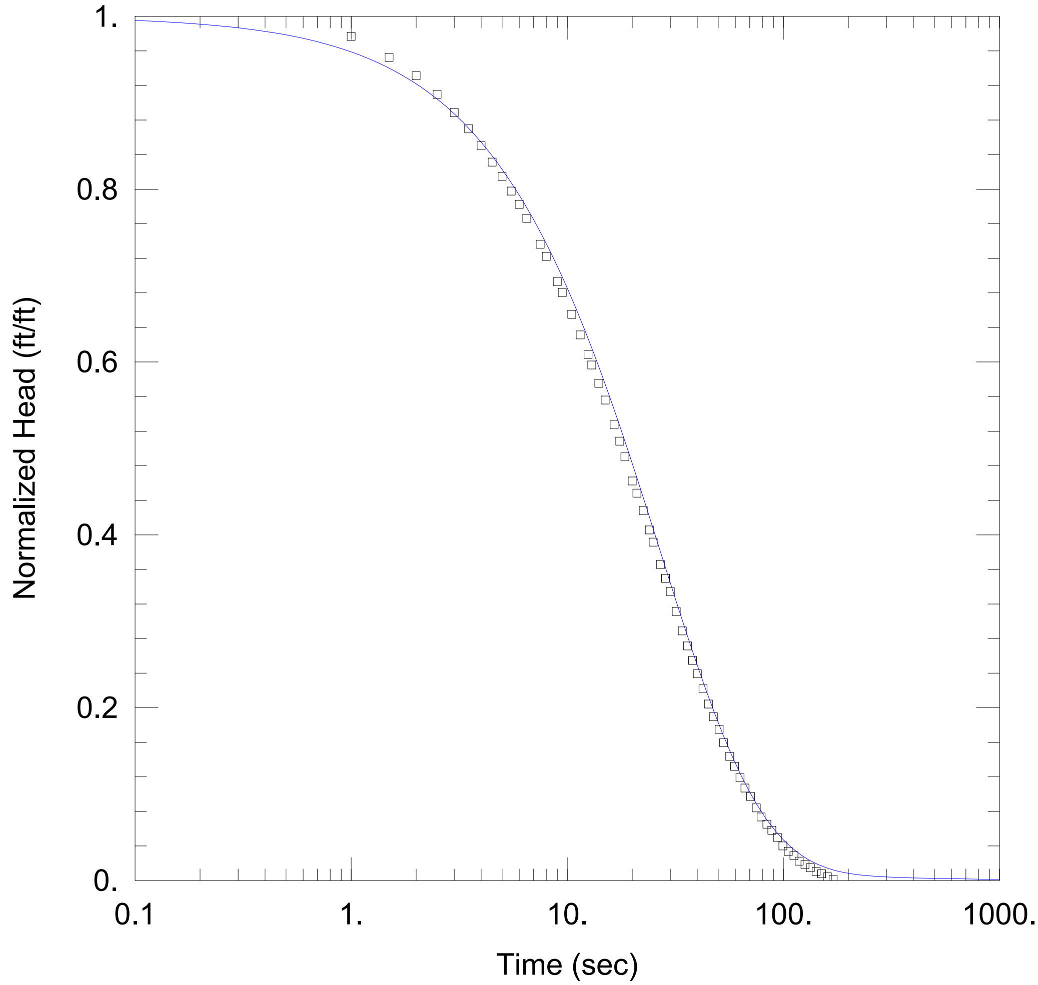
SOLUTION

Aquifer Model: Confined

Kr = 0.00635 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 1.0E-11 ft^{-1}



04 RH1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 4/14/2021

AQUIFER DATA

Saturated Thickness: 10. ft

WELL DATA (04)

Initial Displacement: 1.43 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.083 ft

Static Water Column Height: 13.79 ft
Screen Length: 4.8 ft
Well Radius: 0.42 ft

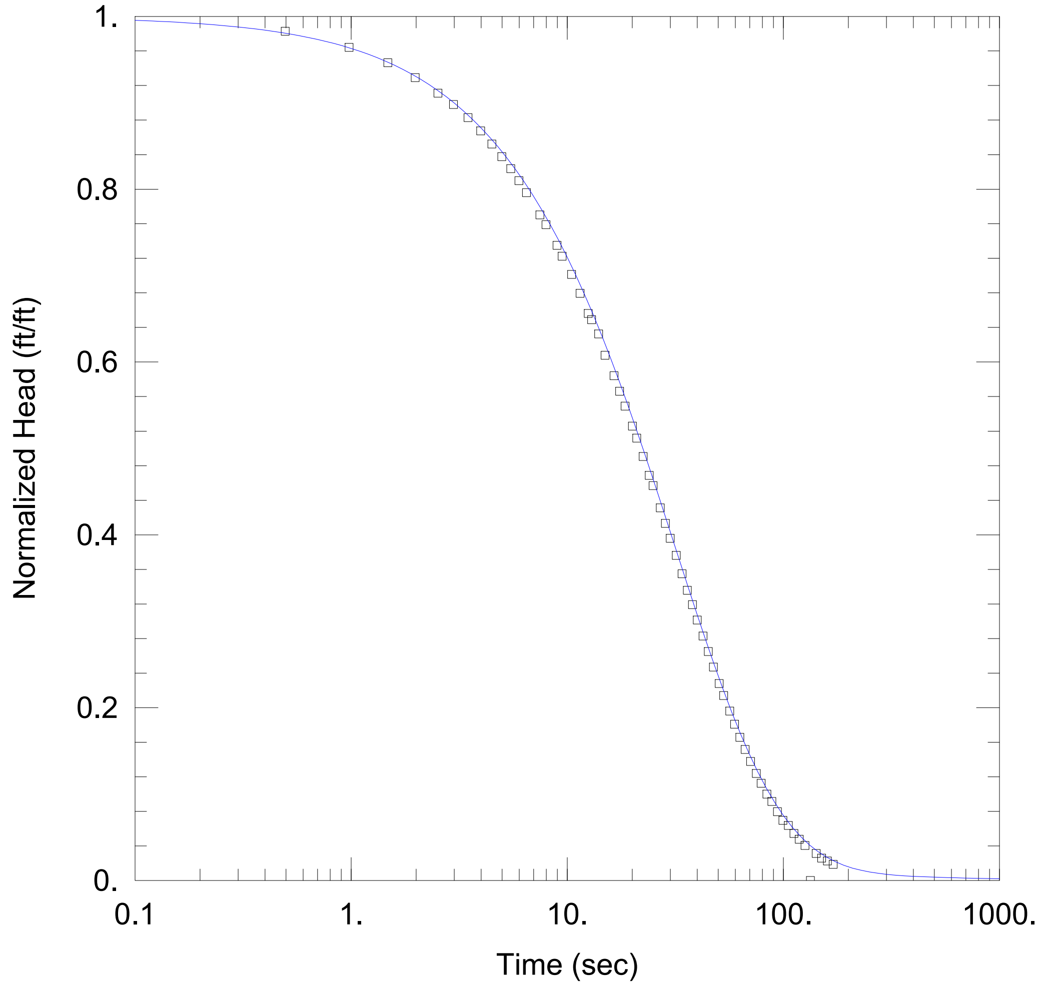
SOLUTION

Aquifer Model: Confined

Kr = 0.00494 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 1.0E-11 ft^{-1}



05 RH2

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 4/14/2021

AQUIFER DATA

Saturated Thickness: 14. ft

WELL DATA (05)

Initial Displacement: 1.51 ft
Total Well Penetration Depth: 13.7 ft
Casing Radius: 0.083 ft

Static Water Column Height: 13.7 ft
Screen Length: 4.8 ft
Well Radius: 0.42 ft

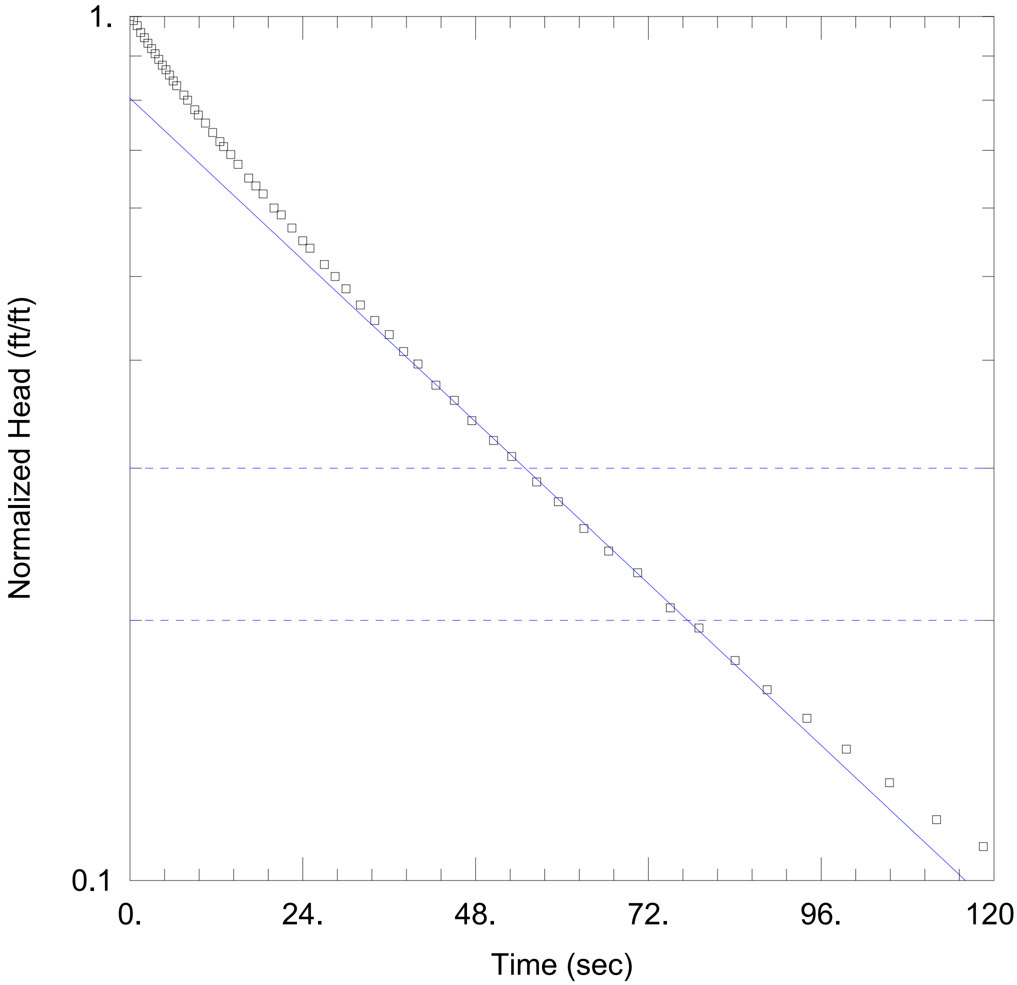
SOLUTION

Aquifer Model: Confined

Kr = 0.00226 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 1.0E-7 ft^{-1}



08R RH1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 4/14/2021

AQUIFER DATA

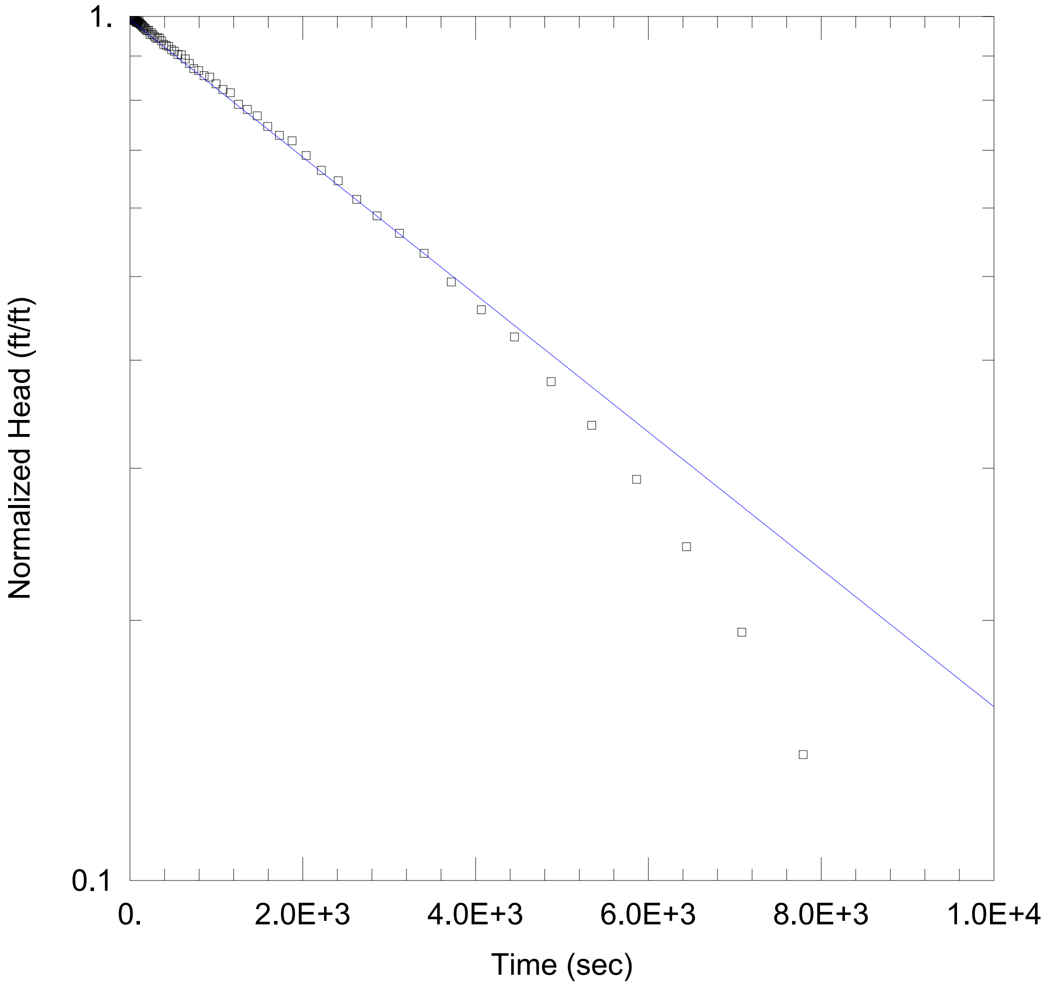
Saturated Thickness: 18. ft	Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (08R)

Initial Displacement: 0.74 ft	Static Water Column Height: 9.61 ft
Total Well Penetration Depth: 9.61 ft	Screen Length: 5. ft
Casing Radius: 0.083 ft	Well Radius: 0.17 ft

SOLUTION

Aquifer Model: Unconfined	Solution Method: Bouwer-Rice
K = 0.000926 cm/sec	y0 = 0.595 ft



17 FH-1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/15/2021

AQUIFER DATA

Saturated Thickness: 25.5 ft
Anisotropy Ratio (Kz/Kr): 1.

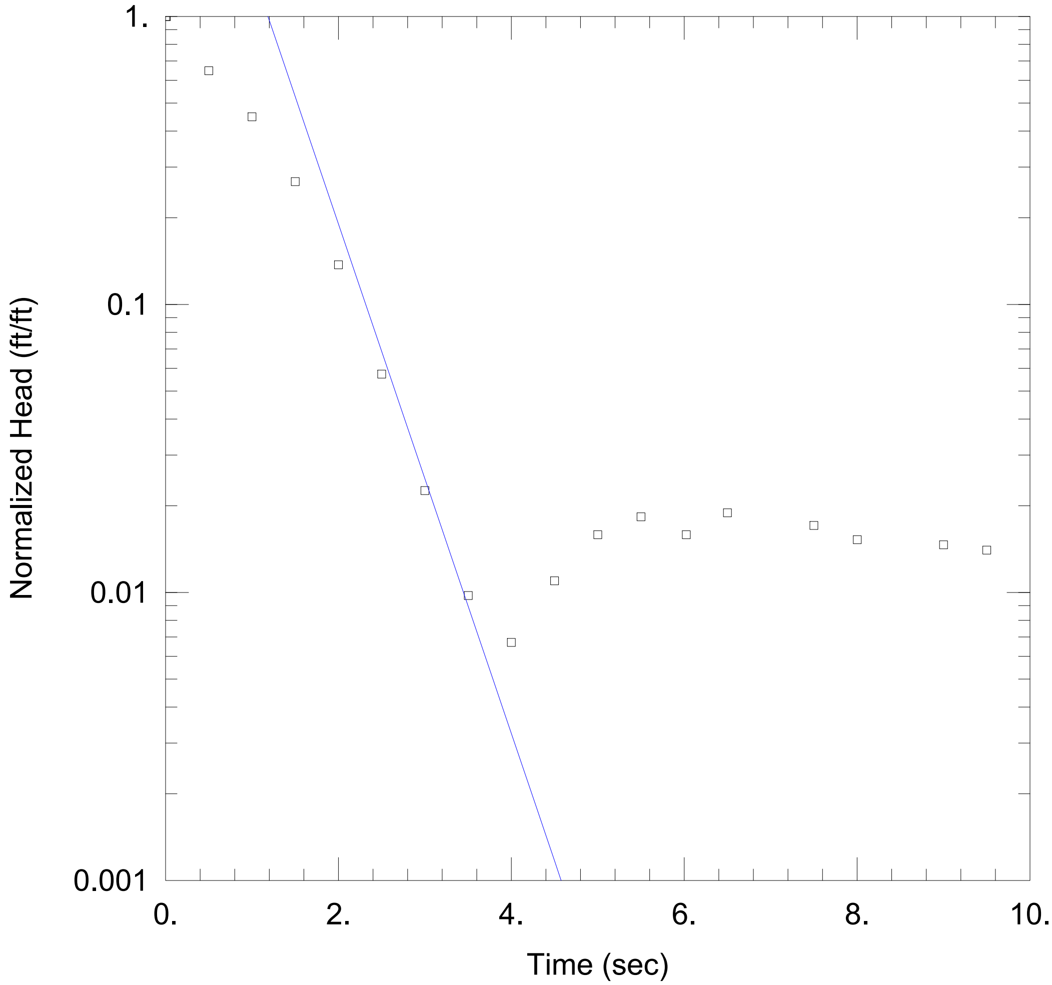
WELL DATA (17)

Initial Displacement: 1.13 ft
Total Well Penetration Depth: 23.5 ft
Casing Radius: 0.086 ft
Static Water Column Height: 23.5 ft
Screen Length: 5. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 8.38E-6 cm/sec
y0 = 1.12 ft



18 RH-1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/15/2021

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.

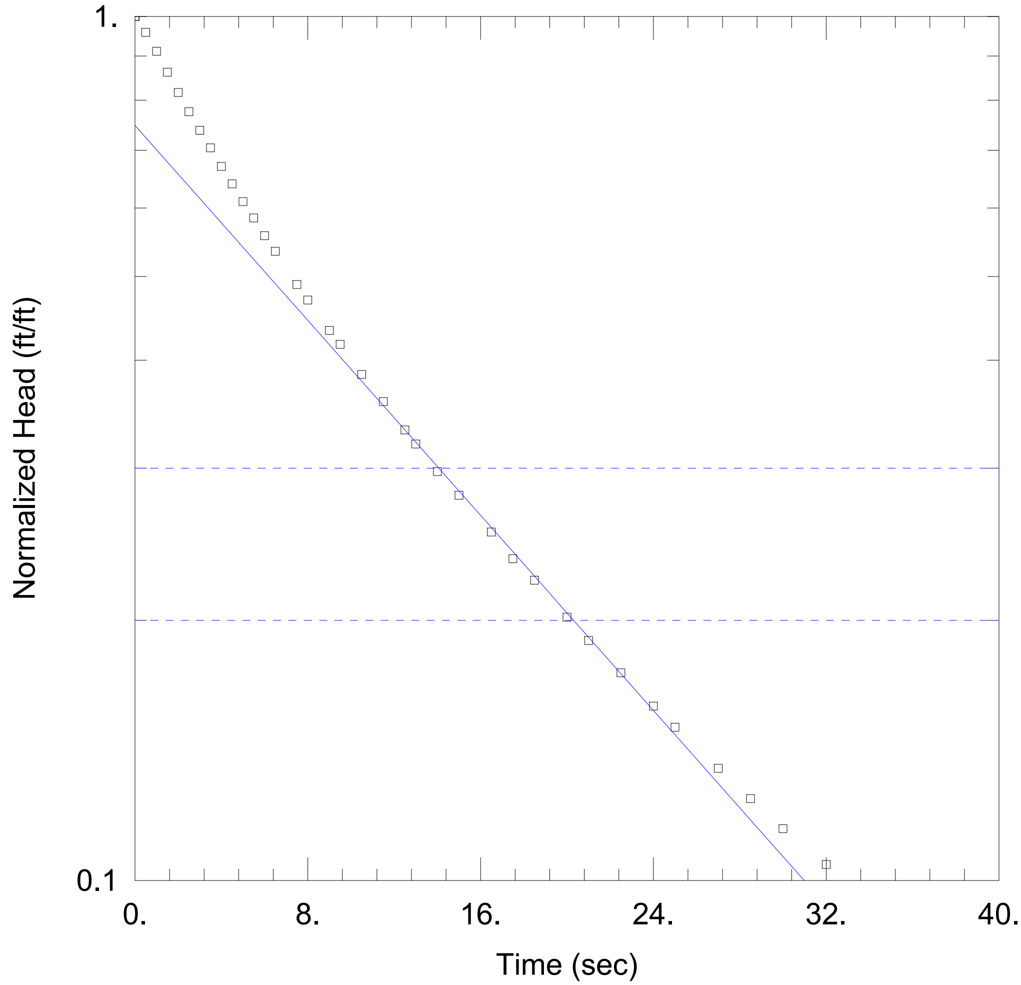
WELL DATA (18)

Initial Displacement: 1.64 ft
Total Well Penetration Depth: 23.5 ft
Casing Radius: 0.083 ft
Static Water Column Height: 26.65 ft
Screen Length: 5. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.103 cm/sec
y0 = 18.3 ft



20 FH-1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/14/2021

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.

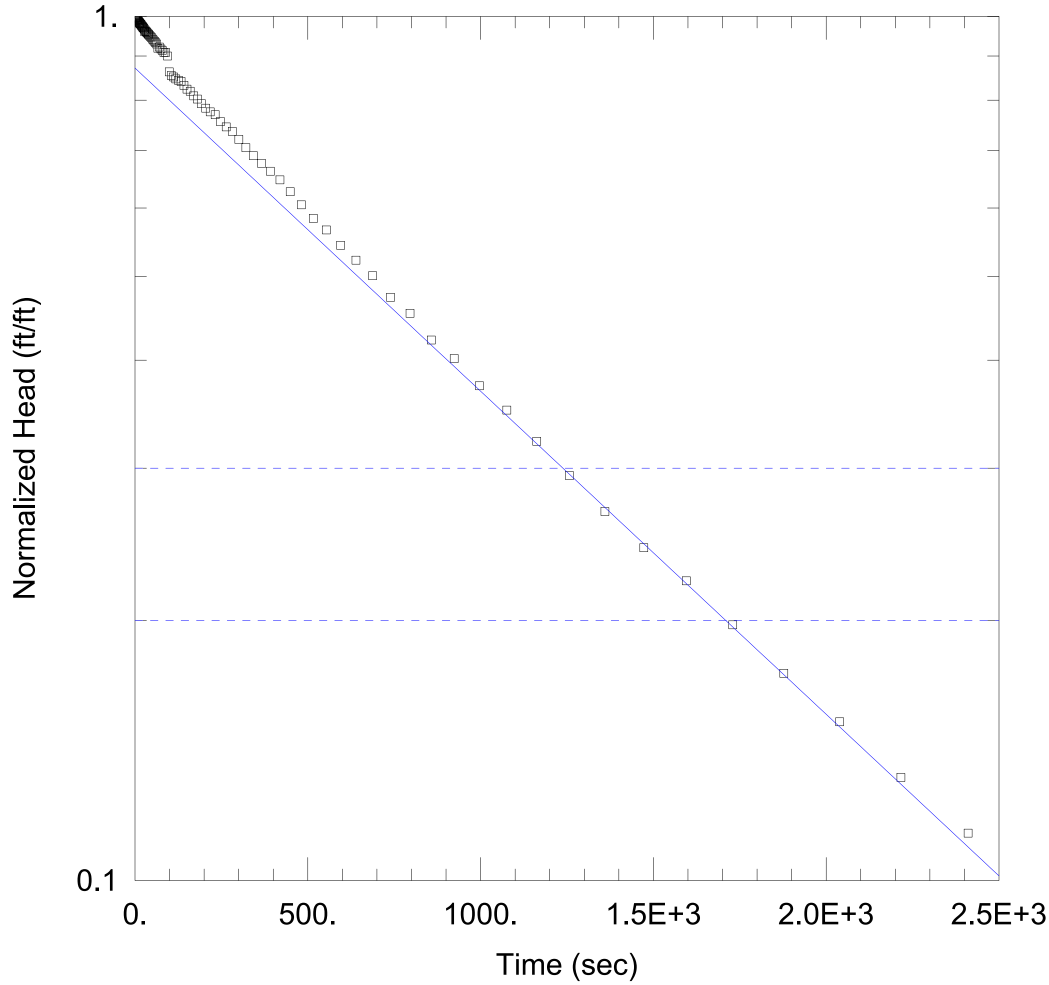
WELL DATA (20)

Initial Displacement: 1.15 ft
Total Well Penetration Depth: 4.75 ft
Casing Radius: 0.083 ft
Static Water Column Height: 7.25 ft
Screen Length: 2.5 ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0036 cm/sec
y0 = 0.86 ft



21 FH-1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/16/2021

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.

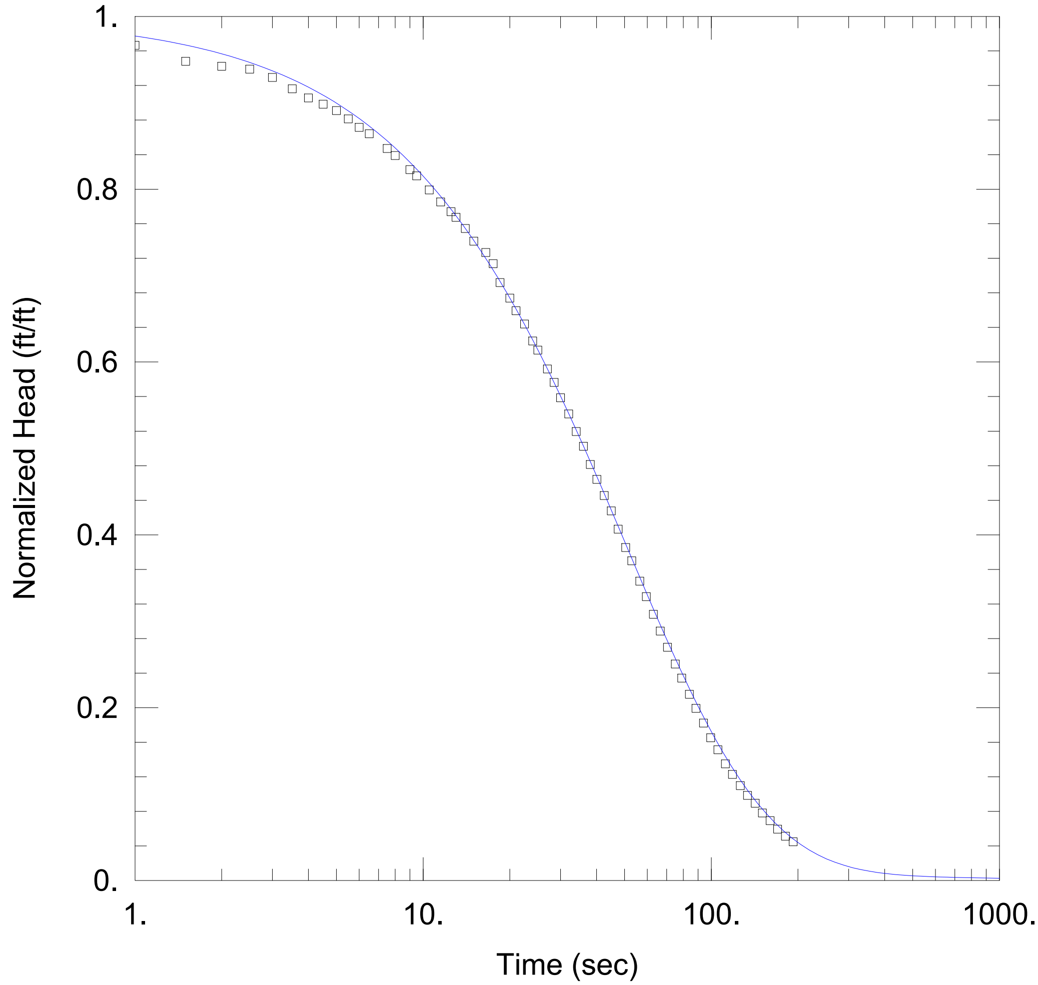
WELL DATA (21)

Initial Displacement: 1.71 ft
Static Water Column Height: 19.77 ft
Total Well Penetration Depth: 4. ft
Screen Length: 4. ft
Casing Radius: 0.086 ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 3.14E-5 cm/sec
y0 = 1.49 ft



34 RH-2

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/14/2021

AQUIFER DATA

Saturated Thickness: 8. ft

WELL DATA (34)

Initial Displacement: 1.23 ft
Total Well Penetration Depth: 42.92 ft
Casing Radius: 0.086 ft

Static Water Column Height: 42.9 ft
Screen Length: 5.02 ft
Well Radius: 0.25 ft

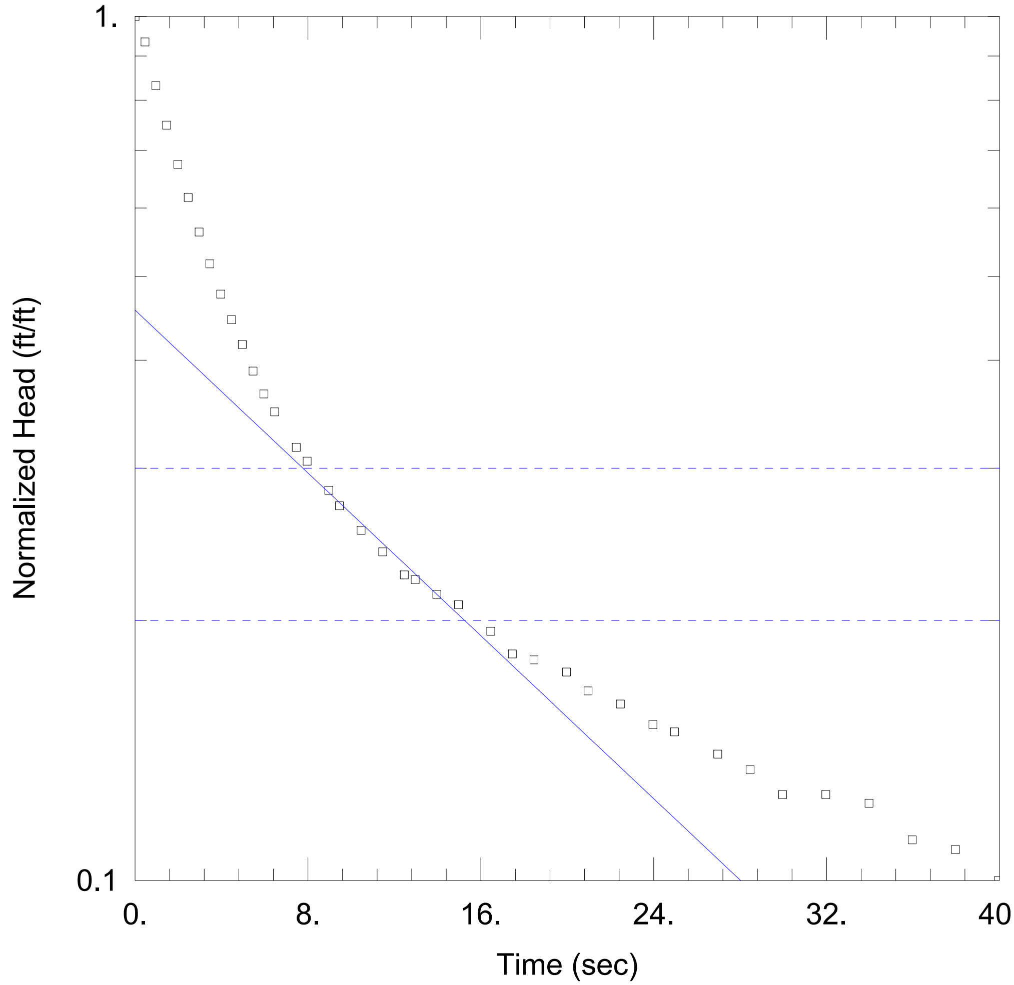
SOLUTION

Aquifer Model: Confined

Kr = 0.0028 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 1.89E-8 ft^{-1}



36 RH1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/13/2021

AQUIFER DATA

Saturated Thickness: 8.1 ft
Anisotropy Ratio (Kz/Kr): 1.

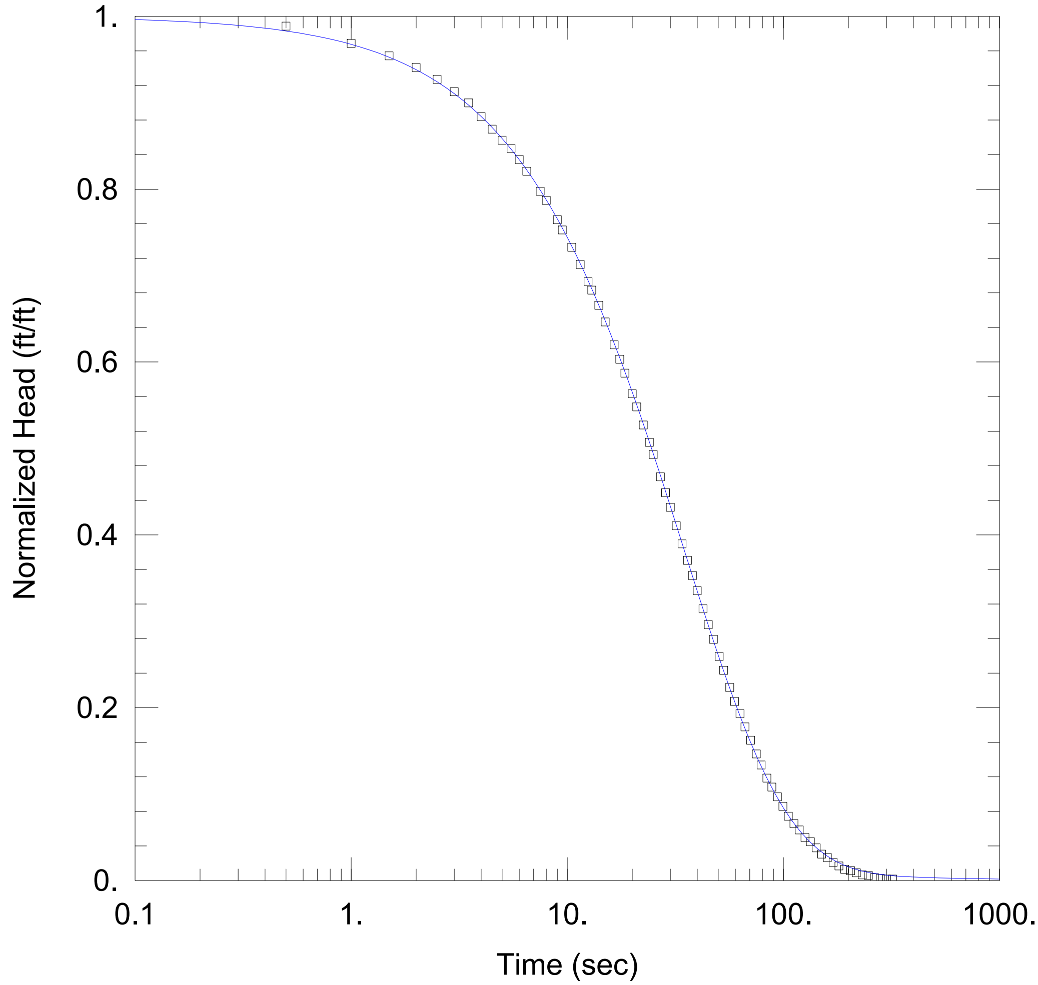
WELL DATA (36)

Initial Displacement: 0.35 ft
Total Well Penetration Depth: 8.13 ft
Casing Radius: 0.086 ft
Static Water Column Height: 9.13 ft
Screen Length: 4. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00326 cm/sec
y0 = 0.16 ft



37 FH2

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/13/2021

AQUIFER DATA

Saturated Thickness: 5.6 ft

WELL DATA (37)

Initial Displacement: 1.25 ft
Total Well Penetration Depth: 46.36 ft
Casing Radius: 0.086 ft

Static Water Column Height: 47.34 ft
Screen Length: 4. ft
Well Radius: 0.25 ft

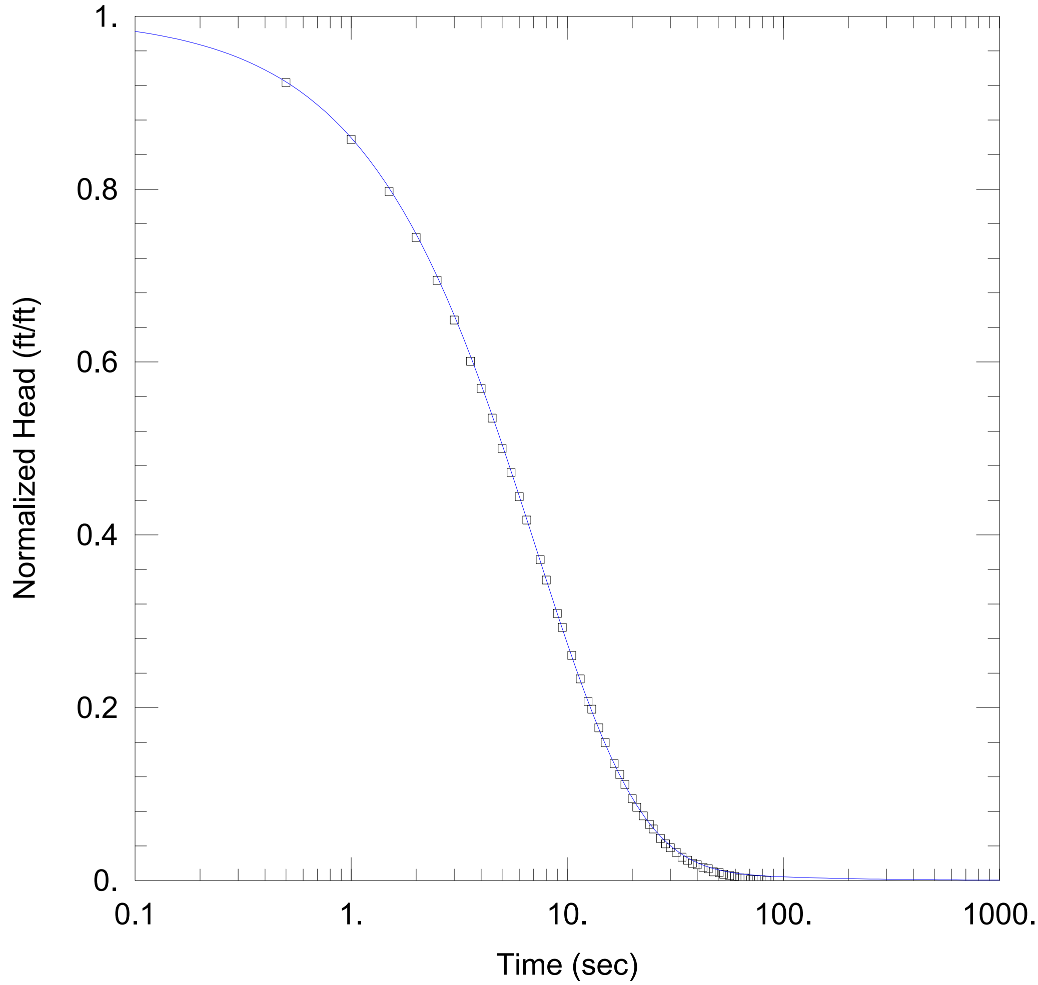
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 0.00633 cm/sec
Kz/Kr = 1.

Ss = 3.58E-10 ft^{-1}



38 RH1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/13/2021

AQUIFER DATA

Saturated Thickness: 12. ft

WELL DATA (38)

Initial Displacement: 1.11 ft
Total Well Penetration Depth: 12. ft
Casing Radius: 0.086 ft

Static Water Column Height: 30.12 ft
Screen Length: 9.2 ft
Well Radius: 0.25 ft

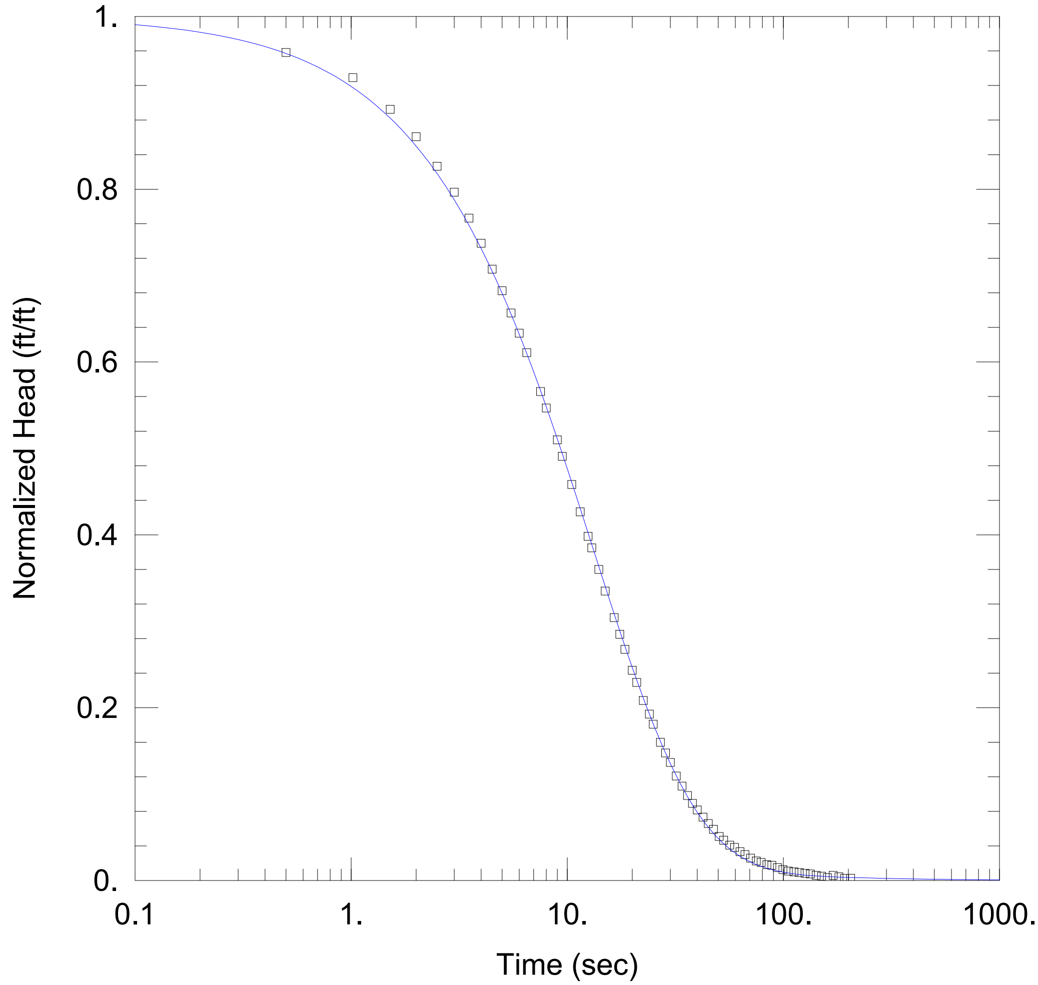
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 0.0113 cm/sec
Kz/Kr = 1.

Ss = 3.18E-10 ft^{-1}



40 FH2

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/13/2021

AQUIFER DATA

Saturated Thickness: 0.3 ft

WELL DATA (40)

Initial Displacement: 1.2 ft
Total Well Penetration Depth: 0.3 ft
Casing Radius: 0.086 ft

Static Water Column Height: 8.79 ft
Screen Length: 0.3 ft
Well Radius: 0.34 ft

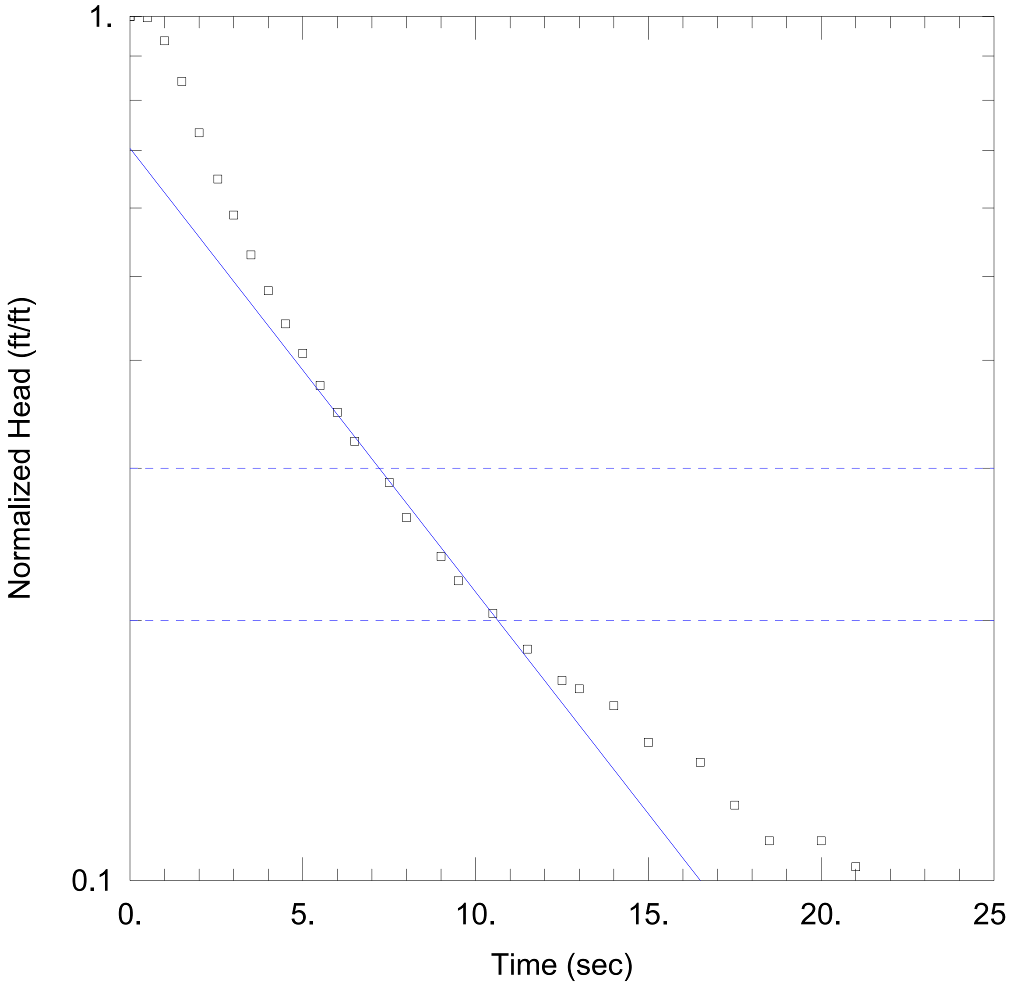
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 0.266 cm/sec
Kz/Kr = 1.

Ss = 3.48E-10 ft^{-1}



41 RH1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/13/2021

AQUIFER DATA

Saturated Thickness: 7. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (41)

Initial Displacement: 0.27 ft
Total Well Penetration Depth: 7. ft
Casing Radius: 0.086 ft

Static Water Column Height: 19.08 ft
Screen Length: 7. ft
Well Radius: 0.25 ft

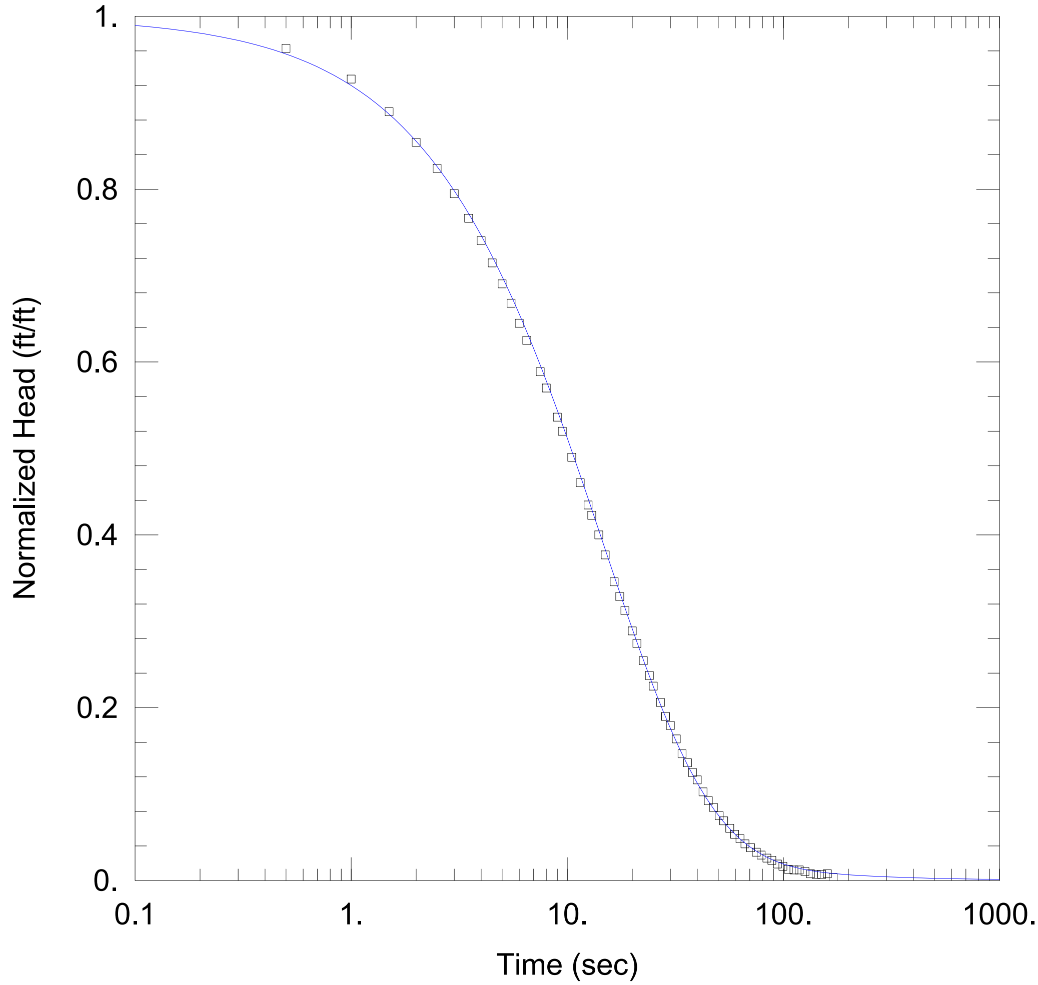
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

K = 0.0042 cm/sec

y0 = 0.19 ft



42 RH1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/13/2021

AQUIFER DATA

Saturated Thickness: 0.6 ft

WELL DATA (42)

Initial Displacement: 1.16 ft
Total Well Penetration Depth: 0.6 ft
Casing Radius: 0.086 ft

Static Water Column Height: 36.37 ft
Screen Length: 0.6 ft
Well Radius: 0.25 ft

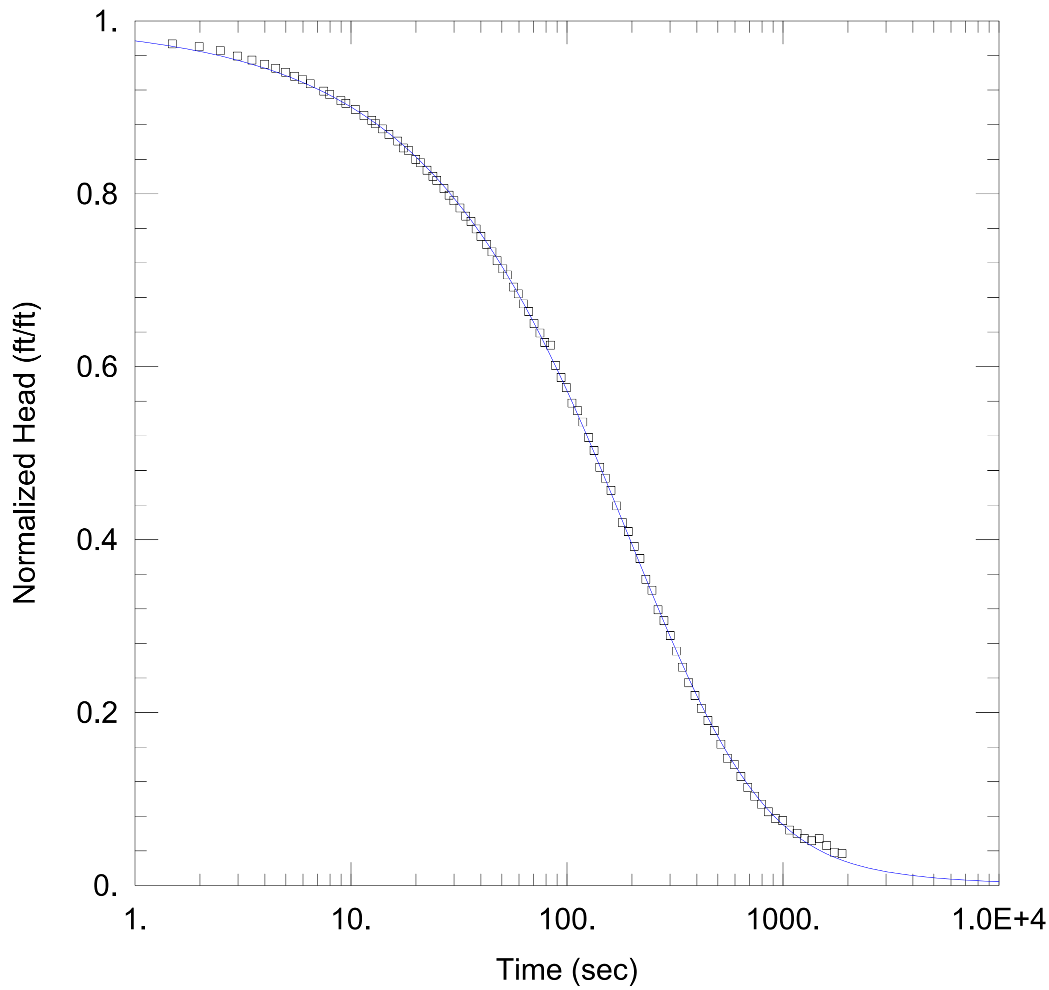
SOLUTION

Aquifer Model: Confined

Kr = 0.0744 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 7.13E-7 ft^{-1}



43 RH2

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/13/2021

AQUIFER DATA

Saturated Thickness: 5.4 ft

WELL DATA (43)

Initial Displacement: 1.28 ft
Total Well Penetration Depth: 5.4 ft
Casing Radius: 0.086 ft

Static Water Column Height: 51.82 ft
Screen Length: 5.4 ft
Well Radius: 0.25 ft

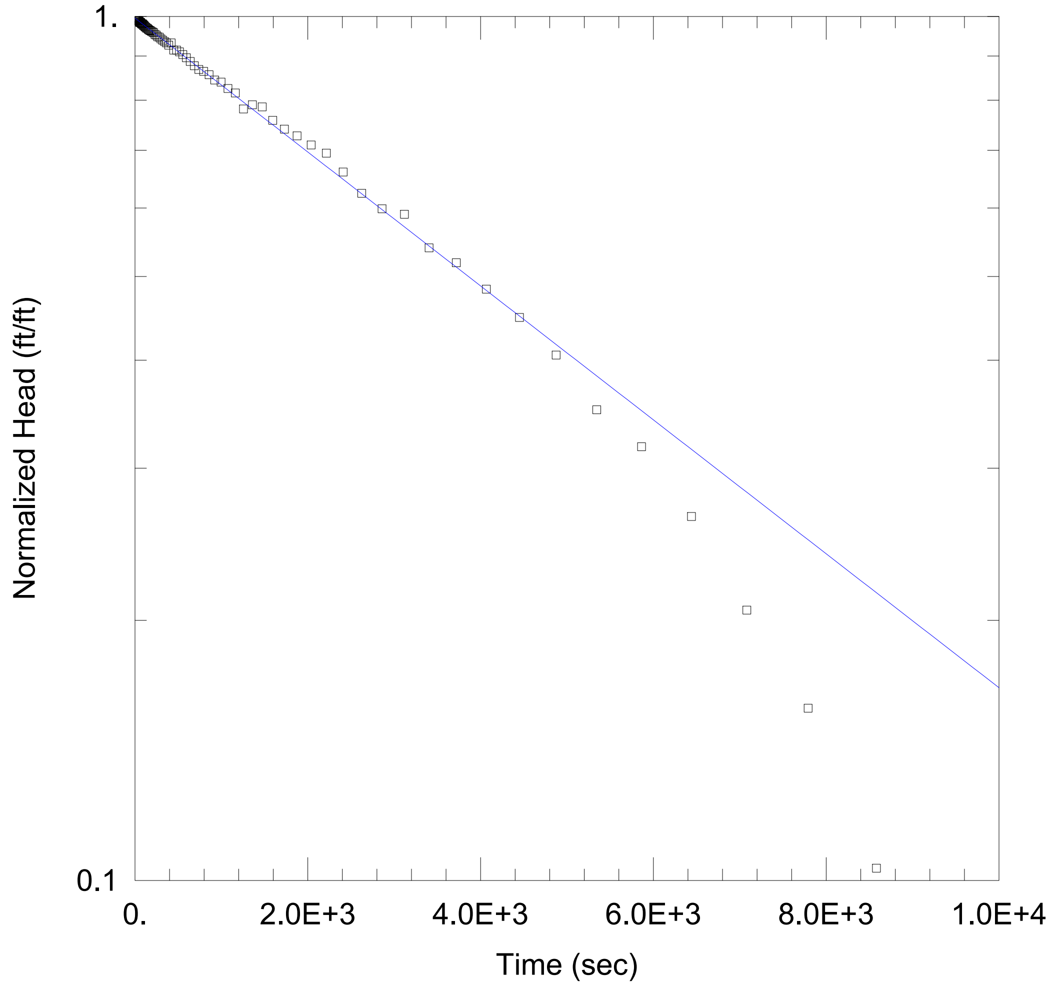
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 0.000237 cm/sec
Kz/Kr = 1.

Ss = 0.000183 ft^{-1}



44 FH1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/13/2021

AQUIFER DATA

Saturated Thickness: 0.7 ft
Anisotropy Ratio (Kz/Kr): 1.

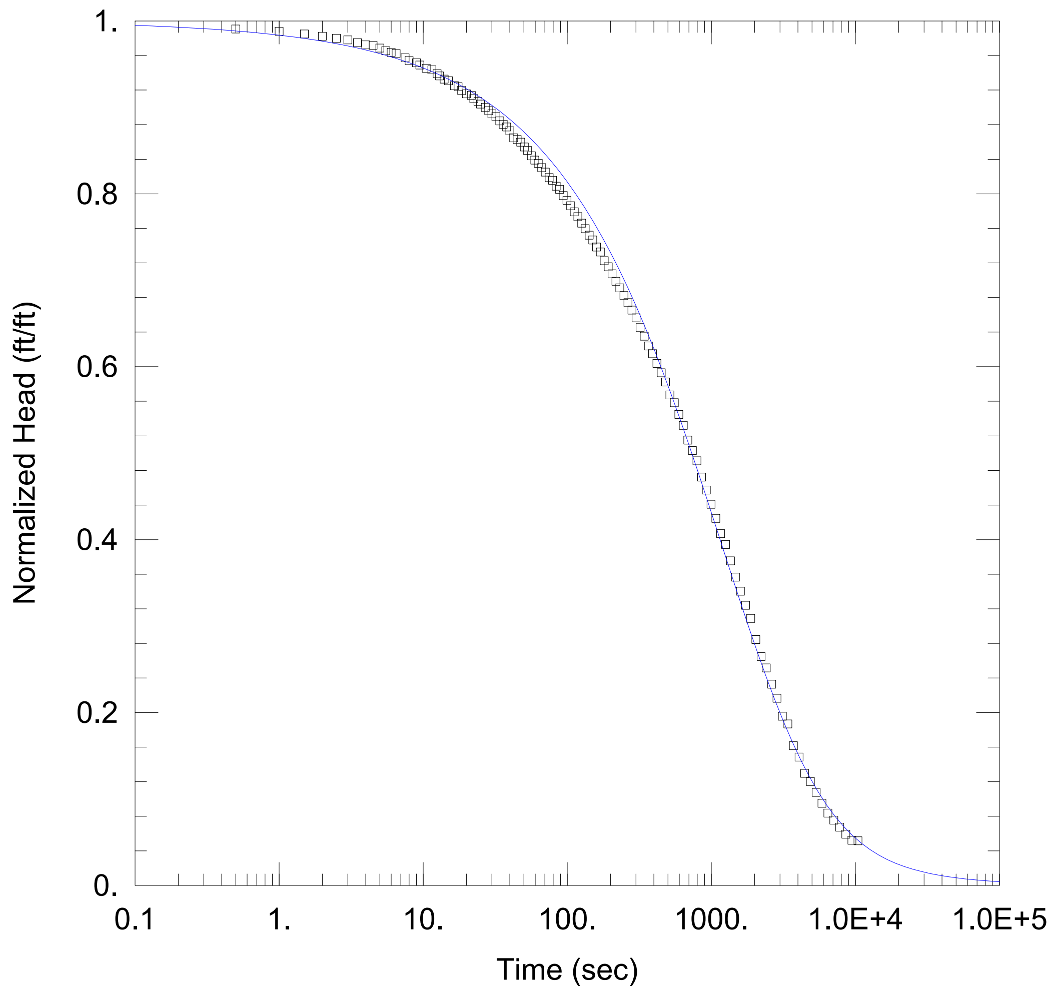
WELL DATA (44)

Initial Displacement: 0.91 ft
Total Well Penetration Depth: 0.7 ft
Casing Radius: 0.086 ft
Static Water Column Height: 33.57 ft
Screen Length: 0.7 ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.95E-5 cm/sec
y0 = 0.906 ft



101D FH1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 4/14/2021

AQUIFER DATA

Saturated Thickness: 5. ft
Anisotropy Ratio (Kz/Kr): 1.

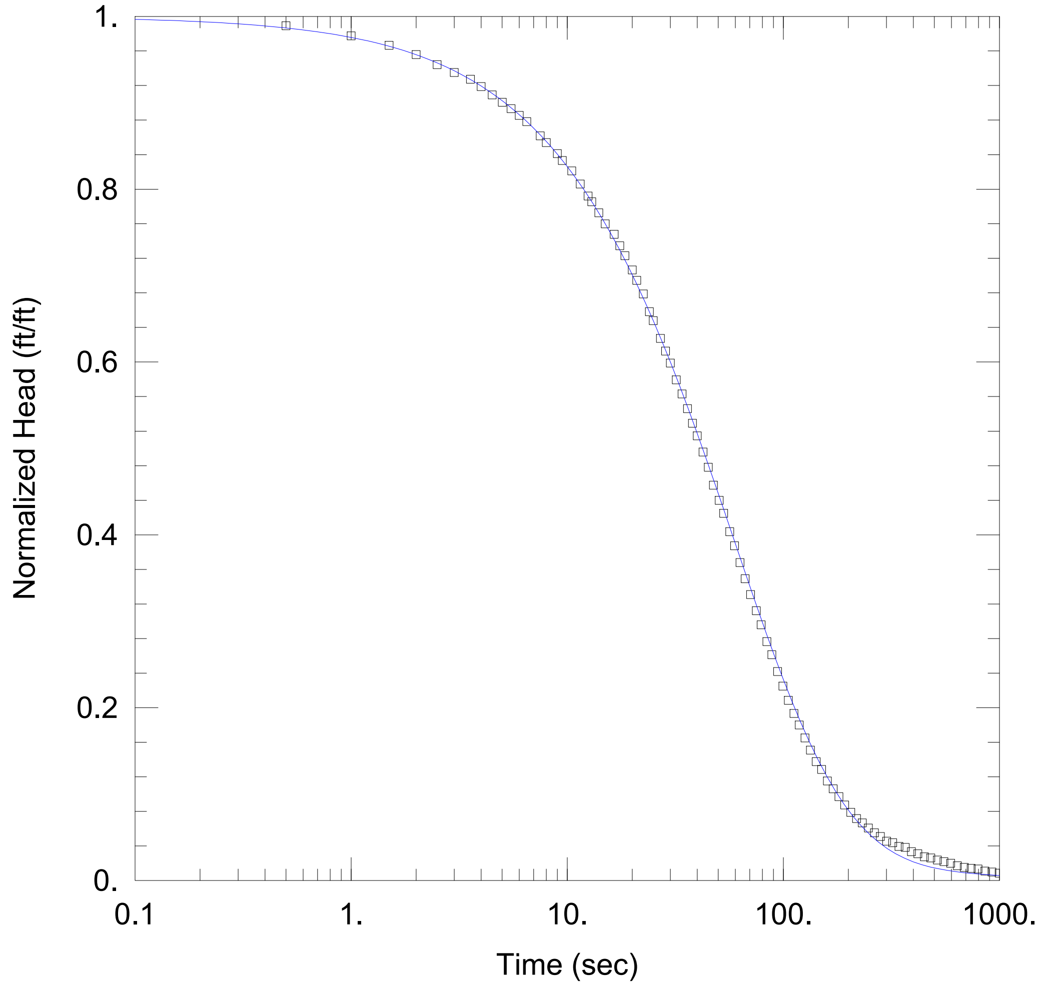
WELL DATA (101D)

Initial Displacement: 1.59 ft
Total Well Penetration Depth: 5. ft
Casing Radius: 0.083 ft
Static Water Column Height: 45.09 ft
Screen Length: 5. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 0.00398 cm^2/sec
S = 0.009



102D RH-1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/14/2021

AQUIFER DATA

Saturated Thickness: 7.7 ft

WELL DATA (102D)

Initial Displacement: 1.65 ft
Total Well Penetration Depth: 7.7 ft
Casing Radius: 0.086 ft

Static Water Column Height: 37.26 ft
Screen Length: 7.7 ft
Well Radius: 0.25 ft

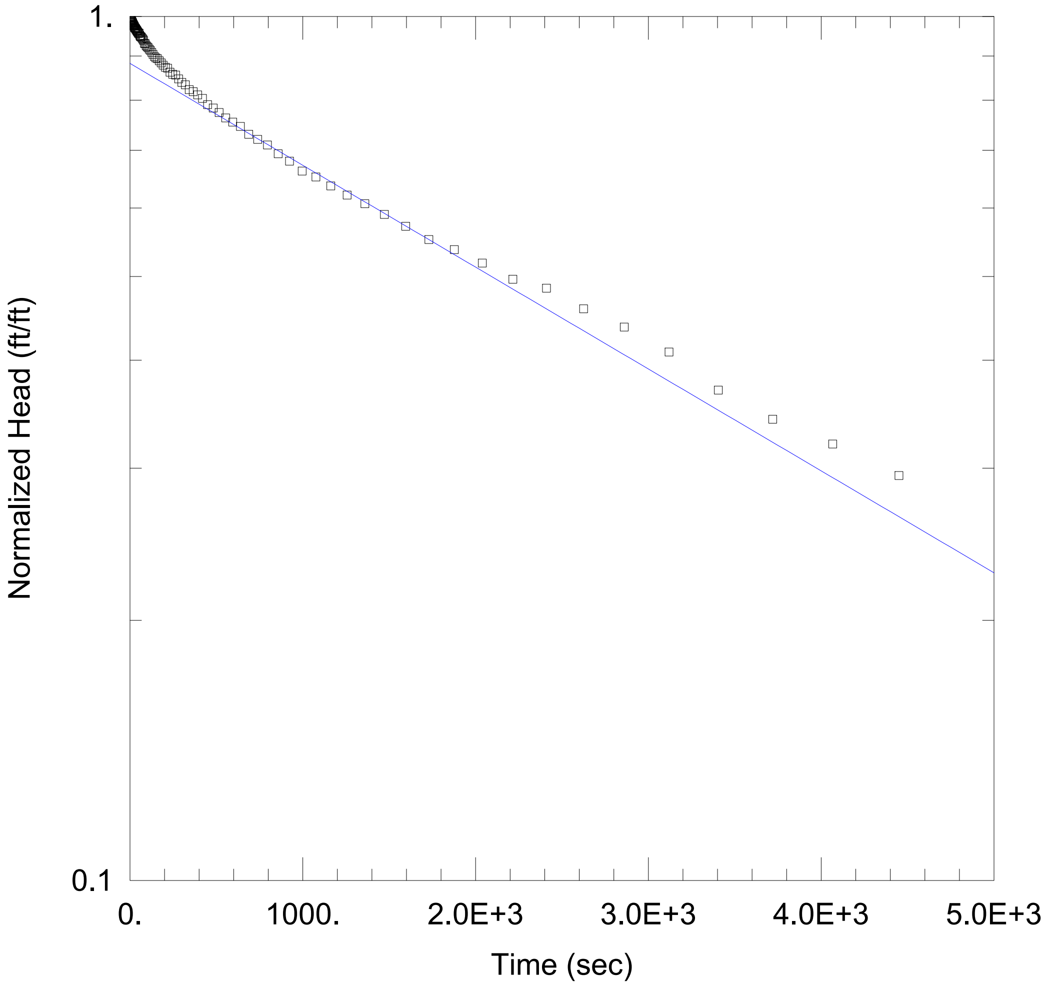
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 0.0013 cm/sec
Kz/Kr = 1.

Ss = 1.68E-7 ft^{-1}



103D FH1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 4/15/2021

AQUIFER DATA

Saturated Thickness: 6. ft
Anisotropy Ratio (Kz/Kr): 1.

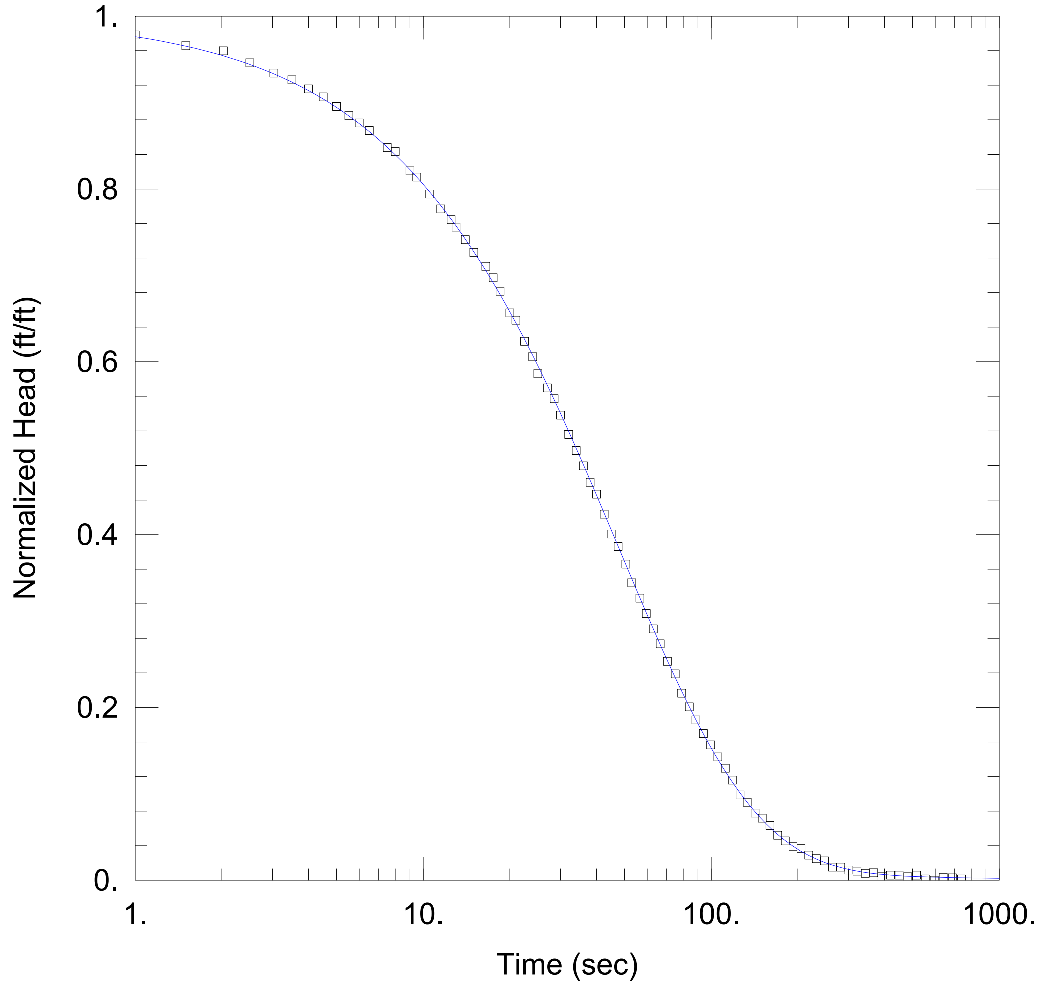
WELL DATA (103D)

Initial Displacement: 1.7 ft
Total Well Penetration Depth: 6. ft
Casing Radius: 0.083 ft
Static Water Column Height: 30.61 ft
Screen Length: 6. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.13E-5 cm/sec
y0 = 1.5 ft



104D FH-2

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/13/2021

AQUIFER DATA

Saturated Thickness: 1.2 ft

WELL DATA (104D)

Initial Displacement: 1.52 ft
Total Well Penetration Depth: 1.2 ft
Casing Radius: 0.086 ft

Static Water Column Height: 129.4 ft
Screen Length: 1.2 ft
Well Radius: 0.25 ft

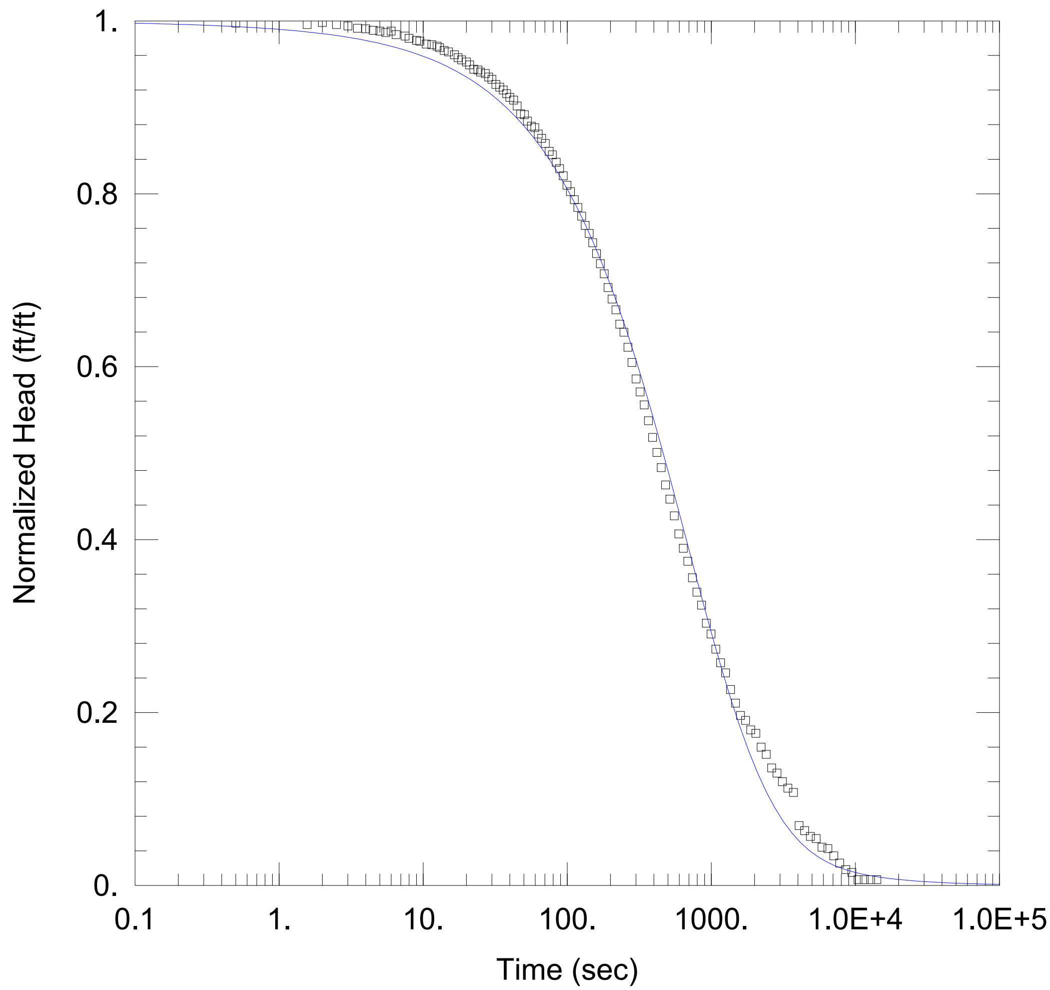
SOLUTION

Aquifer Model: Confined

Kr = 0.0219 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 2.44E-12 ft^{-1}



105D FH-1

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/19/2021

AQUIFER DATA

Saturated Thickness: 1.5 ft

WELL DATA (105D)

Initial Displacement: 1.2 ft
Total Well Penetration Depth: 1.5 ft
Casing Radius: 0.086 ft

Static Water Column Height: 22.13 ft
Screen Length: 1.5 ft
Well Radius: 0.25 ft

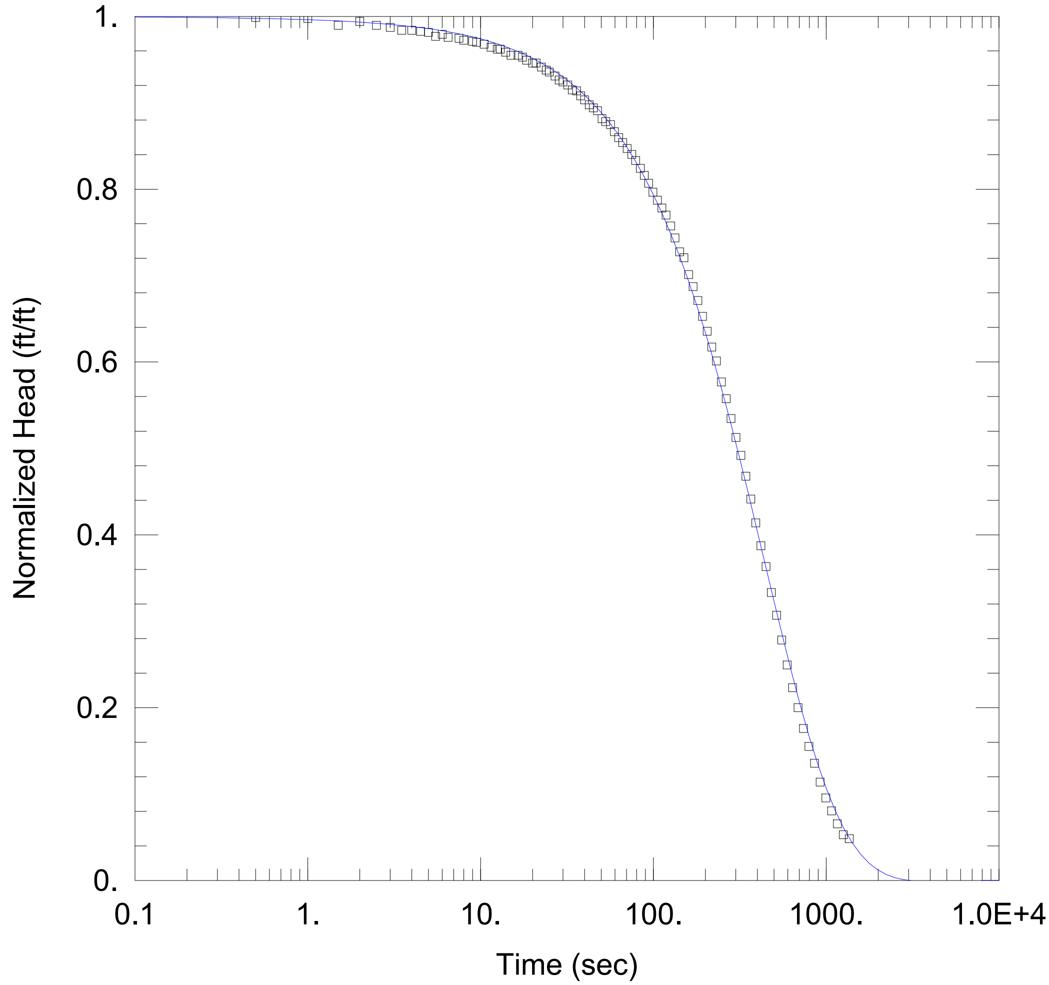
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 0.000273 cm/sec
Kz/Kr = 1.

Ss = 0.000412 ft^{-1}



ND2 RH-2

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/15/2021

AQUIFER DATA

Saturated Thickness: 24. ft

WELL DATA (ND2)

Initial Displacement: 0.87 ft
Total Well Penetration Depth: 11.15 ft
Casing Radius: 0.083 ft

Static Water Column Height: 11.15 ft
Screen Length: 11.15 ft
Well Radius: 0.33 ft

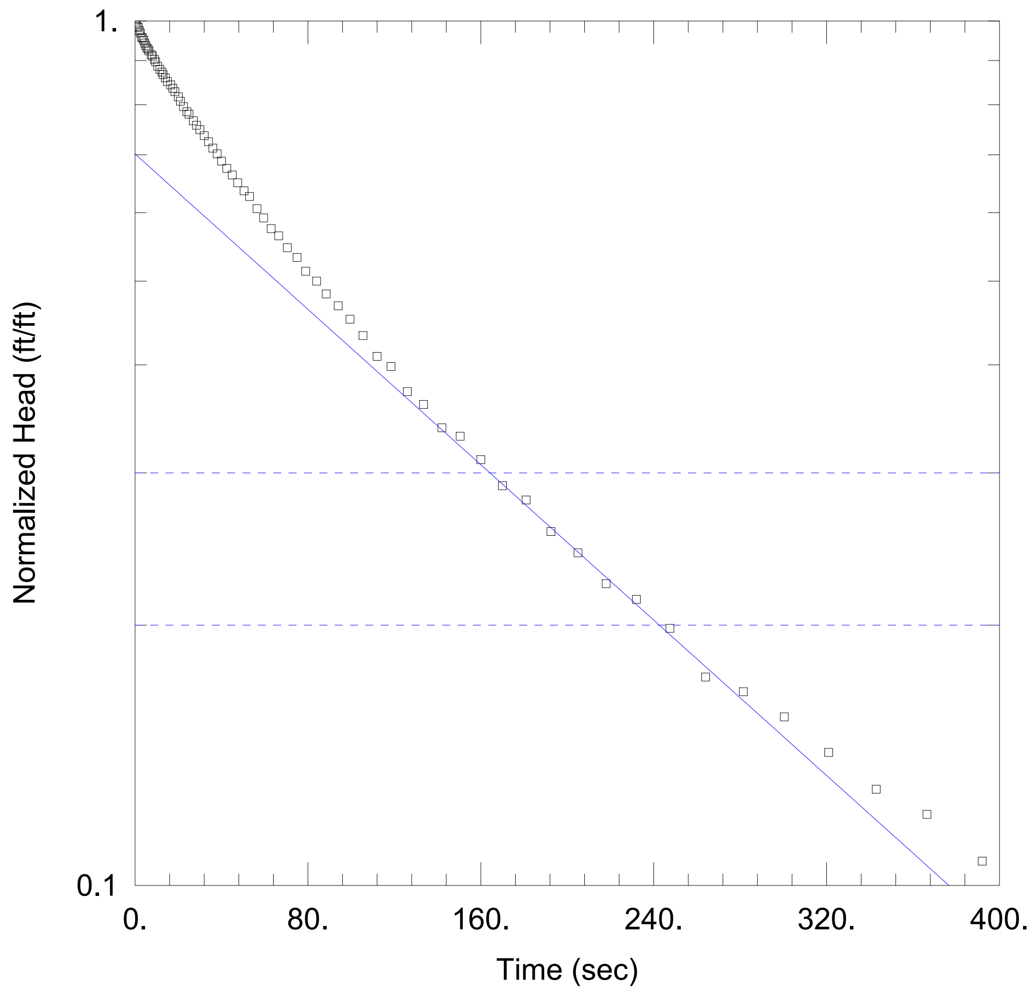
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 4.84E-5 cm/sec
Kz/Kr = 1.

Ss = 6.45E-7 ft^{-1}



ND3 RH2

PROJECT INFORMATION

Company: Ramboll
Client: Dynegy Midwest Generation, LLC
Location: Vermilion Power Plant
Test Date: 04/15/2021

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.

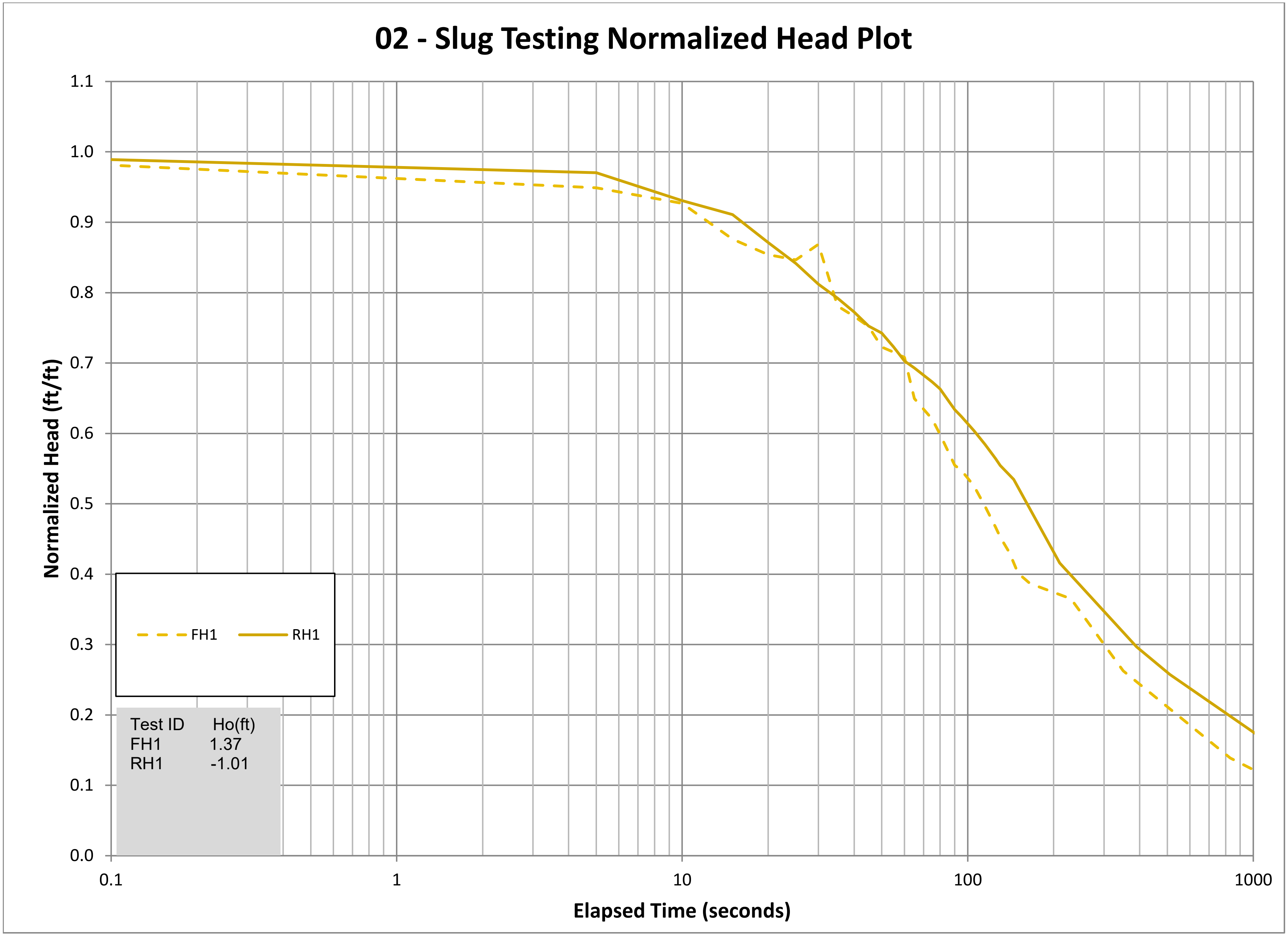
WELL DATA (ND3)

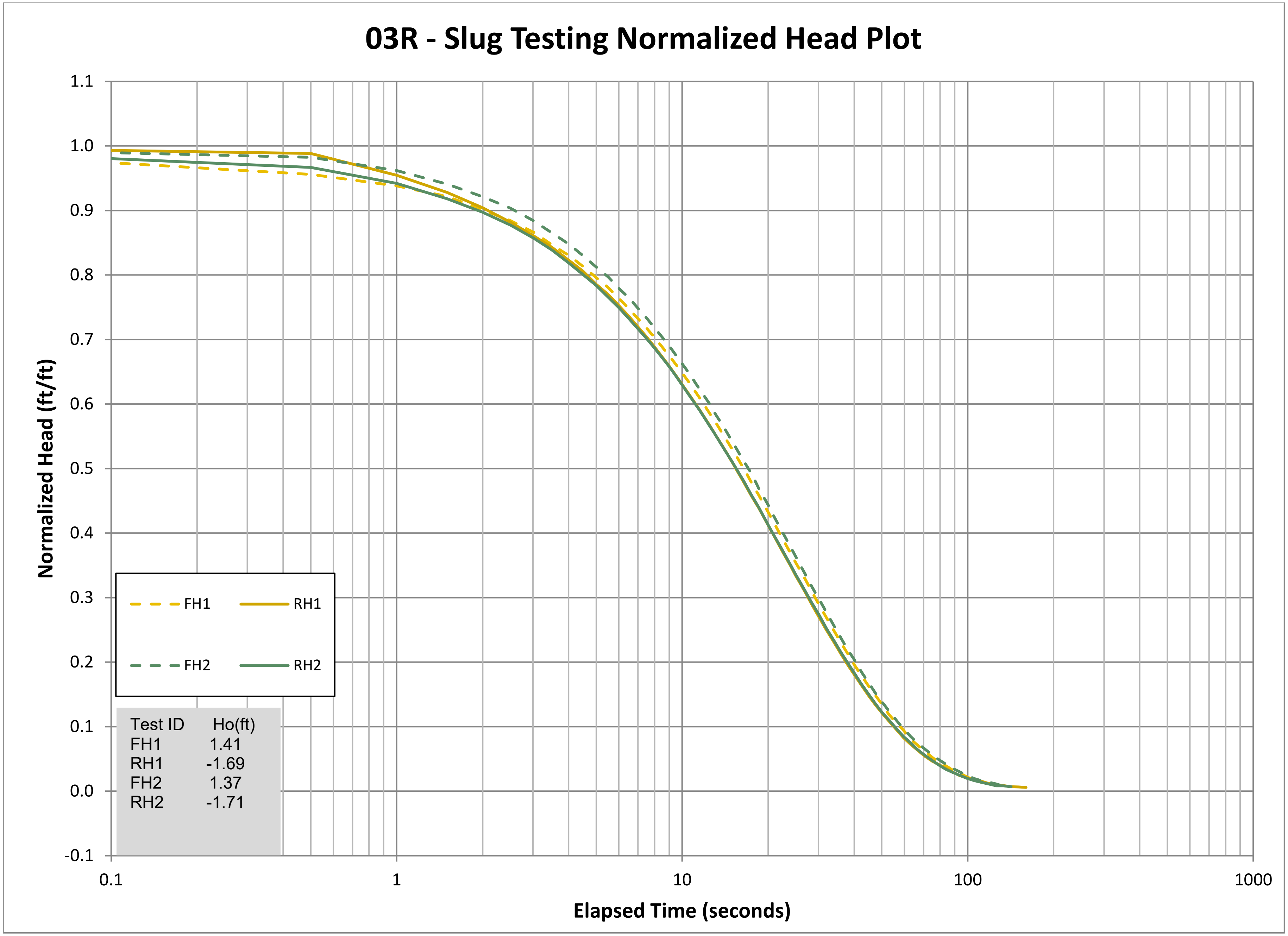
Initial Displacement: 1.2 ft
Static Water Column Height: 11.15 ft
Total Well Penetration Depth: 11.15 ft
Screen Length: 11.15 ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft

SOLUTION

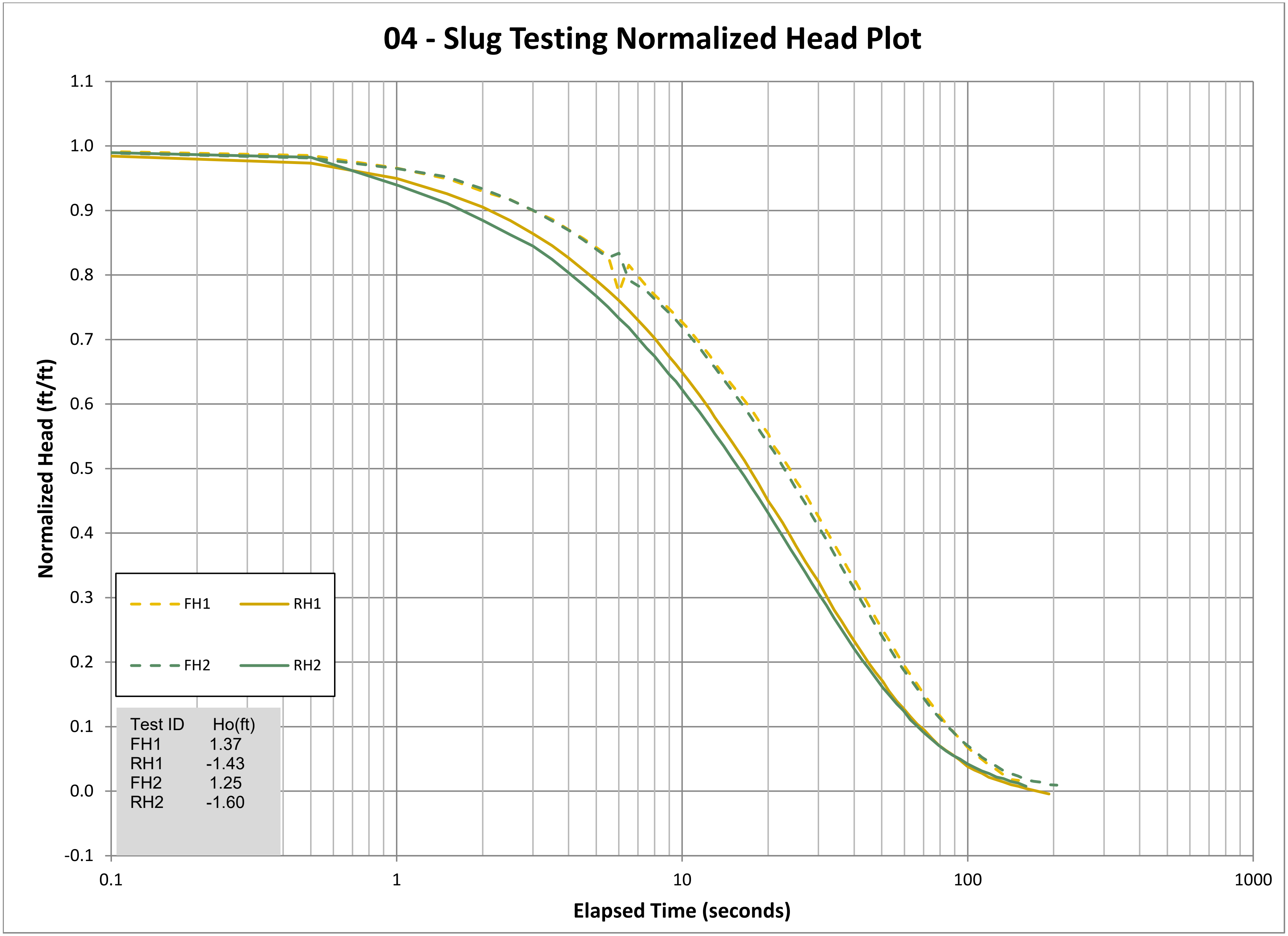
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

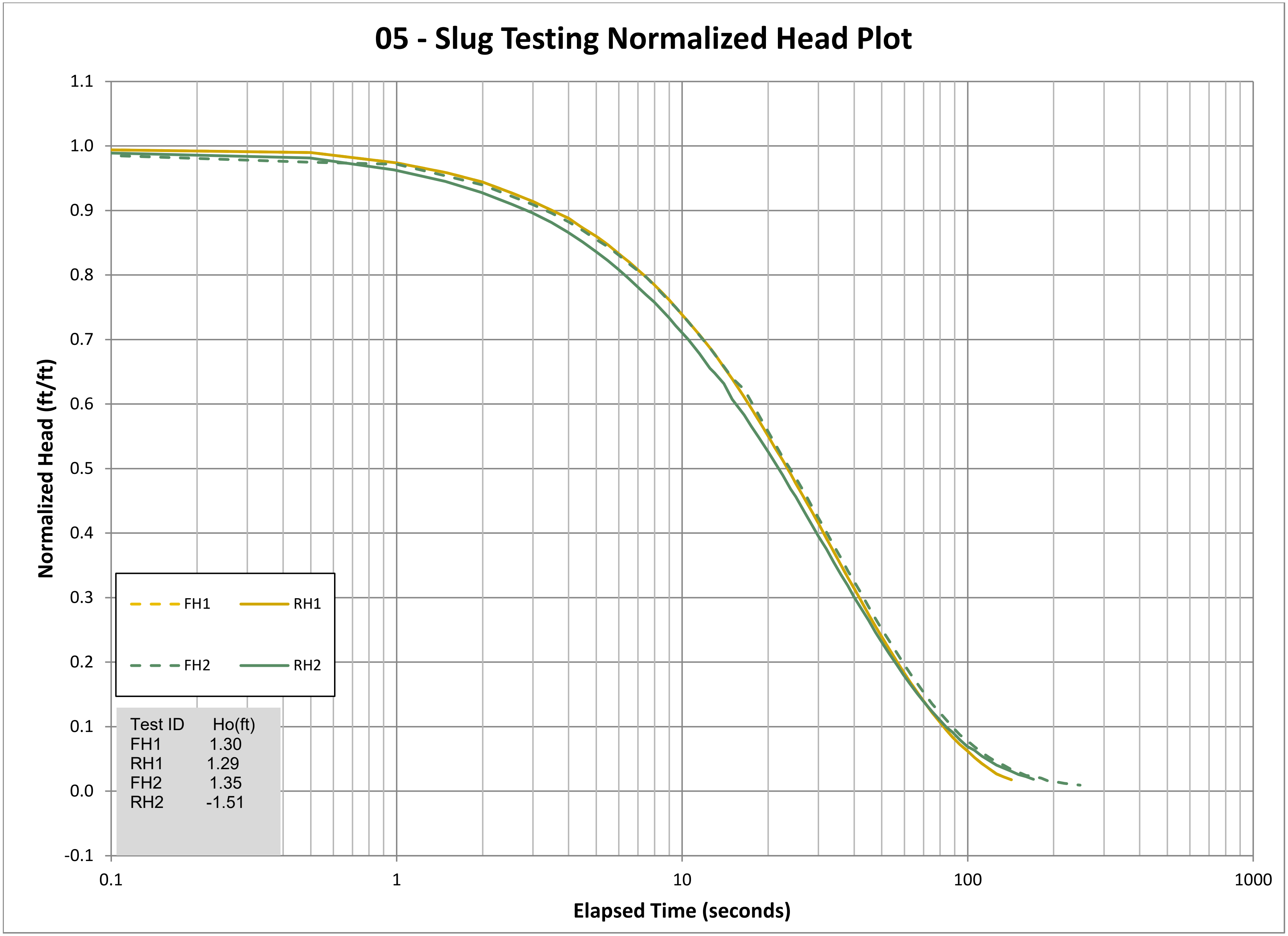
K = 0.000125 cm/sec
y0 = 0.842 ft

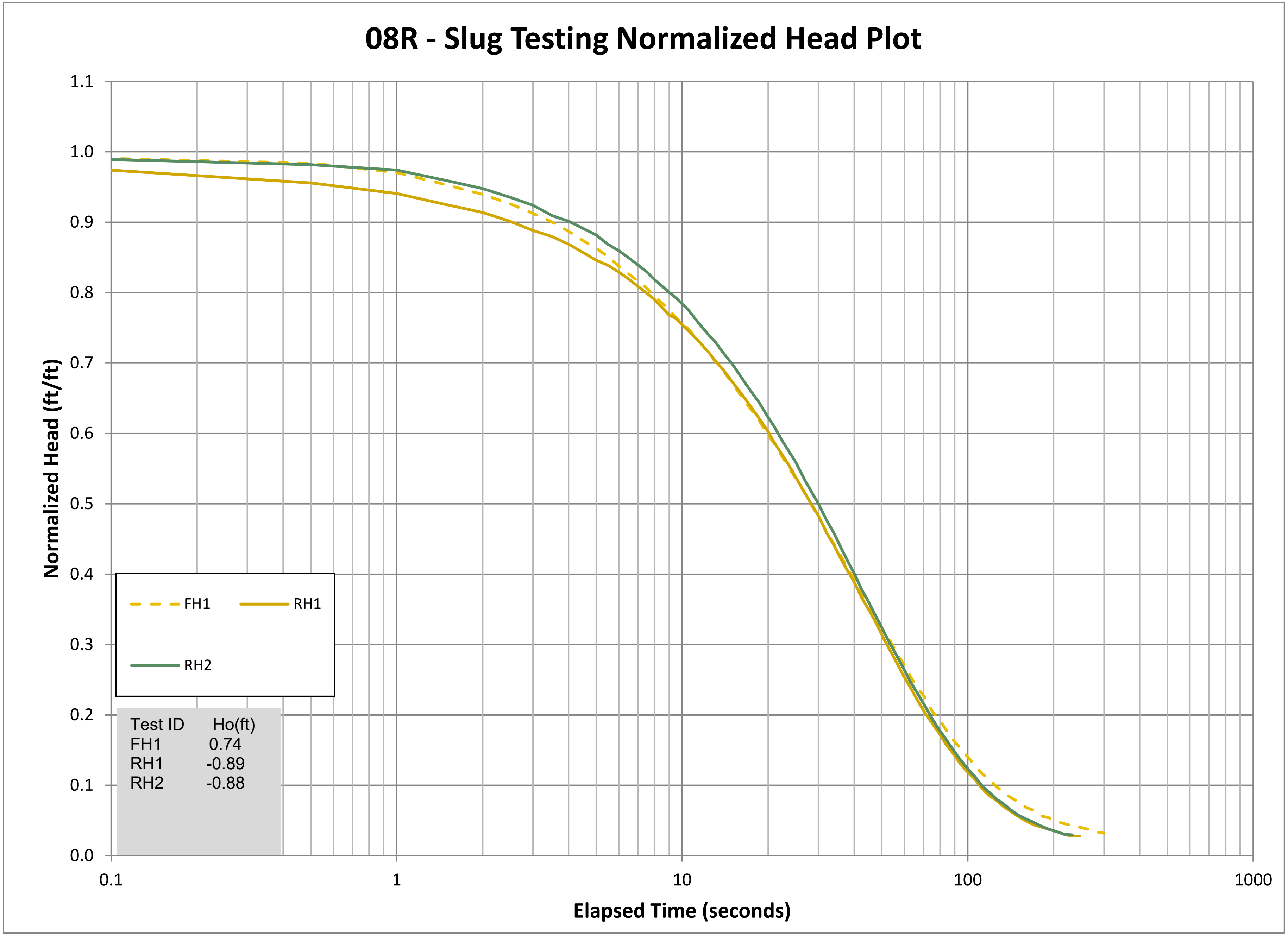

02 - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
1
10
100
1000
Elapsed Time (seconds)
FH1
RH1
Test ID Ho(ft)
FH1 1.37
RH1 -1.01

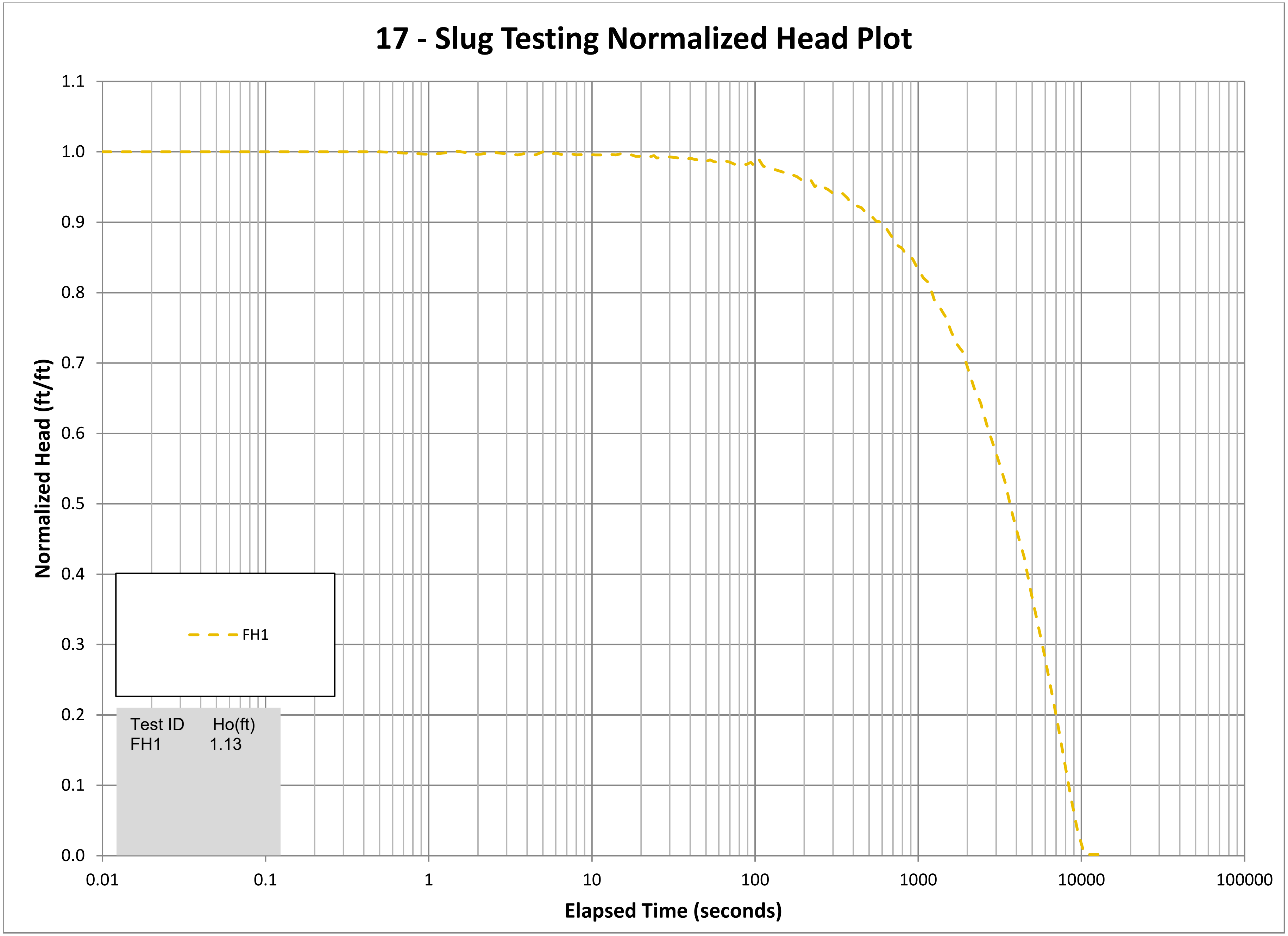


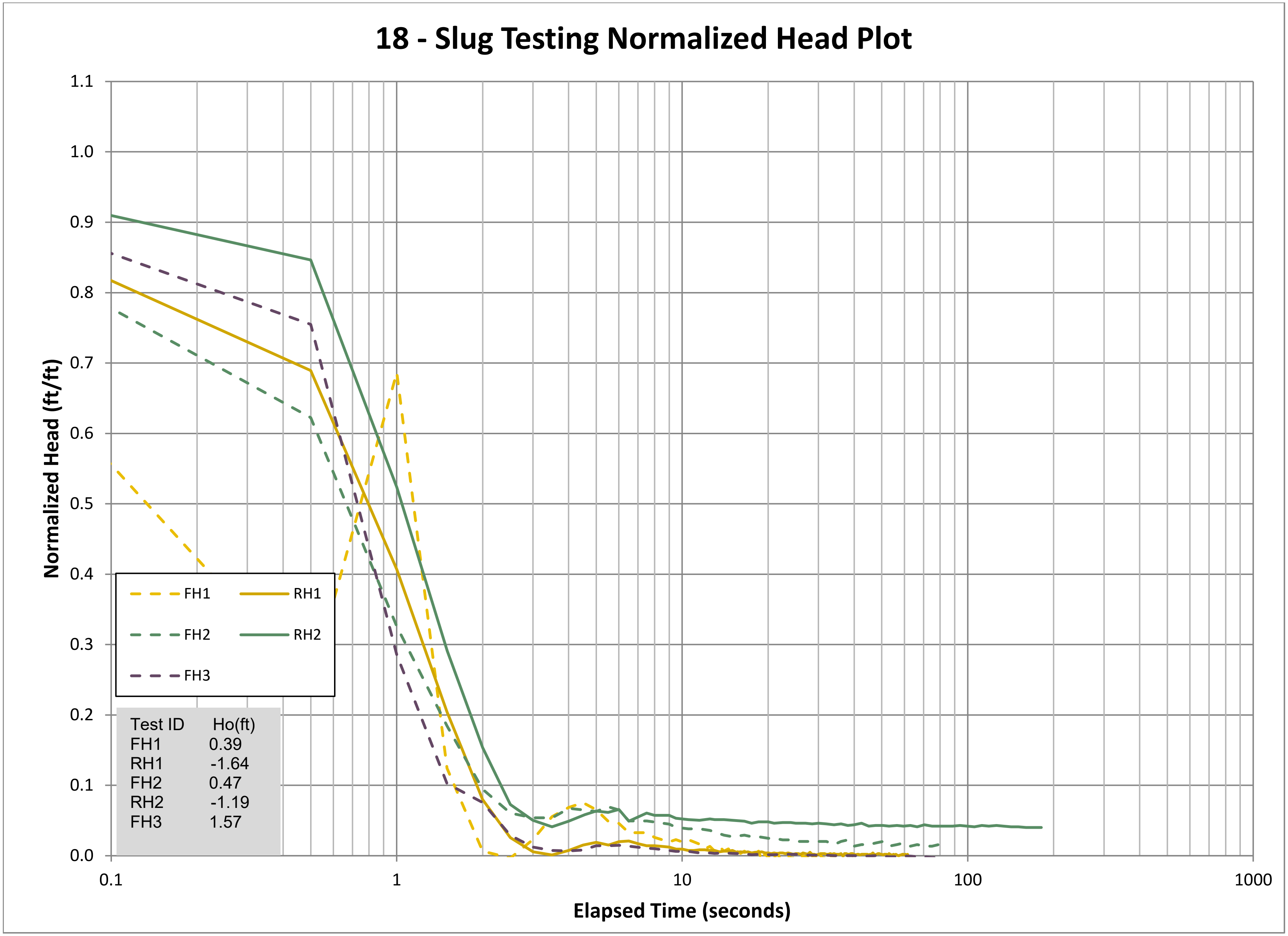
03R - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
Elapsed Time (seconds)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0.1
1
10
100
1000
FH1
RH1
FH2
RH2
Test ID Ho(ft)
FH1 1.41
RH1 -1.69
FH2 1.37
RH2 -1.71


04 - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0.1
1
10
100
1000
Elapsed Time (seconds)
FH1
RH1
FH2
RH2
Test ID Ho(ft)
FH1 1.37
RH1 -1.43
FH2 1.25
RH2 -1.60

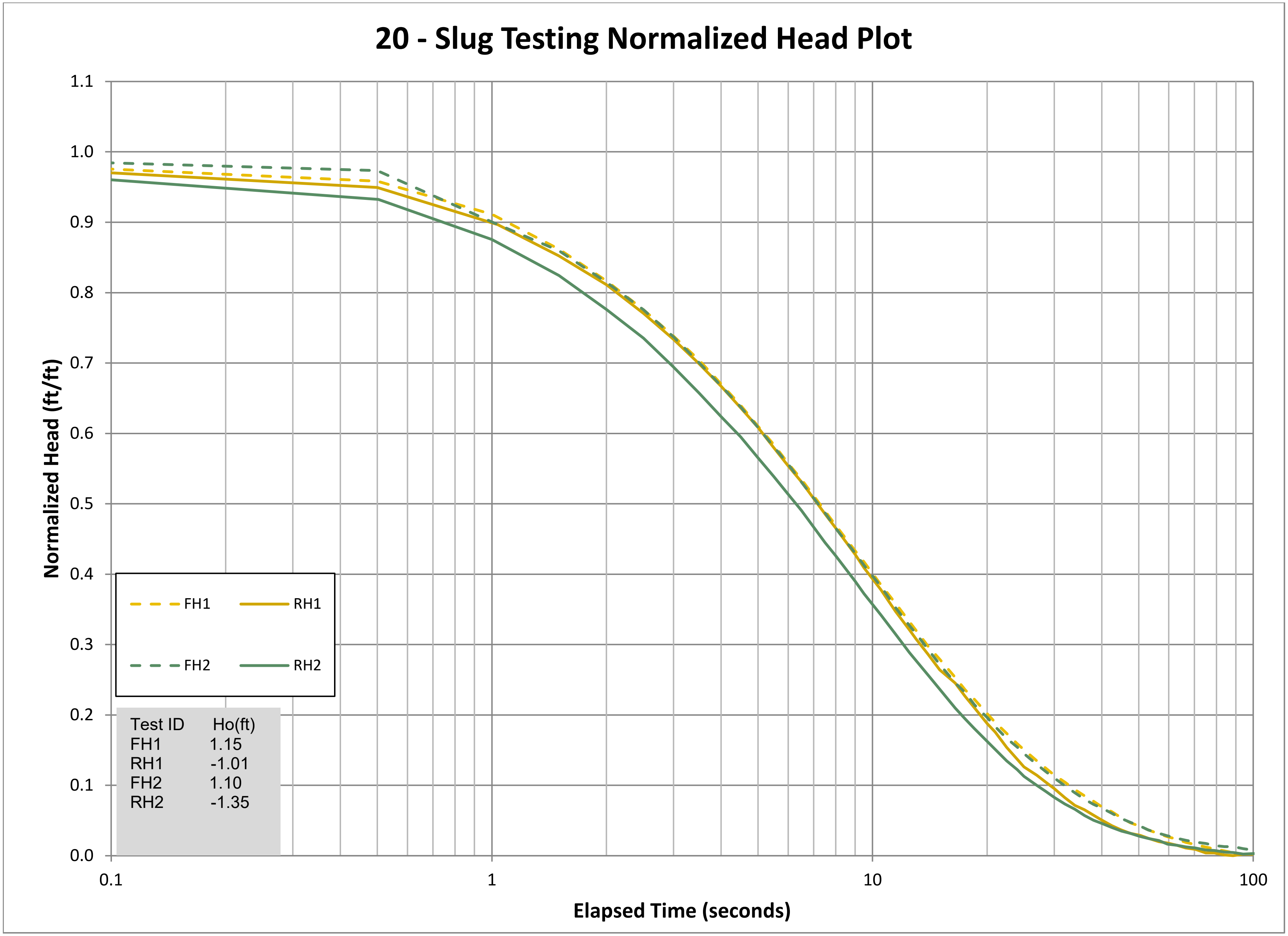

05 - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0.1
1
10
100
1000
Elapsed Time (seconds)
FH1
RH1
FH2
RH2
Test ID Ho(ft)
FH1 1.30
RH1 1.29
FH2 1.35
RH2 -1.51

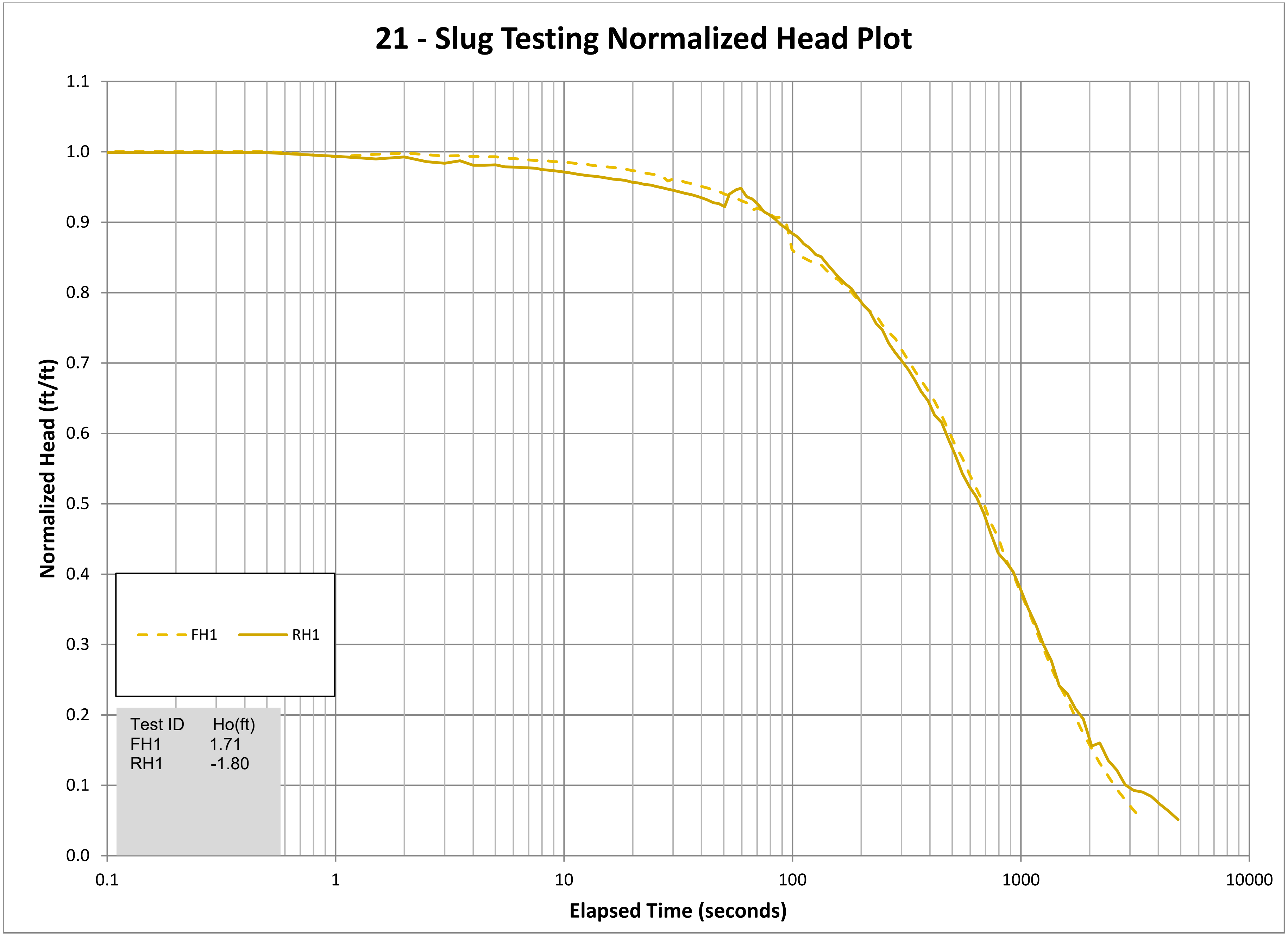

08R - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
1
10
100
1000
Elapsed Time (seconds)
FH1
RH1
RH2
Test ID Ho(ft)
FH1 0.74
RH1 -0.89
RH2 -0.88

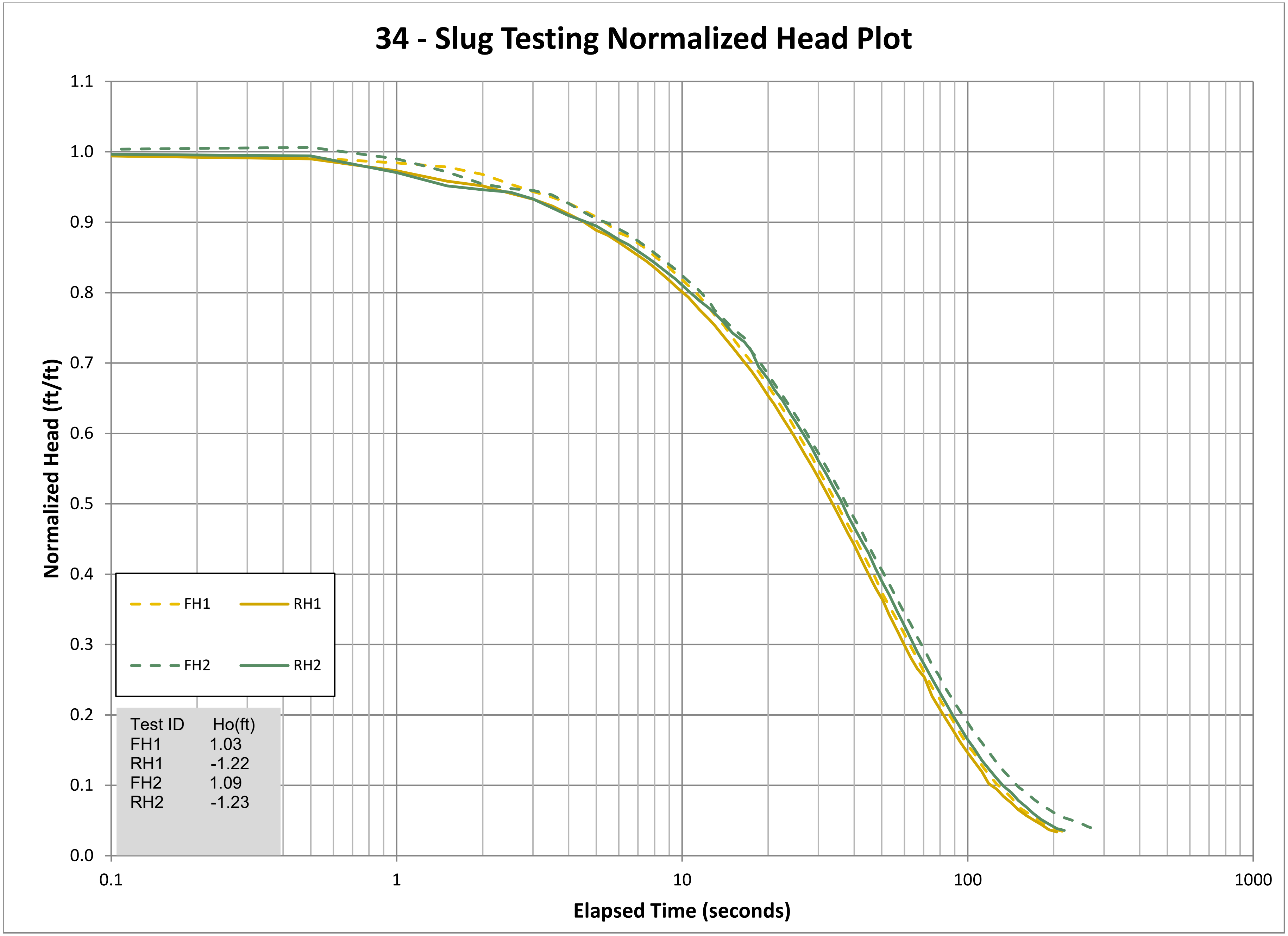

17 - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.01
0.1
1
10
100
1000
10000
100000
Elapsed Time (seconds)
FH1
Test ID Ho(ft)
FH1 1.13



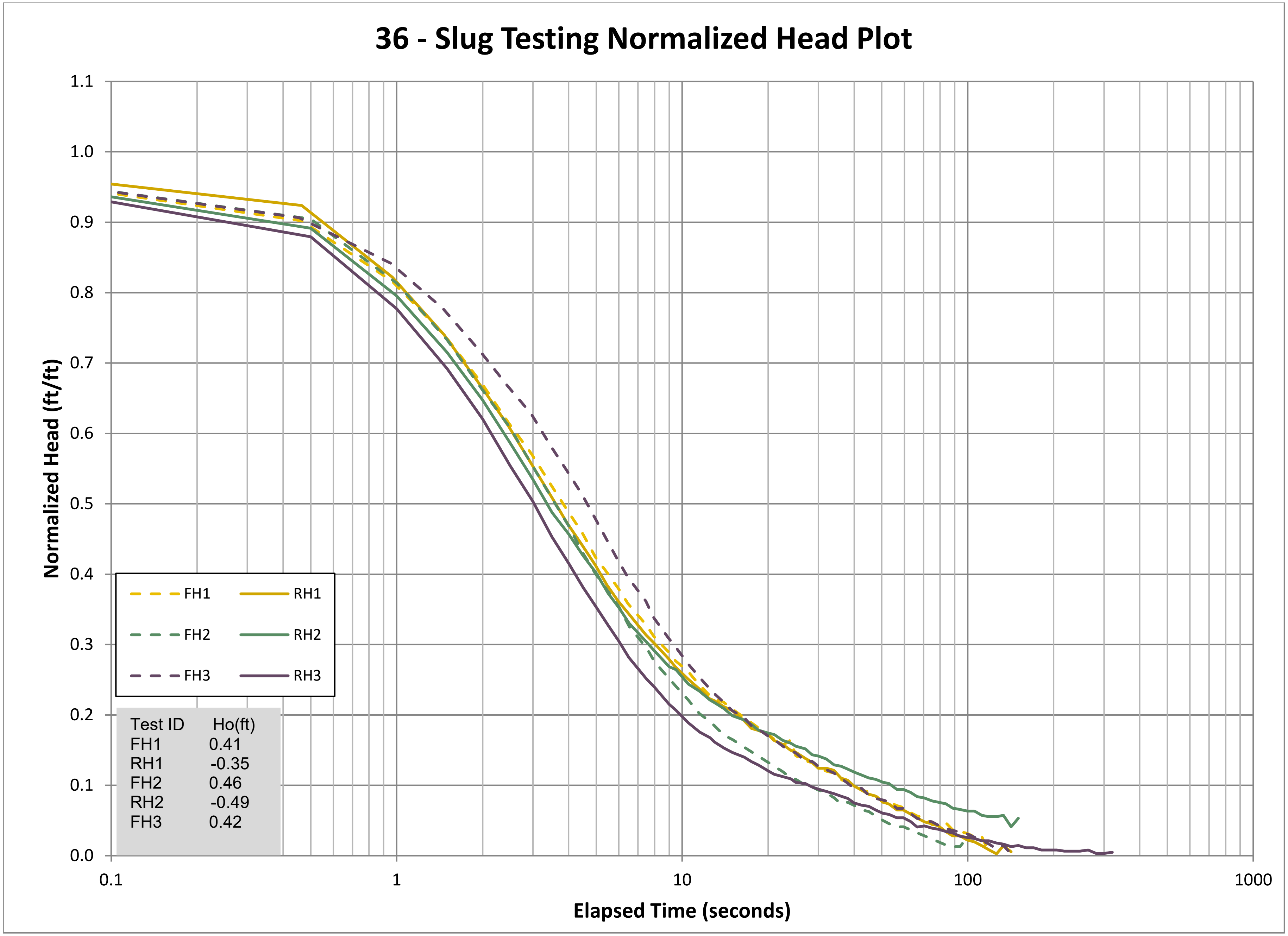
18 - Slug Testing Normalized Head Plot
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Normalized Head (ft/ft)
0.1
1
10
100
1000
Elapsed Time (seconds)
FH1
RH1
FH2
RH2
FH3
Test ID Ho(ft)
FH1 0.39
RH1 -1.64
FH2 0.47
RH2 -1.19
FH3 1.57

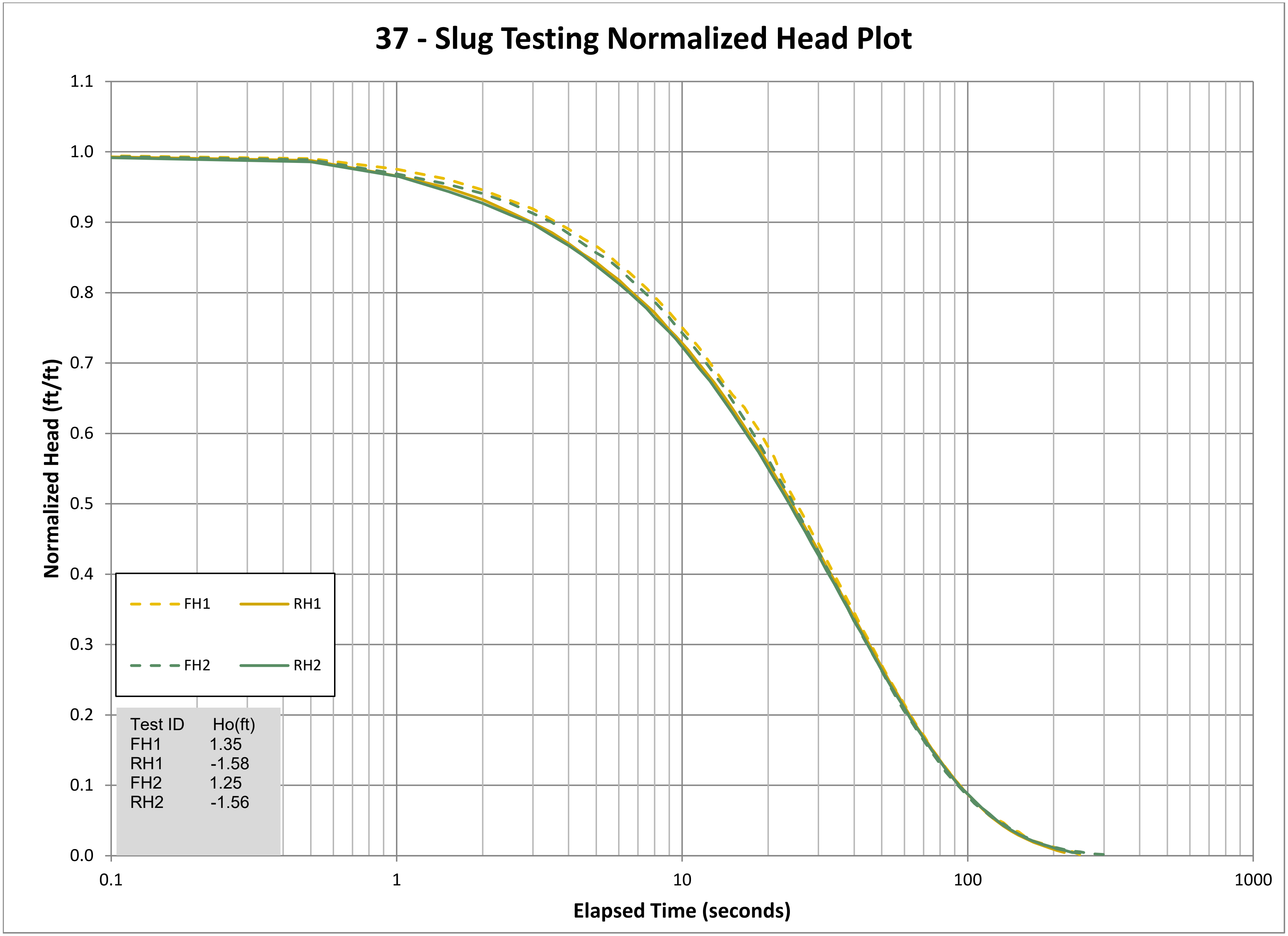

20 - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
Elapsed Time (seconds)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
1
10
100
FH1
RH1
FH2
RH2
Test ID Ho(ft)
FH1 1.15
RH1 -1.01
FH2 1.10
RH2 -1.35


21 - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
Elapsed Time (seconds)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
1
10
100
1000
10000
FH1
RH1
Test ID Ho(ft)
FH1 1.71
RH1 -1.80

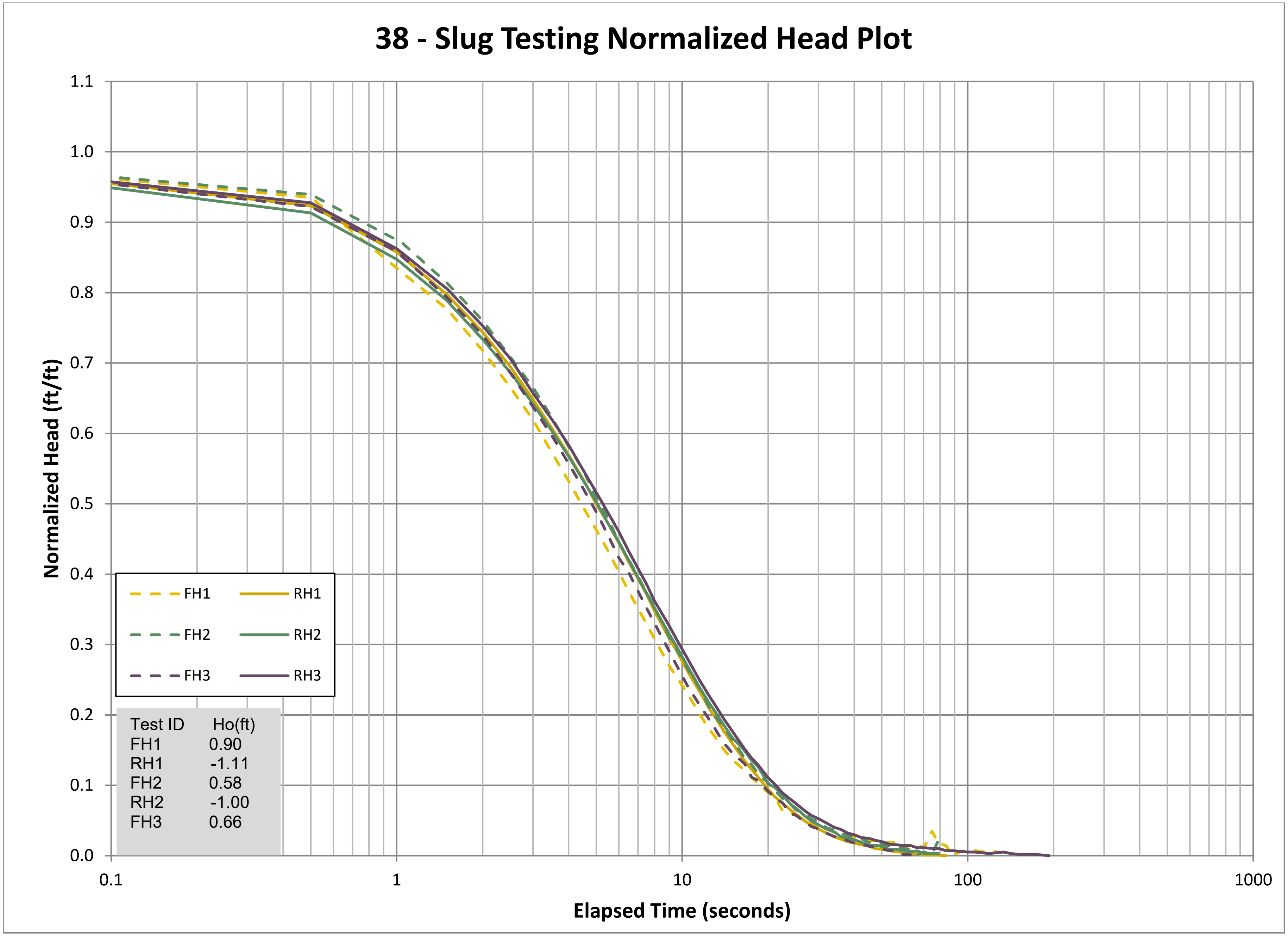


34 - Slug Testing Normalized Head Plot
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Normalized Head (ft/ft)
0.1
1
10
100
1000
Elapsed Time (seconds)
FH1
RH1
FH2
RH2
Test ID Ho(ft)
FH1 1.03
RH1 -1.22
FH2 1.09
RH2 -1.23

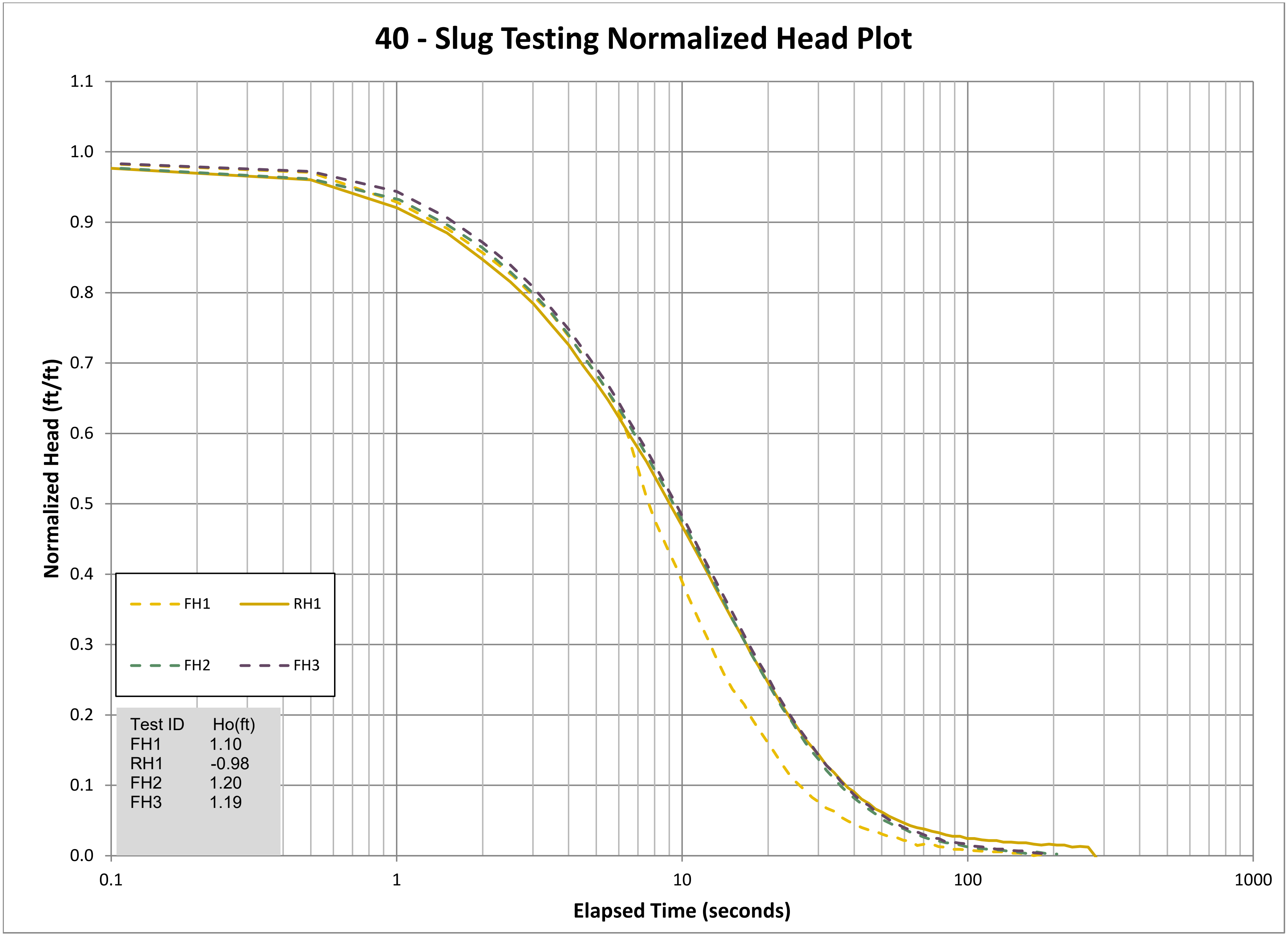

36 - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
1
10
100
1000
Elapsed Time (seconds)
FH1
RH1
FH2
RH2
FH3
RH3
Test ID Ho(ft)
FH1 0.41
RH1 -0.35
FH2 0.46
RH2 -0.49
FH3 0.42

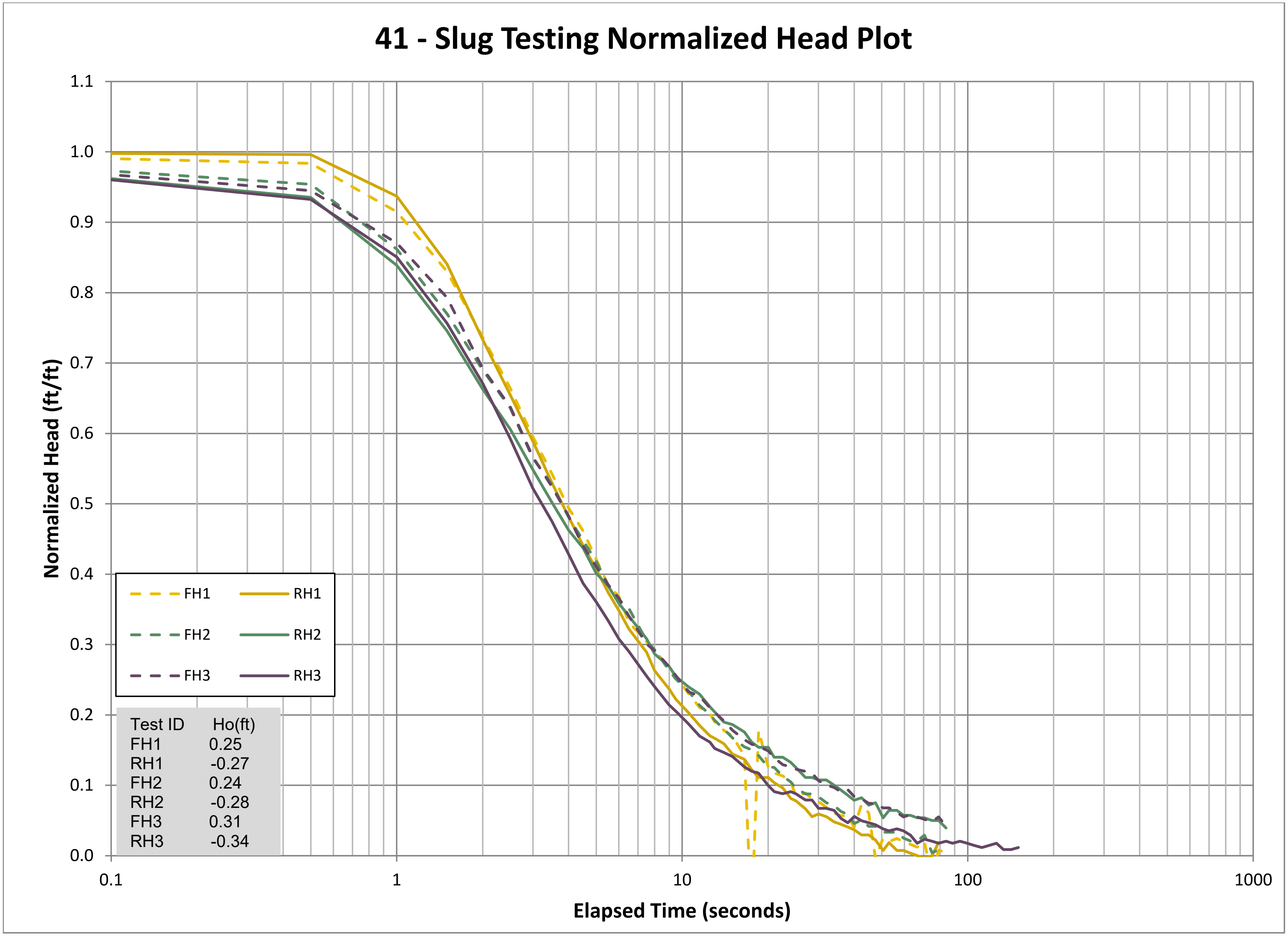


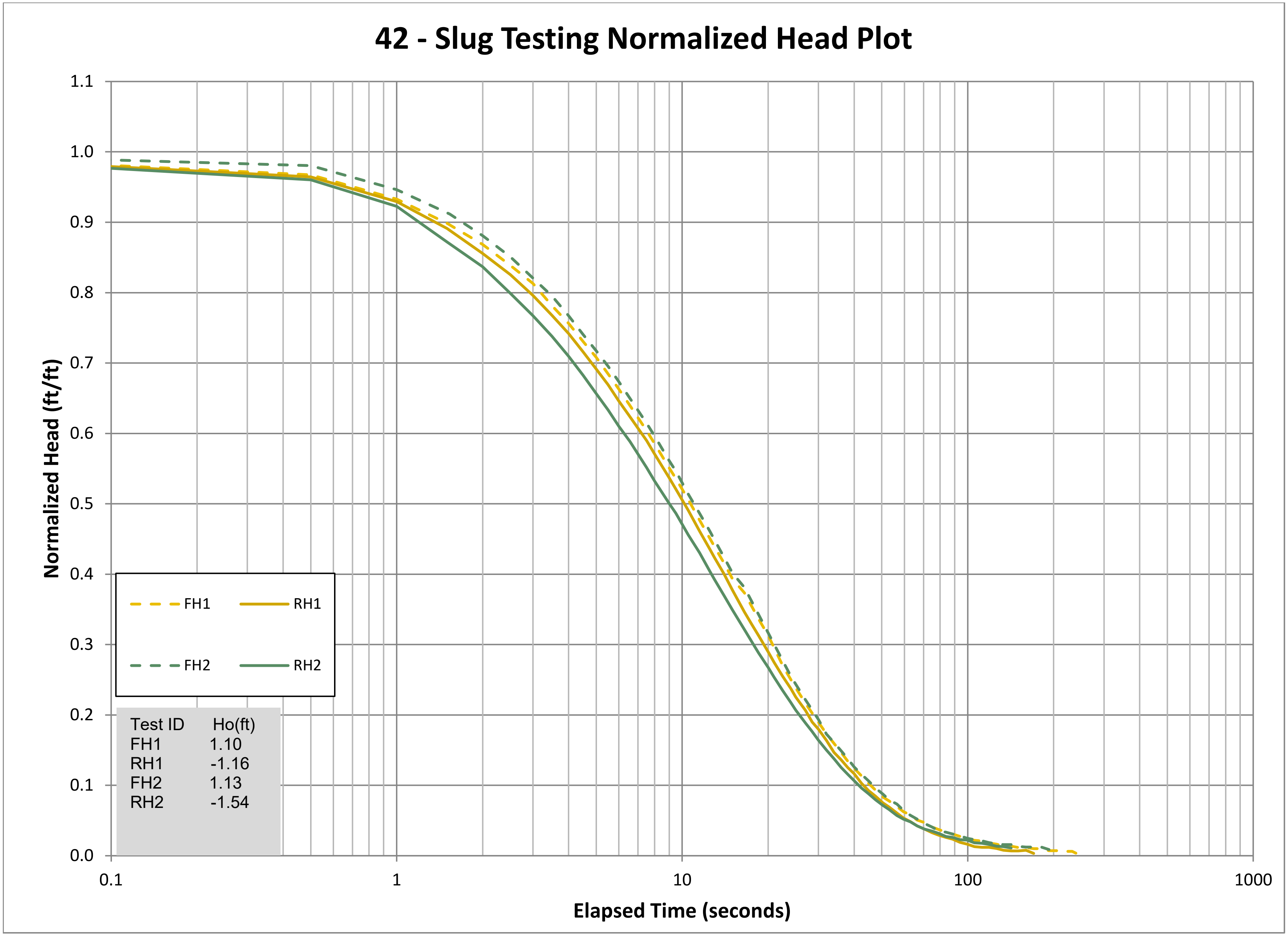
37 - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
Elapsed Time (seconds)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
1
10
100
1000
FH1
RH1
FH2
RH2
Test ID Ho(ft)
FH1 1.35
RH1 -1.58
FH2 1.25
RH2 -1.56



38 - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
1
10
100
1000
Elapsed Time (seconds)
FH1
RH1
FH2
RH2
FH3
RH3
Test ID Ho(ft)
FH1 0.90
RH1 -1.11
FH2 0.58
RH2 -1.00
FH3 0.66


40 - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
Elapsed Time (seconds)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
1
10
100
1000
FH1
RH1
FH2
FH3
Test ID Ho(ft)
FH1 1.10
RH1 -0.98
FH2 1.20
FH3 1.19


41 - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
Elapsed Time (seconds)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
1
10
100
1000
FH1
RH1
FH2
RH2
FH3
RH3
Test ID Ho(ft)
FH1 0.25
RH1 -0.27
FH2 0.24
RH2 -0.28
FH3 0.31
RH3 -0.34



42 - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
1
10
100
1000
Elapsed Time (seconds)
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RH1
FH2
RH2
Test ID Ho(ft)
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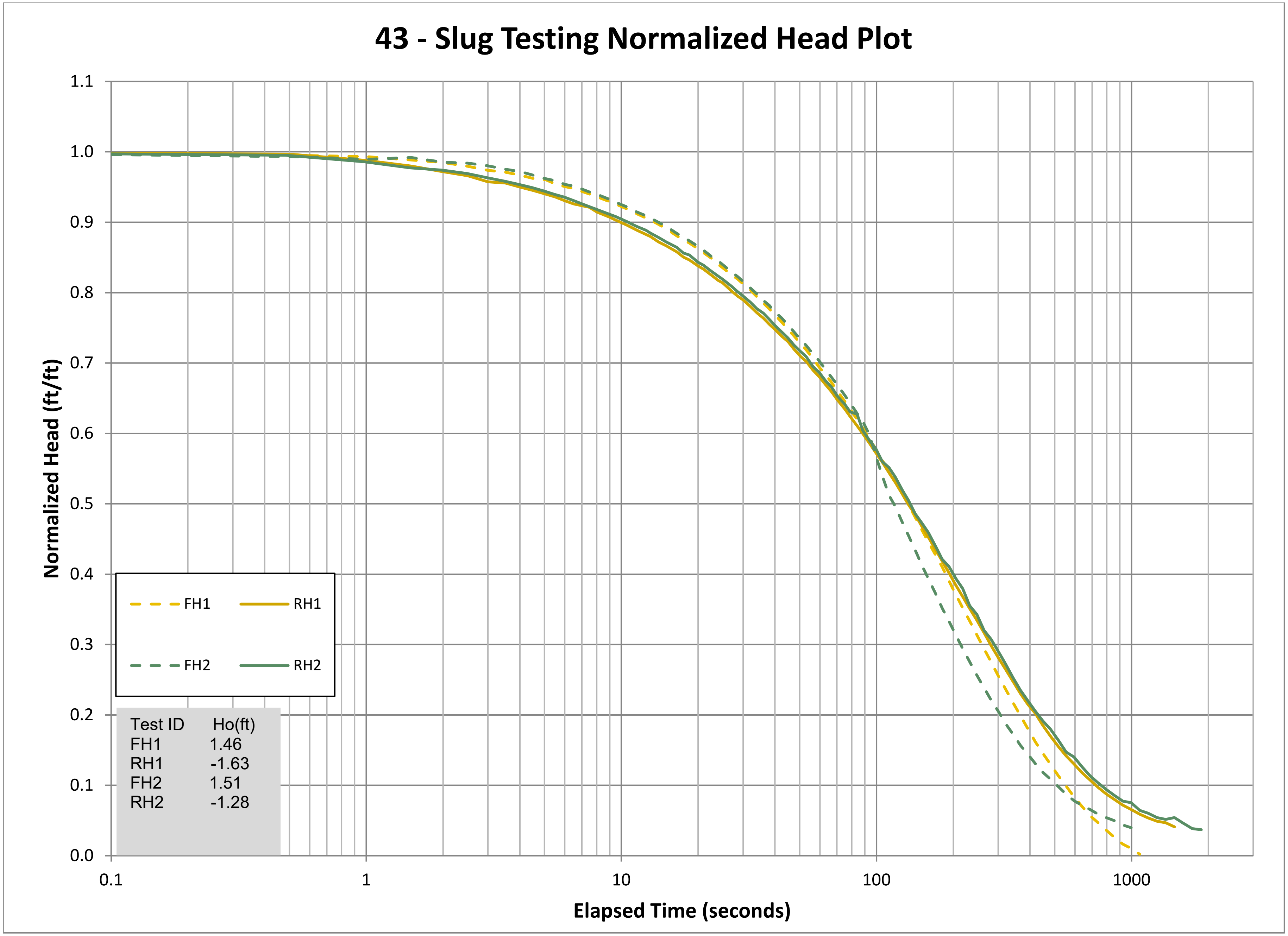
RH1 -1.16
FH2 1.13
RH2 -1.54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0.5
0.4
0.3
0.2
0.1
0.0
0.1
1
10
100
1000
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RH1
FH2
RH2
Test ID Ho(ft)
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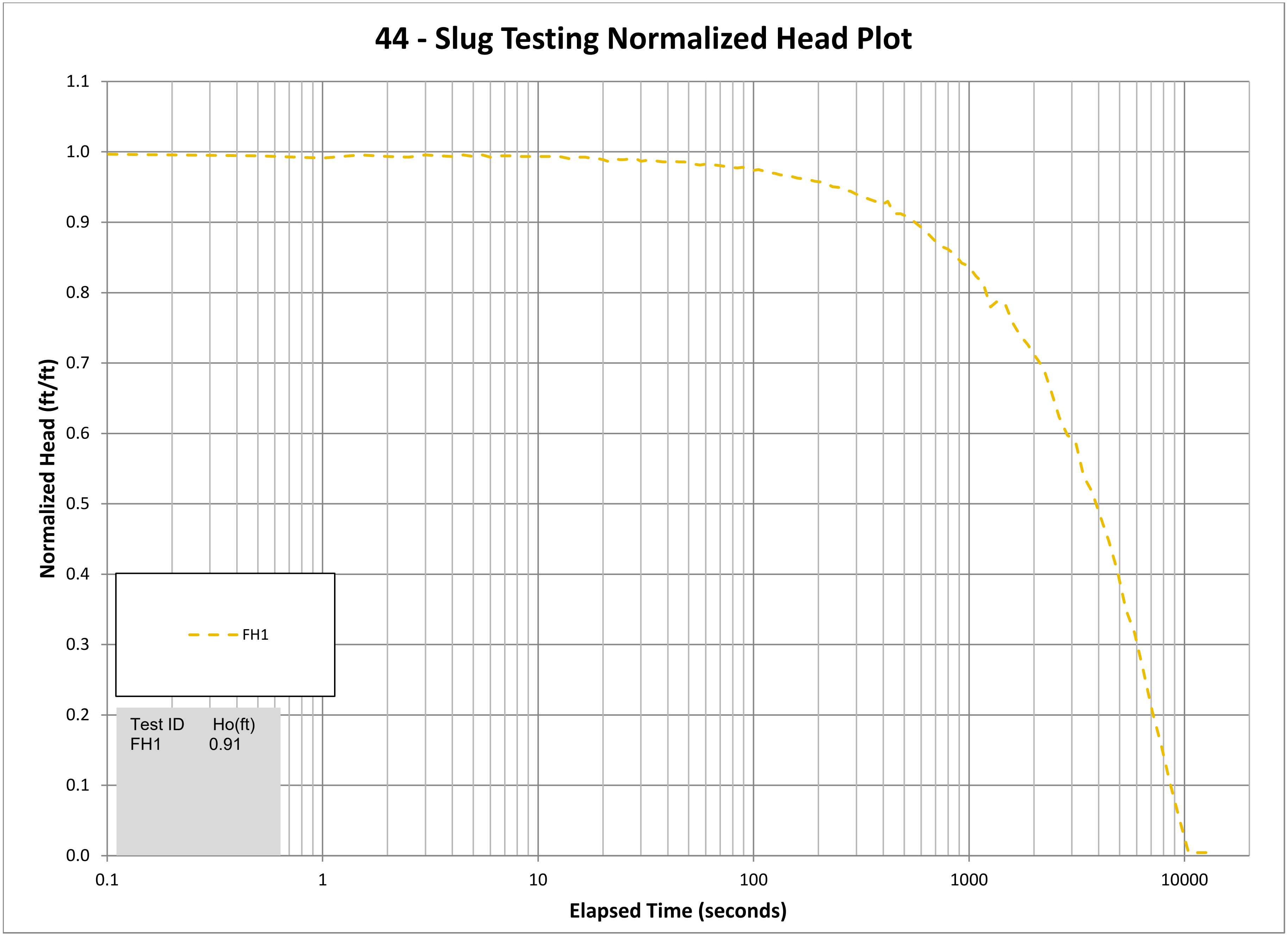
RH1 -1.63
FH2 1.51
RH2 -1.28



44 - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
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0.5
0.4
0.3
0.2
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0.1
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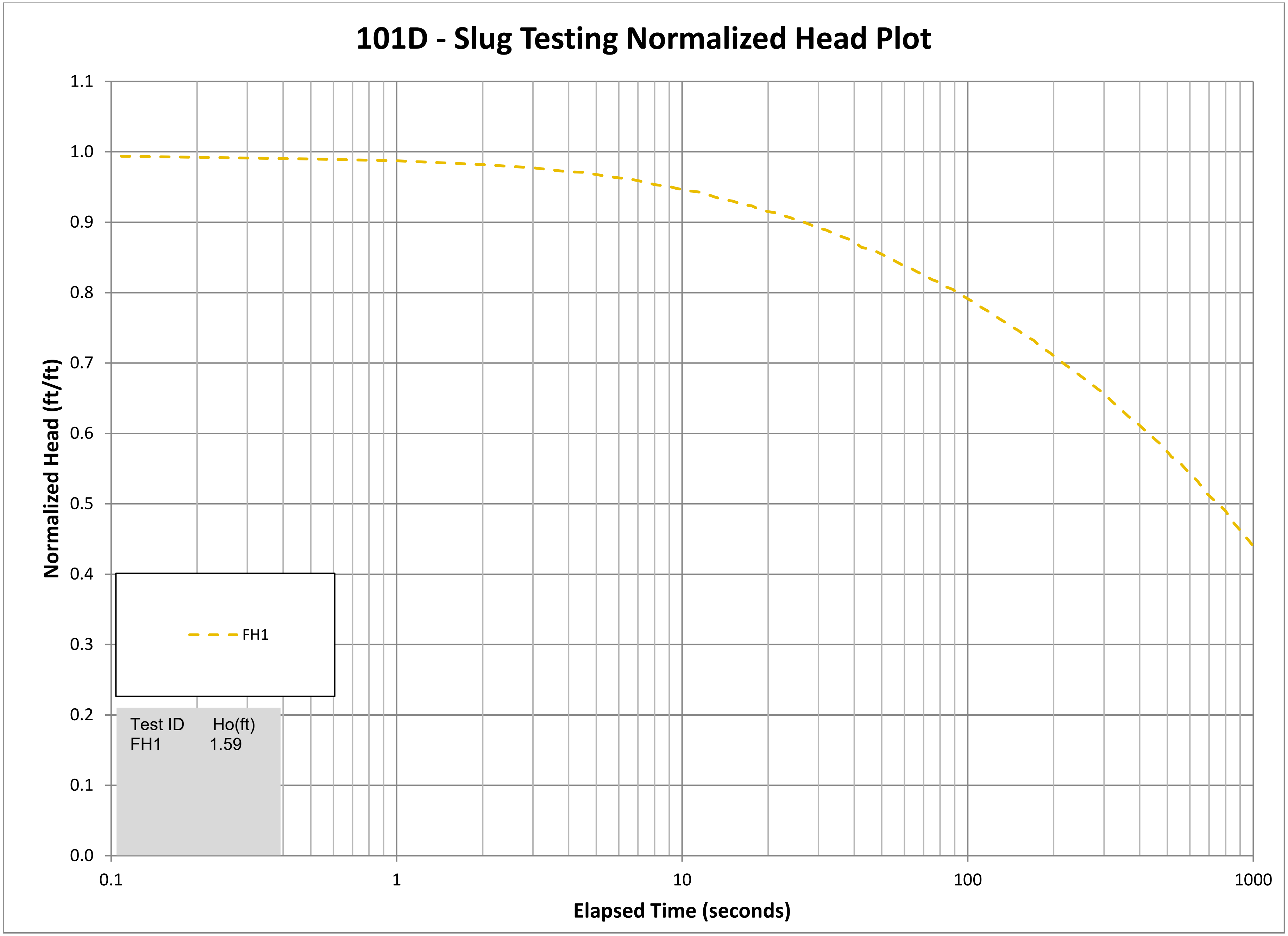
10
100
1000
10000
Elapsed Time (seconds)
FH1
Test ID Ho(ft)
FH1 0.91


101D - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
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0.6
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0.3
0.2
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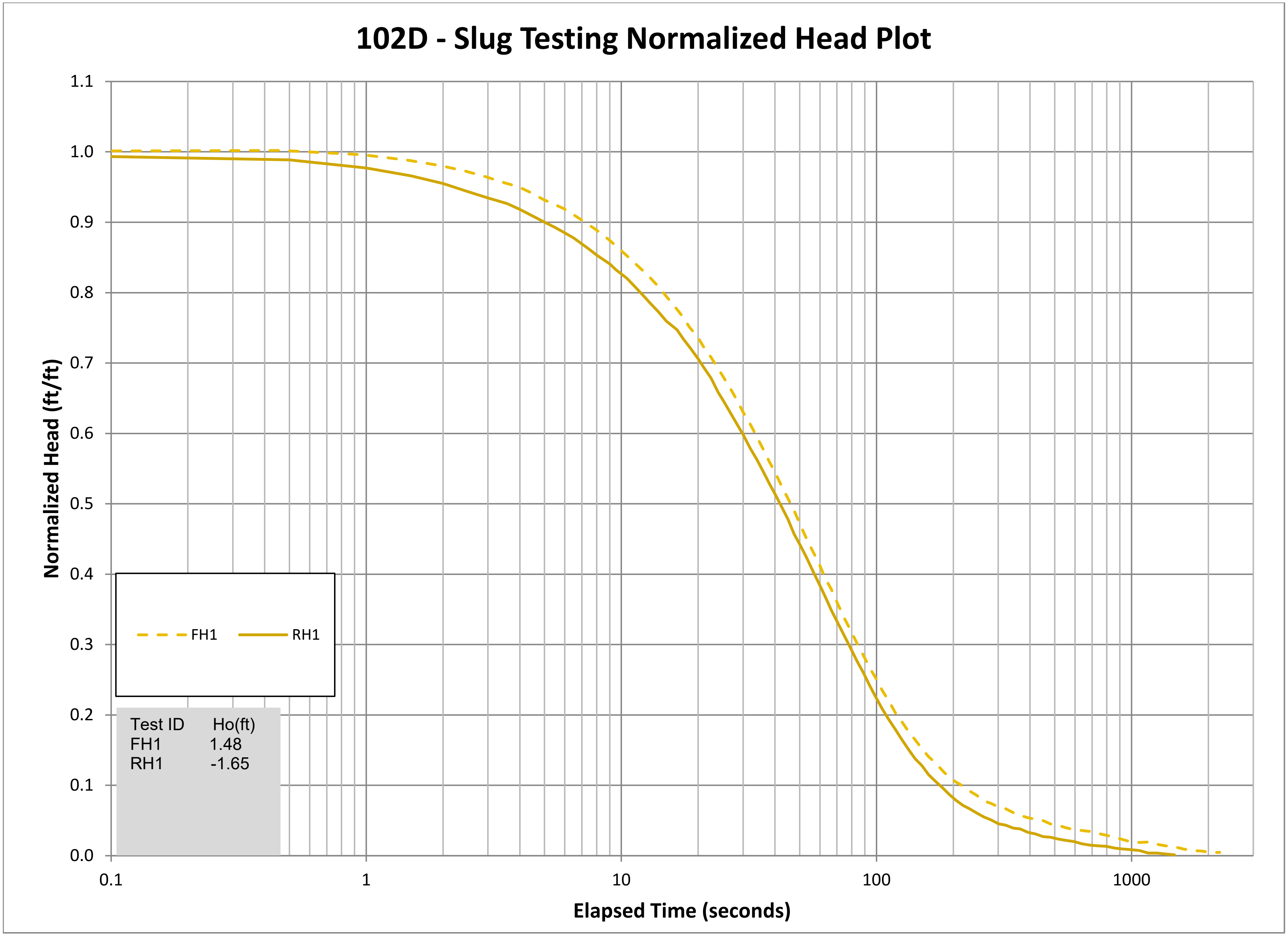
1
10
100
1000
Elapsed Time (seconds)
FH1
Test ID Ho(ft)
FH1 1.59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0.2
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0.1
1
10
100
1000
Elapsed Time (seconds)
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RH1
Test ID Ho(ft)
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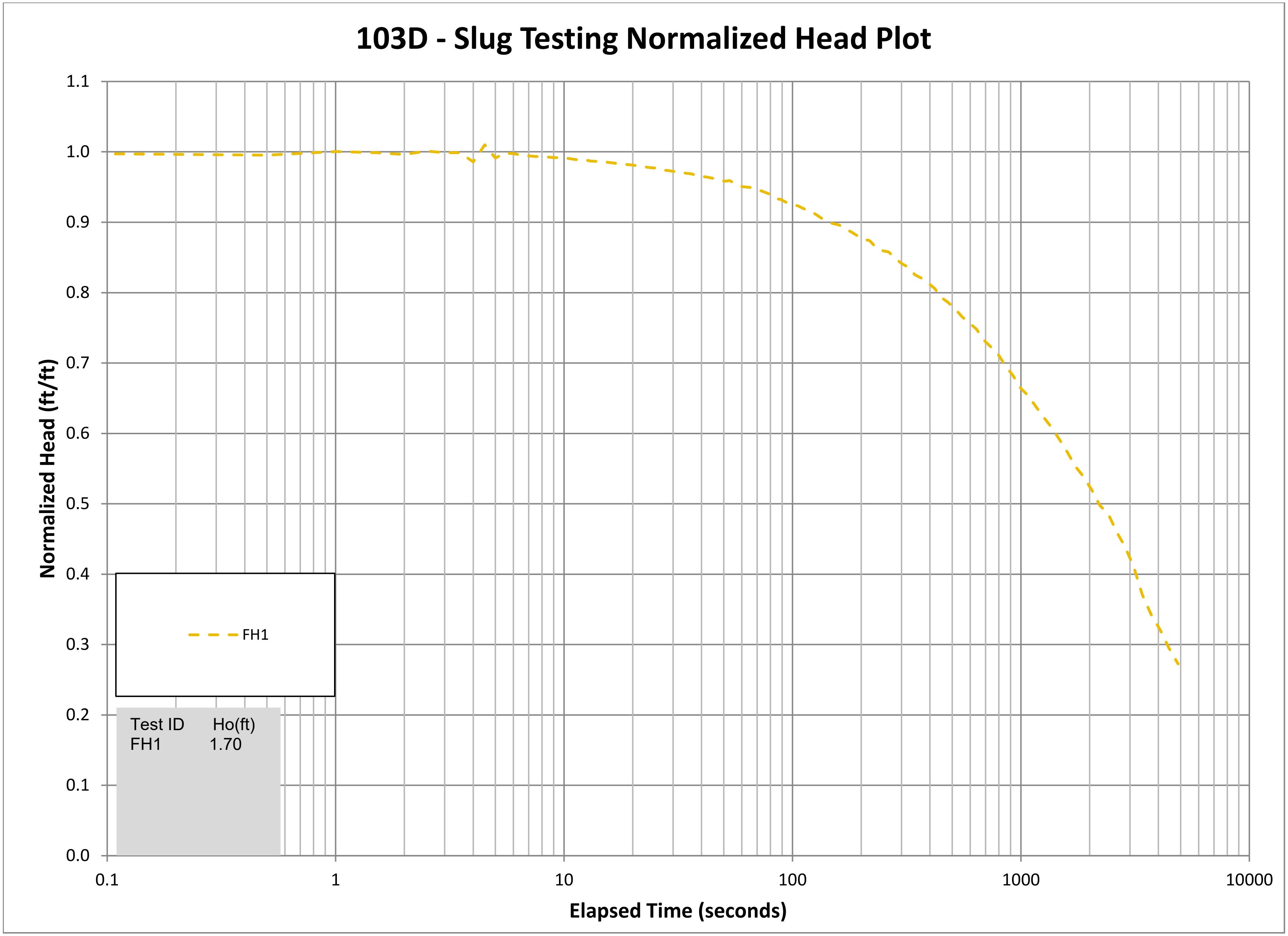
RH1 -1.65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Normalized Head (ft/ft)
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0.6
0.5
0.4
0.3
0.2
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0.0
0.1
1
10
100
1000
10000
Elapsed Time (seconds)
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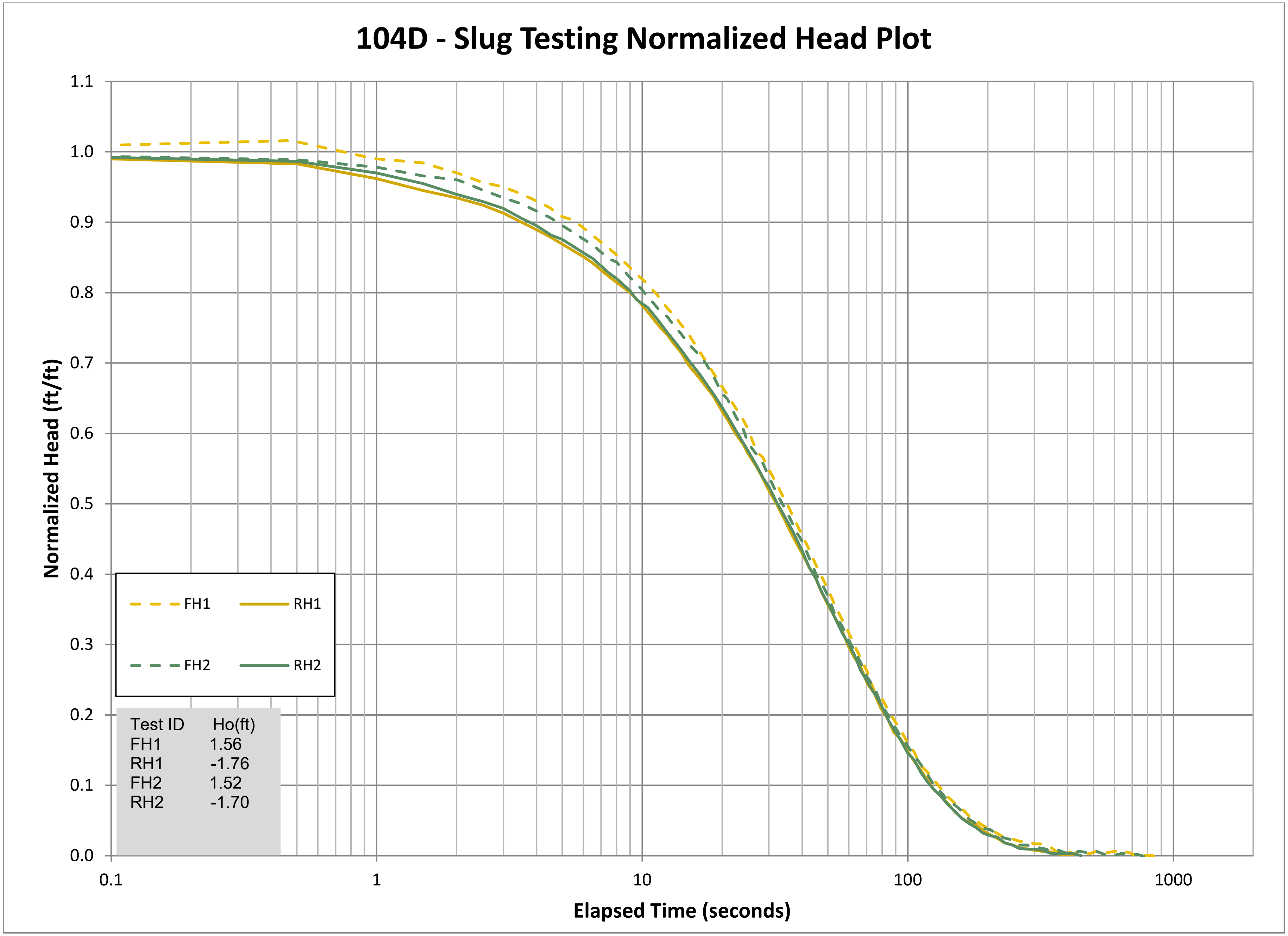
Test ID Ho(ft)
FH1 1.70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0.2
0.1
0.0
0.1
1
10
100
1000
Elapsed Time (seconds)
FH1
RH1
FH2
RH2
Test ID Ho(ft)
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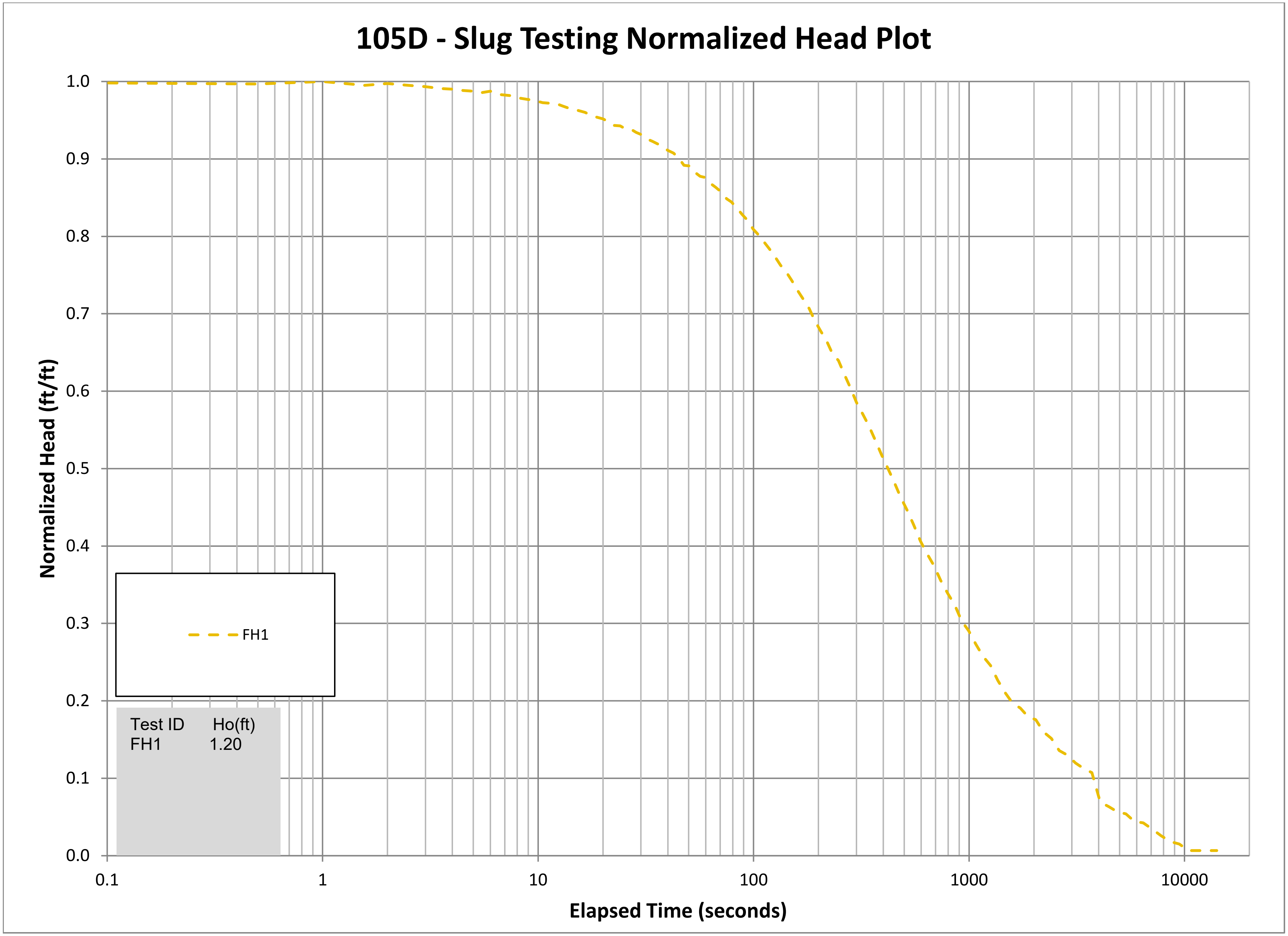
RH1 -1.76
FH2 1.52
RH2 -1.70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0.7
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0.3
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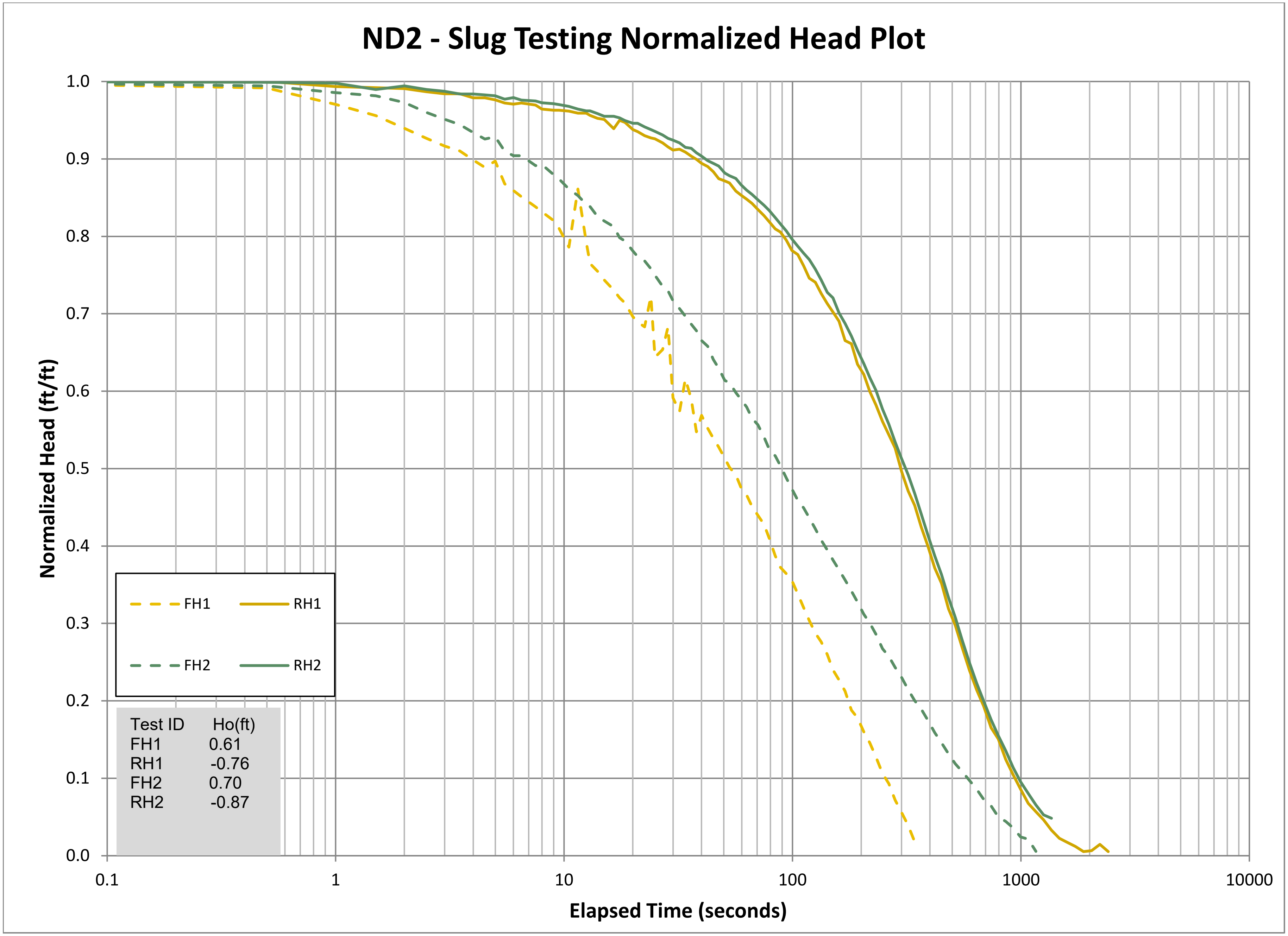
0.0
0.1
1
10
100
1000
10000
Elapsed Time (seconds)
FH1
Test ID Ho(ft)
FH1 1.20


ND2 - Slug Testing Normalized Head Plot
Normalized Head (ft/ft)
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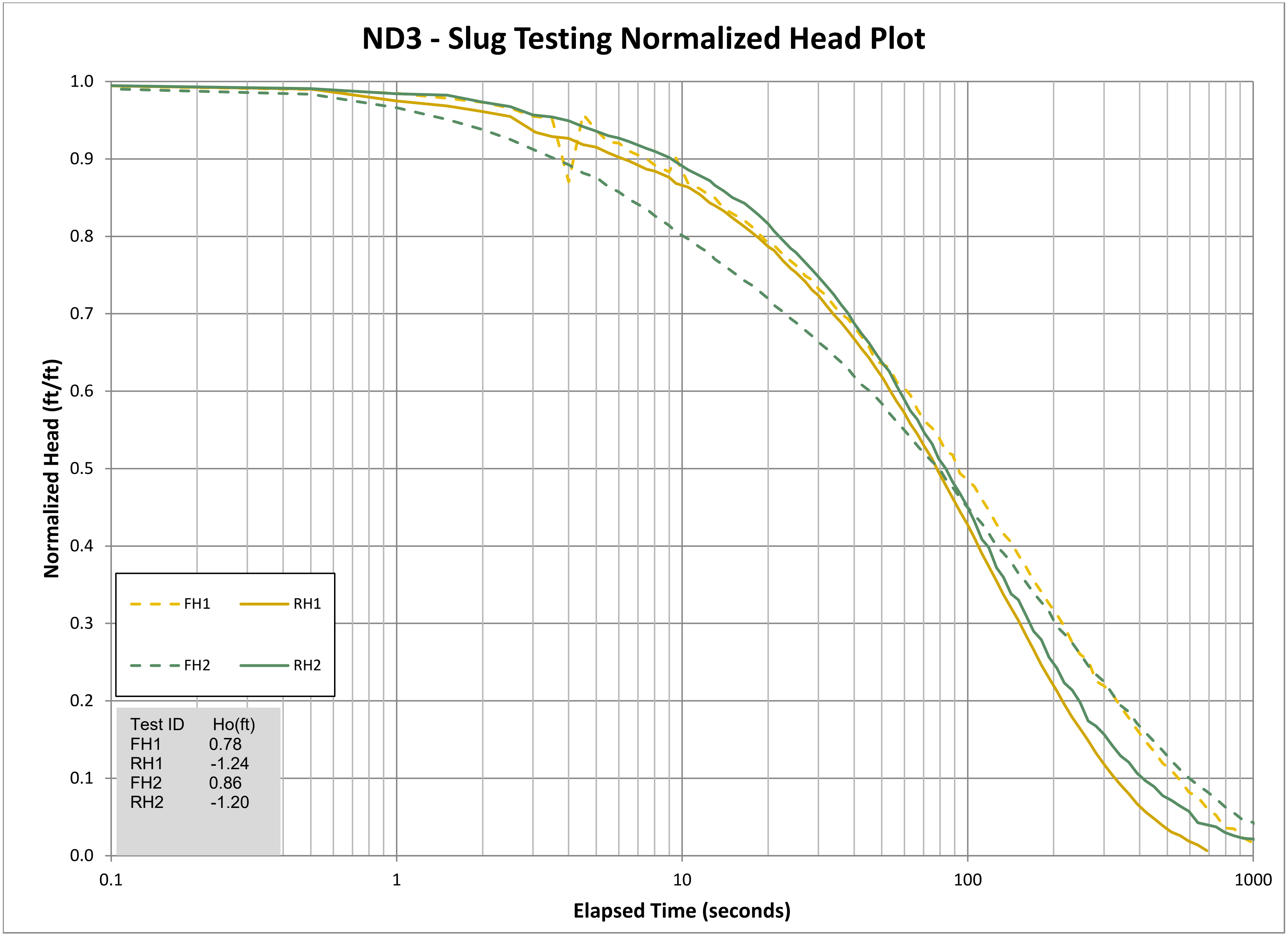
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
1
10
100
1000
10000
Elapsed Time (seconds)
FH1
RH1
FH2
RH2
Test ID Ho(ft)
FH1 0.61
RH1 -0.76
FH2 0.70
RH2 -0.87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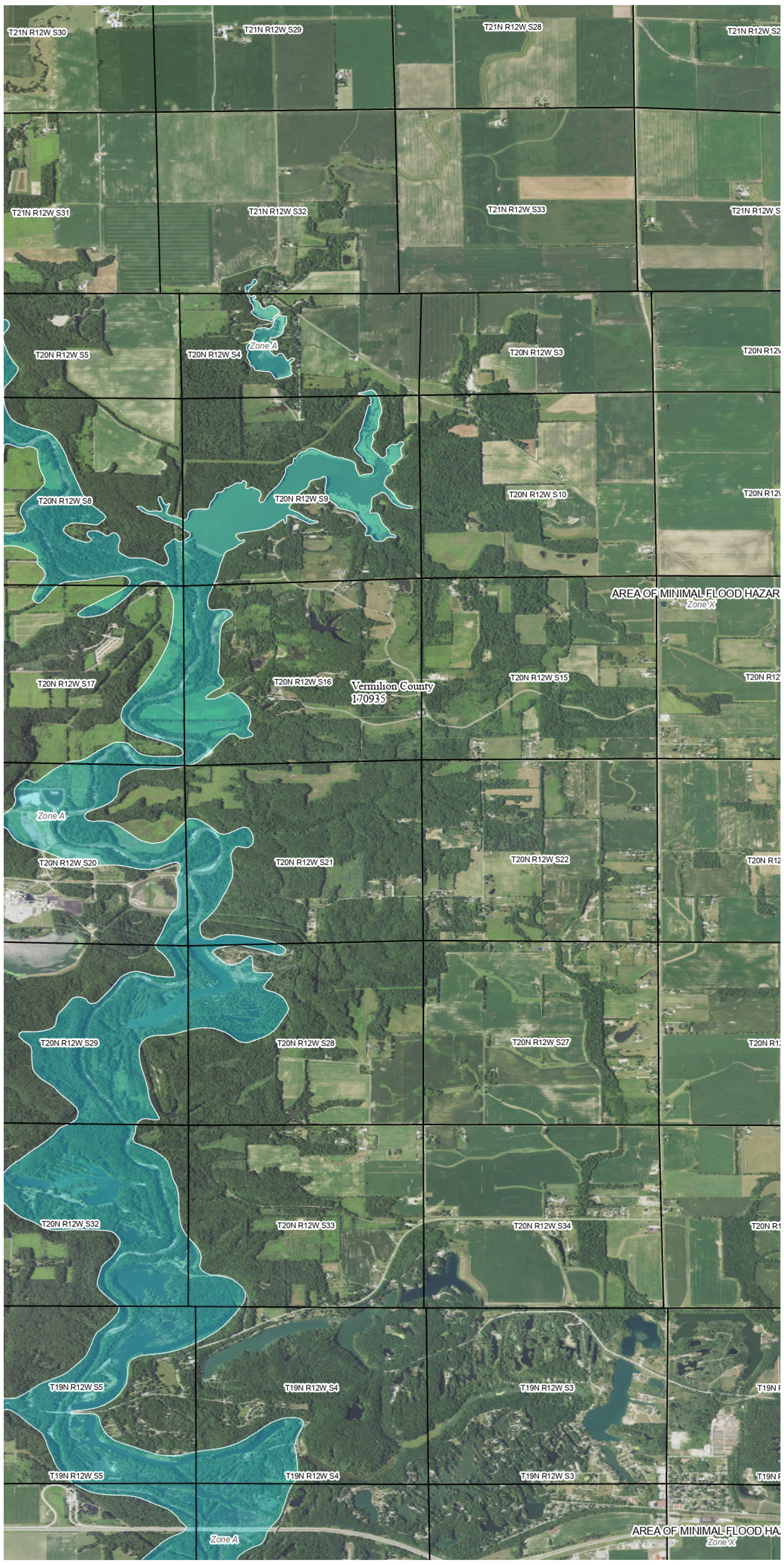
0.4
0.3
0.2
0.1
0.0
0.1
1
10
100
1000
Elapsed Time (seconds)
FH1
RH1
FH2
RH2
Test ID Ho(ft)
FH1 0.78
RH1 -1.24
FH2 0.86
RH2 -1.20

APPENDIX F
FEMA FLOOD HAZARD MAP

87°46'54.23"W 40°15'26.41"N



87°39'20.81"W 40°7'3.7"N

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP
FOR DRAFT FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee See Notes *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- B 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- 8 Coastal Transect
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates, refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Basemap information shown on this FIRM was provided in digital format by the United States Geological Survey (USGS). The basemap shown is the USGS National Map: Orthoimagery. Last refreshed October, 2020.

This map was exported from FEMA's National Flood Hazard Layer (NFHL) on **6/30/2021 12:49 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time. For additional information, please see the Flood Hazard Mapping Updates Overview Fact Sheet at https://www.fema.gov/media-library/assets/documents/118418

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards. This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date.

SCALE

Map Projection:
GCS, Geodetic Reference System 1980;
Vertical Datum: No elevation features on this FIRM
For information about the specific vertical datum for elevation features, datum conversions, or vertical monuments used to create this map, please see the Flood Insurance Study (FIS) Report for your community at https://msc.fema.gov

N

1 inch = 2,000 feet **1:24,000**

0 1,000 2,000 4,000 6,000 8,000 Feet

0 210 420 840 1,260 1,680 Meters

FEMA
National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

VERMILION COUNTY, ILLINOIS AND INCORPORATED AREAS

PANEL **275** OF **500**

Panel Contains:

COMMUNITY	NUMBER	PANEL
VERMILION COUNTY	170935	0275

MAP NUMBER
17183C0275D
EFFECTIVE DATE
May 16, 2012

ATTACHMENT I

Groundwater Monitoring Plan (845.630-650)

Design and Construction Plans of a Groundwater Monitoring System

Groundwater Sampling and Analysis Program

Intended for
Dynegy Midwest Generation, LLC

Date
October 25, 2021

Project No.
1940100722

GROUNDWATER MONITORING PLAN

NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL Bright ideas. Sustainable change.

GROUNDWATER MONITORING PLAN
VERMILION POWER PLANT NORTH ASH POND AND OLD EAST ASH POND

Project name	**Vermilion Power Plant North Ash Pond and Old East Ash Pond**
Project no.	**1940100722**
Recipient	**Dynegy Midwest Generation, LLC**
Document type	**Groundwater Monitoring Plan**
Revision	**FINAL**
Date	**October 25, 2021**

Ramboll
234 W. Florida Street
Fifth Floor
Milwaukee, WI 53204
USA

T 414-837-3607
F 414-837-3608
https://ramboll.com

Brian G. Hennings, PG
Senior Managing Hydrogeologist

Eric J. Tlachac, PE
Senior Managing Engineer

Nathaniel R. Keller
Senior Hydrogeologist

Chase J. Christenson, PG
Hydrogeologist

LICENSED PROFESSIONAL CERTIFICATIONS

35 I.A.C. § 845.630 Groundwater Monitoring Systems (PE)

I, Eric J. Tlachac, a qualified professional engineer in good standing in the State of Illinois, certify that the groundwater monitoring system described in this document (Groundwater Monitoring Plan, Vermilion Power Plant North Ash Pond and Old East Ash Pond) has been designed and constructed to meet the requirements of 35 I.A.C. § 845.630. The monitoring system was developed based on information included in the Hydrogeologic Site Characterization Report (Ramboll 2021; included in the Operating Permit to which this Groundwater Monitoring Plan is attached).

Eric J. Tlachac
Qualified Professional Engineer
062-063091
Illinois
Date: October 25, 2021

35 I.A.C. § 845.630 Groundwater Monitoring Systems (PG)

I, Brian G. Hennings, a qualified professional geologist in good standing in the State of Illinois, certify that the groundwater monitoring system described in this document (Groundwater Monitoring Plan, Vermilion Power Plant North Ash Pond and Old East Ash Pond) has been designed and constructed to meet the requirements of 35 I.A.C. § 845.630. The monitoring system was developed based on information included in the Hydrogeologic Site Characterization Report (Ramboll 2021; included in the Operating Permit to which this Groundwater Monitoring Plan is attached).

Brian G. Hennings
Professional Geologist
196.001482
Illinois
Date: October 25, 2021

CONTENTS

Licensed Professional Certifications		**2**
1.	**Introduction**	**6**
1.1	Overview	6
1.2	Site Location and Background	6
1.3	Conceptual Model	7
2.	**Groundwater Monitoring Systems**	**10**
2.1	Existing Monitoring Well Network and Analysis	10
2.1.1	Groundwater Quality Investigations (1982-2018)	10
2.1.2	Part 845 Well Installation and Monitoring	10
2.2	Proposed Part 845 Monitoring Well Network	11
2.3	Well Abandonment	12
3.	**Applicable Groundwater Quality Standards**	**13**
3.1	Groundwater Classification	13
3.2	Statistical Evaluation of Background Groundwater Data	13
3.3	Applicable Groundwater Protection Standards	13
4.	**Groundwater Monitoring Plan**	**15**
4.1	Monitoring Networks and Parameters	15
4.1.1	Part 845 Groundwater Monitoring	15
4.2	Sampling Schedule	15
4.3	Groundwater Sample Collection	16
4.4	Laboratory Analysis	16
4.5	Quality Assurance Program	16
4.6	Groundwater Monitoring System Maintenance Plan	17
4.7	Statistical Analysis	18
4.8	Data Reporting	18
4.9	Compliance with Applicable On-site Groundwater Protection Standards	18
4.10	Alternate Source Demonstrations	18
4.11	Assessment of Corrective Measures and Corrective Action	19
5.	**References**	**20**

TABLES (IN TEXT)

Table A	2017-2018 Groundwater Monitoring Parameters
Table B	Part 845 Groundwater Monitoring Program Parameters
Table C	Proposed Part 845 Monitoring Well Network
Table D	Part 845 Groundwater Monitoring Program Parameters
Table E	Part 845 Sampling Schedule

TABLES (ATTACHED)

Table 1-1	Part 845 Requirements Checklist
Table 2-1	Monitoring Well Locations and Construction Details
Table 3-1	Background Groundwater Quality and Standards
Table 4-1	Sampling and Analysis Summary
Table 4-2	Detection and Reporting Limits for Part 845 Parameters

FIGURES (ATTACHED)

Figure 1-1	Site Location Map
Figure 1-2	Site Map
Figure 1-3	Uppermost Aquifer Groundwater Elevation Contours, March 29, 2021
Figure 1-4	Potential Migration Pathway Groundwater Contour Elevation Contours, March 29, 2021
Figure 2-1	Proposed Part 845 Groundwater Monitoring Well Network

APPENDICES

Appendix A	Statistical Analysis Plan

ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
ASD	Alternate Source Demonstration
bgs	below ground surface
CCR	coal combustion residuals
cm/s	centimeters per second
CSM	conceptual site model
DMG	Dynegy Midwest Generation, LLC
GMP	Groundwater Monitoring Plan
GWPS	groundwater protection standard
HCR	Hydrogeologic Site Characterization Report
ID	identification
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
LGU	Lower Groundwater Unit
Middle Fork	Middle Fork of the Vermilion River
MGU	Middle Groundwater Unit
NA	not applicable
NAP	North Ash Pond
NEAP	New East Ash Pond
No.	number
NPDES	National Pollutant Discharge Elimination System
OEAP	Old East Ash Pond
Part 845	Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
PMP	potential migration pathway
QA/QC	quality assurance/quality control
Ramboll	Ramboll Americas Engineering Solutions, Inc.
RL	reporting limit
SI	surface impoundment
Site	NAP and OEAP
TDS	total dissolved solids
UA	Uppermost Aquifer
USEPA	United States Environmental Protection Agency
VPP	Former Vermilion Power Plant
WLO	water level only

1. INTRODUCTION

1.1 Overview

In accordance with requirements of the Standards for the Disposal of Coal Combustion Residuals (CCR) in Surface Impoundments (SIs): Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845 (Part 845) (Illinois Environmental Protection Agency [IEPA], April 15, 2021), Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Groundwater Monitoring Plan (GMP) on behalf of the former Vermilion Power Plant (VPP) (**Figure 1-1**), operated by Dynegy Midwest Generation, LLC (DMG). This report will apply specifically to the CCR Units referred to as the North Ash Pond (NAP; Vistra identification [ID] number [No.] 910; and IEPA ID No. W1838000002-01), and the Old East Ash Pond (OEAP; Vistra ID No. 911; and IEPA ID No. W1838000002-03). However, information gathered to evaluate other CCR units at the VPP regarding geology, hydrogeology, and groundwater quality is included, where appropriate. The 41-acre NAP is an extension of the 21.3-acre OEAP. The southern end of the NAP overlies the northern end of the OEAP. Both are inactive, unlined CCR SIs that were used to manage CCR and non-CCR waste streams and to clarify process water prior to discharge in accordance with the National Pollutant Discharge Elimination System (NPDES) permit at the VPP. This GMP includes Part 845 content requirements specific to 35 I.A.C. § 845.630 (Groundwater Monitoring System), 35 I.A.C. § 845.640 (Groundwater Sampling and Analysis), and 35 I.A.C. § 845.650 (Groundwater Monitoring Program) for the NAP and OEAP at the VPP.

A checklist which identifies the specific requirements of 35 I.A.C. § 845.630, 35 I.A.C. § 845.640, and 35 I.A.C. § 845.650 is included in **Table 1-1**. The table provides references to sections, tables, and figures included in this document to locate the information that meets specific requirements of 35 I.A.C. § 845.630, 35 I.A.C. § 845.640, and 35 I.A.C. § 845.650.

1.2 Site Location and Background

The NAP and OEAP are located in east central Illinois in Vermilion County, approximately five miles northeast of the Village of Oakwood, located within Section 20, Township 20 North, Range 12 West (**Figure 1-1**). The VPP is an approximately 982-acre property consisting of 19 parcels, including a retired coal-fired power plant and SIs. The VPP ceased operations in 2011 when the power plant was retired.

The NAP and OEAP, which are the subject of this GMP, are located adjacent to each other in the northern portion of the VPP. The NAP is bordered on the north by fallow fields owned by the Illinois Department of Natural Resources (IDNR); to the east by the Middle Fork of the Vermilion River (Middle Fork); to the south by the OEAP; and to the west by steep bluffs that include the Illinois Department of Conservation designated Orchid Hill Natural Heritage Landmark, which is partially within the VPP property boundary but is administered by IDNR. The OEAP is bordered to the north and northeast by the Middle Fork; to the southeast, south, and west by steep bluffs; and to the northwest by the NAP. The NAP and OEAP are both located on terraces adjacent to the Middle Fork, which is bordered to the east and west by steep bluffs.

Figure 1-2 depicts the location of the inactive NAP and OEAP. The combined area, including the NAP and OEAP, will hereinafter be referred to as the Site.

All ash ponds at the VPP are out of service. Until a portion of the coal pile was substantially removed in March 2011, the NAP received inflows from coal-pile runoff. The NPDES-permitted outfalls to the Middle Fork are still in effect; however, the only flows from the NAP and OEAP are during significant periods of precipitation and controlled discharges via Outfall 001, usually occurring once or twice a year.

The OEAP was built as part of the original plant construction and put into service in the mid-1950's. The OEAP continued in operation until the NAP was constructed and put on-line in the mid-1970's. The NAP was utilized for sluiced coal ash disposal from the mid-1970's to 1989-1990, at which time all ash disposal was diverted to the New East Ash Pond (NEAP). The NEAP was expanded in 2002. The NAP was originally designed and operated for coal ash sedimentation and control; and received plant process wastewater, sluiced coal ash, and stormwater runoff from the pond embankments. Treated process wastewater was discharged through an overflow outlet structure.

1.3 Conceptual Model

Significant site investigation has been completed at the VPP to characterize the geology, hydrogeology, and groundwater quality. Based on extensive investigation and monitoring, the NAP and OEAP have been well characterized and detailed in the Hydrogeologic Site Characterization Report (HCR; included in the Operating Permit to which this Plan is attached). A conceptual site model (CSM) has been developed and is discussed below.

In addition to the CCR present in the NAP and OEAP, there are five layers of unlithified material present above the bedrock, which were categorized into hydrostratigraphic units in this report. Underlying the constructed CCR unit, the six (including bedrock) hydrostratigraphic units in descending order are:

- **Upper Unit**: Clayey sands to sandy clays of the Cahokia Alluvium which are the uppermost unit in the Middle Fork bottomlands.
- **Middle Groundwater Unit (MGU)**: Alluvial deposits of coarser grained material encountered at the base of the Cahokia Alluvium. This unit is laterally continuous below the NAP and OEAP and is designated as the uppermost aquifer.
- **Upper Confining Unit**: Low permeability till composed of clay with isolated sand lenses. This unit is present both below the NAP and OEAP, and in the uplands, and limits vertical migration of groundwater.
- **Lower Groundwater Unit (LGU)**: Glacial outwash and re-worked glacial deposits of the Henry Formation is the lowermost, laterally extensive coarse grained unlithified deposit identified beneath the Site and in the uplands. Based on permeability and continuous lateral extent, this unit is identified as a potential migration pathway (PMP).
- **Lower Confining Unit**: Composed of silty or sandy clay with isolated sand lenses and is the lowermost unlithified deposit. Low permeability unit limits vertical migration of groundwater.
- **Bedrock Confining Unit**: Lowermost unit identified at the Site and underlies all unlithified deposits. This unit occurs within Pennsylvanian shale which is the uppermost lithified unit at the Site.

Groundwater flow direction and gradients have not changed significantly since the first hydrogeologic study of the NAP and OEAP was completed in 1983, and recent data supports the existing CSM which has been refined to incorporate additional data and is summarized as follows:

- The NAP and OEAP overlie the Upper Unit in most areas of the Site, with the exception of the northern portion and western boundary of the NAP, where the upper unit is absent.
- Groundwater migrates within high permeability sands and gravels of the MGU and LGU that flow to the east under normal river conditions (**Figure 1-3** and **Figure 1-4**). There is the potential for short duration and temporary flow direction reversal during periods of high river stage.
- Groundwater flows into to the Middle Fork through the MGU and LGU which are the primary pathways that contaminant migration could occur (**Figure 1-3** and **Figure 1-4**). Upward gradients measured in the underlying shale bedrock indicate that the Middle Fork is a regional discharge area.
- Vertical gradients measured between the bedrock, LGU, and MGU are generally upward near the Middle Fork indicating that it is a regional discharge area.

Part 845 parameters were monitored in the MGU and LGU monitoring wells at the NAP and OEAP as part of the groundwater quality investigations performed between 1988 and 2018. The totals data collected from 2017 to 2018 were supplemented with sampling of additional locations in 2021. The results indicate that the following parameters were greater than the applicable 35 I.A.C. § 845.600 groundwater protection standards (GWPSs) and are considered potential exceedances:

- Arsenic – at downgradient wells 02, 03R, 07R, 08R, 34, 37, 38, and 40; intermediate well 18; and upgradient wells 21, 42, 43, 44, 101, 102, 103, 104, and 105.
- Beryllium - at upgradient well 105.
- Boron - at downgradient wells 03R, 04, 05, 07R, 08R, 36, 40, and 41; at intermediate wells 17 and 18; and at upgradient wells 01, 101, and 104.
- Chromium- at downgradient well 07R; at upgradient well 105.
- Cobalt- at downgradient well 07R; at upgradient well 105.
- Lead- at downgradient well 07R; at upgradient well 105
- Lithium - at downgradient wells 04, 05, 07R, 08R, 36, and 40; at intermediate well 18; and at upgradient wells 01 and 105.
- Molybdenum - at downgradient wells 03R, 07R, 08R, and 36.
- pH – at downgradient well 40.
- Sulfate - at downgradient wells 03R, 07R, 08R, 36 and 40; at intermediate wells 17 and 18; and at upgradient wells 01 and 104.
- Thallium – at downgradient well 40.
- Total Dissolved Solids (TDS) - at downgradient wells 02, 03R, 07R, 08R, 36, and 40; at intermediate wells 17 and 18; and at upgradient well 01.
- Radium 226 and 228 combined- at downgradient well 07R; and at upgradient well 105.

Concentration results for the above parameters were compared directly to 35 I.A.C. § 845.600 GWPS, without an evaluation of background concentrations. Evaluation of background groundwater quality data has been completed as part of this GMP, and compliance with Part 845 will be determined following the first round of groundwater sampling. The first round of groundwater sampling for compliance will be completed the quarter following issuance of the Operating Permit in accordance with this GMP.

2. GROUNDWATER MONITORING SYSTEMS

2.1 Existing Monitoring Well Network and Analysis

This GMP is being provided to propose a groundwater monitoring network and monitoring program specific to the NAP and OEAP that will comply with Part 845 regulations. Monitoring networks and programs that apply to other units are not discussed in this GMP. Groundwater monitoring at the VPP has been performed periodically since 1992 to evaluate and assess the groundwater quality in the vicinity of the NAP, OEAP, and NEAP. The remaining discussion in this document will include only monitoring well locations and results that are applicable and specific to the NAP and OEAP.

2.1.1 Groundwater Quality Investigations (1982-2018)

Currently, there are no IEPA-required groundwater monitoring programs for the NAP and OEAP. Although groundwater monitoring was not required at the NAP and OEAP, a network of monitoring wells was voluntarily installed between 1982 and 2010 as part of previous investigations. Groundwater monitoring at certain wells was conducted as early as 1988 and monitoring generally continued through 2007, at which time the voluntary monitoring was discontinued. Four quarterly rounds of groundwater monitoring were also completed at the NAP and OEAP during 2011 as part of the 2012 hydrogeologic investigations (Kelron, 2012a; Kelron, 2012b). Groundwater monitoring was re-established at the NAP and OEAP in July 2017 and continued for six rounds ending in May 2018. Thirteen NAP and OEAP monitoring wells (01, 02, 03R, 04, 05, 06R, 08R, 10, 17, 18, 20, 21, and 34) were sampled for water quality and field parameters listed in **Table A** below.

Table A. 2017-2018 Groundwater Monitoring Parameters

Field Parameters			
pH	Temperature	Turbidity	Oxidation/Reduction Potential
Dissolved Oxygen	Specific Conductance	Groundwater Elevation	
Metals (Dissolved)			
Arsenic	Barium	Boron	
Iron	Manganese	Selenium	
Inorganics			
Fluoride (dissolved)	Sulfate (total)	Chloride (total)	
TDS	Nitrate-N (total)		

2.1.2 Part 845 Well Installation and Monitoring

In 2021, seven additional monitoring wells (36, 37, 38, 41, 42, 43, and 44) were installed along the perimeter of the NAP, two wells (40 and 07R) were added at the OEAP, and ten monitoring wells (101/101S, 102/102S, 103/103S, 104/104S, and 105/105S) were completed in the bluff upgradient of the NAP and OEAP to assess the vertical and horizontal lithology, stratigraphy, chemical properties, and physical properties of geologic layers to a minimum of 100 feet bgs as specified in 35 I.A.C. § 845.620(b).

Prospective Part 845 monitoring wells were sampled and analyzed for eight rounds between March 2021 and August 2021 and the results were used for selection of the NAP and OEAP Part 845 monitoring well network. Groundwater samples were collected and analyzed for 35 I.A.C. § 845.600 parameters as summarized in **Table B** below.

Table B. Part 845 Groundwater Monitoring Program Parameters

Field Parameters[1]			
Groundwater Elevation	pH	Turbidity	
Metals (Total)			
Antimony	Boron	Cobalt	Molybdenum
Arsenic	Cadmium	Lead	Selenium
Barium	Calcium	Lithium	Thallium
Beryllium	Chromium	Mercury	
Inorganics (Total, except TDS)			
Fluoride	Sulfate	Chloride	TDS
Other (Total)			
Radium 226 and 228 combined			

[1] Dissolved oxygen, temperature, specific conductance, and oxidation/reduction potential were recorded during sample collection.

Data and results from the Part 845 background monitoring were included in the water quality discussion included in the HCR (included in the Operating Permit to which this Plan is attached). The data collected from background locations during the Part 845 monitoring were used to evaluate and calculate background concentrations for the NAP and OEAP. The evaluation and discussion are included in **Section 3.2** of this report.

Data collected from the groundwater quality investigations and the Part 845 background monitoring were also used for selection of the Part 845 monitoring well network proposed in **Section 2.2**.

2.2 Proposed Part 845 Monitoring Well Network

The groundwater monitoring network proposed in this plan will include ten monitoring wells screened in the MGU (*i.e.,* uppermost aquifer [04, 05, 07R, 08R, 17, 20, 36, 38, 40, and 41]), nine wells screened in the LGU (*i.e.,* PMP [02, 03R, 21, 34, 37, 42, 43, 101, and 103]), two temporary wells (water level only) screened in CCR materials (ND3 and OED1), and one temporary water level only surface water staff gage (SG01). The proposed network is summarized in **Table C** below and displayed on **Figure 2-1**. Nineteen wells (five background and 14 compliance) will be used to monitor groundwater concentrations within the hydrostratigraphic units.

The groundwater samples collected from the 19 wells will be 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 will yield groundwater samples that represent the quality of downgradient groundwater at the CCR boundary (as required in 845.630(a)(2)). Monitoring well depths and construction details are listed in **Table 2-1** and summarized in **Table C** below.

Table C. Proposed Part 845 Monitoring Well Network

Well ID	Monitored Unit	Well Screen Interval (feet bgs)	Well Type[1]
02	LGU (PMP)	30.1 – 39.7	Compliance
03R	LGU (PMP)	29.0 – 34.0	Compliance
04	MGU (UA)	8.7 – 13.5	Compliance
05	MGU (UA)	9.1 – 13.9	Compliance
07R	MGU (UA)	11.0 – 21.0	Compliance
08R	MGU (UA)	9.5 – 14.5	Compliance
17[2]	MGU (UA)	54.0 – 59.0	Compliance
20	MGU (UA)	12.5 – 17.5	Compliance
21	LGU (PMP)	104.0 – 109.0	Background
34	LGU (PMP)	49.1 – 54.1	Compliance
36	MGU (UA)	16.0 – 21.0	Compliance
37	LGU (PMP)	48.0 – 53.0	Compliance
38	MGU (UA)	21.0 – 31.0	Compliance
40	MGU (UA)	12.5 – 17.5	Compliance
41	MGU (UA)	21.0 – 31.0	Compliance
42	LGU (PMP)	50.0 – 60.0	Background
43	LGU (PMP)	55.0 – 65.0	Background
101	LGU (PMP)	141.0 – 151.0	Background
103	LGU (PMP)	155.0 – 165.0	Background
ND3[2,3]	CCR	8.7 – 23.3	WLO
OED1[2,3]	CCR	23.7 – 43.3	WLO
SG01[2,4]	Surface Water	NA	WLO

[1] Well type refers to the role of the well in the monitoring network.
[2] Location is temporary pending implementation of impoundment closure per an approved Construction Permit Application.
[3] Well is to be for water level data collection only.
[4] SG01 is a surface water level measuring point.
NA = Not Applicable
UA = uppermost aquifer
WLO = water level only

2.3 Well Abandonment

Well 01 was installed in 1982, west of the OEAP. The log (JMA-1) included as an attachment in the HCR (included in the Operating Permit to which this Plan is attached) does not indicate how the annulus was sealed. The well is located in the vicinity of a drainage swale where significant erosion has been observed. Given the unknown competency of the annular seal, and proximity to active erosion, well 01 is proposed for abandonment to eliminate the potential for vertical migration of surface water into the subsurface.

3. APPLICABLE GROUNDWATER QUALITY STANDARDS

3.1 Groundwater Classification

The classification of groundwater at NAP and OEAP has been evaluated and based on the detailed geologic information provided in the 2012 hydrogeologic investigations (Kelron, 2012a; Kelron, 2012b) for the MGU (*i.e.,* uppermost aquifer), the NAP and OEAP can be classified as Class I - Potable Resource Groundwater. The MGU is comprised of predominantly sand and gravel with some silt and is the primary groundwater transport pathway. Based on the 2012 hydrogeologic investigations, the thickness of the MGU ranges from 5 to 26 feet, with an average thickness of 10.1 feet. (Kelron, 2012a; Kelron, 2012b). Field hydraulic conductivity tests performed on the MGU indicate a geometric mean hydraulic conductivity of 2.1 x 10^{-3} centimeters per second (cm/s) (Kelron, 2012a; Kelron, 2012b). Sands and gravels with thicknesses greater than 5 feet or with a hydraulic conductivity of greater than 1 x 10^{-4} cm/s meets the provisions of Class I - Potable Resource Groundwater (35 I.A.C. § 620.210).

3.2 Statistical Evaluation of Background Groundwater Data

A Statistical Analysis Plan (**Appendix A**) has been developed to describe procedures that will be used to establish background conditions and implement compliance monitoring as necessary and required by 35 I.A.C. § 845.640 and 35 I.A.C. § 845.650. The 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 (USEPA)'s *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance,* March 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 was either the tolerance interval or the prediction 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). A comparison of the statistical background concentrations and groundwater quality standards listed in 35 I.A.C. § 845.600(a)(1) and the resulting GWPSs are summarized in **Table 3-1**.

3.3 Applicable Groundwater Protection Standards

The applicable 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 results of the statistical analysis of background groundwater data (**Table 3-1**) indicate that most background concentrations in the MGU (*i.e.,* uppermost aquifer) and LGU (*i.e.,* PMP) are less than the groundwater quality standards listed in 35 I.A.C. § 845.600(a)(1). Therefore, for these parameters, the groundwater quality standards listed in 35 I.A.C. § 845.600(a)(1) will be applied to the results from the proposed groundwater monitoring network. The exceptions include arsenic and boron, where the background concentration is greater than the 35 I.A.C. § 845.600(a)(1) standard. In these instances, the GWPS will be the background concentration.

Under most circumstances, the GWPS will be compared to the lower confidence limit for the observed concentrations for each constituent in each compliance well. Exceptions are when there are high percentages (greater than 50 percent) of non-detects in compliance well data, for which a future mean (for 50 to 70 percent non-detects) or median (for greater than 70 percent non-detects) will be compared to the GWPS. 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.

Evaluation of the applicable standards will occur in conjunction with the analysis of groundwater quality results. Background calculations and the resulting concentrations may be updated as appropriate, in accordance with the Statistical Analysis Plan included in **Appendix A**.

4. GROUNDWATER MONITORING PLAN

The groundwater monitoring plan will monitor and evaluate groundwater quality to demonstrate compliance with the groundwater quality standards included in 35 I.A.C. § 845.600(a). The groundwater monitoring program will include sampling and analysis procedures that are consistent and that provide an accurate representation of groundwater quality at the background and downgradient wells as required by 35 I.A.C. § 845.630. As discussed in **Section 2.2**, one Part 845 groundwater monitoring network specific to the NAP and OEAP has been proposed.

4.1 Monitoring Networks and Parameters

4.1.1 Part 845 Groundwater Monitoring

The proposed Part 845 monitoring well network will consist of five background monitoring wells (21, 42, 43, 101, and 103), 14 compliance monitoring wells (02, 03R, 04, 05, 07R, 08R, 17, 20, 34, 36, 37, 38, 40, and 41), two temporary water level only wells (ND3 and OED1), and one temporary water level only surface water staff gage (SG01) to monitor potential impacts from the NAP and OEAP (**Figure 2-1**). These monitoring wells are screened within the MGU (*i.e.,* uppermost aquifer [04, 05, 07R, 08R, 17, 20, 36, 38, 40, and 41]) and the LGU (*i.e.,* PMP [02, 03R, 21, 34, 37, 42, 43, 101, and 103]) along the perimeter of the NAP and OEAP. Groundwater samples will be collected and analyzed for the laboratory and field parameters in **Table D** below:

Table D. Part 845 Groundwater Monitoring Program Parameters

Field Parameters[1]			
Groundwater Elevation	pH	Turbidity	
Metals (Total)			
Antimony	Boron	Cobalt	Molybdenum
Arsenic	Cadmium	Lead	Selenium
Barium	Calcium	Lithium	Thallium
Beryllium	Chromium	Mercury	
Inorganics (Total, except TDS)			
Fluoride	Sulfate	Chloride	TDS
Other (Total)			
Radium 226 and 228 combined			

[1] Dissolved oxygen, temperature, specific conductance, and oxidation/reduction potential were recorded during sample collection.

All parameters listed above were sampled a minimum of eight times by October 18, 2021 to establish background groundwater quality in accordance with 35 I.A.C. § 845.650(b)(1)(A). Discussion of background groundwater quality is included in **Section 3.2**.

4.2 Sampling Schedule

Groundwater sampling for the Part 845 monitoring well network will initially be performed quarterly according to the schedule in **Table E** below:

Table E. Part 845 Sampling Schedule

Frequency	Duration
Monthly (groundwater elevations only)	Begins: the quarter following approval of this plan and issuance of the Operating Permit.
	Ends: Following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii).
Quarterly (groundwater quality)	Begins: the quarter following approval of this plan and issuance of the Operating Permit.
	Ends: Following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii), or upon IEPA approval of an alternate schedule as allowed by 35 I.A.C. § 845.650(b)(4).
Semi-annual (groundwater quality)	Begins: Following 5 years of quarterly groundwater monitoring and IEPA approval of a demonstration that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and not exhibiting statistically-significant increasing trends, monitoring effectiveness is not compromised by a semi-annual schedule, and sufficient data has been collected to characterize groundwater.
	Ends: Following detection of a statistically-significant increasing trend in groundwater concentrations or an exceedance of the standards in 35 I.A.C. § 845.600 (quarterly monitoring shall be resumed in these circumstances), or following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii).

4.3 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 4.5** (**Table 4-1**).

4.4 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. RLs for the applicable parameters are summarized in **Table 4-2**. Concentrations lower than the RL will be reported as less than the RL.

4.5 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). 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 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.

4.6 Groundwater Monitoring System Maintenance Plan

Consistent with the requirements of 35 I.A.C. § 845.630(e)(2), maintenance will be performed 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.
- Annual 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 maintenance of a monitoring well cannot address an identified deficiency, a replacement well will be installed.

4.7 Statistical Analysis

Statistical analysis will be consistent with procedures listed in 35 I.A.C. § 845.640(f). A Statistical Analysis Plan, provided in **Appendix A**, has been developed to summarize the statistical procedures that will be used to evaluate the groundwater results.

4.8 Data Reporting

Groundwater monitoring and analysis completed as part of the Part 845 monitoring under an approved monitoring program will be reported to IEPA within 60 days after completion of sampling and the data placed in the facility's operating record as required by 35 I.A.C. § 845.610(b)(3)(D). Within 14 days of posting to the operating record, information will be posted to the publicly accessible internet site "Illinois CCR Rule Compliance Data and Information" as required by 35 I.A.C. § 845.810(d). Information will also be provided to IEPA annually by January 31 as required by 35 I.A.C. § 845.550, for data collected the preceding year. The report will include the status of the groundwater monitoring and any required corrective action plan for the NAP and OEAP in addition to other requirements detailed in 35 I.A.C. § 845.610(e).

4.9 Compliance with Applicable On-site Groundwater Protection Standards

In accordance with 35 I.A.C. § 845.600(a)(1), the groundwater protection standard at the waste boundary will be the higher of either the 35 I.A.C. § 845.600 standard or the concentration determined by background groundwater monitoring.

As provided in 35 I.A.C. § 845.780(c)(2), at the end of the 30-year post-closure care period, groundwater monitoring will continue to be conducted in post-closure care until the groundwater results show the concentrations are:

- Below the GWPS in 35 I.A.C. § 845.600; and
- Not increasing for those constituents over background, using the statistical procedures and performance standards in 35 I.A.C. § 845.640(f) and (g), provided that:
  - Concentrations have been reduced to the maximum extent feasible; and
  - Concentrations are protective of human health and the environment.

If one or more constituents are detected and confirmed by an immediate resample, to be greater than the GWPS in any sampling event, an Alternate Source Demonstration (ASD) will be evaluated as described in **Section 4.10**.

4.10 Alternate Source Demonstrations

As allowed in 35 I.A.C. § 845.650(e), following detection of an exceedance of the GWPS, an ASD will be evaluated and, if completed, submitted to IEPA within 60 days. The ASD will provide lines of evidence that a source other than the NAP and OEAP caused the contamination and the NAP and OEAP did not contribute to the contamination, 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.

The ASD will include information and analysis that supports the conclusions and a certification of accuracy by a qualified professional engineer. Once the ASD is approved by IEPA, the Part 845 groundwater monitoring will continue as defined in **Section 4.1.1**.

If an ASD is not completed and submitted, or IEPA does not approve the ASD, a notification of the exceedance will be provided to IEPA and placed in the operating record. Additional actions will also be completed as required by 35 I.A.C § 845.650(d)(1) through (3); including, initiation of an assessment of corrective measures under 35 I.A.C § 845.660. As allowed in 35 I.A.C § 845.650(e)(7) a petition for review of IEPA's non-concurrence under 35 I.A.C. § 105 may also be filed.

4.11 Assessment of Corrective Measures and Corrective Action

As described in 35 I.A.C. § 845.660, if the ASD summarized in **Section 4.10** has not been approved by IEPA, an assessment of corrective measures will be initiated within 90 days of the detection of a result exceeding 35 I.A.C. § 845.600 standards (*i.e.,* receipt of laboratory data). The assessment of corrective measures will include at least the following (35 I.A.C. § 845.660(c)):

- The 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;
- The time required to begin and complete the corrective action plan; and
- The institutional requirements, such as State or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the corrective action plan.

Within one year of completing the assessment of corrective measures, a corrective action plan will be developed to identify the selected remedy in accordance with 35 I.A.C. § 845.670. If closure of the CCR Unit is required, a closure alternatives analysis will be completed as specified in 35 I.A.C. § 845.710. The analysis and selected alternative will be submitted to IEPA in a Closure Plan as specified by 35 I.A.C. § 845.720. Groundwater monitoring proposed in this Addendum will continue as specified until the post closure care period has expired and IEPA has approved termination of post-closure care.

5. REFERENCES

Illinois Environmental Protection Agency, 2021. *Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845.* April 15, 2021.

Kelron Environmental (Kelron), 2012a. *Hydrogeology and Groundwater Quality of the North Ash Pond System, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC.* March 15, 2012.

Kelron Environmental (Kelron), 2012b. *Hydrogeology and Groundwater Quality of the Old East Ash Pond, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC.* March 15, 2012.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021. *Hydrogeologic Site Characterization Report. North Ash Pond and Old East Ash Pond. Vermilion Power Plant. Oakwood, Illinois*.

United States Environmental Protection Agency (USEPA), March 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance*. Office of Resource Conservation and Recovery, Program Implementation and Information Division, United States Environmental Protection Agency, Washington D.C. EPA/530/R-09/007.United States Environmental Protection Agency (USEPA), 2015. Title 40 of the Code of Federal Regulations, Part 257.

TABLES

TABLE 1-1. PART 845 REQUIREMENTS CHECKLIST

GROUNDWATER MONITORING PLAN

VERMILION POWER PLANT

NORTH ASH POND AND OLD EAST ASH POND

OAKWOOD, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in GMP
845.630	**Groundwater Monitoring Systems**	
845.630(a)(2)	Potential contaminant pathways must be monitored.	Sections 1.3, 2.2, & 4.1.1
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)	Sections 2.2 & 4.1.1 Table 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 4 Tables 4-1 & 4-2
845.640(b)	Methods are appropriate	Section 4 Tables 4-1 & 4-2
845.640(c)	Groundwater elevations must be measured in each well prior to purging, each time groundwater is sampled.	Section 4.3
845.640 (d)(e)(f)(g)(h)	Establishement of background and application of statistical methods	Sections 3 & 4.7 Appendix A
845.640(i)	Analyze total recoverable metals	Sections 4.1.1 & 4.4
845.640(j)	Analyze groundwater samples using a certified laboratory	Section 4.4

TABLE 1-1. PART 845 REQUIREMENTS CHECKLIST
GROUNDWATER MONITORING PLAN
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in 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 4.1.1
845.650(b)(c)	Groundwater Monitoring Frequency	Sections 4.1.1 & 4.2
845.650(d)(e)	Exceedances of the groundwater protection standard	Sections 4.9, 4.10, & 4.11
NA	Staff gauge/ piezometer to monitor head in impoundment?	Sections 2.2 & 4.1.1 Figure 2-1 (ND3 and OED1)
NA	Staff gauge/ piezometer to monitor head of neighboring surface water body?	Sections 2.2 & 4.1.1 Figure 2-1 (SG01)

[O: EDP 07/26/21; U: CJC 09/23/21; C: LDC 10/06/21]

Notes:
GMP = Groundwater Monitoring Plan
NA = Not Applicable

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
GROUNDWATER MONITORING PLAN
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, 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)
02	C	LGU	11/03/1982	593.87	593.87	Top of PVC	590.39	30.10	39.70	560.30	550.70	39.70	549.40	9.6	2	40.182334	-87.743855
03R	C	LGU	12/07/1993	589.86	589.86	Top of PVC	587.83	29.00	34.00	558.80	553.80	35.30	551.30	5	2	40.184122	-87.746092
04	C	UA	11/04/1982	590.89	590.89	Top of PVC	587.38	8.70	13.50	578.70	573.90	13.50	573.90	4.8	2	40.186394	-87.74493
05	C	UA	11/04/1982	595.65	595.65	Top of PVC	592.28	9.10	13.90	583.10	578.30	13.90	578.30	4.8	2	40.187159	-87.747129
07R	C	UA	04/27/2021	594.50	594.50	Top of PVC	591.83	11.00	21.00	580.83	570.83	21.00	551.83	20	2	40.182309	-87.743853
08R	C	UA	12/06/1993	589.86	589.86	Top of PVC	587.92	9.50	14.50	578.50	573.50	18.00	570.00	5	2	40.184136	-87.746095
17	C	UA	12/06/1993	623.19	623.19	Top of PVC	619.62	54.00	59.00	565.60	560.60	60.00	547.60	5	2	40.182087	-87.746641
20	C	UA	12/08/1993	592.27	592.27	Top of PVC	590.18	12.50	17.50	577.70	572.70	18.50	571.20	5	2	40.186949	-87.743335
21	B	LGU	12/08/1993	672.71	672.71	Top of PVC	670.69	104.00	109.00	566.40	561.40	110.00	558.40	5	2	40.179682	-87.744962
34	C	LGU	10/21/2010	592.45	592.45	Top of PVC	590.11	49.10	54.10	540.90	535.88	54.30	535.70	5	2	40.186921	-87.743359
36	C	UA	03/03/2021	589.96	589.96	Top of PVC	587.82	16.00	21.00	571.82	566.82	21.00	565.80	5	2	40.183141	-87.745676
37	C	LGU	03/03/2021	589.71	589.71	Top of PVC	587.84	48.00	53.00	539.84	534.84	53.00	525.80	5	2	40.183133	-87.745668
38	C	UA	03/02/2021	591.69	591.69	Top of PVC	589.14	21.00	31.00	568.14	558.14	31.00	552.10	10	2	40.189062	-87.744898
40	C	UA	10/03/2018	592.27	592.27	Top of PVC	589.57	12.50	17.50	577.07	572.07	17.50	--	5	2	40.182269	-87.742987
41	C	UA	03/04/2021	587.17	587.17	Top of PVC	585.07	21.00	31.00	564.07	554.07	31.00	548.10	10	2	40.185445	-87.745262
42	B	LGU	03/07/2021	608.40	608.40	Top of PVC	605.41	50.00	60.00	555.41	545.41	60.00	545.40	10	2	40.182788	-87.748374
43	B	LGU	03/07/2021	607.84	607.84	Top of PVC	605.30	55.00	65.00	550.30	540.30	65.00	530.30	10	2	40.184888	-87.750015
101	B	LGU	03/05/2021	706.67	706.67	Top of PVC	704.09	141.00	151.00	563.09	553.09	151.00	544.10	10	2	40.179149	-87.754113
103	B	LGU	03/09/2021	720.38	720.38	Top of PVC	717.38	155.00	165.00	562.38	552.38	165.00	540.40	10	2	40.179842	-87.748995
ND3	WLO	CCR	02/05/2019	614.55	614.55	Top of PVC	610.78	8.65	23.31	602.13	587.48	23.87	586.91	14.66	2	40.1831	-87.747349
OED1	WLO	CCR	02/06/2019	630.41	630.41	Top of PVC	627.29	23.68	43.34	603.61	583.95	43.83	583.46	19.66	2	40.181608	-87.745161
SG01	WLO	SW	04/01/2021	689.32	689.32	Top of PVC	689.32	--	--	--	--	689.30	--	0	2	40.173756	-87.745091

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
GROUNDWATER MONITORING PLAN
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, 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)

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
-- = data not available
BGS = below ground surface
CCR = Coal Combustion Residual
ft = foot or feet
HSU = Hydrostratigraphic Unit
LGU = lower groundwater unit
PVC = polyvinyl chloride
SW = surface water
UA = uppermost aquifer

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TABLE 3-1. BACKGROUND GROUNDWATER QUALITY AND STANDARDS
GROUNDWATER MONITORING PLAN
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Parameter	Background Concentration	845 Limit	Groundwater Protection Standard	Unit
Antimony, total	0.001	0.006	0.006	mg/L
Arsenic, total	0.06	0.010	0.060	mg/L
Barium, total	0.52	2.0	2.0	mg/L
Beryllium, total	0.001	0.004	0.004	mg/L
Boron, total	2.45	2	2.45	mg/L
Cadmium, total	0.001	0.005	0.005	mg/L
Chloride, total	82	200	200	mg/L
Chromium, total	0.02	0.1	0.1	mg/L
Cobalt, total	0.004	0.006	0.006	mg/L
Fluoride, total	1.14	4.0	4.0	mg/L
Lead, total	0.006	0.0075	0.0075	mg/L
Lithium, total	0.03	0.04	0.04	mg/L
Mercury, total	0.0002	0.002	0.002	mg/L
Molybdenum, total	0.02	0.1	0.1	mg/L
pH (field)	7.8 / 6.8	9.0 / 6.5	9.0 / 6.5	SU
Radium 226 and 228 combined	1.9	5	5	pCi/L
Selenium, total	0.001	0.05	0.05	mg/L
Sulfate, total	227	400	400	mg/L
Thallium, total	0.002	0.002	0.002	mg/L
Total Dissolved Solids	746	1200	1200	mg/L

Notes:
For pH, the values presented are the upper / lower limits
Groundwater protection standards for calcium and turbidity do not apply per 35 I.A.C. § 845.600(b)
mg/L = milligrams per liter
SU = standard units
pCi/L = picocuries per liter

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RAMBOLL

TABLE 4-1. SAMPLING AND ANALYSIS SUMMARY
GROUNDWATER MONITORING PLAN
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

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 4 °C for all samples)	Sample Hold Time from Collection Date
Metals											
Metals [6]	6020, Li - EPA 200.7	19	3	0	0	2	24	plastic	600 mL	HNO_3 to pH<2	6 months
Mercury	7470A or 6020	19	3	0	0	2	24	plastic	400 mL	HNO_3 to pH<2	28 days
Inorganic Parameters											
Fluoride	9214 or EPA 300	19	3	0	0	2	24	plastic	300 mL	Cool to 4 °C	28 days
Chloride	9251 or EPA 300	19	3	0	0	2	24	plastic	100 mL	Cool to 4 °C	28 days
Sulfate	9036 or EPA 300	19	3	0	0	2	24	plastic	50 mL	Cool to 4 °C	28 days
Total Dissolved Solids	SM 2540 C	19	3	0	0	2	24	plastic	200 mL	Cool to 4 °C	7 days
Radium											
Radium 226	9315 or EPA 903	19	0	0	0	0	19	plastic	1000 mL	HNO_3 to pH<2	6 months
Radium 228	9320 or EPA 904	19	0	0	0	0	19	plastic	1000 mL	HNO_3 to pH<2	6 months
Field Parameters											
pH	SM 4500-H+ B	19	NA	NA	NA	NA	19	flow-through cell	NA	none	immediately
Dissolved Oxygen [8]	SM 4500-O/405.1	19	NA	NA	NA	NA	19	flow-through cell	NA	none	immediately
Temperature [8]	SM 2550	19	NA	NA	NA	NA	19	flow-through cell	NA	none	immediately
Oxidation/Reduction Potential [8]	SM 2580 B	19	NA	NA	NA	NA	19	flow-through cell	NA	none	immediately
Specific Conductance [8]	SM 2510 B	19	NA	NA	NA	NA	19	flow-through cell	NA	none	immediately
Turbidity [7]	SM 2130 B	19	NA	NA	NA	NA	19	flow-through cell or hand-held turbidity meter	NA	none	immediately

[O: EDP 07/26/21; U: CJC 09/23/21; C: LDC 10/06/21]

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 sample. 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] Metals = antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, lead, lithium, molybdenum, selenium, thallium. Metals may be analyzed via ICP/ ICP-MS USEPA methods 6010 or 6020 depending on laboratory instrument availability
[7] If turbidity exceeds 10 NTUs, a duplicate sample filtered through a .45 micron filter may be collected for metals analysis in addition to the unfiltered sample. Both samples would be submitted for analysis.
[8] Parameter collected for quality assurance and quality control for field sampling purposes only; not required to be collected or reported under Part 845; collection of parameter may be discontinued without notification.
< = less than
°C = degrees Celsius
HNO_3 = nitric acid
mL = milliliter
NA = not applicable
NTU = nephelometric turbidity unit

TABLE 4-2. DETECTION AND REPORTING LIMITS FOR PART 845 PARAMETERS
GROUNDWATER MONITORING PLAN
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Constituent	CAS	Unit	Analytical Methods [1]	USEPA MCL [2]	IL Part 845.600	RL [4, 5]	MDL [5]
Metals							
Antimony	7440-36-0	mg/L	6020	0.006	0.006	0.003	0.00036
Arsenic	7440-38-2	mg/L	6020	0.01	0.01	0.001	0.00013
Barium	7440-39-3	mg/L	6020	2	2	0.001	0.00028
Beryllium	7440-41-7	mg/L	6020	0.004	0.004	0.001	0.000017
Boron	7440-42-8	mg/L	6020	NS	2	0.01	0.0023
Cadmium	7440-43-9	mg/L	6020	0.005	0.005	0.001	0.000042
Calcium	7440-70-2	mg/L	6020	NS	NS	0.15	0.15
Chromium	7440-47-3	mg/L	6020	0.1	0.1	0.004	0.00027
Cobalt	7440-48-4	mg/L	6020	0.006	0.006	0.002	0.000017
Lead	7439-92-1	mg/L	6020	0.015	0.0075	0.001	0.000025
Lithium	7439-93-2	mg/L	6020 or EPA 200.7	0.04	0.04	0.02	0.0001
Mercury	7439-97-6	mg/L	6020 or 7470A	0.002	0.002	0.0002	0.000078
Molybdenum	7439-98-7	mg/L	6020	0.1	0.1	0.001	0.000063
Selenium	7782-49-2	mg/L	6020	0.05	0.05	0.001	0.00032
Thallium	7440-28-0	mg/L	6020	0.002	0.002	0.001	0.000062
Inorganics							
Fluoride	7681	mg/L	9214 or EPA 300	4	4	0.25	0.065
Chloride	16887-00-6	mg/L	9251 or EPA 300	250 [3]	200	1	0.15
Sulfate	18785-72-3	mg/L	9036 or EPA 300	250 [3]	400	1	0.24
Total Dissolved Solids	10052	mg/L	SM 2540C	500 [3]	1200	17	--
Other							
Radium 226 and 228 Combined	7440-14-4	pCi/L	9315/9320 or EPA 903/904	5	5	-- [6]	-- [7]
Field							
pH	NA	SU	SM 4500-H+ B	NS	6.5-9.0	NA	NA
Oxidation/Reduction Potential	NA	mV	SM 2580 B	NS	NS	NA	NA
Dissolved Oxygen	NA	mg/L	SM 4500-O/405.1	NS	NS	NA	NA
Temperature	NA	^{o}C	SM 2550	NS	NS	NA	NA
Specific Conductivity	NA	µS/cm	SM 2510 B	NS	NS	NA	NA

TABLE 4-2. DETECTION AND REPORTING LIMITS FOR PART 845 PARAMETERS

GROUNDWATER MONITORING PLAN

VERMILION POWER PLANT

NORTH ASH POND AND OLD EAST ASH POND

OAKWOOD, ILLINOIS

Constituent	CAS	Unit	Analytical Methods [1]	USEPA MCL [2]	IL Part 845.600	RL [4, 5]	MDL [5]
Turbidity	NA	NTU	SM 2130 B	NS	NS	NA	NA

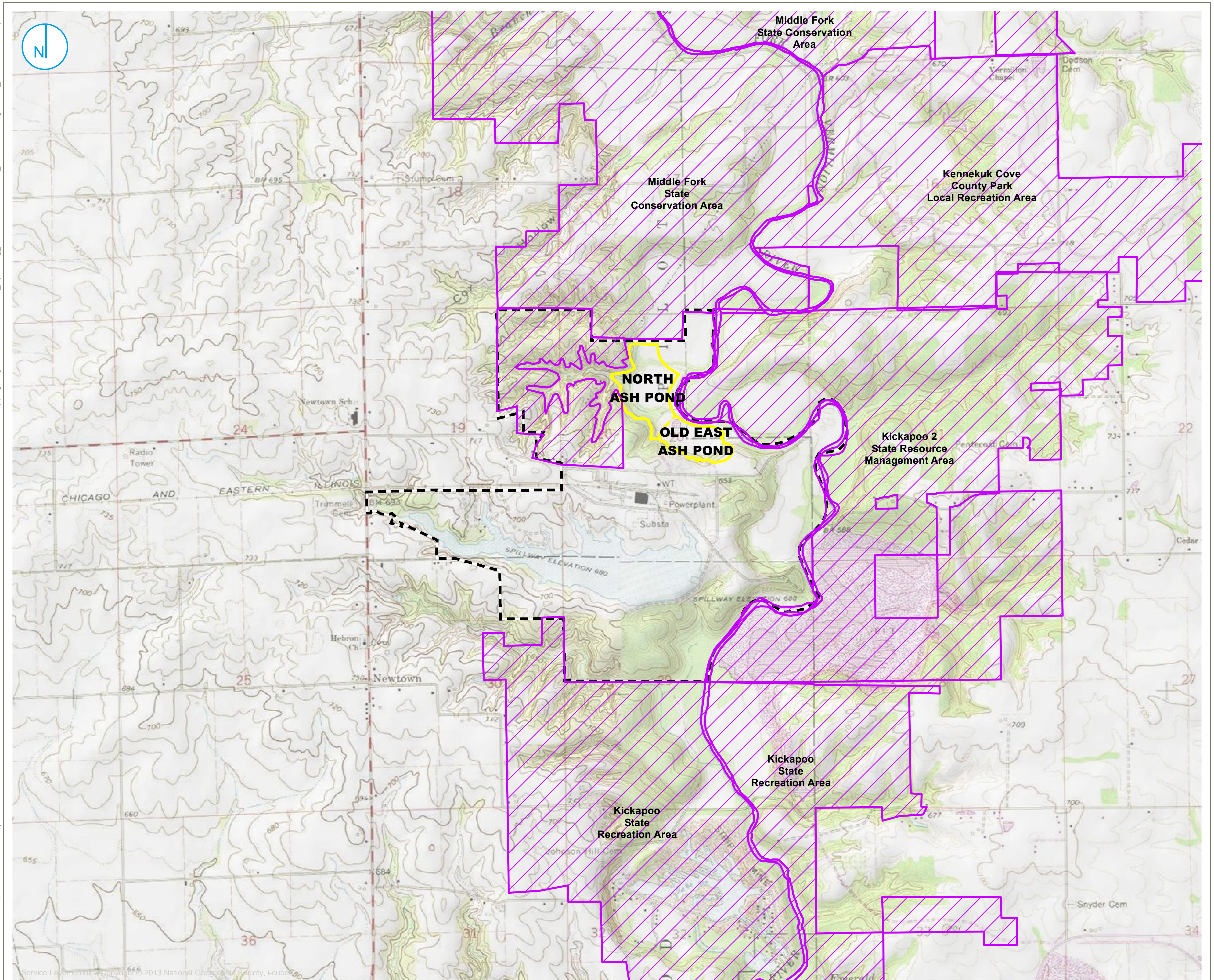
[O: EDP 07/26/21; U: CJC 09/23/21; C: LDC 10/06/21]

Notes:

[1] Analytical method numbers are from SW-846 unless otherwise indicated. Metals will be analyzed via Method 6020 or 6010 depending on laboratory equipment availability. Selected method will ensure reporting limits (RLs) are below Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.600 groundwater protection standards.

[2] USEPA MCL = United States Environmental Protection Agency Maximum Contaminant Level.
[3] USEPA SMCL = United States Environmental Protection Agency Secondary Maximum Contaminant Level.
[4] RLs will be less than the 35 I.A.C. § 845.600 groundwater protection standards.
[5] RLs and method detection limits (MDLs) will vary depending on the laboratory performing the work.
[6] All radium results will be reported (values may be positive or negative) and will include uncertainty and the calculated MDC.
[7] Laboratories calculate a minimum detectable concentration (MDC) based on the sample.
CAS = Chemical Abstract Number
MDL = Method detection limit as established by the laboratory
mg/L = milligrams per liter
mV = millivolts
pCi/L = picoCuries per liter
NS = No standard
NTU = nephelometric turbidity unit
RL = Reporting limit as established by the laboratory
SM = Standard Methods for the Examination of Water and Wastewater
SU = standard units
µS/cm = microSiemens per centimeter
^{o}C = degrees Celsius

FIGURES



Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\GMP\Figure 1-1_Site Location Map.mxd

PROJECT: 169000XXXX | DATED: 10/8/2021 | DESIGNER: STOLZSD

SITE LOCATION MAP

GROUNDWATER MONITORING PLAN
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 1-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

UNDERGROUND COAL MINE
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 200 400
Feet

SITE MAP

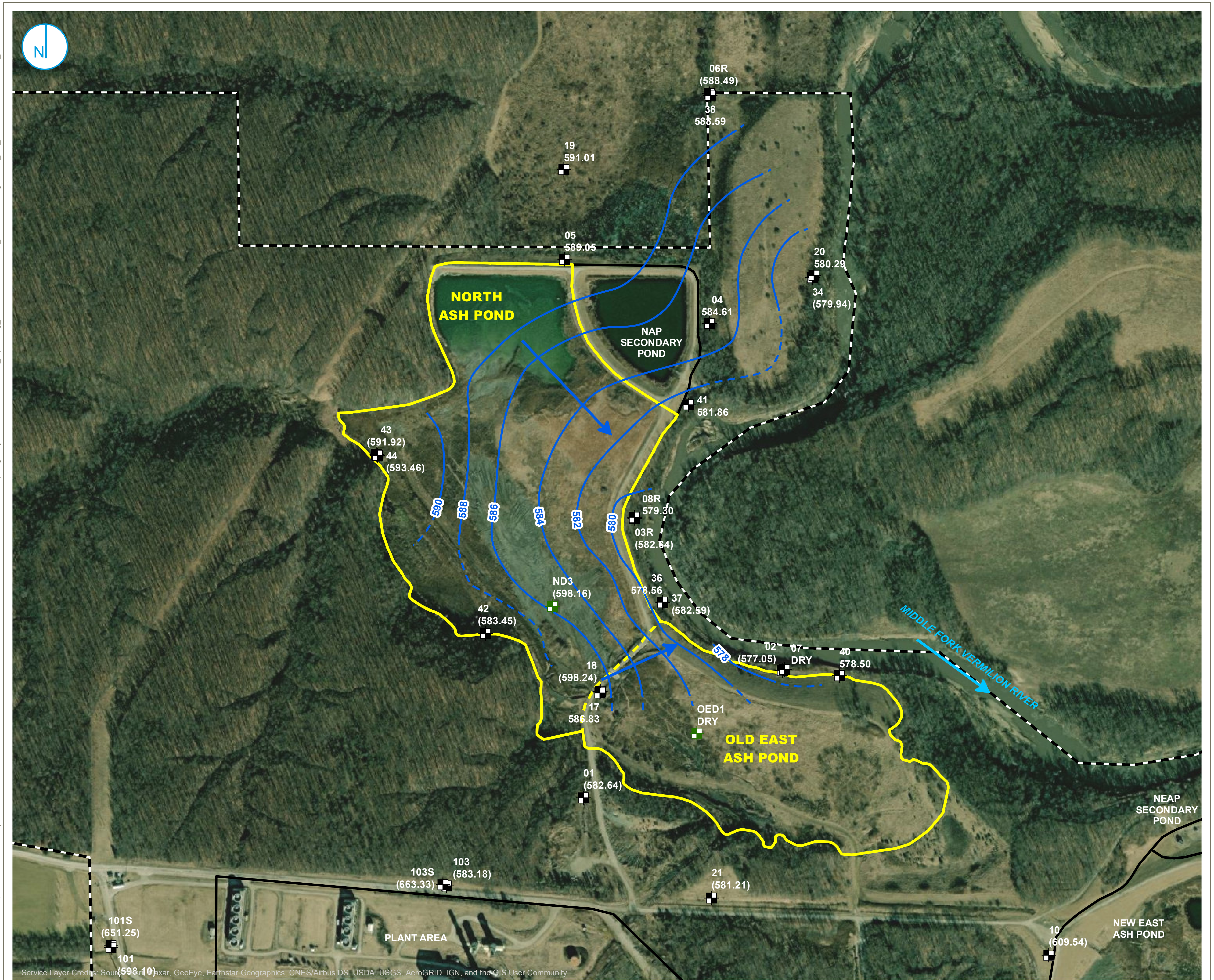
GROUNDWATER MONITORING PLAN
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 1-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\GMP\Figure 1-2_Site Map.mxd

PROJECT: 169000XXXX | DATED: 10/8/2021 | DESIGNER: STOLZSD



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

NOTE:
ELEVATIONS IN PARENTHESIS WERE NOT USED FOR CONTOURING.
NM = NOT MEASURED

0 200 400 Feet

UPPERMOST AQUIFER GROUNDWATER ELEVATION CONTOURS
MARCH 29, 2021

GROUNDWATER MONITORING PLAN
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

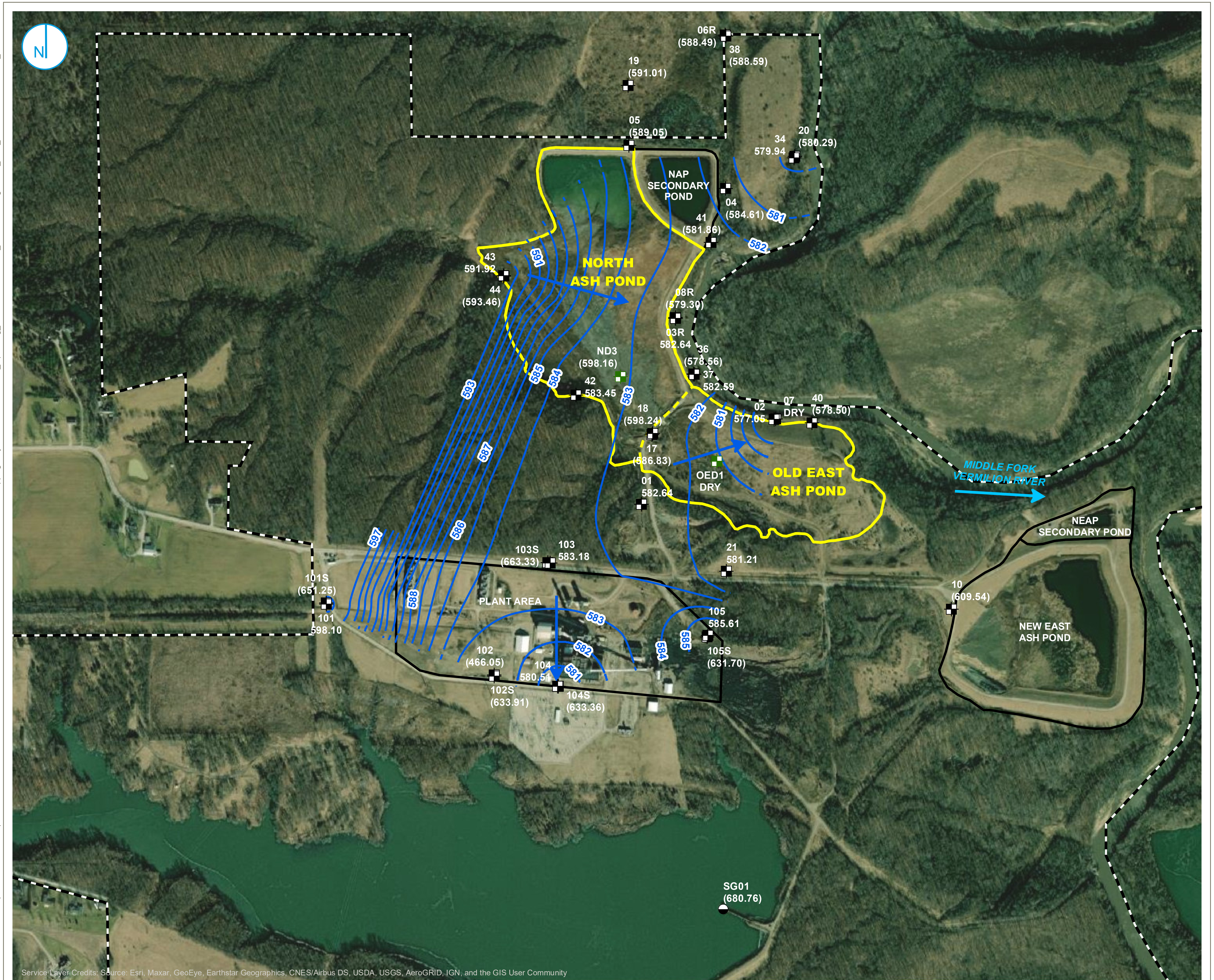
FIGURE 1-3

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 169000XXXX | DATED: 10/8/2021 | DESIGNER: STOLZSD

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\GMP\Figure 1-3_UA_GWE Contours Event 1_20210329.mxd



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
STAFF GAGE
GROUNDWATER ELEVATION CONTOUR (1-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

NOTE:
ELEVATIONS IN PARENTHESIS WERE NOT USED FOR CONTOURING.
NM = NOT MEASURED

0 300 600 Feet

POTENTIAL MIGRATION PATHWAY GROUNDWATER ELEVATION CONTOURS MARCH 29, 2021

GROUNDWATER MONITORING PLAN
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 1-4

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

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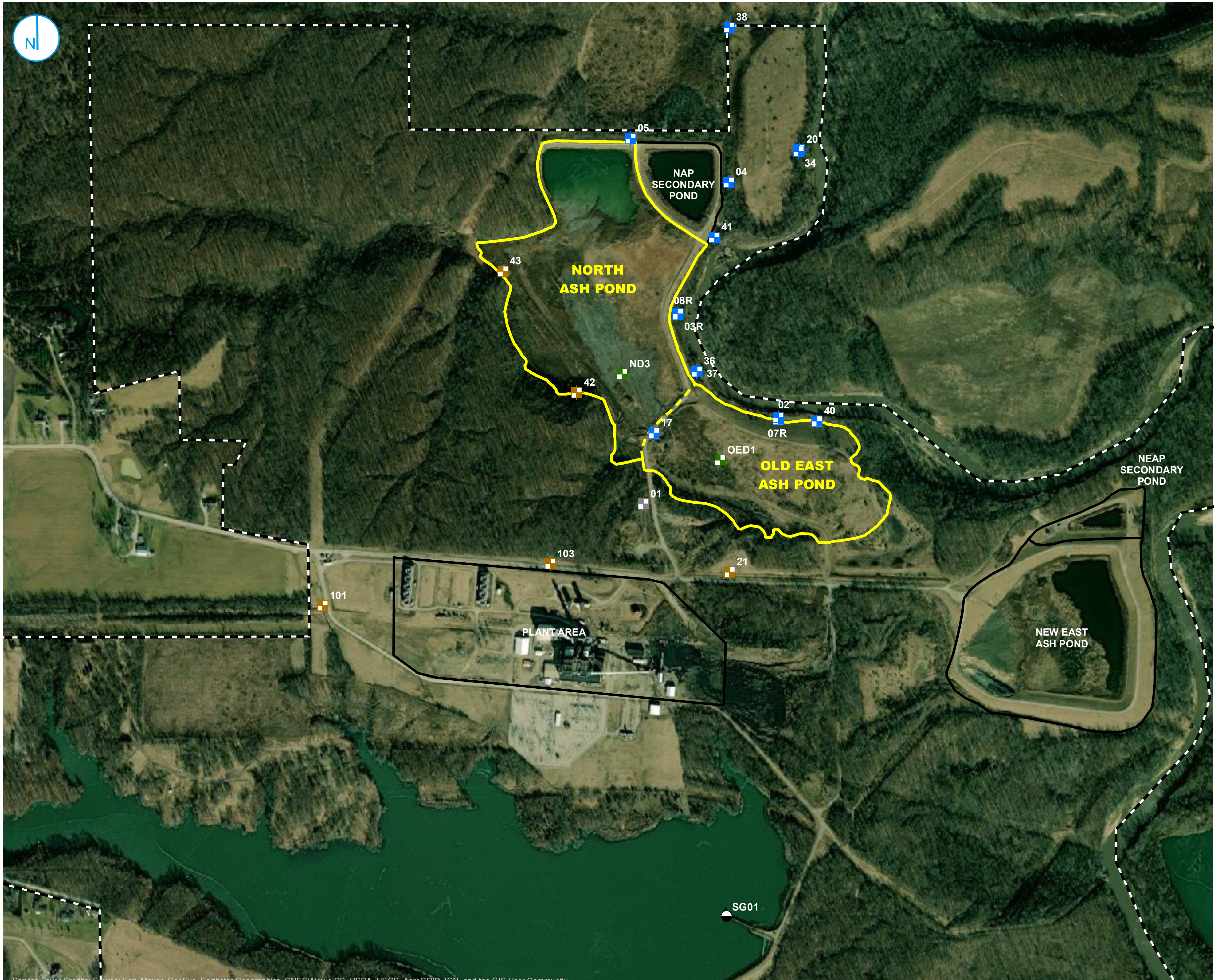
PROJECT: 169000XXXX | DATED: 10/8/2021 | DESIGNER: STOLZSD



Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\GMP\Figure 2-1_Proposed 845 GW Monitoring Well Network.mxd

PROJECT: 169000XXXX | DATED: 10/11/2021 | DESIGNER: STOLZSD

COMPLIANCE WELL
BACKGROUND WELL
SOURCE SAMPLE LOCATION
MONITORING WELL TO BE ABANDONED
STAFF GAUGE
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 300 600 Feet

PROPOSED PART 845 GROUNDWATER MONITORING WELL NETWORK

GROUNDWATER MONITORING PLAN
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 2-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

APPENDIX A
STATISTICAL ANALYSIS PLAN

Prepared for
Dynegy Midwest Generation, LLC

Date
October 25, 2021

Project No.
1940100722

STATISTICAL ANALYSIS PLAN

NORTH ASH POND AND OLD EAST ASH POND VERMILION POWER PLANT OAKWOOD, ILLINOIS

Bright ideas. Sustainable change.

STATISTICAL ANALYSIS PLAN
VERMILION POWER PLANT NORTH ASH POND AND OLD EAST ASH POND

Project Name	**Vermilion Power Plant North Ash Pond and Old East Ash Pond**
Project No.	**1940100722**
Recipient	**Dynegy Midwest Generation, LLC**
Document Type	**Statistical Analysis Plan**
Version	**FINAL**
Date	**October 25, 2021**

Ramboll
234 W. Florida Street
Fifth Floor
Milwaukee, WI 53204
USA

T 414-837-3607
F 414-837-3608
https://ramboll.com

Brian G. Hennings, PG
Senior Managing Hydrogeologist

Eric J. Tlachac, PE
Senior Managing Engineer

Rachel A. Banoff, EIT
Project Statistician

LICENSED PROFESSIONAL CERTIFICATIONS

This certification is based on the description of the statistical methods selected to evaluate groundwater as presented in the following Statistical Analysis Plan; Vermilion Power Plant North Ash Pond and Old East Ash Pond. The procedures described in the plan will be used to establish background conditions and implement compliance monitoring as necessary and required by 35 I.A.C. § 845.640 and 35 I.A.C. § 845.650. The 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,* March 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 will be either the tolerance interval or the prediction 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 lower confidence limit 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 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 (Statistical Analysis Plan; Vermilion Power Plant North Ash Pond and Old East Ash Pond) 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: October 25, 2021

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 (Statistical Analysis Plan; Vermilion Power Plant North Ash Pond and Old East Ash Pond) 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: October 25, 2021

35 I.A.C. § 845.640 Statistical Analysis

I, Rachel A. Banoff, a qualified professional, certify that the statistical methods described in this document (Statistical Analysis Plan; Vermilion Power Plant North Ash Pond and Old East Ash Pond), 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: October 25, 2021

CONTENTS

Licensed Professional Certifications		**2**
1.	**Introduction**	**6**
1.1	Statistical Analysis Objectives	6
1.2	Statistical Analysis Plan Approach	6
2.	**Background Monitoring and Data Preparation**	**8**
2.1	Sample Independence	8
2.2	Non-Detect Data Processing	9
2.3	Testing for Normality	9
2.4	Testing for Outliers	9
2.5	Trend Analysis	10
2.6	Spatial Variation	10
2.7	Temporal Variation	10
2.8	Updating Background	11
3.	**Compliance Monitoring**	**13**
3.1	GWPS Establishment and Exceedance Determination	13
3.1.1	The Upper Tolerance Limit	14
3.1.2	Parametric Confidence Intervals around a Mean	16
3.1.3	Non-Parametric Confidence Intervals around a Median	16
3.1.4	The Upper Prediction Limit for a Future Mean	17
3.1.5	The Non-Parametric Upper Prediction Limit for a Future Median	17
3.1.6	Parametric Linear Regression and Confidence Band	18
3.1.7	Non-Parametric Thiel-Sen Trend Line and Confidence Band	20
3.2	Determination of Statistically Significant Increases over Background	21
4.	**References**	**22**

TABLES (IN TEXT)

Table A Statistical Calculations Used in Compliance Monitoring Procedures

ACRONYMS AND ABBREVIATIONS

§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
ANOVA	analysis of variance
CCR	coal combustion residuals
COC	constituents of concern
GWPS	groundwater protection standard
IEPA	Illinois Environmental Protection Agency
LCL	lower confidence limit
LTL	lower tolerance limit
MSE	mean squared error
P	probability
Part 845	Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
ROS	regression on order statistics
SI	surface impoundment
SSI	statistically significant increase
SWFPR	site-wide false positive rate
Unified Guidance	*Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (USEPA, 2009)
UPL	upper prediction limit
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 (Part 845). Facilities regulated under Part 845 are required to develop and sample a groundwater monitoring well network to evaluate whether impounded CCR materials are impacting downgradient groundwater quality. The groundwater quality evaluation must include selection and certification by a qualified professional engineer of the statistical procedures to be used. 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 and 35 I.A.C. § 845.650. 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*) (March 2009).

This Statistical Analysis Plan does not include procedures for groundwater sample collection and analysis, as these activities are conducted in accordance with the Sampling and Analysis Plan prepared for each CCR unit in accordance with 35 I.A.C. § 845.640. This Statistical Analysis Plan will be used as the primary reference for evaluating groundwater quality during operation and post-closure care.

1.1 Statistical Analysis Objectives

This Statistical Analysis Plan is intended to provide a logical process and framework for conducting the statistical analyses of data obtained during groundwater monitoring conducted in accordance with the Sampling and Analysis Plan for each CCR unit. The Statistical Analysis Plan will enable a qualified professional engineer to certify that the selected statistical methods are appropriate for evaluating the groundwater monitoring data for the applicable CCR unit(s).

1.2 Statistical Analysis Plan Approach

The main sections of this Statistical Analysis Plan should be viewed as a "generic" outline of statistical methods utilized for each CCR unit and constituent required to be monitored. The statistical analysis of the groundwater monitoring data, however, will be conducted on an individual-constituent or well basis, and may involve the use of appropriate statistical procedures depending on multiple factors such as detection frequency and normality distributions.

The CCR Rule outlines two phases of groundwater monitoring:

- Background Monitoring in accordance with 35 I.A.C. § 845.650(b)(1)
- Compliance Monitoring in accordance with 35 I.A.C. § 845.650

Each phase of the groundwater monitoring program requires specific statistical procedures to accomplish the intended purpose. During the background monitoring phase, background groundwater quality will be established utilizing upgradient and background wells and downgradient groundwater quality data will be collected to facilitate statistics in subsequent phases. Compliance Monitoring is then initiated through the evaluation of the downgradient groundwater monitoring data for exceedances of the groundwater protection standard (GWPS) established by Part 845 (concentration specified in 35 I.A.C. § 845.600 or an IEPA-approved background concentration). The developed statistical analysis plan will be implemented for each monitoring phase and in accordance with the statistical procedures.

2. BACKGROUND MONITORING AND DATA PREPARATION

The background and compliance monitoring wells were sampled and analyzed for constituents, as listed in Part 845 (antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chloride, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, pH, radium 226 and 228 combined, selenium, sulfate, thallium, total dissolved solids, and turbidity), during the baseline phase of the groundwater monitoring program.

The background monitoring well(s) were placed upgradient of the CCR unit, or at an alternative background location, where they are not affected by potential leakage from the CCR unit. Compliance monitoring wells were placed at the waste boundary of the CCR unit, along the same groundwater flow path. As 35 I.A.C. § 845.630(a) specifies, the location of these wells ensures that background accurately represents the quality of unaffected groundwater, while compliance wells accurately represent groundwater quality at the waste boundary and monitor all potential contaminant pathways.

As required by 35 I.A.C. § 845.650(a)(1), eight sampling events were completed within 180 days of April 21, 2021. As outlined, groundwater sampling procedures included sampling of the background and compliance wells using low-flow sampling methods, collection of one field quality control sample per event, and groundwater samples were not field filtered before laboratory analysis of total recoverable metals.

Following completion of the eight sampling events, background groundwater quality was established for Part 845 constituents. Groundwater monitoring will be conducted quarterly for at least the first five years. In accordance with 35 I.A.C. § 845.650(b)(4), after the first five years, a request to reduce the monitoring frequency to semiannual may be submitted to IEPA if all of the following can be demonstrated:

- Groundwater monitoring effectiveness will not be compromised by the reduced frequency
- Sufficient data has been collected to characterize groundwater
- Monitoring to date does not show any statistically significant increasing trends
- The concentrations of monitored constituents at the compliance monitoring wells are below the applicable GWPSs established in 35 I.A.C. § 845.600

The following subsections outline the statistical tests and procedures (methods) that will be utilized to evaluate data collected for each constituent in both background and compliance wells for Background and Compliance Monitoring. When necessary and contingent upon equivalent statistical power, an alternative test not included in this Statistical Analysis Plan may be chosen due to site-specific data requirements.

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. The sampling schedules for both the baseline and compliance monitoring periods are specified in 35 I.A.C. § 845.650(b) and may conflict with the statistical assumption of independence of sample results.

2.2 Non-Detect Data Processing

The reporting limit (RL) will be used as the lower level for the reporting of non-detected groundwater quality data. For all summary statistics (box plots, timeseries, etc.), the RL will be substituted for concentrations reported below the RL, including non-detects. With professional judgement, analytical results between the RL and the method detection limit, *i.e.,* estimated values, typically identified with a “J” flag, may be utilized if provided by the laboratory.

For all statistical test procedures:

- 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 between 15 percent and 50 percent, either the Kaplan-Meier or robust regression on order statistics (ROS) 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 percent, a non-parametric test will be used
- If only one background result is detected that value will be used as the non-parametric upper prediction limit (UPL)

2.3 Testing for Normality

Many statistical analyses assume that sample data are normally distributed (parametric). However, environmental data are frequently not normally distributed (nonparametric). 35 I.A.C. § 845.640(g) requires the knowledge of the background data distribution for comparison to compliance results. 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.

When possible, transformation of datasets to achieve normal distributions is preferred.

2.4 Testing for Outliers

Part 845 constituents will be screened for the existence of outliers using a method 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.
- Time series, box-whisker plots, and probability plots provide visual tools to identify potential outliers, and evaluation of seasonal, spatial, or temporal variability for both normally and non-normally distributed data.

Data quality control, groundwater geochemistry, and sampling procedures will be evaluated as potential sources of error leading to an outlier result. The outlier tests cannot be used alone to determine whether a value is a true outlier that should be excluded from future statistical analysis. Corroborating evidence needed to exclude values includes a discrete data reporting or analytical error, or potential laboratory bias. Absent corroborating evidence, the flagged values are considered true, but extreme, values in the data set. Professional judgement will be used to exclude extreme outliers from further statistical analyses. Outliers will be retained in the database.

With professional judgement, a confirmatory sample may be collected to allow for the distinction between an outlier and a true representation of groundwater quality at the monitoring point. If re-sampling is conducted, this sample will be collected within 90 days following outlier identification. If the confirmatory sample indicates the original result as an outlier, it will be reported as such.

2.5 Trend Analysis

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

A linear regression, coupled with a t-test for slope significance at a 95 percent confidence level (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 percent confidence level (0.05 significance level), will 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 unit being monitored was 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. 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 as 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.

Hydrologic factors such as drought, recharge patterns or regular (*e.g.,* seasonal) water table fluctuations may be responsible for the temporal variation. In these cases, it may be useful to test for the presence of a significant temporal effect by first constructing a parallel time series plot and then running a formal one-way analysis of variance (ANOVA) (α = 0.05) for temporal effects. A one-way ANOVA for temporal effects considers multiple well data sets for individual sampling events or seasons as the relevant statistical factor. If event-specific analytical differences or seasonality appear to be an important temporal factor, the one-way ANOVA for temporal effects can be used to formally identify seasonality, parallel trends, or changes in lab performance that affect other temporal effects. The one-way ANOVA for temporal effects assumes that the data groups are normally distributed with constant variance. It is also assumed that for each of a series of background wells, measurements are collected at each well on sampling events or dates common to all the wells. Results of the ANOVA can also be used to create temporally stationary residuals, where the temporal effect has been 'subtracted from' the original measurements. These stationary residuals may be used to replace the original data in subsequent statistical testing.

If the data cannot be normalized, a similar test for a temporal or seasonal effect can be performed using the Kruskal-Wallis test (α = 0.05). Each sampling event should be treated as a separate 'well,' while each well is treated as a separate 'sampling event.' In this case, no residuals can be computed since the Kruskal-Wallis test employs ranks of the data rather than the measurements themselves.

Where both spatial and temporal variation occur, two-way ANOVA can be considered where both well location and sampling event/season are treated as statistical factors. This procedure is described in Davis (1994).

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 1 to 2 years under a quarterly monitoring program), are available for comparison to historical data. Professional judgement will be used to evaluate whether any background data appear to be affected by a release and need to be excluded from a background update. A t-test for equal means (if normal data distribution) or appropriate non-parametric test (if non-normal data distribution) such as a Mann-Whitney (or Wilcoxon) rank-sum or box-whisker plots, will be conducted to evaluate whether 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 they are equivalent. In addition, time series graphs or other trend evaluation statistics 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 (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. In accordance with the *Unified Guidance*, continual background updates will not be conducted due to the lack of sufficient samples for a statistical comparison.

3. COMPLIANCE MONITORING

Compliance monitoring is designed to monitor groundwater for evidence of a release by comparing Part 845 constituents in compliance wells to both background concentrations and the GWPS. Compliance Monitoring will begin the 1st quarter following approval of this Groundwater Monitoring Plan and issuance of the Operating Permit. The selected Compliance Monitoring statistical method used to compare compliance groundwater quality data for each constituent to the GWPS will provide for adequate statistical power, error levels and individual test false positive rates, and be appropriate for the distribution and detection frequency of the background dataset. Statistical power is the ability of a statistical test to detect a true exceedance.

In accordance with 35 I.A.C. § 845.610(b)(3)(D), compliance monitoring statistical analyses will be completed and submitted to IEPA within 60 days after completion of sampling.

3.1 GWPS Establishment and Exceedance Determination

In accordance with 35 I.A.C. § 845.600(a), the GWPS will be the constituent concentrations specified in 35 I.A.C. § 845.600(a)(1) except for when the background concentration is greater, or no concentration is specified (*i.e.,* for calcium and turbidity), in which case the GWPS will be the background concentration. The GWPS based on background concentration will be calculated using a parametric upper tolerance limit (UTL), a parametric UPL for a future mean, or a non-parametric UPL for a future median.

Statistical calculations that will be utilized in Compliance Monitoring procedures are summarized in **Table A** below and listed in **Sections 3.1.1** through **3.1.7**. Depending on the distribution of the data and the percentage of non-detects, it may be more appropriate to use a parametric model over a non-parametric model. As necessary, other techniques as mentioned in the *Unified Guidance* and/or new methods will be implemented.

Table A. Statistical Calculations Used in Compliance Monitoring Procedures

Compliance Monitoring						
Significant Trend?	Background Data			Compliance Data		
	Percent Non-Detects	Distribution	GWPS Determination	Percent Non-Detects	Distribution	Method to Determine Exceedance
No	0 ≤ 50	Normal	35 I.A.C § 845.600(a)(1) constituent concentration or The Upper Tolerance Limit	≤75	Normal	Parametric Lower Confidence Limit around a Normal Mean
				≤75	Log-Normal	Parametric Lower Confidence Limit around a Lognormal Geometric Mean
				NA	Non-Normal	Non-Parametric Lower Confidence Limit around a Median
				>75	Unknown/ Cannot be determined	
	50 ≤ 70	Normal	The Upper Prediction Limit for a Future Mean	NA	NA	Future mean
	>70	Non-Normal	Upper Prediction Limit for a Future Median	NA	NA	Future median
	100	Non-Normal	Double Quantification Rule	NA	NA	Individual Retesting Values
Yes	0 ≤ 50	Normal	UCL of Confidence Band around Linear Regression	≤75	Residuals after subtracting trend are normal, equal variance	Lower Limit from Confidence Band around Linear Regression
	50 ≤ 100	Non-Normal	UCL of Confidence Band around Thiel-Sen trend line	≤75	Residuals not normal	Lower Limit from Confidence Band around Thiel-Sen

3.1.1 The Upper Tolerance Limit

The UTL will be used to calculate the GWPS when pooled background data are normally distributed, with a non-detect frequency of 50 percent or less. When non-detect frequency is 15 percent or less, half the RL will be substituted for non-detects. The *Unified Guidance* recommends 95 percent confidence level and 95 percent coverage (95/95 tolerance interval).

- When non-detect frequency is 15 percent 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 or the ROS method will be used when the detection frequency is between 15 percent and 50 percent. 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 or ROS estimate of the mean and standard deviation will be substituted for the sample mean and standard deviation.
- If background normality cannot be achieved, non-parametric UTLs will not be calculated until a minimum of 60 background samples have been collected (to achieve 95 percent coverage).

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 are tabulated in Table 17-3 in Appendix D of the *Unified Guidance*. If exact values are not provided, then κ values can be estimated by linear interpolation.

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:

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

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

s_y = background sample log-standard deviation

When the GWPS is based on the 35 I.A.C. § 845.600(a)(1) constituent concentrations or a UTL derived from the background dataset, an exceedance in compliance wells relative to the GWPS will be evaluated using confidence intervals. A confidence interval defines the upper and lower bound of the true mean of a constituent concentration in groundwater within a specified confidence range.

- Non-detects in compliance data will be handled similarly to upgradient analyses, with half the RL substituted for non-detects when the frequency is 15 percent or less.
- The Kaplan-Meier, or the ROS method, will be used when the detection frequency is between 15 percent and 50 percent to compute estimates of the mean and standard deviation adjusted for the presence of left-censored values. These estimates will then be substituted for the sample mean and standard deviation.

Once the GWPS is established for background data using the UTL, either parametric or non-parametric confidence intervals will be computed for each constituent in compliance wells to identify GWPS exceedances.

3.1.2 Parametric Confidence Intervals around a Mean

If compliance data are approximately normal, one-sided parametric confidence intervals around a sample mean will be constructed for each constituent and well pair. The lower confidence limit (LCL) will be calculated as:

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

$\overline{x}$ = 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 (Table 16-1 in Appendix D of the *Unified Guidance*)

The chosen t value will aim to achieve both a low false-positive rate, and high statistical power. Minimum α values are tabulated in Table 22-2 of Appendix D of the *Unified Guidance*. The selected minimum α value, from which the t value will be derived, will have at least 80 percent power (1-β = 0.8) when the underlying mean concentration is twice the GWPS.

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

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

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

s_y = compliance sample log-standard deviation

3.1.3 Non-Parametric Confidence Intervals around a Median

Non-parametric confidence intervals around the median will be computed if the compliance data contain greater than 50 percent non-detects or are not normally distributed. The mathematical algorithm used to construct non-parametric confidence intervals 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.

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 close to the product of (n+1) x 0.50. If the result of (n+1) x 0.50 is a fraction (for even-numbered sample sizes), the rank values immediately above and below will be selected as possible candidate endpoints. If the result of (n+1) x 0.50 is an integer (for odd-numbered sample sizes), one will be added to and subtracted from the result to get the upper and lower candidate endpoints. The ranks of the endpoints will be denoted L* and U*. For a one-sided LCL, the confidence level associated with endpoint L* will be computed as:

$$1 - \alpha = Bin(L^* - 1; n, 0.50) = \sum_{x=L^*}^{n} \binom{n}{x} \left(\frac{1}{2}\right)^n$$

If the candidate endpoint(s) do not achieve the desired confidence level, new candidate endpoints (L*–1) and (U*+1) and achieved confidence levels will be calculated. If one candidate endpoint equals the data minimum or maximum, only the rank of the other endpoint will be changed. Achievable confidence levels are tabulated using these equations in Table 21-11 in Appendix D of the *Unified Guidance*.

Both parametric and non-parametric confidence limits will then be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance monitoring wells. A GWPS exceedance is determined if the LCL exceeds the GWPS.

3.1.4 The Upper Prediction Limit for a Future Mean

The parametric UPL for a future mean will be used to calculate the GWPS if the pooled background data contain 50 to 70 percent non-detects and normality can be achieved. The Kaplan-Meier or ROS methods will be used to estimate the mean and standard deviation. The non-parametric UPL for a future median will be calculated as the GWPS if background samples cannot be normalized or contain greater than 70 percent non-detects. The parametric UPL for a future mean will be calculated from the background dataset at follows:

$$UPL_{1-\alpha} = \overline{x} + \kappa s$$

$\overline{x}$ = background sample mean

s = background standard deviation

κ = multiplier based on the order (p) of the future mean to be predicted, the number of compliance wells to be tested (w), the background sample size (n) the number (c) of constituents of concern (COCs), the “1-of-m” retesting scheme, and the evaluation schedule (annual, semi-annual, quarterly). Values are tabulated in 19-5 to 19-9 in Appendix D of the *Unified Guidance*.

The mean of order p will be computed for each well and compared against the UPL. For any compliance point mean that exceeds the limit, p additional resamples may be collected at that well for a 1-of-2 retesting scheme. Resample means will then be compared to the UPL. A GWPS exceedance has been deemed to occur at a compliance well when the initial mean and all resample means exceed the UPL.

3.1.5 The Non-Parametric Upper Prediction Limit for a Future Median

The non-parametric UPL for a future median will be used to calculate the GWPS if the pooled background data contain greater than 70 percent non-detects and normality cannot be achieved. Non-parametric methods assume that the data does not have an underlying distribution. To calculate the non-parametric UPL on a future value, the target per-constituent false positive rate (αconst) will be determined as follows:

$$\alpha_{const} = 1 - (1 - \alpha)^{1/c}$$

α = the site-wide false positive rate (SWFPR) of 0.10 recommended by the *Unified Guidance*

c = the number of monitoring constituents

The number of yearly statistical evaluation (nE) will be multiplied by the number of compliance wells (w) to determine the look-up table entry, w*. The background sample size (n) and w* will be used to select an achievable per-constituent false positive rate value in Table 19-24 of Appendix D in the *Unified Guidance*. The chosen achievable per-constituent false positive rate value will determine the type of non-parametric prediction limit (maximum or 2nd highest value in background) and a retesting scheme for a future median. The background data will be sorted in ascending order, and the upper prediction limit will be set to the appropriate order statistic previously determined by the achievable per-constituent false positive rate value in Table 19-24. If all constituent measurements in a background sample are non-detect, the Double Quantification rule will be used. The use of the Double Quantification rule in Compliance Monitoring will only be applicable if the RL is above the 35 I.A.C. § 845.600(a)(1) constituent concentration or a constituent concentration is not specified in § 845.600(a)(1). This scenario is highly unlikely. The constituent will also be removed from calculations identifying the target false positive rate.

Two initial measurements per compliance well will be collected. If both do not exceed the upper prediction limit, a third initial measurement will not be collected since the median of order 3 will also not exceed the limit. If both exceed the prediction limit, a third initial measurement will not be collected since the median will also exceed the limit. If one initial measurement is above and one below the limit, a third initial observation may be collected to determine the position of the median relative to the UPL. Up to three resamples will be collected in order to assess the resample median. In all cases, if two or more of the compliance point observations are non-detect, the median will be set equal to the RL. The median value for each compliance well will be compared to the UPL. For the 1-of-2 retesting scheme, if any compliance point median exceeds the limit, up to three additional resamples will may be collected from that well. The resample median will be computed and compared to the UPL. A GWPS exceedance has been deemed to occur at a compliance well when either the initial median, or both the initial median and resample median exceed the UPL.

If the concentrations of detected constituents are below the established GWPS, Compliance Monitoring will continue.

3.1.6 Parametric Linear Regression and Confidence Band

If the t-test detects a significant trend in the parametric linear regression line using either background or compliance data for a particular constituent, confidence bands accounting for trends will be constructed to account for the trend-induced variation. If this is not accounted for, a wider confidence interval will inevitably be calculated for a given confidence level and sample size (n). A wider confidence interval 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 confidence intervals 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 does also to reflect this change at that point in time.

Linear regression will be used when background or compliance data are approximately normally distributed, with a constant sample variance around the mean, and the frequency of non-detects is low. The linear regression of concentration against sampling date (time) will be computed as follows:

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

x_i = i^{th} concentration value and

t_i = i^{th} sampling date

$\bar{t}$ = sampling mean date

s_t^2 = variance of the sampling dates

This estimate leads to the following regression equation:

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

$\bar{x}$ = 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 (MSE) will be computed as follows:

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

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

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

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

$\hat{x}_0$ = estimated mean concentration from the regression equation at time t0

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

For background data, the UCL around the linear regression line will be used as the GWPS for the trending constituent. For compliance data, confidence bands around the linear regression line will be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance wells. A GWPS exceedance is determined when the LCL based on the trend line first exceeds the GWPS.

3.1.7 Non-Parametric Thiel-Sen Trend Line and Confidence Band

If the Mann-Kendall test detects a significant trend in the non-parametric Thiel-Sen line using either background or compliance data for a particular constituent, confidence bands accounting for trends will be constructed to account for the trend-induced variation. The Thiel-Sen trend line will be used as a non-parametric alternative to linear regression when trend residuals cannot be normalized or if there are a higher percentage of non-detects in either background or compliance data. 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 x1, x2, xn. 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-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:

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

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:

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

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 (ti, xi) will be formed with a sample date (ti) and the concentration measurement from that date (xi). 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 time points (tj) 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 ($\hat{x}_j^B$). An LCL will be constructed for the lower α^{th} percentile $\hat{x}_j^{[\alpha]}$ from the distribution of estimated concentrations at each time point (tj). For a UCL, compute the upper $(1-\alpha)^{th}$ percentile, $\hat{x}_j^{[1-\alpha]}$ at each time point (tj).

For background data, the UCL around the Thiel-Sen trend line will be used as the GWPS for the trending constituent. For compliance data, confidence bands around the Thiel-Sen trend line will be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance wells. A GWPS exceedance is confirmed when the LCL based on the trend line first exceeds the GWPS.

3.2 Determination of Statistically Significant Increases over Background

In accordance with 35 I.A.C. §§ 845.610(b)(3)(B) and 845.640(h), individual monitoring event concentrations for each constituent detected in the compliance monitoring wells during compliance monitoring sampling events will be compared to the background concentration as determined by the methods described above. An exceedance of the background concentration for any constituent measured at any compliance monitoring well, or constituent detection if not detected in the background samples, constitutes a Statistically Significant Increase (SSI). An exception to this method is pH, where two-sided (upper and lower) tolerance limits are established from the distribution of the background groundwater quality data. An exceedance of either the UTL or lower tolerance limit (LTL) would constitute an SSI for pH.

4. REFERENCES

Davis, C.B., 1994. *Environmental Regulatory Statistics.* In GP Patil & CR Rao (Eds.) *Handbook of Statistics, Volume 12: Environmental Statistics*, Chapter 26. New York: Elsevier Science B.V.

United States Environmental Protection Agency (USEPA), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance*. EPA 530-R-09-007. March 2009.

ATTACHMENT J

Public Notification and Meeting Certification (845.240)

Dianna Tickner
Dynegy Midwest Generation, LLC
1500 Eastport Plaza Drive
Collinsville, IL 62234

January 28, 2022

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: 35 IAC 845.220(a)(9) Certification Statement
Vermilion Power Plant North Ash Pond/Old East Ash Pond (IEPA ID # W1838000002- 01,03)**

Dear Mr. Darin LeCrone:

For the above-refenced CCR surface impoundment and in accordance with 35 IAC 845.220(a)(9), Dynegy Midwest Generation, LLC 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, LLC

Dianna Tickner

Dianna Tickner
Director, Decommissioning & Demolition

Vermilion Public Meeting Issues Summary, December 9, 2021

On Tuesday, November 9, 2021, Dynegy Midwest Generation, LLC made available to the public its plans to close and provide any necessary corrective action for the Old East Ash Pond/North Ash Pond and New East Ash Pond CCR surface impoundments located at Vermilion Power Plant. On Thursday, December 9, 2021, Dynegy Midwest Generation, LLC (DMG) held in-person and virtual public meetings at 3:00 pm and 5:30 pm to present its decision-making process, a comparison of projected groundwater impacts for the alternatives presented, and an objective comparison of the pros and cons of each alternative presented. During the question-and-answer portion of the meeting, the public asked questions relating to the closure or corrective action and the company provided answers.

As required by Section 845.240(g), Dynegy Midwest Generation, LLC distributed to those public meeting attendees who requested a copy a general summary of the issues raised by the public. A response to those issued raised by the public and a summary of any revisions, changes and considerations made to the closure plans on December 22, 2021.

No.	Issue/Topic	Summary of Response Provided at Meeting	Additional Written Response
1	Public Engagement and Access to Natural Resources for recreational users	The Middle Fork River Advisory Committee will be formed after the closure permit is approved. The committee will consist of company representatives, IEPA, and other stakeholders. The public will continue to have access to Orchid Hill. DMG does not have plans to remove the access road. The work will not necessitate restricting use of the Middle Fork.	
2	Financial Assurance	The costs associated with long term monitoring, maintenance, and any potential construction cost overruns will be paid by DMG. DMG has provided the state financial assurance as required under 35 I.A.C. § 845 subpart I. DMG purchased bonds in accordance with Part 845 from reputable bonding agencies guaranteeing payment.	If DMG were to sell or transfer the property, it would also transfer all Part 845 permits, which requires IEPA's approval and a demonstration by the new owner that the new owner has complied with the financial assurance requirements of Part 845 guaranteeing performance of the closure and corrective action. DMG has complied with the Part 845 financial assurance requirements for each of the CCR surface impoundments it is closing under Part 845. The

No.	Issue/Topic	Summary of Response Provided at Meeting	Additional Written Response
			financial assurance provisions in Part 845 are robust and were constructed based on other established financial assurance program regulations. Financial assurance has already been provided for closure activities, post-closure activities, and to address the need for potential remediation of releases and will be updated in the future as needed. The mechanisms for financial assurance provided for under Part 845 are all ones that have been successfully used in other regulatory contexts and that can be easily accessed by IEPA. For Vermilion, DMG is using surety bonds guaranteeing performance as its financial assurance mechanism. In the unlikely event of a default, this form of financial assurance allows the surety to step in to perform the closure, post-closure care, or corrective action or to pay a penal sum that will be placed into the CCR Surface Impoundment Financial Assurance Fund within the State Treasury, assuring the work under Part 845 will be performed.
3	Worker Safety	The company has a strong commitment to safety and holds both its employees and contractors to a high standard. All work will be performed in accordance with regulatory requirements, including OSHA (29CFR1910) and 35 I.A.C. § 845.530. The operating permit dated October 25, 2021, includes a Safety and Health Plan that stipulates requirements for safe performance of work and the pre-requisite training. The company encourages all contractors use local and minority workers.	
4	Timeline	DMG presented a draft timeline.	Table 2-1. CCR Proposed Closure Schedule from the Final Closure Plan is attached. This schedule details the timeframe from the Preliminary Written

No.	Issue/Topic	Summary of Response Provided at Meeting	Additional Written Response
			Closure Plan to Final Closure Activities of the Proposed Landfill and CCR Impoundments.
5	Landfill Design, Permitting and Construction	DMG and its affiliated companies currently operates five landfills in Illinois and has extensive experience in the operation and closure of landfills. The company hires experienced and reputable consultants to design, monitor, and construct landfills. Design, construction, operation and monitoring of the landfill will be done in accordance with 35 I.A.C. § 811 and a permit issued by IEPA, which includes, but is not limited to, the following requirements: • Groundwater monitoring will be performed during operation and for 30 years post-closure. • Monitoring reports and annual reports will be submitted to IEPA. • Structural integrity monitoring of the landfill. • Financial assurance, in the form of bonds, to cover ongoing operation, closure and monitoring. • Lining the landfill with a geomembrane liner (see below). See table 2-1 for proposed closure schedule Geomembranes have successfully been used to line landfills for several decades. The properties and performance of geomembranes has been extensively researched and is well documented by the ASTM and other independent testing organizations. Research shows that geomembrane liners should last at least 200 years. The surface area, and depth of the proposed landfill, cannot be finalized until the site characterization and geotechnical work is completed. This information will be provided in the final design documents. One objective of the design is to minimize the site-line from the river.	A significant amount of research has been conducted to evaluate the expected service life of geomembranes under different field conditions. The Geosynthetics Research Institute developed the foremost technical paper on this topic entitled "Geomembrane Lifetime Predictions: Unexposed and Exposed Conditions" (Koerner et al., 2011) to summarize the findings from a 12-year study on this topic and to provide guidance on the expected service life for geomembranes. The expected service life of a geomembrane is dependent on whether it is exposed or unexposed to ultraviolet radiation and other environmental factors, as well as the in-service temperature of the geomembrane. The geomembrane in the final cover system will be covered with soil, so it will be unexposed. Considering the soil cover thickness and the climate at the site, the highest expected in-service temperature at the depth of the geomembrane is about 20˚C (68˚F). According to Koerner et al. (2011), the expected service life of an HDPE geomembrane under these conditions is nearly 450 years. In accordance with Section 845.780(c), the monitoring and inspection period is at least 30 years.

No.	Issue/Topic	Summary of Response Provided at Meeting	Additional Written Response
6	Power Plant Demolition Plan and Permitting	Prior to demolition, DMG must obtain a demolition permit from the State. Preparation of the permit application is underway. The permit application will be submitted to the State following the approval of the submitted impoundment closure plan. If the impoundment closure plan is not approved, then the plant will not be demolished. The demolition plan includes the following: • Results of an environmental site assessment performed to identify asbestos or other hazardous materials • Description of how the identified materials will be handled and disposed • Fugitive dust plans for asbestos removal and demolition of the structures Asbestos is known to be present within the power plant, as it was used to insulate piping and equipment when the plant was constructed and operated. DMG will hire a licensed asbestos contractor to handle removal and disposal. The contractor will perform the work in accordance with OSHA, and other relevant regulations. DMG is not planning to remove the pump house along the river as it is not part of the impoundment closure plan or necessary for the construction of the landfill. The active transformer switch station, which is not operated by DMG, will be preserved to ensure that power from wind turbines continues to be transmitted during and after demolition.	There are also appurtenant structures such as the cooling towers and massive foundations, the large equipment required to remove the power plant foundations and the hauling of the coal yard waste. Approximately 5,000 roundtrip truckloads are estimated for the power plant demolition and removal.
7	Impoundment Removal and Restoration	The final design plans for the removal and site restoration of the former units will be completed following IEPA approval of the closure and corrective action permit.	In light of public interest, DMG is revisiting the viability of beneficial reuse of CCR at the Vermilion Units. DMG is a strong proponent of beneficially reusing CCR. In 2020, the company beneficially reused more than 60% of all byproducts and more

No.	Issue/Topic	Summary of Response Provided at Meeting	Additional Written Response
		The initial volume of CCR estimates in the ponds were updated when additional information became available. The NEAP volume estimate was reduced following draining of the unit, which represents the majority of the reduction in total volume. The CCR will be removed from the units mechanically with excavation equipment. Prior to transporting the CCR to the onsite landfill using high-capacity off-road haul trucks, the CCR will be dewatered by excavating the material from the unit, spreading it out on another area of the unit and running a disk through it during dry weather. Water generated from these activities will be managed in the secondary units in accordance with an NPDES permit issued by the IEPA. As required by Part 845, environmental controls will be in place to manage fugitive dust, surface water, and soil erosion. The limits of excavations will be determined by conducting visual observations to confirm CCR has been removed from the impoundments. Once the units have been excavated and backfilled or graded, the secondary ponds, the gabions, and the white rock from the NEAP will be removed.	than 85% of the fly ash generated by the coal fleet. If CCR is reused, it will be in encapsulated applications. The removal of CCR will be verified in accordance with industry practice. The CCR will be excavated down to native soil until all CCR visible by the naked eye is removed. DMG's final design for restoration of the former units will include either the development of native wetland(s), and/or upland plants using active (not passive) methods to minimize invasive species The CCR volumes reported in the 2021 Closure Plans are presented below based on the current available survey, boring log, and historical topographic contour data available: • North Ash Pond (NAP) – 1,171,000 CYs • Old East Ash Pond (OEAP) – 992,000 CYs • New East Ash Pond (NEAP) – 376,000
8	Riverbank Stabilization	The Middle Fork River is subject to rapid changes in elevation, intensifying streambank erosion. As such, the riverbank will be inspected after 25-year rainfall events in addition to monthly inspections. A Safety and Emergency Response Plan (SERP) has been submitted to IEPA. We have developed a preliminary design for temporary streambank stabilization protection should it become necessary,	The SERP includes a description of how to address erosion. There will be monitoring and measuring of the erosion and when the extent meets defined criteria an evaluation will be conducted to identify whether maintenance measures are required and if so, provide maintenance recommendations. The implementation of temporary stabilization

No.	Issue/Topic	Summary of Response Provided at Meeting	Additional Written Response
		and started a dialogue with IEPA, USACE, and Park Service to discuss the safety and emergency response plan. The final design for any temporary measure will be submitted to US Army Corps should the need for the measure arise in accordance with the safety and emergency response plan submitted to IEPA. Should temporary streambank protection become necessary, there may be minimal impact to the streambank, but not the river.	measures will include design, permitting, construction, and removal of temporary measures.
9	Groundwater Quality and Closure Monitoring Around the Units	The site has been thoroughly characterized and the groundwater flow system is well understood. Groundwater flows east to the Middle Fork. It is not possible for groundwater to flow in any other direction. Potential exceedances of the groundwater protection standards were detected only in wells located adjacent to the units and between the units and the Middle Fork. A January 2012, IEPA study concluded that there are no off-site wells that can be impacted from CCR units and there are no risks to current groundwater users. In 2020, DMG performed a supplemental study, which was submitted to the Illinois Pollution Control Board and IEPA that confirmed the IEPA findings. Since groundwater is not flowing towards private wells, DMG is not committing to testing neighboring wells. Several chemicals present in CCR are also naturally occurring in Illinois. Since groundwater can only flow toward the river, if these chemicals are present elsewhere, they are either naturally occurring or from another source, not the units. • In accordance with Part 845, groundwater will be regularly monitored, data will be posted on the website, and annual reports will be submitted to IEPA. Part 845 requires we monitor groundwater until it meets the standards.	Figure 1, attached to this document, shows the location of water wells and surface water intakes (from publicly available data sources) within one mile of the Vermilion Power Plant. As stated at the meeting, and shown on this figure, there are no potable water supply wells or surface water intakes that can be impacted by groundwater from the NAP, OEAP, or NEAP. The trench is part of interim controls intended to intercept groundwater that contributes to discoloration along the streambanks until the CCR is removed. As discussed in the meeting, the final flow rate of the trench has not been determined. Impacted groundwater that is not captured by the trench will be addressed by source control (removal of the CCR) and monitored natural attenuation. Because there are no known groundwater impacts or riverbank discoloration attributable to the NEAP, a trench along the NEAP is not being proposed As part of the Human Health and Ecological Risk Assessment conducted at the Vermilion Power

No.	Issue/Topic	Summary of Response Provided at Meeting	Additional Written Response
		• Water from the (seepage collection) trench will go to the NAP secondary pond and discharge through an NPDES permitted outfall. If necessary, the water will be treated prior to discharge. Impacted groundwater that is not captured by the trench will be addressed by source control (removal of the CCR) and monitored natural attenuation. The performance of these corrective measures will be monitored on a regular basis. DMG is not aware of CCR in river sediment and the risk assessment did not identify any risk to the river.	Plant, potential risks to human and ecological receptors exposed to sediment in the Middle Fork of the Vermilion River were characterized. Sediment concentrations in the river were conservatively modeled for all CCR-related constituents that were detected in groundwater. The modeling, which is based on the approach used by the US EPA is conservative. The modeled sediment concentrations for all constituents were less than benchmarks that have been determined by US EPA and others to be protective of human and ecological health. Thus, no risks to human health or the environment associated with potential exposure to sediment in the Middle Fork of the Vermilion River were identified.

Table 2-1. CCR Proposed Closure Schedule

Milestone	Timeframe (all preliminary estimates)
Preliminary Written Closure Plan	October 2021
Final Closure Plan	February 2022
Notification of Intent to Close Placed in Operating Record	By the date the owner or operator initiates closure of a CCR surface impoundment, the owner or operator must prepare a notification of intent to close a CCR surface impoundment. The notification must be placed in the facility's operating record as required by Section 845.800(d)(22) and Section 845.730(d).
Agency Coordination and Permit Acquisition • Coordinating with State Agencies for Compliance for Closure and on-site Landfill • Acquiring various State permits	 Year 1 – 8 Year 2 – 8
Dewater and Stabilize CCR	

• Complete unit water removal and CCR Dewatering, as necessary • Complete Stabilization	Year 1 - Ongoing NA
Mobilization (Plant Demolition)	Year 2
Plant Demolition (for onsite Landfill)	Year 2 through 6
Mobilization New Landfill	Year 6
Mobilization CCR Closure	Year 7
Excavate CCR and Haul to Landfill	Year 8 – 12
Estimate of Year in Which All Closure Activities Will be Completed	Year 2033

Vermilion Public Meeting Questions not answered during meeting, December 9, 2021

During the question-and-answer portion of the public meetings held on Thursday, December 9, 2021, the public asked questions relating to the closure or corrective action. As required by Section 845.240(f)(3), this document provides written responses to the questions not answered during the meetings or in our response summary provided on December 22, 2021. The responses below were posted to the public website on January 17, 2022.

No.	Issue / Topic	Questions submitted by public and not answered at public meeting	Written Response
1	Groundwater Quality and Closure Monitoring Around the Units	Chemically, how do you remove the pollutants including heavy metals and arsenic from the soil, water, and old ponds. What physical chemical process?	All visible CCR will be removed. Any future impacts will be mitigated through an IEPA approved corrective action plan.
2	Groundwater Quality and Closure Monitoring Around the Units	Some surface water does not flow downhill on surface but absorbs down into the soil. It can end up in the water table and deeper into old mines, aquifers, etc. What will you do to insure that is does not end up in people's wells?	Figure 1, attached to this document, shows the location of water wells and surface water intakes (from publicly available data sources) within one mile of the Vermilion Power Plant. As stated at the meeting, and shown on this figure, there are no potable water supply wells or surface water intakes that can be impacted by groundwater from the NAP, OEAP, or NEAP.

No.	Issue / Topic	Questions submitted by public and not answered at public meeting	Written Response
3	Groundwater Quality and Closure Monitoring Around the Units	How you will clean the decades of pollutants that are in the soil around and in the entire area, riverbed, etc.?	All visible CCR will be removed. Any future impacts will be mitigated through an IEPA approved corrective action plan.
4	Groundwater Quality and Closure Monitoring Around the Units	If the discoloration of the river is a concern, what does that mean for what's in the water?	As part of the Human Health and Ecological Risk Assessment conducted at the Vermilion Power Plant, potential risks to human and ecological receptors exposed to surface water and sediment in the Middle Fork of the Vermilion River were characterized. Surface water and sediment concentrations in the river were conservatively modeled for all CCR-related constituents that were detected in groundwater. The modeling, which is based on the approach used by the US EPA is conservative. The modeled surface water and sediment concentrations for all constituents were less than benchmarks that have been determined by US EPA and others to be protective of human and ecological health. Thus, no risks to human health or the environment associated with potential exposure to surface water and sediment in the Middle Fork of the Vermilion River were identified.
5	Groundwater Quality and Closure Monitoring Around the Units	River's meander over time. Within the years of closure, how will you prevent the release of pond contaminants into the river? I am not convinced that trenches will catch it before it releases.	The trench is part of interim controls intended to intercept groundwater that contributes to discoloration along the streambanks until the CCR is removed. Impacted groundwater that is not captured by the trench will be addressed by source control (removal of the CCR) and monitored natural attenuation. The performance of these corrective measures will be monitored on a regular basis.
6	Groundwater Quality and Closure Monitoring Around the Units	The site needs to be monitored for many decades until it is no longer deemed a problem.	The site will be monitored in accordance with a groundwater monitoring plan to be approved by IEPA.

No.	Issue / Topic	Questions submitted by public and not answered at public meeting	Written Response
7	Groundwater Quality and Closure Monitoring Around the Units	How does the company know with such certainty that the contaminants will not ever reach private wells offsite?	The site has been thoroughly characterized and the groundwater flow system is well understood. Groundwater flows east to the Middle Fork. It is not possible for groundwater to flow in any other direction. Potential exceedances of the groundwater protection standards were detected only in wells located adjacent to the units and between the units and the Middle Fork. As stated at the meeting, and shown on the attached Figure 1, there are no potable water supply wells or surface water intakes that can be impacted by groundwater from the NAP, OEAP, or NEAP.
8	Groundwater Quality and Closure Monitoring Around the Units	Where can we find the well testing data?	Groundwater data are provided on the publicly available website: https://www. https://www.luminant.com/illinois-ccr/
9	Groundwater Quality and Closure Monitoring Around the Units	What constituents were found in the monitoring wells?	Groundwater data and tables summarizing the concentrations of constituents that were detected in groundwater are available in the Hydrogeologic Characterization Reports which are included in the operating permit applications provided on the publicly available website: https:// https://www.luminant.com/illinois-ccr/
10	Construction Labor	Will you hire local labor?	We will encourage the successful bidder to hire local qualified labor. We will follow part 845 in assuring all workers meet the training requirements.
11	Construction Labor	Will you hire union labor?	We will follow part 845 in assuring all workers meet the training requirements.
12	Landfill Design, Permitting and Construction	Is there anything to prevent the proposed landfill from accepting coal ash from other sites?	The landfill will be limited to accepting waste from the Vermilion property.
13	Landfill Design, Permitting and Construction	How can we be sure that the liner won't fail?	The landfill will be designed, constructed, and operated in accordance with Illinois landfill program, as administered by IEPA.

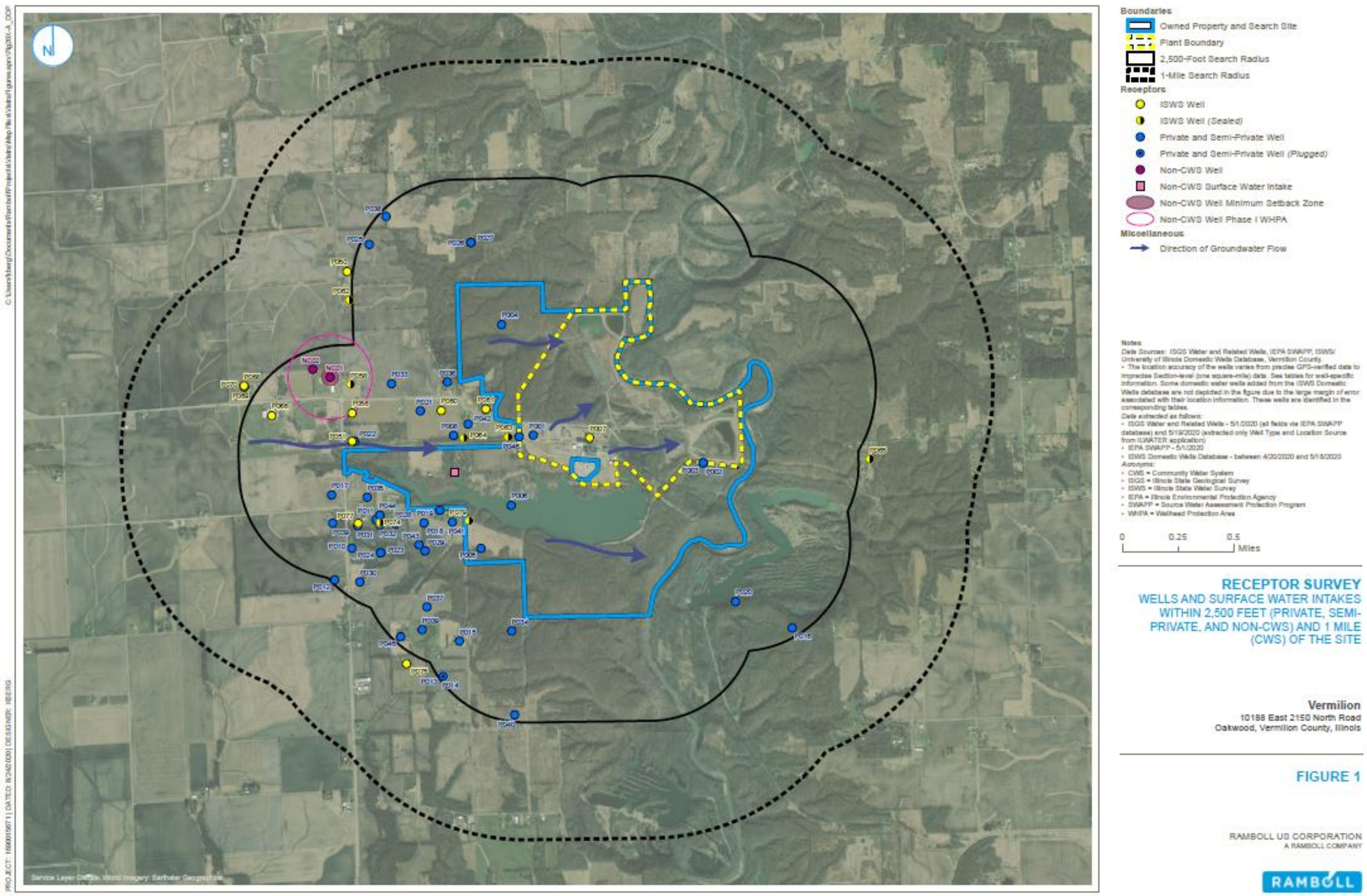
No.	Issue / Topic	Questions submitted by public and not answered at public meeting	Written Response
14	Landfill Design, Permitting and Construction	What is the surface area in acres of the new landfill?	That will be determined in the landfill permit application under part 811.
15	Landfill Design, Permitting and Construction	What would be the proposal elevation of the new landfill (above existing elevation)?	The location of the landfill will be above the 500-year floodplain. The design, including the height, will be finalized once IEPA approves the closure plan.
16	Landfill Design, Permitting and Construction	What dust mitigations measures will be in place to protect the rive and the immediate river corridor which is home to a large fresh water eco-system and valued forested acreage	All activities at the site will be subject to the construction permit storm water protection plan and fugitive dust plan and comply with all applicable federal and state requirements.
17	Landfill Design, Permitting and Construction	What measures will be in place to protect the workers and the area residents down wind of the demolition?	All activities at the site will be subject to the construction permit storm water protection plan and fugitive dust plan and comply with all applicable federal and state requirements.
18	Landfill Design, Permitting and Construction	Will you take into consideration that weather conditions such as anticipated high winds or storms? What about rainfall?	All activities at the site will be subject to the construction permit storm water protection plan and fugitive dust plan and comply with all applicable federal and state requirements.
19	Landfill Design, Permitting and Construction	Will there be water tanks on the site before and during the demolition and how will they be used to mitigate dust damage?	water suppression equipment will be available and used as needed to mitigate dust during demolition.
20	Landfill Design, Permitting and Construction	Before the old plant is demolished, to what extent will heavy-metal byproducts like arsenics, mercury, lead as well as PCB's and process chemicals be removed so that dust from the demolition is as benign as possible.	The demolition will require permits for the removal and management of contaminated media and will be conducted in accordance with federal, state, and local regulations.
21	Landfill Design, Permitting and Construction	Will the demolition process be overseen by a third party? If so, who?	The demolition process is subject to local and IEPA oversight.
22	Site	Which Ponds (primary and secondary) are in the flood [plains]?	The north and old east ash ponds are within the 100-year flood plains, the new east ash pond is located outside the 100-year flood plain.

No.	Issue / Topic	Questions submitted by public and not answered at public meeting	Written Response
23	Site	Will old transformers and hydraulic equipment be removed before demolition?	Yes, the transformers have already been removed. The hydraulic equipment will be removed once demolition begins.
24	Site	Will the secondary pond as the ash pits remain in place after the ash removal project is complete?	Secondary ponds will remain as long as required for stormwater management and treatment, to meet NPDES limits.
25	Site	My question has to do with the demolition of the power plant itself, the outbuildings, and the smokestacks.	Powerplant structure to be demolished to accommodate landfill construction
26	Site	Dynegy in the past has coordinated with IDNR regarding the management and monitoring of Orchid Hill natural area. Could that partnership be reestablished?	It is established and continues, and DMG will continue protection of the area.
27	Site	Has there been any consideration as to the future ownership of the entire site or Orchid Hill exclusively?	At the present time, DMG will continue to own the area.
28	Site	Is there any staff onsite that could allow access to the Orchard Hill natural area?	Access will not be limited after closure is completed.
29	Financial Insurance	The plans outlined appear to promise to move the site toward eventual restoration as the coal ash and the structures are removed. Both the land and the water will be restored to health. This will take time, with the completion projected to occur in 2033, twenty-two years after the power station ceased to operate. It will also take money. Dynegy has estimated a cost of $129 million dollars, for which they will post a bond. Several important questions remain. The original cost estimate was about $50 million higher. What happens if that turns out to be the correct figure? Who will pay for the cost overrun?	DMG is currently responsible for closure cost.
31	Financial Insurance	Posting a bond is not at all like setting aside money in a trust fund. What guarantees are there that Dynegy/Vistra will be able to pay the entire cost? It is a relatively small amount to a large corporation like Vistra, but it is a huge amount to the citizens of Illinois	In the event of nonperformance, the bond guarantees the payment of closure cost.

No.	Issue / Topic	Questions submitted by public and not answered at public meeting	Written Response
32	Financial Insurance	Dynegy/Vistra could be sold, or the land could be sold, perhaps as a small part of a much larger transaction. We need to be certain that all these closure plans will be funded and carried out no matter who owns the site of the old Vermilion Power Station in 2033. The cleanup obligation, like the pollution problem itself, needs to run with the land. This needs to be clearly stated in any written agreement.	If DMG were to sell or transfer the property, it would also transfer all Part 845 permits, which requires IEPA's approval and a demonstration by the new owner that the new owner has complied with the financial assurance requirements of Part 845 guaranteeing performance of the closure and corrective action. DMG has complied with the Part 845 financial assurance requirements for each of the CCR surface impoundments it is closing under Part 845. The financial assurance provisions in Part 845 are robust and were constructed based on other established financial assurance program regulations. Financial assurance has already been provided for closure activities, post closure activities, and to address the need for potential remediation of releases and will be updated in the future as needed. The mechanisms for financial assurance provided for under Part 845 are all ones that have been successfully used in other regulatory contexts and that can be easily accessed by IEPA. For Vermilion, DMG is using surety bonds guaranteeing performance as its financial assurance mechanism. In the unlikely event of a default, this form of financial assurance allows the surety to step in to perform the closure, post-closure care, or corrective action or to pay a penal sum that will be placed into the CCR Surface Impoundment Financial Assurance Fund within the State Treasury, assuring the work under Part 845 will be performed.
33	Financial Insurance	The Plan calls for thirty years of post-closure care, monitoring and maintenance. Who pays for that, and how is the payment guaranteed? Again, this needs to be clarified now, while all the parties are working on the details.	In the event of nonperformance, the bond guarantees the payment of post closure care, monitoring and maintenance.

No.	Issue / Topic	Questions submitted by public and not answered at public meeting	Written Response
34	Miscellaneous	You need to make sure that you follow the highest standards i.e., storms (100 yrs. floods) are becoming normal.	DMG is strictly following part 845.
35	Miscellaneous	It was nearly impossible to hear company and public speakers at this meeting. You need to make sure to address this problem before the next hearing. I would contend than an inaudible presentation does not fulfill the hearing requirements.	DMG is strictly following part 845.
36	Miscellaneous	Why didn't you let us submit questions outside of the meeting?	DMG is strictly following part 845.

Figure 1


Boundaries
Owned Property and Search Site
Plant Boundary
2,500-Foot Search Radius
1-Mile Search Radius
Receptors
ISWS Well
ISWS Well (Sealed)
Private and Semi-Private Well
Private and Semi-Private Well (Plugged)
Non-CWS Well
Non-CWS Surface Water Intake
Non-CWS Well Minimum Setback Zone
Non-CWS Well Phase I WHPA
Miscellaneous
Direction of Groundwater Flow
Acronyms:
CWS = Community Water System
ISGS = Illinois State Geological Survey
ISWS = Illinois State Water Survey
IEPA = Illinois Environmental Protection Agency
SWAPP = Source Water Assessment Protection Program
WHPA = Wellhead Protection Area
0 0.25 0.5 Miles
RECEPTOR SURVEY
WELLS AND SURFACE WATER INTAKES WITHIN 2,500 FEET (PRIVATE, SEMI-PRIVATE, AND NON-CWS) AND 1 MILE (CWS) OF THE SITE
Vermilion
10188 East 2150 North Road
Oakwood, Vermilion County, Illinois
FIGURE 1
RAMBOLL US CORPORATION
A RAMBOLL COMPANY

In accordance with 845.240(f)(4), a list people who requested to be added to the IEPA Listserv for Vermilion is as follows:

Vermilion Listserv	
Name	email
Pat Nolan	pnolen96@aol.com
Carol Curtis	agneslynn@me.com
Karen Brown Kane	Karen.Kane@gmail.com
Mike Camp	Mikeechocamp@gmail.com
Christine Main	chrismain1219@gmail.com
David Main	david.main76@gmail.com
Nancy Goodall	ntgoodall@gmail.com
Alice Englebretsen	aliceenglebretsen@gmail.com
Lois Kain	lois2@comcast.net
Carolyn Trimble	carolyntrimble1@gmail.com
Alicia Henry	aliciahenry228@gmail.com
Wayne Karplus	eaglewayne25@aol.com
Germaine Light	germainelight53@gmail.com
Marykay Solecki	mksolecki@gmail.com
John Taft	john.taft@comcast.net
John Griesbaum	jbaum75@gmail.com
Andrew Rehn	arehn@prairierivers.org
Trent Thomas	trent.thomas@illinois.gov
Pam Richart	prichart@ecojusticecollaborative.org
Vince and Carrie Rancuret	vrancuret@gmail.com
Joyce Blumenshire	joblumen@yahoo.com
Sue Tinkle	tinkandtom@sbcglobal.net
Jan Predmore	janpred65@gmail.com
Lana Richart	lrichart@ecojusticecollaborative.org
Randy Smith	rsmith77@aol.com
Bob Jennings	okwd206@outlook.com

ATTACHMENT K

Groundwater Modeling Results (845.220)

Intended for
Dynegy Midwest Generation, LLC

Date
January 28, 2022

Project No.
1940100722

GROUNDWATER MODELING REPORT

NORTH ASH POND AND OLD EAST ASH POND

VERMILION POWER PLANT
OAKWOOD, ILLINOIS

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND

Project Name	**Vermilion Power Plant North Ash Pond and Old East Ash Pond**
Project No.	**1940100722**
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Ramboll
234 W. Florida Street
Fifth Floor
Milwaukee, WI 53204
USA

T 414-837-3607
F 414-837-3608
https://ramboll.com

Jake J. Walczak, PG
Senior Hydrogeologist

Brian G. Hennings, PG
Senior Managing Hydrogeologist

CONTENTS

Executive Summary		**6**
1.	**Introduction**	**9**
1.1	Overview	9
1.2	Previous Groundwater Modeling Reports	9
1.3	Site Location and Background	10
1.4	Site History and CCR Units	10
2.	**Site Geology and Hydrogeology**	**12**
3.	**Groundwater Quality**	**15**
4.	**Groundwater Model**	**16**
4.1	Overview	16
4.2	Conceptual Site Model	16
4.3	Model Approach	16
5.	**Model Setup and Calibration**	**19**
5.1	Model Descriptions	19
5.2	Flow and Transport Model Setup	20
5.2.1	Grid and Boundary Conditions	20
5.2.2	Flow Model Input Values and Sensitivity	21
5.2.2.1	Model Layers	21
5.2.2.2	Hydraulic Conductivity	21
5.2.2.3	Recharge	22
5.2.2.4	Storage and Specific Yield	23
5.2.2.5	River Parameters	23
5.2.2.6	General Head Boundary Parameters	24
5.2.3	Transport Model Input Values and Sensitivity	24
5.2.3.1	Initial Concentrations	24
5.2.3.2	Source Concentrations	24
5.2.3.3	Effective Porosity	25
5.2.3.4	Storage and Specific Yield Sensitivity	25
5.2.3.5	Dispersivity	25
5.2.3.6	Retardation	26
5.3	Flow and Transport Model Assumptions and Limitations	26
5.4	Calibration Flow and Transport Model Results	27
6.	**Simulation of Closure Scenario**	**29**
6.1	Overview and Prediction Model Development	29
6.2	HELP Model Setup and Results	30
6.3	Simulation of Closure Scenarios	30
6.3.1	Closure Scenario 1 Predicted Boron Concentrations	31
6.3.2	Closure Scenario 2 Predicted Boron Concentrations	32
6.3.3	Closure Scenario 3 Predicted Boron Concentrations	33
6.3.4	Evaluation of Mass Flux to the Middle Fork	34
7.	**Conclusions**	**35**
8.	**References**	**37**

TABLES (IN TEXT)

Table A	History of Construction and Operation

TABLES (ATTACHED)

Table 2-1	Monitoring Well Locations and Construction Details
Table 2-2	Flow and Transport Model Calibration Targets
Table 5-1	Flow Model Input and Sensitivity Analysis Results
Table 5-2	Transport Model Input Values (Calibration)
Table 5-3	Transport Model Input Values (Sensitivity)
Table 6-1	HELP Model Input and Output Values
Table 6-2	Prediction Model Input Values

FIGURES (IN TEXT)

Figure A	Boron Correlation with Lithium, Molybdenum, Sulfate, and TDS in Downgradient Wells

FIGURES (ATTACHED)

Figure 1-1	Site Location Map
Figure 1-2	Site Map
Figure 2-1	Monitoring Well Location Map
Figure 2-2	Uppermost Aquifer Groundwater Elevation Contours, March 29, 2021
Figure 2-3	Potential Migration Pathway Groundwater Elevation Contours, March 29, 2021
Figure 4-1	Closure Scenario Calibration and Prediction Model Timeline
Figure 5-1	Model Grid for Layers 1 through 3
Figure 5-2	Model Grid for Layers 4 through 7
Figure 5-3	Boundary Conditions for Layer 1
Figure 5-4	Boundary Conditions for Layer 2
Figure 5-5	Boundary Conditions for Layer 3
Figure 5-6	Boundary Conditions for Layer 4
Figure 5-7	Boundary Conditions for Layer 5
Figure 5-8	Boundary Conditions for Layer 6
Figure 5-9	Boundary Conditions for Layer 7
Figure 5-10	Distribution of Hydraulic Conductivity Zones (feet/day) for Layer 1
Figure 5-11	Distribution of Hydraulic Conductivity Zones (feet/day) for Layer 2
Figure 5-12	Distribution of Hydraulic Conductivity Zones (feet/day) for Layer 3
Figure 5-13	Distribution of Hydraulic Conductivity Zones (feet/day) for Layer 4
Figure 5-14	Distribution of Hydraulic Conductivity Zones (feet/day) for Layer 5
Figure 5-15	Distribution of Hydraulic Conductivity Zones (feet/day) for Layer 6
Figure 5-16	Distribution of Hydraulic Conductivity Zones (feet/day) for Layer 7
Figure 5-17	Distribution of Recharge Zones (feet/day)
Figure 5-18	Observed versus Simulated Groundwater Elevations Layer 2
Figure 5-19	Observed versus Simulated Groundwater Elevations Layer 3
Figure 5-20	Observed versus Simulated Groundwater Elevations Layer 4
Figure 5-21	Observed versus Simulated Groundwater Elevations Layer 5
Figure 5-22	Observed versus Simulated Groundwater Elevations Layer 6
Figure 5-23	Observed versus Simulated Groundwater Elevations Layer 7
Figure 5-24	Steady State MODFLOW Calibration Results – Observed versus Simulated (ft)

Figure 5-25	Steady State MODFLOW Calibration Results – Observed versus Residuals (ft)
Figure 5-26	Observed and Simulated Boron Concentrations (mg/L)
Figure 5-27	Distribution of Boron Concentrations (mg/L) in the Calibrated Model (MGU)
Figure 6-1	Seepage Collection Trench Alignment with Replacement Observation Wells
Figure 6-2	Distribution of Recharge Zones (feet/day) for all Closure Scenarios
Figure 6-3	CBR-Onsite (Scenario 1, MGU) - Model Predicted Boron Concentration in Middle Groundwater Unit
Figure 6-4	CBR-Onsite (Scenario 1, MGU) – Model Predicted Boron Plume in Middle Groundwater Unit Approximately 50 Years after Implementation
Figure 6-5	CBR-Onsite (Scenario 1, LGU) - Model Predicted Boron Concentration in Lower Groundwater Unit
Figure 6-6	CBR-Onsite (Scenario 2, MGU) - Model Predicted Boron Concentration in Middle Groundwater Unit
Figure 6-7	CBR-Onsite (Scenario 2, MGU) - Model Predicted Boron Plume in Middle Groundwater Unit Approximately 47 Years after Implementation
Figure 6-8	CBR-Onsite (Scenario 2, LGU) - Model Predicted Boron Concentration in Lower Groundwater Unit
Figure 6-9	CBR-Offsite (Scenario 3, MGU) - Model Predicted Boron Concentration in Middle Groundwater Unit
Figure 6-10	CBR-Offsite (Scenario 3, MGU) – Model Predicted Boron Plume in Middle Groundwater Unit Approximately 43 Years after Implementation
Figure 6-11	CBR-Offsite (Scenario 3, LGU) - Model Predicted Boron Concentration in Lower Groundwater Unit
Figure 6-12	Normalized Model Predicted Boron Flux to Middle Fork

APPENDICES

Appendix A	MODFLOW, MT3DMS and HELP Model Files (Electronic Only)

ACRONYMS AND ABBREVIATIONS

§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
BCU	bedrock confining unit
CBR	closure by removal
CCR	coal combustion residuals
cm/s	centimeters per second
Company Lake	Illinois Power Company Lake
CSM	conceptual site model
DMG	Dynegy Midwest Generation, LLC
ft/day	feet/foot per day
GHB	general head boundary conditions
GMP	Groundwater Monitoring Plan
GMR	Groundwater Model Report
GWPS	Groundwater Protection Standard
HCR	Hydrogeologic Site Characterization Report
HELP	Hydrologic Evaluation of Landfill Performance
ID	identification
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
Kd	soil adsorption coefficient
K_d	linear partition coefficients
K_{dF}	Frendlich partition coefficients
Kelron	Kelron Environmental
Kh/Kv	vertical anisotropy
L/kg	liters per kilogram
LGU	lower groundwater unit
mg/L	milligrams per liter
MGU	middle groundwater unit
Middle Fork	Middle Fork of the Vermilion River
mL/g	milliliters per gram
MNA	monitored natural attenuation
NAP	North Ash Pond
NAVD88	North American Vertical Datum of 1988
NEAP	New East Ash Pond
NGVD29	National Geodetic Vertical Datum of 1929
NID	National Inventory of Dams
No.	number
NPDES	National Pollutant Discharge Elimination System
NRT	Natural Resource Technology, Inc.
OEAP	Old East Ash Pond
Part 845	35 I.A.C. § 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments

PMP	Potential Migration Pathway
R2	correlation coefficient
Ramboll	Ramboll Americas Engineering Solutions, Inc.
SI	surface impoundment
Site	combined area including NAP and OEAP
SU	standard units
TDS	total dissolved solids
TVD	total-variation-diminishing
UCU	upper confining unit
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UU	upper unit
VPP	Former Vermilion Power Plant

EXECUTIVE SUMMARY

Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Groundwater Model Report (GMR) on behalf of the former Vermilion Power Plant (VPP), operated by Dynegy Midwest Generation, LLC (DMG), in accordance with requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) Section (§) 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845) (Illinois Environmental Protection Agency [IEPA], April 15, 2021). This document presents the results of predictive groundwater modeling simulations for proposed closure scenarios for the North Ash Pond (NAP; Vistra identification [ID] number [No.] 910, IEPA ID No. W1838000002-01) and the Old East Ash Pond (OEAP; Vistra ID No. 911, IEPA ID No. W1838000002-03).

The NAP and OEAP (collectively referred to as the Site) are on the VPP property which is located four miles northeast of the Village of Oakwood in Vermilion County (**Figure 1-1**). The VPP property is situated in a predominantly agricultural area. The NAP and OEAP coal combustion residuals (CCR) units, which are the subject of this GMR, are located adjacent to each other in the northern portion of the VPP. The NAP is bordered to the north by fallow fields owned by Illinois Department of Natural Resources (IDNR); to the east by the Middle Fork of the Vermilion River (Middle Fork); to the south by the OEAP; and to the west by steep bluffs that include the Illinois Department of Conservation designated Orchid Hill Natural Heritage Landmark, which is partially within the VPP property boundary but is administered by IDNR. The OEAP is bordered to the north and northeast by the Middle Fork; to the southeast, south, and west by steep bluffs; and to the northwest by the NAP. The NAP and OEAP are both located on terraces adjacent to the Middle Fork, which is bordered to the east and west by steep bluffs.

A detailed summary of site conditions was provided in the Hydrogeologic Site Characterization Report (HCR; Ramboll, 2021a). Seven distinct water-bearing units have been identified in the vicinity of the NAP and OEAP based on stratigraphic relationships and common hydrogeologic characteristics. The units are described as follows:

- Fill Unit: comprised predominantly of CCR (primarily fly ash, bottom ash, and boiler slag) within the NAP and OEAP and occurs within saturated materials.
- Upper Unit (UU): includes mixed alluvial deposits of clay, silt, sand, and minor gravel of the Cahokia Alluvium.
- Middle Groundwater Unit (MGU): is composed of alluvial sand and gravel that corresponds to the lower portion of the Cahokia Formation in the bottomlands of the river valley. This unit is not present outside of the river valley. This is the uppermost coarse-grained deposit beneath the NAP and OEAP, and is considered the uppermost aquifer.
- Upper Confining Unit (UCU): comprised of clay, silt, and minor amounts of sand lenses within the Upper Till. The low permeability deposits of the UCU lie directly above the lower groundwater unit (LGU), inhibiting the vertical movement of groundwater between the MGU and the LGU.
- Lower Groundwater Unit (LGU): the LGU is composed of sand, gravel, silt, and some clay described as glacial outwash and re-worked glacial deposits. This unit has been identified as a potential migration pathway (PMP) for groundwater.

- Lower Confining Unit: composed of clay, silt, and some sand, is the lowermost unlithified confining unit at the Site described as the Lower Till Unit. The base of this unit is the top of bedrock.
- Bedrock Confining Unit (BCU): the lowermost unit identified at the Site, and underlies all unlithified deposits. This unit occurs within Pennsylvanian shale bedrock, which is the uppermost lithified unit at the Site. As presented by Kelron Environmental (Kelron, 2003), groundwater in the shale flows into the overlying alluvium and enters directly into the Middle Fork in some locations. Groundwater within the bedrock is at the end of its flow path as indicated by upward hydraulic gradients, high dissolved mineral content, and isotopic analysis indicating water is significantly older by 13,000 to 35,000 radiocarbon years before present than recent groundwater in the overlying unlithified deposits.

The NAP and OEAP overlie the recharge area for the underlying transmissive geologic media, which are composed of coarse grained unlithified deposits (*i.e.*, alluvium [MGU], and glacial outwash and re-worked glacial deposits [LGU]). The groundwater from all units flows toward the Middle Fork which is the receiving body of water for the area.

A review and summary of data collected from 2015 through 2021 for parameters with groundwater protection standards (GWPS) listed in 35 I.A.C. § 845.600 is provided in the HCR (Ramboll, 2021a). Groundwater concentrations presented in HCR Table 4-1 and summarized in the History of Potential Exceedances (Ramboll, 2021b) are considered potential exceedances because the methodology used to determine them is proposed in the groundwater monitoring plan (Ramboll, 2021c) and has not been reviewed or approved by IEPA at the time of this submittal. The following constituents with potential exceedances of the GWPS listed in 35 I.A.C. § 845.600 were identified: boron, lithium, molybdenum, sulfate, and total dissolved solids (TDS) (Ramboll, 2021b).

Statistically significant correlations between boron concentrations and concentrations of other parameters identified as potential exceedances of the GWPS indicate boron is an acceptable surrogate for lithium, molybdenum, sulfate, and TDS in the groundwater model. 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. Site-specific partition coefficients were calculated as part of a study to evaluate whether monitored natural attenuation (MNA) is a feasible groundwater remedial alternative for the VPP (Geosyntec Consultants, Inc. [Geosyntec], 2022a) following completion of closure construction (*i.e.*, CCR removal). The anticipated effects on constituent behavior compared to the groundwater fate and transport model indicate the fate and transport model likely over-predicts the time to reach the GWPS for lithium and molybdenum.

Data collected from the 2021 field investigations were used to update the existing groundwater model which was initially developed in 2012 (Natural Resource Technology, Inc. [NRT], 2012a; NRT, 2012b), and later updated in 2014 (NRT, 2014a; NRT, 2014b). The updated MODFLOW and MT3DMS models were then used to evaluate three closure by removal (CBR) scenarios, including CBR utilizing either an onsite (CBR-Onsite) or offsite (CBR-Offsite) landfill, using information provided in the CCR Final Closure Plan (Geosyntec, 2022b):

- Scenario 1: CBR-Onsite (groundwater collection trench [trench] removed at completion of CCR removal)

- Scenario 2: CBR-Onsite (trench remains after CCR is removed)
- Scenario 3: CBR-Offsite (trench remains after CCR is removed)

Predictive simulations of source control indicate groundwater in the primary transport zone (the MGU) will achieve the GWPS for Scenarios 1, 2, and 3 in 50, 47, and 43 years after implementation of the closure scenarios, respectively. From a modeling perspective, the difference between the predicted time to reach the GWPS for boron (2 milligrams per liter [mg/L]) in the MGU in Scenario 1 (50 years) versus Scenario 2 (47 years) is negligible. In other words, both scenarios are predicted to reach the GWPS after approximately 50 years, the simulated three-year difference between these two scenarios is not significant. These results also indicate there is no significant benefit in the modeled time to reach the GWPS for continued operation and maintenance of the groundwater collection trench beyond the completion of the removal.

Groundwater in the PMP (LGU) is predicted to achieve the GWPS for Scenarios 1, 2, and 3 in 112, 116, and 109 years after implementation of the closure scenarios, respectively. The longer response times simulated for the LGU are expected based on the conceptual site model (CSM). Because groundwater has a longer flow path and passes through low permeability deposits of the UCU before it reaches the LGU, it is expected that the concentrations in the LGU will take longer to respond to source control measures than wells in the MGU. From a modeling perspective, the differences among the predicted times to reach the GWPS for boron (2 mg/L) in the LGU for Scenarios 1, 2, and 3 in 112, 116, and 109 years after implementation of the closure scenarios, respectively, is negligible. All three scenarios are predicted to reach the GWPS after approximately 110 years; the simulated seven-year difference among these three scenarios after 100 years is not significant.

The predicted reductions in mass flux to the river cells (representing the Middle Fork) following source control for Scenarios 1, 2, and 3 indicate for all three scenarios that mass flux is predicted to be reduced by 50 percent approximately 10 years after implementation, by 80 percent within approximately 35 years after implementation, and by 95 percent within approximately 130 years after implementation.

Results of groundwater fate and transport modeling conservatively estimate that groundwater will attain the GWPS for all constituents identified as potential exceedances of the GWPS in the primary migration pathway (the MGU) within 50 years of closure implementation for all three Scenarios. The LGU, which has much lower boron concentrations (less mass), is estimated to take approximately 110 years to reach the GWPS due to the longer flow paths through low permeability deposits of the UCU before it reaches the LGU and ultimately the Middle Fork. Results of the groundwater fate and transport modeling also indicate that the flux of these constituents to the Middle Fork will reduce by 80 percent within 35 years of closure implementation for all three Scenarios. The anticipated effects of MNA on constituent behavior compared to the groundwater fate and transport model indicate the fate and transport model likely over-predicts the time to reach the GWPS for lithium and molybdenum.

1. INTRODUCTION

1.1 Overview

In accordance with requirements of Part 845 (IEPA, 2021), Ramboll has prepared this GMR on behalf of VPP, operated by DMG. This report will apply specifically to the CCR Units referred to as the NAP and OEAP (**Figure 1-1**). However, information gathered to evaluate other CCR units at the VPP regarding geology, hydrogeology, and groundwater quality is included, where appropriate. The 41-acre NAP is an expansion of the 21.3-acre OEAP. The southern end of the NAP overlies the northern end of the OEAP. Both are inactive, unlined CCR surface impoundments (SIs) that were used to manage CCR and non-CCR waste streams and to clarify process water prior to discharge in accordance with the plant’s National Pollutant Discharge Elimination System (NPDES) permit (IL0004057) at the VPP. This GMR presents and evaluates the results of predictive groundwater modeling simulations for three proposed CBR closure scenarios, including CBR utilizing either an onsite (CBR-Onsite) or offsite (CBR-Offsite) landfill for the NAP and OEAP:

- Scenario 1: CBR-Onsite (trench removed at completion of CCR removal)
- Scenario 2: CBR-Onsite (trench remains after CCR is removed)
- Scenario 3: CBR-Offsite (trench remains after CCR is removed)

1.2 Previous Groundwater Modeling Reports

The information presented in this GMR expands upon previous groundwater modeling completed at VPP and includes data collected in support of the previous groundwater models as well as data collected as part of 2021 field investigations to support development of a HCR (Ramboll, 2021a). The HCR was provided as an attachment to the Initial Operating Permit application required by 35 I.A.C. § 845.230. Previous groundwater modeling reports completed for the NAP and OEAP located at the VPP include the following (recent to oldest):

- ***NRT, 2014, Corrective Action Plan, North Ash Pond System, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC, April 2, 2014.***

  A revised Corrective Action Plan (originally issued on March 27, 2012) that describes the physical setting of the NAP at the VPP and proposed actions necessary to close this facility consistent with 35 I.A.C. § 840, including a calibrated groundwater fate and transport model used to test the corrective action alternatives. The Corrective Action Plan was revised in response to the geotechnical study conducted by URS Corporation, “Geotechnical Report, North Ash Pond and Old East Ash Pond, Vermilion Site Embankment Evaluations, Oakwood, Illinois”, dated November 18, 2013. This version, dated April 2, 2014, supersedes the version from March 2012.

- ***NRT, 2014, Corrective Action Plan, Old East Ash Pond, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC, April 2, 2014.***

  A revised Corrective Action Plan (originally issued on March 27, 2012) that describes the physical setting of the OEAP at the VPP and proposed actions necessary to close this facility consistent with 35 I.A.C. § 840, including a calibrated groundwater fate and transport model used to test the corrective action alternatives. The Corrective Action Plan was revised in response to the geotechnical study conducted by URS Corporation, “Geotechnical Report, North Ash Pond and Old East Ash Pond, Vermilion Site Embankment Evaluations, Oakwood, Illinois", dated November 18, 2013. This version, dated April 2, 2014, supersedes the version from March 2012.

- ***NRT, 2012, Corrective Action Plan, North Ash Pond System, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC, March 27, 2012.***

  A Corrective Action Plan that describes the physical setting of the NAP at the VPP and proposed actions necessary to close this facility consistent with 35 I.A.C. § 840, including a calibrated groundwater fate and transport model used to test the corrective action alternatives.

- ***NRT, 2012, Corrective Action Plan, Old East Ash Pond, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC, March 27, 2012.***
  A Corrective Action Plan that describes the physical setting of the OEAP at the VPP and proposed actions necessary to close this facility consistent with 35 I.A.C. § 840, including a calibrated groundwater fate and transport model used to test the corrective action alternatives.

1.3 Site Location and Background

The VPP is located in east central Illinois in Vermilion County, approximately five miles northeast of the Village of Oakwood, located within Section 20, Township 20 North, Range 12 West (**Figure 1-1**). The VPP is an approximately 982-acre property consisting of 19 parcels, including a retired coal-fired power plant and SIs. The VPP ceased operations in 2011 when the power plant was retired.

The NAP and OEAP CCR Units, which are the subject of this GMR, are located adjacent to each other in the northern portion of the VPP. The NAP is bordered to the north by fallow fields owned by IDNR; to the east by the Middle Fork; to the south by the OEAP; and to the west by steep bluffs that include the Illinois Department of Conservation designated Orchid Hill Natural Heritage Landmark, which is partially within the VPP property boundary but is administered by IDNR. The OEAP is bordered to the north and northeast by the Middle Fork; to the southeast, south, and west by steep bluffs; and to the northwest by the NAP. The NAP and OEAP are both located on terraces adjacent to the Middle Fork, which is bordered to the east and west by steep bluffs.

Figure 1-2 depicts the location of the inactive NAP and OEAP. The combined area including the NAP and OEAP will hereinafter be referred to as the Site.

1.4 Site History and CCR Units

All ash ponds at the VPP are out of service. Until the coal pile was substantially removed in March 2011, the NAP received inflows from coal-pile runoff. The NPDES-permitted outfalls to the Middle Fork are still in effect; however, the only flows from the NAP and OEAP are during significant periods of precipitation with controlled releases via Outfall 001, usually occurring once or twice a year.

The 41-acre NAP is an expansion of the 21.3-acre OEAP. The southern end of the NAP overlies the northern end of the OEAP. The OEAP was built as part of the original plant construction and put into service in the mid-1950's. The OEAP continued in operation until the NAP was constructed and put on-line in the mid-1970's. The NAP was utilized for sluiced coal ash disposal from the mid-1970's to approximately 1989/1990, at which time all ash disposal was diverted to the New

East Ash Pond (NEAP; Vistra ID No. 912, IEPA ID No. W1838000002-04, National Inventory of Dams [NID] No. IL50291). The NEAP was expanded in 2002.

The NAP was originally designed and operated for coal ash sedimentation and control. The pond received plant process wastewater, sluiced coal ash, and stormwater runoff from the pond embankments. Treated process wastewater was discharged through an overflow outlet structure. The approximate dates of construction of VPP CCR Units, are summarized in **Table A** below.

Table A. History of Construction and Operation

Date	Event
mid-1950's	Construction of OEAP
mid-1970's	Construction of NAP; CCR disposal to OEAP ceased
1989-1990	Construction of original East Ash Pond (1989 pond footprint), CCR disposal at NAP ceased
2002	Embankment raised to expand the capacity of the East Ash Pond (1989 pond footprint) in 2002, forming the footprint of the present-day NEAP
2011	CCR disposal to NEAP ceased

2. SITE GEOLOGY AND HYDROGEOLOGY

NAP and OEAP hydrogeologic and groundwater quality data was presented in the HCR (Ramboll, 2021a) and used to establish a CSM for this GMR, and is summarized below.

The six principal types of unlithified materials overlying bedrock present at the VPP consist of the following in descending order:

- **Fill and CCR:** (identified as Layer 1 [Kelron, 2012a; Kelron, 2012b]) CCR 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 compositions of CCR and re-worked native silt and clay.
- **Mixed deposits of the Cahokia Alluvium:** including silt deposits (identified as Layer 2a [Kelron, 2012a; Kelron, 2012b]), sand and gravel deposits with some intermittent silt (identified as Layer 2b [Kelron, 2012a; Kelron, 2012b]), and clay and silty clay (identified as Layer 3 [Kelron, 2012a; Kelron, 2012b]).
- **Alluvial sand and gravel with some silt:** composed of alluvial sand and gravel that corresponds to the lower portion of the Cahokia Formation in the bottomlands of the river valley (identified as Layer 4 [Kelron, 2012a; Kelron, 2012b]).
- **Upper Till Unit:** Wedron Formation till, including diamicton, consisting of clay and silty clay with occasional sand lenses (identified as Layer 5 and Layer 7, respectively [Kelron, 2012a; Kelron, 2012b]).
- **Glacial outwash and re-worked glacial deposits:** with sand, silty sand, and clayey sand predominating (identified as Layer 6 [Kelron, 2012a; Kelron, 2012b]).
- **Lower Till Unit:** Glasford Formation till, consisting of primarily clay, silty clay, and sandy clay with occasional sand lenses (identified as Layer 8 [Kelron, 2012a; Kelron, 2012b]).

Prior to 2021, there were 11 monitoring wells around the NAP and 7 monitoring wells around the OEAP for monitoring groundwater. Nine additional monitoring wells (36 through 44, and 07R) were installed in 2021 around the perimeter of the NAP and OEAP to meet the requirements of Part 845 and 10 monitoring wells (101 through 105, and 101S through 105S) were completed in the upland areas south and west of the NAP and OEAP to characterize upland hydrogeologic conditions. Construction details for monitoring wells and piezometers are provided in **Table 2-1** and depicted in **Figure 2-1**. Boring logs, monitoring well and piezometer construction forms are provided in Appendix B of the HCR.

Seven distinct water-bearing units have been identified in the vicinity of the NAP and OEAP based on stratigraphic relationships and common hydrogeologic characteristics. The units are described as follows:

- **Fill Unit** (identified as Unit 0 [Kelron, 2012a; Kelron, 2012b]): comprised predominantly of CCR (primarily fly ash, bottom ash, and boiler slag) within the NAP and OEAP and occurs within saturated materials. Fill materials are present at elevations ranging from 651 to 571 feet North American Vertical Datum of 1988 (NAVD88). The base of this unit is the base of ash within the NAP and OEAP presented on Figure 2-8 in the HCR (Ramboll, 2021a). Water levels (the phreatic surface) measured in piezometer ND3 within the fill unit indicate the phreatic surface is greater than the elevation of the water levels in the underlying MGU (**Figure 2-2; Table 2-2**).

- **UU** (identified as Unit 1 [Kelron, 2012a; Kelron, 2012b]): includes mixed alluvial deposits of clay, silt, sand, and minor gravel of the Cahokia Alluvium. This unit is composed of primarily fine grained unlithified natural geologic materials of the Cahokia Alluvium that occur at elevations ranging from 595 to 571 feet National Geodetic Vertical Datum of 1929 (NGVD29). The UU is the uppermost native material present in the bottomlands within the river valley. This unit may be covered by the fill material of the NAP and OEAP and may be very thin or absent beneath portions of the NAP (Kelron, 2012a; Kelron, 2012b). There is only one monitoring well installed within the UU (MW-06R) located north of the NAP.
- **MGU** (identified as Unit 2 [Kelron, 2012a; Kelron, 2012b]): the MGU is composed of alluvial sand and gravel that corresponds to the lower portion of the Cahokia Formation in the bottomlands of the river valley. This unit is not present outside of the river valley. These alluvial deposits lie unconformably on top of the underlying glacial till and terminate laterally along the western bluffs of the river valley where the deposits rest unconformably against the till that comprises the uplands. This moderate permeability layer has a thickness ranging from 5 to 26 feet, with a median thickness of 9.8 feet, is the uppermost coarse-grained deposit beneath the NAP and OEAP, and is considered the uppermost aquifer.
- **UCU** (identified as Upland Confining Unit [Unit 5a] and Middle Confining Unit [Unit 3] [Kelron, 2012a; Kelron, 2012b]): comprised of clay, silt, and minor amounts of sand lenses within the Upper Till Unit. The low permeability deposits of the UCU lie directly above the LGU, inhibiting the vertical movement of groundwater between the MGU and the LGU (Kelron, 2012a; Kelron, 2012b). Wells 101S, 102S, 103S, 104S, and 105S are screened within discontinuous sand lenses observed in the upland area west of the NAP and OEAP. These sand lenses are present at elevations above the pre-construction ground surface in the NAP and OEAP. These wells went dry during development and 103S did not contain enough water to sample, indicating that the lateral continuity and extent of these sand lenses is limited. Well 44, located west of the NAP along the bluff, is also screened within a discontinuous sand lens of the UCU below the preconstructed ground surface for the NAP and OEAP above the LGU.
- **LGU** (identified as Units 4 and 5b [Kelron, 2012a; Kelron, 2012b]): the LGU is composed of sand, gravel, silt, and some clay described as glacial outwash and re-worked glacial deposits. Soil borings and monitoring wells 101 through 105, completed in 2021, confirmed the presence of a laterally continuous sand unit between the elevations of 553 and 560 feet NAVD88 in the upland that is in connection with the LGU in the river valley. Although overlain and underlain by confining units, the LGU is in lateral connection across the Site at upgradient locations (01, 21, 42, 43, 101, 102, 103, 104, and 105) along the southwest side of the Middle Fork Valley and in downgradient wells (02, 03R, 34, and 37). The thickness of the LGU ranges from 2 to 18 feet in the bottomlands, with average and median thicknesses of approximately 10 feet. The uppermost elevation of the top of this unit is 565 feet NGVD29 (observed in the upland areas) and the lowermost base elevation is 536 feet NGVD29 (observed in the bottomlands). Thirteen monitoring wells are screened within the LGU (**Table 2-1**).
- **Lower Confining Unit** (identified as Unit 6 [Kelron, 2012a; Kelron, 2012b]): composed of clay, silt, and some sand, is the lowermost unlithified confining unit at the Site described as the Lower Till Unit. It extends across the upland and bottomland areas, except at locations

where it is missing due to non-deposition or erosion. At locations where this unit is missing, the lower confining unit is the shale bedrock. It ranges in thickness from zero (not present) to greater than 16 feet and has average and median thicknesses of greater than 8 and greater than 5 feet, respectively, since most borings stopped short of its base. The highest elevation at which this unit was intercepted by borings at the Site was 562 feet NGVD29 and the lowest elevation was 520 feet NGVD29. The base of this unit is the top of bedrock.

- **BCU** (identified as Unit 7 [Kelron, 2012a; Kelron, 2012b]): the lowermost unit identified at the Site, and underlies all unlithified deposits. This unit occurs within Pennsylvanian shale bedrock, which is the uppermost lithified unit at the Site. As presented by Kelron (2003), groundwater in the shale flows into the overlying alluvium and enters directly into the Middle Fork in some locations. Groundwater within the bedrock is at the end of its flow path as indicated by upward hydraulic gradients, high dissolved mineral content, and isotopic analysis indicating water is significantly older by 13,000 to 35,000 radiocarbon years before present than recent groundwater in the overlying unlithified deposits.

Groundwater flow direction (**Figure 2-2 and Figure 2-3**) and gradients have not changed significantly since the first hydrogeologic study of the NAP/OEAP was completed in 1983, and recent data supports the existing CSM which has been refined to incorporate additional data as follows:

- The NAP/OEAP overlies the UU in most areas of the Site, with the exception of the northern portion and western boundary of the NAP, where the UU is absent.
- Groundwater migrates within high permeability sands and gravels of the MGU and LGU that flow to the east under normal river conditions. There is the potential for short duration and temporary flow direction reversal during periods of high river stage.
- Groundwater flows into the Middle Fork through the MGU and LGU, which are the primary pathways that contaminant migration could occur. Upward gradients measured in the underlying shale bedrock indicate that the Middle Fork is a regional discharge area (HCR, Ramboll, 2021a).
- Vertical gradients measured between the bedrock, LGU, and MGU are generally upward near the Middle Fork, indicating that it is a regional discharge area (HCR, Ramboll, 2021a).

3. GROUNDWATER QUALITY

The classification of groundwater at NAP and OEAP has been evaluated and based on the detailed geologic information provided in the 2012 hydrogeologic investigations (Kelron, 2012a; Kelron, 2012b) for the MGU (*i.e.*, uppermost aquifer), the NAP and OEAP can be classified as Class I - Potable Resource Groundwater. The MGU is comprised of predominantly sand and gravel with some silt and is the primary groundwater transport pathway. Based on the 2012 hydrogeologic investigations, the thickness of the MGU ranges from 5 to 26 feet, with an average thickness of 10.1 feet (Kelron, 2012a; Kelron, 2012b). Field hydraulic conductivity tests performed on the MGU indicate a geometric mean hydraulic conductivity of 2.1 x 10^{-3} centimeters per second (cm/s) (Kelron, 2012a; Kelron, 2012b). Sands and gravels with thicknesses greater than 5 feet or with a hydraulic conductivity of greater than 1 x 10^{-4} cm/s meets the provisions of Class I - Potable Resource Groundwater (35 I.A.C. § 620.210).

Groundwater quality investigations were completed intermittently at the NAP and OEAP from 1983 to 2018. In 2021, additional wells were installed to comply with Part 845 requirements, specifically to reduce the lateral spacing between monitoring points and to further characterize the upland bluff and PMPs. Wells were sampled for the parameters listed in 35 I.A.C. § 845.600. A review and summary of data collected from 2015 through 2021 for parameters with GWPSs listed in 35 I.A.C. § 845.600 is provided in the HCR (Ramboll, 2021a).

Concentration results presented in the HCR were compared directly to 35 I.A.C. § 845.600 GWPSs to determine potential exceedances. The results are considered potential exceedances because the results were compared directly to the standard and did not include an evaluation of background groundwater quality or utilize the statistical methodologies proposed in the groundwater monitoring plan (GMP; Ramboll, 2021c) attached to the Operating Permit application.

Groundwater concentrations from 2015 to 2021 are summarized in the History of Potential Exceedances (Ramboll, 2021b) (attached to the Operating Permit Application) and are considered potential exceedances because the methodology used to determine them is proposed in the Statistical Analysis Plan (Appendix A to the GMP, Ramboll 2021c), which has not been reviewed or approved by IEPA at the time of submittal of the Part 845 Operating Permit application.

The History of Potential Exceedances attached to the Operating Permit Application summarizes all potential groundwater exceedances following the proposed Statistical Analysis Plan. The following potential exceedances were identified:

- Boron – determined at wells 01, 03R, 04, 05, 07R, 08R, 17, 36, 40, 41 and 104.
- Lithium – determined at wells 04, 05, 07R, 08R, 36, and 40.
- Molybdenum – determined at wells 03R, 07R, and 08R.
- pH – determined at well 40 as an exceedance of the lower limit. Porewater sample results provided in Table 2-3 of the HCR indicate the minimum pH reading from samples collected from the NAP (location ND3) and the OEAP (location OED1) was 7.9 standard units (SU); therefore, the low pH (less than 6.5 SU) determined in the history of potential exceedances is not attributable to either the NAP or OEAP. No further discussion of pH is provided in this GMR.
- Sulfate – determined at wells 01, 03R, 07R, 17, 36, and 40.
- TDS – determined at wells 01, 07R, 17, 36, and 40.

4. GROUNDWATER MODEL

4.1 Overview

Data collected at the Site from the 2021 field investigation were used to update the existing groundwater model which was initially developed in 2012 (NRT, 2012a; NRT, 2012b), and later updated in 2014 (NRT, 2014a; NRT, 2014b). The updated model was then used to evaluate CBR closure scenarios, including CBR utilizing either an onsite (CBR-Onsite) or offsite (CBR-Offsite) landfill. The results of the CBR closure scenarios are summarized and evaluated in this GMR. Associated model files are included as **Appendix A.**

4.2 Conceptual Site Model

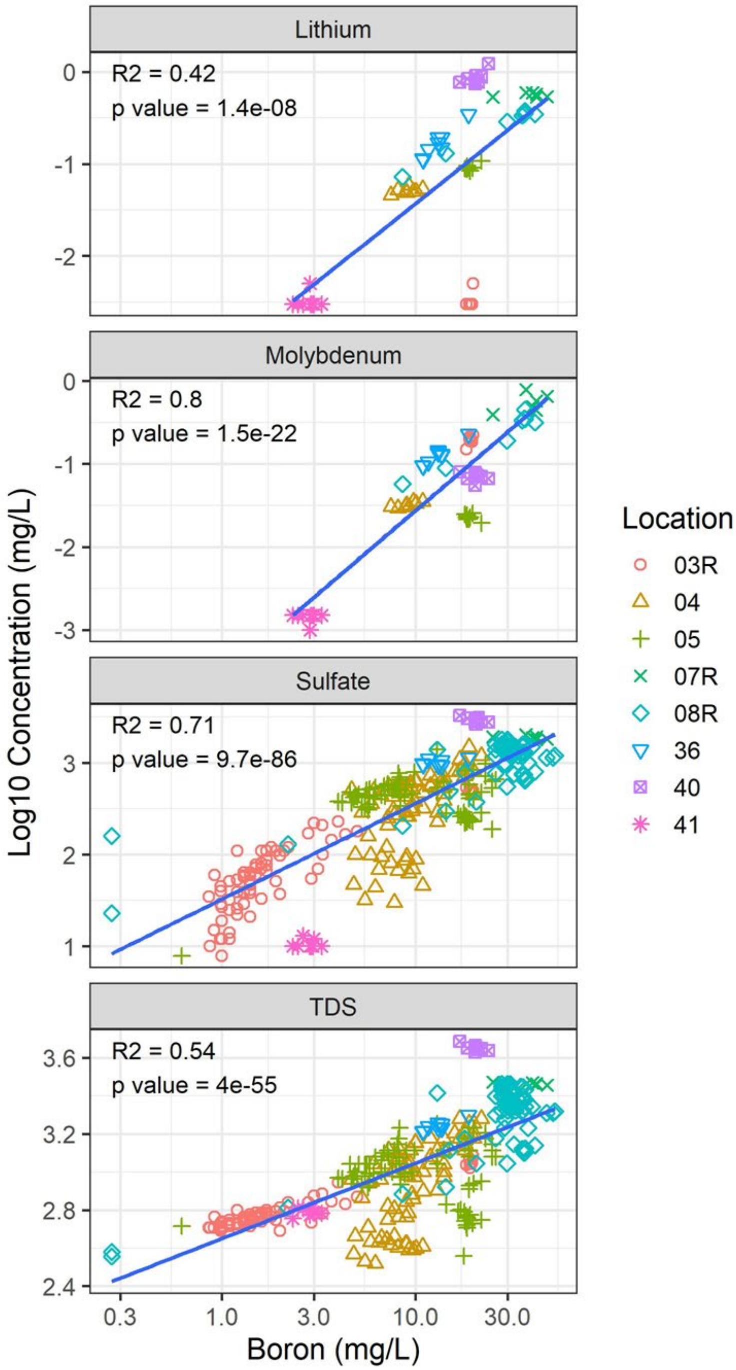
The hydrogeologic investigation reports (Kelron, 2012a; Kelron, 2012b) are the foundation of the site setting and CSM that describes groundwater flow at the Site, which was refined with additional data collected in the 2021 field investigation and presented in the HCR. The NAP and OEAP overlie the recharge area for the underlying transmissive geologic media, which are composed of coarse grained unlithified deposits (*i.e.,* alluvium [MGU], and glacial outwash and re-worked glacial deposits [LGU]). Groundwater enters the model domain vertically via recharge, and there is also a small component of groundwater that flows into the system via thin water bearing strata in the upland glacial deposits upgradient of the NAP and OEAP (*i.e.,* upgradient portions of LGU that are not within the model domain). The groundwater from the MGU and LGU flows into the Middle Fork.

Boron was selected for transport modeling. Boron is commonly used as an indicator parameter for contaminant transport modeling for CCR because: (i) it is commonly present in coal ash leachate; (ii) it is mobile and typically not very reactive but conservative (*i.e.*, low rates of sorption or degradation) in groundwater; and (iii) it is less likely than other constituents to be present in background groundwater from natural or other anthropogenic sources. The only significant sources of boron are the NAP and OEAP. The NEAP is constructed over shale bedrock, and groundwater does not flow toward the NAP and OEAP from the vicinity of the NEAP. Mass (boron) is added to groundwater via vertical recharge through CCR, and horizontal groundwater flow through CCR where it is in contact with the water table. Mass flows with groundwater toward the Middle Fork. The primary transport pathway is the MGU as indicated by groundwater observations. The LGU is also a PMP, although the amount of mass in this unit is limited by the UCU that separates the MGU and LGU (Kelron, 2012a; Kelron, 2012b).

4.3 Model Approach

Comparisons of observed lithium, molybdenum, sulfate, and TDS concentrations to boron (**Figure A**, below) indicate statistically significant correlations between these parameters at downgradient wells with identified potential exceedances 03R, 04, 05, 07R, 08R, 36, 40, and 41. Observed concentrations were transformed into Log10 concentrations for evaluation. The correlation coefficient (R2) and p values (indicator of statistical significance) are also provided on **Figure A**. Higher R2 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. All four correlations have p values less than the target of 0.05, indicating correlations are statistically significant. The correlations are strongest between molybdenum and boron, sulfate and boron, and TDS and boron. The correlation with lithium is not as strong, primarily due to the absence of lithium exceedances observed at well 03R (*i.e.*, the cluster of points is well below the trendline on **Figure A**). The statistically significant correlations associated with boron concentrations indicate boron is an acceptable surrogate for lithium, molybdenum, sulfate, and TDS in the groundwater model, and concentrations of these parameters are expected to change along with model predicted boron concentrations.

Figure A. Boron Correlation with Lithium, Molybdenum, Sulfate, and TDS in Downgradient Wells



A three-dimensional groundwater flow and transport model was calibrated to represent the conceptual flow system described above. Initial modeling was performed for a sufficient period (40 years) to allow modeled boron concentrations in the primary transport layer (MGU) to achieve steady concentrations. The model was calibrated to match groundwater elevation and concentration observed during the 2021 field investigation. Prediction simulations were then performed to evaluate the effects of CBR closure scenarios for the NAP and OEAP on groundwater quality for a period of 120 to 126 years following initial corrective action measures, which include dewatering of the NAP and OEAP, removal of all CCR, and construction of a groundwater collection trench north of the OEAP. The calibration and prediction model timelines are illustrated in **Figure 4-1**.

Three model codes were used to simulate groundwater flow and contaminant transport:

- Groundwater flow was modeled in three dimensions using MODFLOW 2005
- Contaminant transport was modeled in three dimensions using MT3DMS
- Percolation (recharge) after removal at the NAP and OEAP was modeled using the results of the Hydrologic Evaluation of Landfill Performance (HELP) model.

5. MODEL SETUP AND CALIBRATION

5.1 Model Descriptions

For the construction and calibration of the numerical groundwater flow model for the site, Ramboll selected the model code MODFLOW, a publicly-available groundwater flow simulation program developed by the United States Geological Survey (USGS) (McDonald and Harbaugh, 1988). MODFLOW is thoroughly documented, widely used by consultants, government agencies and researchers, and is consistently accepted in regulatory and litigation proceedings. 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 USGS (McDonald and Harbaugh, 1988) and has been updated several times. Major assumptions of the code are: (i) groundwater flow is governed by Darcy's law; (ii) the formation behaves as a continuous porous medium; (iii) flow is not affected by chemical, temperature, or density gradients; and (iv) 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 was used for these simulations with Groundwater Vistas 7 software for model pre- and post- processing tasks (Environmental Simulations, Inc., 2017).

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 total-variation-diminishing (TVD) method for the solution schemes. The finite difference solution has numerical dispersion for low-dispersivity transport scenarios but conserves good mass balance. The particle-tracking method avoids numerical dispersion but was not accurate in conserving mass. The TVD solution is not subject to significant numerical distribution and adequately conserves mass, but is numerically intensive, particularly for long-term models such as developed for the NAP and OEAP. The finite difference solution was used for this simulation.

Major assumptions of MT3DMS are: (i) changes in the concentration field do not affect the flow field; (ii) changes in the concentration of one solute do not affect the concentration of another solute; (iii) chemical and hydraulic properties are constant within a grid cell; and (iv) sorption is instantaneous and fully reversible, while decay is not reversible.

The HELP model was developed by the United States Environmental Protection Agency (USEPA). HELP is a one-dimensional hydrologic model of water movement across, into, through and out of a landfill or soil column based on precipitation, evapotranspiration, runoff, and the geometry and hydrogeologic properties of a layered soil and waste profile. For this modeling, results of the HELP model, HELP Version 4.0 (Tolaymat and Krause, 2020), were used to estimate the hydraulic conditions beneath removal areas.

5.2 Flow and Transport Model Setup

The modeled area was approximately 7,900 feet by 9,950 feet with the NAP and OEAP located in the northeast quadrant. The eastern edge of the model is bounded by the Middle Fork. The north, west, and south edges of the model were selected to maintain sufficient distance from the NAP and OEAP to reduce boundary interference with model calculations, while not extending too far past the extent of available calibration data. The north, west, and south edges of the model also approximate topographic highs, surface water divides, watershed boundaries, and/or Illinois Power Company Lake (Company Lake) boundaries when possible. The model grid and boundary conditions are displayed in **Figure 5-1 through Figure 5-9**.

Evaluation of monitoring well data for the NAP and OEAP has not identified statistically significant seasonal trends in groundwater quality which could affect model applicability for prediction of boron transport. The MODFLOW model was calibrated to median groundwater elevation collected from March to July 2021 presented in **Table 2-2**. MT3DMS was run on the calibrated flow model and model-simulated concentrations were calibrated to the median observed boron concentration values at the monitoring wells calculated from boron concentrations results from March to July 2021 presented in **Table 2-2**. Multiple iterations of MODFLOW and MT3DMS calibration were performed to achieve an acceptable match to observed flow and transport data. For the NAP and OEAP, the calibrated flow and transport models were used in predictive modeling to evaluate the CBR closure scenarios by removing saturated ash cells and using HELP modeled recharge values to simulate changes proposed in the closure scenarios.

5.2.1 Grid and Boundary Conditions

A seven layer, 316 x 398 node grid was established with 25 foot grid spacing (**Figure 5-1** and **Figure 5-2**). Boundary conditions are illustrated in **Figure 5-3 through Figure 5-9**. The north, south and west edges of the model are no-flow (Neumann) boundaries in all layers of the model with the exceptions of the southern edge in Layer 4, where a river (Mixed) boundary represents the Company Lake, and the western and southern edges in Layer 5, where a general head (Dirichlet) boundary was placed to simulate flow in the coarse-grained glacial deposits composing the LGU. The eastern edges of the model are no-flow (Neumann) boundaries in Layers 1 through 2, and either no-flow (Neumann) or river (Mixed) boundaries that represent the Middle Fork in Layers 3 through 7. No-flow (Neumann) boundaries were used to reduce the occurrence of dry cells near the surface where layer thickness is thin within the UCU in Layers 1 through 3 on the western edge of the model. The bottom of the model was also a no-flow (Neumann) boundary. The top of the model was a time-dependent specified flux (Neumann) boundary, with specified flux rates equal to the recharge rate. A specified mass flux (Cauchy condition) boundary was used to simulate downward percolation of solute mass from the NAP and OEAP. This boundary condition assigns a specified concentration to recharge water entering the node, and the resulting concentration in the node is a function of the relative rate and concentration of recharge water (water percolating from the impoundments) compared to the rate and concentration of other water entering the node.

5.2.2 Flow Model Input Values and Sensitivity

Flow model input values and sensitivity analyses results are presented in **Table 5-1** and described below.

The flow model calibration targets (*i.e.*, median groundwater elevations from March to July 2021 and target well locations) are summarized in **Table 2-2**. In the flow calibration model, the target for MGU well 18 was placed in layer 2. Layer 2 (UU) is more representative of the materials screened at well 18 and resulted in an improved flow calibration for the target elevation at well 18. Wells 101S, 102S, 103S, 104S, and 105S are screened within discontinuous sand lenses observed in the upland area west of the NAP and OEAP. These sand lenses are present at elevations above the pre-construction ground surface in the NAP and OEAP. These wells went dry during development and 103S did not contain enough water to sample, indicating that the lateral continuity and extent of these sand lenses is limited. Groundwater elevations measured at wells 101S, 102S, 103S, 104S, and 105S were not included as flow model calibration targets. Low groundwater elevations monitored between March and July 2021 indicated well 102 did not fully recover to static groundwater levels following development; therefore, the median groundwater elevation at well 102 was not used as a flow model calibration target. Several flow model calibration targets were added to the model that were outside the immediate vicinity of the NAP and OEAP to improve overall flow calibration both horizontally and vertically across the model domain, and include groundwater elevation targets at monitoring well locations 10, 19, 22, 35D, 35S, 101, 103, 104 and 105.

Sensitivity analysis was conducted by changing input values and observing changes in the sum of squared residuals. Horizontal conductivity, vertical conductivity, and river and general head conductance terms were all varied between one-tenth and ten times calibrated values. Recharge terms were varied between one-half and two times calibrated values. River stage and general head boundary head terms were varied between 90 and 110 percent of calibrated values. When the calibrated model was tested, the sum of squared residuals was 440.8. Sensitivity test results were categorized into negligible, low, moderate, moderately high, and high sensitivity based on the change in the sum of squared residuals as summarized in the notes in **Table 5-1**.

5.2.2.1 Model Layers

The bottom elevation of the BCU in layer 7 was flat lying and assumed to be an elevation of 430 feet NAVD88. In the previous 2012 and 2014 models, the layers of the model grid were all flat lying and thicknesses were approximated from hydrostratigraphic unit thicknesses presented in the 2012 Hydrogeologic Investigation (Kelron, 2012a; Kelron, 2012b), including the bottom of the fill (ash) layer. In the current model, all available boring log data included in the HCR (Ramboll, 2021a) was used to develop surfaces utilizing Surfer® software for each of the seven distinct water-bearing units described in **Section 2**. The approximate base of ash surface in the NAP/OEAP was developed from information provided by Geosyntec and presented in the HCR (Ramboll, 2021a). The resulting surfaces were imported as layers into the model to represent the distribution and change in thickness of each water-bearing unit across the model domain.

5.2.2.2 Hydraulic Conductivity

Hydraulic conductivity values and sensitivity results are summarized in **Table 5-1**. When available, these values were derived from field or laboratory measured values reported in the 2021 NAP and OEAP HCR (Ramboll, 2021a), 2021 NEAP HCR (Ramboll, 2021d), 2012

Hydrogeologic Investigation (Kelron, 2012a and Kelron, 2012b) and the Regional and Local Hydrogeology and Geochemistry: Vermilion Power Plant, Illinois (Kelron, 2003) to be representative of site specific conditions. The sources of the hydraulic conductivity values are summarized in **Table 5-1**. Conductivity zones that did not have representative site data (*i.e.,* zones 7 and 10, representing the lower till unit and cells above the river cells, respectively) were determined through model calibration. No horizontal anisotropy was assumed. Vertical anisotropy (presented as Kh/Kv in **Table 5-1**) was applied to conductivity zones to simulate preferential flow in the horizontal direction in these materials. Permeability tests discussed in the 2021 NAP and OEAP HCR (Ramboll, 2021a), 2021 NEAP HCR (Ramboll, 2021d), 2012 Hydrogeologic Investigation (Kelron, 2012a; Kelron, 2012b) and the Regional and Local Hydrogeology and Geochemistry: Vermilion Power Plant, Illinois (Kelron, 2003) indicate vertical conductivity values that are generally lower than horizontal.

The spatial distribution of the hydraulic conductivity zones (**Figure 5-10 through Figure 5-16**) in each layer simulates the distribution of hydrostratigraphic units as reported in the HCR (Ramboll, 2021a). The limits of the fill unit hydraulic conductivity zone (zone 2) in the current model were updated to reflect the limits of the ash fill determined from data provided by Geosyntec and presented in the HCR (Ramboll, 2021a). This adjustment to the ash fill extent was propagated through all related ash fill property zones and boundary conditions (*i.e.*, recharge, storage, effective porosity, and constant concentration cells). The distribution of all other hydraulic conductivity zones was determined through analysis of each of the seven distinct water-bearing unit layer surfaces within Surfer® software and importing zone distribution data from Surfer® into the model. Conductivity zone 10 was also placed above river cells representing the Middle Fork to improve communication between the river and the groundwater in layers above the layer in which the river was placed.

The model was highly sensitive to changes in horizontal conductivity in zones 3 (UCU), 5 (MGU), 8 (BCU), and 9 (NEAP Berm), where the model was moderately sensitive to horizontal conductivity in the remaining hydrostratigraphic units and negligible in zone 10 (the zone placed above the river cells to improve communication with the river). The model was highly sensitive to changes in vertical conductivity in zone 1 (UU [western - includes mixed alluvial deposits of clay, silt, sand, and minor gravel of the Cahokia Alluvium in the vicinity of the NAP and OEAP]) and zone 8 (BCU), while the model exhibited a negligible to moderate sensitivity in the remaining zones.

5.2.2.3 Recharge

Recharge rates were determined through calibration in the 2012 and 2014 models and were adjusted during calibration of current model to the groundwater elevation and groundwater quality data collected in 2021 (**Table 5-1**). The spatial distribution of recharge zones were based on the location and type of material present at land surface (**Figure 5-17**). Nine different zones were created to simulate recharge in the model area. The recharge occurring through the ash fill placed in the NAP and OEAP was split into four different values. Zones 2 and 6 represent recharge in NAP and OEAP areas. Increased recharge was simulated in an area between the NAP and OEAP (zone 8); and, decreased recharge was simulated in an area within the OEAP where the fill unit materials are underlain by the UCU materials (zone 9). Recharge zone (zone 5) was used to simulate recharge through the NAP Secondary Pond. A recharge zone (zone 7) was also used to simulate recharge occurring through the ash fill placed in the NEAP. The remaining three zones were created to simulate recharge through the UU alluvium (eastern, zone 4 and western, zone 1) and the UCU (zone 3).

The model had a high sensitivity to changes in recharge in zones 1 (UU) and 7 (fill unit - NEAP). The model had low to moderate sensitivity to changes in recharge in the remaining zones, with the exception of zone 9 (fill unit – OEAP area underlain by UCU), where sensitivity was negligible.

5.2.2.4 Storage and Specific Yield

As in the 2012 and 2014 models, the current calibration model did not use these terms because it was run at steady state. For the transport model, which was run in transient, no field data defining these terms were available so published values were used consistent with Fetter (1988). Specific yield was set to equal effective porosity values described in **Section 5.2.3.3**. The spatial distribution of the storage and specific yield zones were consistent with those of the hydraulic conductivity zones. The sensitivity of these parameters was tested by evaluating their effect on the transport model as described in **Section 5.2.3.4**.

5.2.2.5 River Parameters

The Middle Fork was simulated using head-dependent flux nodes in modeled river reaches 1 through 3 that required inputs for river stage, width, bed thickness, and bed hydraulic conductivity (**Table 5-1**). These river parameters were developed in the 2012 and 2014 models, and only the river stage parameter was modified in development of the current calibration model. River width, bed thickness, and bed hydraulic conductivity parameters were used to calculate a conductance term for the boundary node. This conductance term was determined by adjusting hydraulic conductivity during model calibration of the 2012 and 2014 models, while bed thickness was set at 1 foot and river width was set at 100 feet. Final hydraulic conductivity value was set at 1 foot per day (ft/day). The length of the modeled river from the 2012 and 2014 models was extended further south to the southeastern edge of the model domain (downstream of the NEAP) using river reach 3. The modeled river stage in the current calibration model was based on available Middle Fork field data (Kelron, 2003; Geosyntec, 2022b). The river boundary was placed in layers 3 through 7 corresponding with simulated river elevation (**Figure 5-5 through Figure 5-9**).

The approximate stage and slope of the river were originally developed in the 2012 and 2014 models. The stage of the river was adjusted during calibration of the current model to reflect updated groundwater elevations collected in 2021, while the slope approximated in the 2012 and 2014 models was maintained. The slope for the section of river that extended further south to the southeastern edge of the model domain (downstream of the NEAP) was estimated based on available data from Kelron (2003) and applied to river reach 3 in the current model.

The model had a high sensitivity to changes in river stage and a negligible sensitivity to changes in river conductance in river reaches 1 through 3.

Company Lake was simulated using head-dependent flux nodes in modeled river reach 4 that required inputs for river stage, width, bed thickness, and bed hydraulic conductivity (**Table 5-1**). River width, bed thickness, and bed hydraulic conductivity parameters were used to calculate a conductance term for the boundary node. This conductance term was determined by adjusting hydraulic conductivity during model calibration of the current model. River width, length, and bed thickness were set at 1 foot. Final hydraulic conductivity value was set at 0.0001 ft/day to be similar in magnitude to the vertical hydraulic conductivity of the UCU underlying Company Lake. The Company Lake river stage was based on the median elevation collected from Company Lake staff gage SG01 from March to July 2021 presented in **Table 2-2**. Company Lake modeled river reach 4 was placed in layers 3 and 4. Sensitivity was not tested for river reach 4 as this feature is not hydraulically connected to the MGU or LGU in the NAP and OEAP.

5.2.2.6 General Head Boundary Parameters

General head boundary conditions (GHB) were used along the western boundary of the model as well as, along the southern boundary of the model in layer 5 (**Figure 5-7**). The GHB at the western limit of the model (reach 0) was used to simulate groundwater flow entering the model domain upgradient of the model limits in the LGU. The GHB at the southern limit of the model (reach 1) was used to simulate the horizontal hydraulic gradient or change in groundwater elevation in the LGU along the southern limit of the model. GHB elevation, conductance, and distance were established during calibration (**Table 5-1**). GHB cell width, distance to the GHB head, and saturated thickness of the cell were set at 1 foot. Final hydraulic conductivity value was set at 5 ft/day to be similar in magnitude to the horizontal hydraulic conductivity of the LGU. The GHB at the western limit of the model (reach 0) and the southern limit of the model (reach 1) were placed in layer 5 with a constant elevation of 599 feet NAVD88 and a variable elevation ranging from 598.78 to 570.51 feet NAVD88 from west to east. The sensitivity to changes in specified head was moderately high for reach 0 and high for reach 1. The flow calibration model had a low sensitivity to changes in GHB conductance.

5.2.3 Transport Model Input Values and Sensitivity

MT3DMS input values are listed in **Table 5-2** and described below. Sensitivity of the transport model is summarized in **Table 5-3**.

In the previous 2012 and 2014 models, groundwater transport was calibrated to groundwater boron concentration ranges at each well as measured from the monitoring wells in 2011. The current model was calibrated to groundwater boron concentration ranges at each well as measured from March to July 2021. The transport model calibration targets are summarized in **Table 2-2**.

Sensitivity analysis was conducted by changing input values and observing percent change in boron concentration at each well from the calibrated model boron concentration. Effective porosity was varied by decreasing and increasing calibrated model values by 0.05. Storage values were multiplied and divided by a factor of 10, and specific yield by a factor of 2. The transport model had a negligible to low sensitivity to changes in storage and specific yield (**Table 5-3**).

5.2.3.1 Initial Concentrations

No initial concentrations were placed in the calibration model. The flow model was run as transient and concentration was added to the model through recharge and constant concentration cells starting at the same time as flow simulation. Modeling was performed for a sufficient period (40 years, **Figure 4-1**) to allow modeled concentrations in the primary transport layer (*i.e.,* MGU) to achieve steady levels.

5.2.3.2 Source Concentrations

Five concentration sources in the form of vertical percolation (recharge) through CCR were simulated in fill unit layer 1 for calibration (**Table 5-2**): (i) percolation through CCR in the northern portion of the NAP (recharge zone 2), (ii) percolation through CCR in the NAP Secondary

Pond (recharge zone 5), (iii) percolation through CCR in the northern portion of the OEAP (recharge zone 6), (iv) percolation through the CCR near the center of the impoundments (recharge zone 8), and (v) percolation through the CCR in the southern portion of the OEAP, where CCR is underlain by UCU materials (recharge zone 9)(**Figure 5-17**). All five sources were simulated by assigning concentration to the recharge input. The CCR sources were also simulated with constant concentration cells placed in fill unit layer 1 (**Figure 5-3**) to simulate saturated ash conditions. From the model perspective, this means that when the simulated water level is above the base of these cells, water that passes through the cell will take on the assigned concentration. All source concentrations were recalibrated in the current transport model to the boron concentration data collected in 2021. The source concentrations applied to the recharge zones and saturated ash cells immediately below the recharge zones have the same concentration values.

Because these are the sources of concentration in the model, the model will be highly sensitive to changes in the input values. For that reason, sensitivity testing was not completed for the source values.

5.2.3.3 Effective Porosity

Effective porosity for each modeled hydrostratigraphic unit were derived from an average between estimated values of 0.20 for silt material, 0.267 for gravel, 0.07 for clay, and 0.28 for sand from Morris and Johnson (1967) and Heath (1983) and presented in **Table 5-2**.

The model had a negligible to moderately high sensitivity to changes in porosity values, not including monitoring locations where the calibration concentration was 0.0 mg/L (*i.e.*, 05, 20, 21, 34, and 38) (**Table 5-3**). The greatest sensitivity for porosity was moderately high for the low porosity sensitivity test at monitoring locations 03R and 37.

5.2.3.4 Storage and Specific Yield Sensitivity

The model had a negligible to moderate sensitivity to changes in storage and specific yield values. Results at monitoring locations where the calibration concentration was 0.0 mg/L and remained less than 0.0 were assigned low sensitivity (*i.e.,* 05, 20, 21, 34, and 38) (**Table 5-3**). The greatest sensitivity for storage and specific yield was moderate for both low and high storage and specific yield sensitivity tests at monitoring location 44.

5.2.3.5 Dispersivity

Physical attenuation (dilution and dispersion) of contaminants is simulated in MT3DMS. Dispersion in porous media refers to the spreading of contaminants over a greater region than would be predicted solely from the average groundwater velocity vectors (Anderson, 1979 and 1984). Dispersion is caused by both mechanical dispersion, a result of deviations of actual velocity at a microscale from the average groundwater velocity, and molecular diffusion driven by concentration gradients. Molecular diffusion is generally secondary and negligible compared to the effects of mechanical dispersion and only becomes important when groundwater velocity is very low. The sum of mechanical dispersion and molecular diffusion is termed hydrodynamic dispersion, or simply dispersion (Zheng and Wang, 1998).

Dispersivity values were applied to the entire model domain and determined during calibration. Longitudinal dispersivity was set at 3 feet. The transverse and vertical dispersivity were set at 1/10 and 1/100 of longitudinal dispersivity. These input values were determined during model calibration. With an approximate travel distance of 100 feet for groundwater from the source to the receiving body of water, the model is not expected to be sensitive to dispersivity inputs and the sensitivity of the model to dispersivity was not tested.

5.2.3.6 Retardation

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. Boron, lithium, molybdenum, sulfate, and TDS 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). Site-specific partition coefficients were calculated as part of the study to evaluate whether MNA is a feasible groundwater remedial alternative for the VPP. The following Site-specific partition coefficients and their anticipated effect on constituent behavior compared to the groundwater fate and transport model are described below.

Either linear (K_d) or Frendlich (K_{dF}) partition coefficients were selected based on the results of batch adsorption testing; additional details are available in the MNA report prepared by Geosyntec (2022a).

- A K_{dF} value of 0.43 liters per kilogram (L/kg) was calculated for boron. This value is low, indicating limited chemical attenuation of boron. The effect of chemical attenuation on transport rates for boron in groundwater is limited, and the time to achieve GWPS predicted by the fate and transport model is likely not to be affected by attenuation mechanisms.
- A K_d value of 8.53 L/kg was calculated for lithium. This value is moderate, indicating some chemical attenuation of lithium, which would affect transport rates in groundwater. The fate and transport model likely over-estimates the time to achieve the lithium GWPS.
- A K_{dF} value of 109 L/kg was calculated for molybdenum. This value is high, indicating significant chemical attenuation of molybdenum, which would affect transport rates in groundwater. The fate and transport model likely over-estimates the time to achieve the molybdenum GWPS.
- A K_d value of 9.97 L/kg was calculated for sulfate. This value is moderate; however, desorption testing completed as part of the MNA evaluation found that almost all sulfate attenuation in the batch testing was reversible (Geosyntec, 2022a). These results indicate the effect of chemical attenuation on transport rates for sulfate in groundwater is limited, and the time to achieve GWPS predicted by the fate and transport model is likely not to be affected by attenuation mechanisms. As noted in the MNA report (Geosyntec, 2022a), sulfate is a primary contributor to TDS at the Site. Declines in groundwater sulfate concentrations will result in a concurrent decline in TDS concentrations.

5.3 Flow and Transport Model Assumptions and Limitations

Simplifying assumptions were made while developing this model:

- Leading up to 2021, the groundwater flow system can be simulated as steady state.
- Natural recharge is constant over the long term.
- Fluctuations in river stage do not affect groundwater flow and transport over the long term.
- Hydraulic conductivity is consistent within hydrostratigraphic units

- The approximate base of ash surface in the NAP and OEAP was developed from information provided by Geosyntec and presented in the HCR (Ramboll, 2021a). Observed concentrations in groundwater exhibit no long-term trend.
- Source concentrations are assumed to remain constant over time.
- Boron is not adsorbed and does not decay, and mixing and dispersion are the only attenuation mechanisms.

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. Since data used for calibration are near the NAP and OEAP, model predictions of transport distant spatially and temporally from the calibrated conditions at the CCR units will not be as reliable as predictions closer to the CCR units and concentrations observed in 2021.

5.4 Calibration Flow and Transport Model Results

Results of the MODFLOW/MT3DMS modeling are presented below. Electronic copies of the model files are attached to this report.

Flow model calibration results are presented in **Figure 5-16 through Figure 5-25**. The mass balance error for the flow model was -0.09 percent and the ratio of the residual standard deviation to the range was 9.7 percent; these values are within the targets for these criteria of 1 percent and 10 percent, respectively. Another flow model calibration goal is that residuals are evenly distributed such that there is no bias affecting modeled flow. The observed heads are plotted versus the simulated heads in **Figure 5-24**. The near-linear relationship between observed and simulated values indicates that the model adequately represents the calibration dataset. The residual mean was 1.52 feet; in general the simulated values were evenly distributed above and below the observed values. This is also illustrated in the observed versus residuals plot at the bottom of **Figure 5-25**; however, some simulated values were significantly underpredicted in the areas far west of the NAP and OEAP, in the vicinity of the NEAP, or in layers that were not the focus of this model (*e.g.*, BCU).

The range of observed boron concentrations in 2021 for transport calibration locations are summarized in **Table 2-2**. The goals of the transport model calibration were to have predicted concentrations fall within the range of observed concentrations, and/or have predicted concentrations above and below the GWPS for boron (2 mg/L) match observed concentrations above or below the standard at each well. One or both of these goals were achieved at all but five of the transport calibration location wells, including 05, 02, 42, 43, and 44 (**Figure 5-26**). Deviations from the observed ranges are discussed below.

- The model under-predicts concentration in well 05, which is screened in the MGU. Monitoring well 05 is positioned sidegradient to the NAP source area. Since the only receiving body is the Middle Fork and the model was developed to represent groundwater flow from the fill units to the Middle Fork, a localized change in flow direction from east to north would be necessary to simulate transport of boron concentration from the NAP to well 05 in the model. The calibrated flow and transport model accurately represent conditions at wells 04 and 41 which are located downgradient of NAP and well 05. For these reasons, the observed groundwater flow directions were maintained and a localized component of northerly flow was not incorporated into the model to move boron towards well 05.

- The model over-predicts boron concentrations at monitoring well 02 and under-predicts boron concentration at monitoring well 03R. Both wells are designated as LGU monitoring wells. Although 03R did meet the transport calibration criteria of matching observed concentrations above or below the standard, the concentration was under-predicted compared to observed concentrations in 2021 (6 mg/L in the model versus median observed concentration of 19.5 mg/L). In general, observed concentrations in the LGU monitoring wells are below the GWPS for boron (2 mg/L), with the exception of monitoring wells 01 and 03R. The 2021 boron concentrations observed at 03R are closer in magnitude to nested MGU well 08R than the other LGU monitoring wells, indicating 03R has a greater connection with the MGU than other LGU wells. The flow and transport model was calibrated to achieve concentration above the standard at LGU downgradient monitoring well 03R, resulting in over-predicted concentrations at LGU monitoring well 02.
- In general, the model over-predicts boron concentrations at upgradient monitoring wells immediately adjacent to the NAP with simulated concentrations above the GWPS for boron when they were observed to be below the standard in 2021. This occurs at monitoring wells 42, 43, and 44. Monitoring wells 42 and 43 are upgradient LGU monitoring wells. Well 44 nested with well 43 is located west of the NAP along the bluff and is screened within a discontinuous sand lens of the UCU below the preconstructed ground surface for the NAP and OEAP above the LGU. The over-predicted concentrations at these upgradient monitoring wells are likely a result of proximity to the overlying fill unit in the model due to discretization of model cells.

The remaining calibration locations had predicted concentrations that fall within the range of observed concentrations and/or have predicted concentrations above and below the GWPS for boron (2 mg/L) match observed concentrations above or below the standard at each well. MGU well 08R, located downgradient of the NAP, where the highest concentrations downgradient of the NAP were observed, was also calibrated near the median concentration of the observed values from March to July 2021. Similarly, MGU wells 07R and 40 located downgradient of the OEAP, where the highest concentrations downgradient of the OEAP were observed, were also calibrated just below the minimum of the observed range and near the median concentration of observed values from March to July 2021, respectively. The calibration result for wells 08R, 07R and 40 indicate the transport calibration model was able to simulate the highest observed concentrations downgradient of the NAP and OEAP in the MGU, which is designated as the uppermost aquifer. The distribution of boron concentrations in the calibrated model are presented on **Figure 5-27**. Observed concentrations of boron within the LGU are below the standard of 2 mg/L in all downgradient wells with the exception of 03R. While the model over-predicts concentrations at 02 and underpredicts concentration at 03R, the modeled concentrations at 37 are adequately calibrated to match boron concentrations just below 2 mg/L.

6. SIMULATION OF CLOSURE SCENARIO

6.1 Overview and Prediction Model Development

Prediction simulations were performed to evaluate the effects of source control measures (CBR closure scenarios; CBR-Onsite and CBR-Offsite) for the NAP and OEAP on groundwater quality following initial corrective action measures, which include dewatering of the NAP and OEAP, as well as construction and operation of a groundwater collection trench north of the OEAP (**Figure 4-1**). As discussed in **Sections 5.2.3.5** physical attenuation (dilution and dispersion) of contaminants in groundwater is simulated in MT3DMS, which captures the physical process of natural attenuation as part of corrective actions for all three closure scenarios simulated. Chemical attenuation is also occurring as discussed in **Section 5.2.3.6** and the anticipated effects on constituent behavior compared to the groundwater fate and transport model indicate the fate and transport model likely over-predicts the time to reach the GWPS for lithium and molybdenum. Closure scenarios were simulated by adding a drain boundary condition in the MGU to simulate operation of the groundwater collection trench (drain input parameters approximated groundwater collection trench designs provided in the CCR Final Closure Plan (Geosyntec, 2022b), applying reduced recharge to simulate dewatering of the NAP and OEAP, and applying HELP-calculated percolation rates based on removal and final soil backfill grading designs also provided in the CCR Final Closure Plan (Geosyntec, 2022b). HELP modeling input and output values are summarized in **Table 6-1** and described in detail below. Prediction simulations were performed to evaluate changes in boron concentrations from three closure scenarios, including Scenario 1: CBR-Onsite (trench removed at completion of CCR removal), Scenario 2: CBR-Onsite (trench remains after CCR is removed), and Scenario 3: CBR-Offsite (trench remains after CCR is removed). The following simplifying assumptions were made during the simulations:

- In the three closure scenarios, HELP-calculated average annual percolation rates were developed from a 30 year HELP model run. This 30-year HELP-calculated percolation rate remained constant over duration of the closure scenario prediction model runs following CBR.
- Groundwater collection trench construction (simulated with the drain boundary condition) has an instantaneous effect on groundwater flow.
- Changes in recharge resulting from dewatering (assumed to decrease calibration model recharge rates by 90 percent) and ash fill removal/ final soil backfill grading (recharge rates are based on HELP-calculated average annual percolation rates) have an instantaneous effect on recharge and percolation through surface materials.
- Boron source concentrations were assumed to remain constant as a function of time following the end of the calibration simulation. Boron concentration in the ash fill removal areas was assumed to be 0 mg/L following construction to simulate removal of ash that is the source of leachate.
- The start of each closure prediction simulation was initiated at the end of the calibration model period of 40 years plus 2.5 years to complete initial corrective action measures. For example, the simulation of Scenario 1: CBR-Onsite begins at 42.5 years (40 years for calibration plus 2.5 years of no changes until construction of the groundwater collection trench is completed and dewatering is initiated). The prediction modeling timeline for each scenario is illustrated in **Figure 4-1**.

- Ash fill removal areas were assumed to be graded following placement of soil backfill based on the design drawings provided in the CCR Final Closure Plan (Geosyntec, 2022b).
- All saturated ash (constant concentration cells) in the transport calibration model were removed instantaneously in all prediction models following ash fill removal/final soil backfill grading. Local fill materials assumed to be sourced from surrounding UCU materials (clay) replaced ash fill in areas of removal.
- Local fill materials applied to the prediction models have similar hydraulic properties as the UCU materials used in the transport calibration models.

6.2 HELP Model Setup and Results

HELP (Version 4.0; Tolaymat and Krause, 2020) was used to estimate percolation through the NAP and OEAP areas for three ash fill removal scenarios. HELP input and output files are included electronically and attached to this report.

HELP input data and results are provided in **Table 6-1**. All scenarios were modeled for a period of 30 years. Climatic inputs were synthetically generated using default equations developed for Decatur, Illinois (the closest weather station included in the HELP database). Precipitation, temperature, and solar radiation was simulated based on the latitude of the NAP and OEAP. Thickness of soil backfill and soil runoff input parameters were developed for the ash fill removal scenarios using data provided the CCR Final Closure Plan (Geosyntec, 2022b).

HELP model results (**Table 6-1**) indicated 3.17 inches of percolation per year for the NAP soil backfill area, 1.75 inches of percolation per year for OEAP soil backfill area, 3.32 inches of percolation per year for the NAP Secondary Pond soil backfill area, and 1.74 inches of percolation per year for the NEAP soil backfill area. The differences in HELP model runs for each area included the following parameters: evaporation zone thickness (limited by soil backfill thickness in the OEAP and NEAP), area, soil backfill thickness, and soil runoff slope length; all other HELP model input parameters were the same for each simulated area.

6.3 Simulation of Closure Scenarios

The calibrated model was used to evaluate the effectiveness of the three closure scenarios by adding a drain to simulate the construction of a groundwater collection trench north of the OEAP, decreasing recharge to simulate dewatering of the ash fill prior to removal, and changing recharge rates to simulate ash fill removal areas at the NAP and OEAP. Removal of leachate inputs from the ash removal areas (source control) was simulated by reducing the boron concentrations associated with recharge in the areas to 0 mg/L. Constant concentration cells that represent areas with potentially saturated ash were also removed from the ash removal areas.

Each prediction scenario was simulated as a continuation of the calibration model until the completion of the estimated construction period of the groundwater collection trench and the start of dewatering as part of the initial corrective action measures had been reached (40 years calibration plus 2.5 years of no changes until construction of the groundwater collection trench is completed and dewatering is initiated). Once the construction of the groundwater collection trench was complete and dewatering was initiated, a drain boundary condition was added to the prediction models and changes to recharge to simulate dewatering were introduced as part of the initial corrective action measures (**Figure 4-1**). Corrective action conditions were maintained until completion of CCR removal, at which time recharge zones were modified to represent ash fill removal areas for each scenario. The prediction model input values are summarized in **Table 6-2** and illustrated in **Figure 6-1** and **Figure 6-2**. As illustrated in **Figure 6-1** additional concentration observation wells, 07R_T and 40_T, were included in the prediction models north of the drain boundary condition cells to replace observation wells 07R and 40, which are located within the trench alignment. Additional observation wells 07R_t and 40_T are used in the model to observe predicted changes in concentration between the trench and the Middle Fork. The three closure scenarios are discussed in this report based on predicted changes in boron concentrations as described below.

6.3.1 Closure Scenario 1 Predicted Boron Concentrations

The design for Scenario 1: CBR-Onsite (trench removed at completion of CCR removal) includes initial corrective action measures (construction of a groundwater collection trench north of the OEAP and dewatering) and CBR utilizing an onsite landfill (estimated to be complete 10 years after the start of corrective action measures) (**Figure 4-1**).

Predicted concentrations start to decline once the initial corrective action measures are initiated within the prediction model. These declines occur as recharge is reduced from dewatering and additional cells become dry within the modeled fill unit. The reduced recharge leads to an increasing number of saturated ash cells (constant concentration cells) becoming inactive and no longer contributing boron source concentrations to the model domain. Also, as a result of dewatering, downward percolation of solute mass from the NAP and OEAP is reduced, which decreases the boron concentration entering the model domain. The prediction model indicates modeled drain cells in the MGU north of the OEAP that represent the groundwater collection trench reduce transport of boron concentrations to the river cells. Following the initial corrective action measures, CBR is initiated in the prediction model and boron concentrations are no longer entering the model domain from recharge or from saturated ash cells (constant concentration cells).

At all downgradient wells in the MGU, except well 36, concentrations in Scenario 1: CBR-Onsite (trench removed at completion of CCR removal) were predicted to decrease rapidly following completion of groundwater collection trench construction and initial dewatering 2.5 years after closure scenario implementation (**Figure 6-3**). At well 36 the model indicates concentrations will increase for a period of time following implementation of corrective measures before decreases are predicted. The predicted increase in concentration at well 36 is likely a result of the proximity of well 36 to the modeled groundwater collection trench. In the model, the groundwater collection trench creates a capture zone which redirects groundwater carrying boron concentration toward the trench and well 36, which increases the predicted concentrations in this area. Predicted concentrations at well 36 increase until the source concentrations are removed and/or the groundwater collection trench is removed. A second increase in concentrations was predicted at monitoring well 36 following the end of the initial corrective action measures (i.e., trench removal and dewatering) and the start of CBR, and is likely the result of changes in localized groundwater flow in response to changes in recharge and hydraulic properties of fill materials and/or removal of the groundwater collection trench at the start of CBR. Following the second simulated increase of concentration at monitoring well 36, concentrations continue to decrease to concentrations below the GWPS for boron following CBR. Well 36 was the last remaining downgradient MGU well to reach concentrations below the GWPS for boron (2 mg/L) after a period of approximately 50 years after implementation of Scenario 1: CBR-Onsite (trench removed at completion of CCR removal).

The prediction model indicated that wells 04, 07R_T, and 40_T, which had concentrations above the GWPS for boron (2 mg/L) prior to closure scenario implementation, will decrease to concentrations below the GWPS for boron within the 10-year initial corrective action measures period and prior to CBR. The prediction model indicated that MGU wells 08R and 41 will not reach the GWPS for boron within the initial corrective action measures period, but will reach the standard within approximately 26 and 16 years, respectively. The predicted extent of the footprint of the boron plume over 2 mg/L after 50 years following implementation of Scenario 1: CBR-Onsite (trench removed at completion of CCR removal) within the MGU illustrated in **Figure 6-4** indicates the plume will be limited to an area on the southwest portion of the NAP and an area on the southcentral portion of the OEAP, where the MGU plume no longer intersects the river.

As discussed previously, the model over-predicts boron concentrations at monitoring well 02, under-predicts boron concentration at monitoring well 03R, and is adequately calibrated at well 37. All three wells are downgradient LGU monitoring wells. Prediction model results (**Figure 6-5**) for wells 02 and 03R are not reasonable given the lack of model calibration at these locations. Results for well 37 are reasonable and behave as expected based on the conceptual site model. Because groundwater has a longer flow path and passes through low permeability deposits of the UCU before it reaches the LGU it is expected that the concentrations in the LGU will take longer to respond to source control measures than wells in the MGU. The predicted time to reach the GWPS for boron (2 mg/L) downgradient of the NAP and OEAP in the LGU is based on prediction model results for downgradient LGU well 37, where concentrations were calibrated to just above the maximum observed boron concentration from March to July 2021. The prediction model indicated well 37 would reach concentrations below the GWPS for boron approximately 112 years after closure scenario implementation (**Figure 6-5**).

6.3.2 Closure Scenario 2 Predicted Boron Concentrations

The design for Scenario 2: CBR-Onsite (trench remains after CCR is removed) includes initial corrective action measures (construction of a groundwater collection trench north of the OEAP and dewatering) and CBR utilizing an onsite landfill (estimated to be complete 10 years after the start of corrective action measures) (**Figure 4-1**) with continued operation of the groundwater collection trench. The only difference between Scenario 1 and Scenario 2 is the continued operation of the groundwater collection trench following CBR in Scenario 2.

Like Scenario 1, at all downgradient wells in the MGU except well 36, concentrations in Scenario 2: CBR-Onsite (trench remains when CCR is removed) were predicted to decrease rapidly following completion of groundwater collection trench construction and initial dewatering 2.5 years after closure scenario implementation (**Figure 6-6**). At well 36, the model indicates concentrations will increase for a period of time following implementation of initial corrective measures before decreases are predicted associated with the capture zone created by the collection trench, as discussed in **Section 6.3.1** for Scenario 1. Unlike Scenario 1, a second increase in concentrations was not predicted at monitoring well 36 as a result of the continued operation of the trench. Following the predicted increase in concentration, well 36 is predicted to reach concentrations below the GWPS for boron approximately 47 years after implementation of Scenario 2: CBR-Onsite (trench remains after CCR is removed).

The prediction model indicated that wells 04, 07R_T, and 40_T, which had concentrations above the GWPS for boron (2 mg/L) prior to closure scenario implementation, will decrease to concentrations below the GWPS for boron within the 10-year initial corrective action measures period and prior to CBR. Like Scenario 1, the prediction model indicated that MGU wells 08R and 41 will not reach the GWPS for boron within the initial corrective action measures period, but will meet the GWPS within approximately 26 and 18 years, respectively. The predicted extent of the footprint of the boron plume over 2 mg/L after 47 years following implementation of Scenario 2: CBR-Onsite (trench remains after CCR is removed) within the MGU illustrated in **Figure 6-7** indicates the plume was limited to an area on the south and west portion of the NAP and an area on the southcentral portion of the OEAP, where the MGU plume only intersects the river at a single model cell that became isolated from the remaining plume. From a modeling perspective, the difference between the predicted time to reach the GWPS for boron (2mg/L) in the MGU in Scenario 1 (50 years) versus Scenario 2 (47 years) is negligible. In other words, both scenarios are predicted to reach the GWPS after approximately 50 years, the simulated three-year difference between these two scenarios is not significant (**Section 5.3**). These results also indicate there is no significant benefit in the modeled time to reach the GWPS for continued operation and maintenance of the groundwater collection trench beyond the required initial corrective action measures period.

As described in **Section 6.3.1** for Scenario 1, prediction model results (**Figure 6-8**) for wells 02 and 03R are not reasonable given the lack of model calibration at these locations. Results for well 37 are reasonable and behave as expected based on the CSM. The prediction model indicates well 37 will reach concentrations below the GWPS for boron approximately 116 years after closure scenario implementation.

6.3.3 Closure Scenario 3 Predicted Boron Concentrations

The design for Scenario 3: CBR-Offsite (trench remains after CCR is removed) includes initial corrective action measures (construction of a groundwater collection trench north of the OEAP and dewatering) and CBR utilizing an offsite landfill (estimated to be complete 4 years after the start of corrective action measures) (**Figure 4-1**) with continued operation of the groundwater collection trench. The only difference between Scenario 2 and Scenario 3 is the reduced initial corrective action measures period (the time to start CBR following initial corrective action measures is reduced by 6 years [from 10 years in Scenario 1 and Scenario 2 to 4 years in Scenario 3]).

Like Scenario 1 and Scenario 2, at all downgradient wells in the MGU except well 36, concentrations in Scenario 3: CBR-Offsite (trench remains after CCR is removed) are predicted to decrease rapidly following completion of groundwater collection trench construction and initial dewatering 2.5 years after closure scenario implementation (**Figure 6-9**). At well 36, the model indicates concentrations will increase for a period of time following implementation of initial corrective measures before decreases are predicted associated with the capture zone created by the collection trench, as discussed in **Section 6.3.1** for Scenario 1. In Scenario 3, a short-term decrease in concentrations was observed at monitoring well 36 following the end of the initial corrective action measures and the start of CBR, which is likely the result of changes in localized groundwater flow in response to changes in recharge and hydraulic properties of fill materials after CBR. Following the short-term decrease observed at monitoring well 36, concentrations continue to increase until approximately 13 years after closure implementation then decrease to concentrations below the GWPS approximately 43 years after implementation of Scenario 3: CBR-Offsite (trench remains after CCR is removed).

The prediction model indicated that wells 04, 07R_T, and 40_T, which had concentrations above the GWPS for boron (2 mg/L) prior to closure scenario implementation, will decrease to concentrations below the GWPS for boron within the 4-year initial corrective action measures period and prior to CBR. Like Scenario 1 and Scenario 2, the prediction model indicates that MGU wells 08R and 41 will not reach the GWPS for boron within the initial corrective action measures period, but will reach the GWPS within approximately 22 and 12 years, respectively. The predicted extent of the footprint of the boron plume over 2 mg/L after 43 years following implementation of Scenario 3: CBR-Offsite (trench remains after CCR is removed) within the MGU illustrated in **Figure 6-10** indicates the plume will be limited to an area in the south and west portion of the NAP and an area in the southcentral portion of the OEAP, where the MGU plume only intersects the river at two separated model cells.

As described in **Section 6.3.1** for Scenario 1, prediction model results (**Figure 6-11**) for wells 02 and 03R are not reasonable given the lack of model calibration at these locations. Results for well 37 are reasonable and behave as expected based on the CSM. The prediction model indicates well 37 will reach concentrations below the GWPS for boron approximately 109 years after closure scenario implementation.

From a modeling perspective, the differences among the predicted times to reach the GWPS for boron (2 mg/L) in the LGU for Scenarios 1, 2, and 3 in 112, 116, and 109 years after implementation of the closure scenarios, respectively, is negligible. All three scenarios are predicted to reach the GWPS after approximately 110 years; the simulated seven-year difference among these three scenarios after 100 years is not significant. The differences are not considered significant as the reliability of model predictions decreases with increasing time from the calibrated model conditions (**Section 5.3**).

6.3.4 Evaluation of Mass Flux to the Middle Fork

Consistent with the CSM, the calibration model simulates the flow of groundwater through the site toward the Middle Fork. Within the model, mass (representing boron) from the NAP and OEAP enters the groundwater and is transported to the Middle Fork where it enters river boundary cells and leaves the model domain. The predicted reductions in mass flux to the river cells following source control for Scenarios 1, 2, and 3 were obtained from the model and presented on **Figure 6-12**. Boron flux was normalized to the total flux removed by river cells at implementation of the closure scenarios (model year 40) to illustrate reductions in mass following initial closure and corrective action activities. In all three scenarios, mass flux is predicted to be reduced by 50 percent approximately 10 years after implementation, 80 percent within approximately 35 years after implementation, and 95 percent within approximately 130 years after implementation.

7. CONCLUSIONS

This GMR has been prepared to evaluate how proposed CBR closure scenarios will achieve compliance with the applicable groundwater standards at the VPP. Data collected from the recent 2021 field investigations were used to update the existing groundwater model, which was initially developed in 2012 (NRT, 2012a; NRT, 2012b), and later updated in 2014 (NRT, 2014a; NRT, 2014b). The updated MODFLOW and MT3DMS models were then used to evaluate three CBR scenarios using information provided in the CCR Final Closure Plan (Geosyntec, 2022b):

- Scenario 1: CBR-Onsite (trench removed at completion of CCR removal)
- Scenario 2: CBR-Onsite (trench remains after CCR is removed)
- Scenario 3: CBR-Offsite (trench remains after CCR is removed)

Predictive simulations of source control and corrective action indicate groundwater in the primary transport zone (the MGU) will achieve the GWPS for Scenarios 1, 2, and 3 in 50, 47, and 43 years, respectively, after implementation of the closure scenarios and corrective action. From a modeling perspective, the difference between the predicted time to reach the GWPS for boron (2mg/L) in the MGU in Scenario 1 (50 years) versus Scenario 2 (47 years) is negligible. In other words, both scenarios are predicted to reach the GWPS after approximately 50 years; the simulated three-year difference between these two scenarios is not significant. These results also indicate there is no significant benefit in the modeled time to reach the GWPS for continued operation and maintenance of the groundwater collection trench beyond the completion of the removal.

Groundwater in the PMP (LGU) is predicted to achieve the GWPS for Scenarios 1, 2, and 3 in 112, 116, and 109 years after implementation of the closure scenarios, respectively. The longer response times simulated for the LGU are expected based on the CSM. Because groundwater has a longer flow path and passes through low permeability deposits of the UCU before it reaches the LGU, it is expected that the concentrations in the LGU will take longer to respond to source control measures than wells in the MGU. From a modeling perspective, the differences among the predicted times to reach the GWPS for boron (2 mg/L) in the LGU for Scenarios 1, 2, and 3 in 112, 116, and 109 years after implementation of the closure scenarios, respectively, is negligible. All three scenarios are predicted to reach the GWPS after approximately 110 years; the simulated seven-year difference among these three scenarios after 100 years is not significant.

The predicted reductions in mass flux to the river cells (representing the Middle Fork) following source control for Scenarios 1, 2, and 3 indicate for the three scenarios that mass flux is predicted to be reduced by 50 percent approximately 10 years after implementation, 80 percent within approximately 35 years after implementation, and 95 percent within approximately 130 years after implementation.

Statistically significant correlations between boron concentrations and concentrations of other parameters identified as potential exceedances of the GWPS indicate boron is an acceptable surrogate for lithium, molybdenum, sulfate, and TDS in the groundwater model. Concentrations of these parameters are expected to change along with model predicted boron concentrations.

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.

Boron, lithium, molybdenum, sulfate, and TDS transport are 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 MT3DMS, which captures the physical process of natural attenuation as part of corrective actions for all three closure scenarios simulated. Site-specific partition coefficients (chemical attenuation) were calculated as part of the study to evaluate whether MNA is a feasible groundwater remedial alternative for the VPP. The anticipated effects on constituent behavior compared to the groundwater fate and transport model summarized below indicate the fate and transport model likely over-predicts the time to reach the GWPS:

- The effect of chemical attenuation on transport rates for boron in groundwater is limited, and the time to achieve GWPS predicted by the fate and transport model is likely not to be affected by attenuation mechanisms.
- Some chemical attenuation of lithium is expected and the fate and transport model likely over-estimates the time to achieve the lithium GWPS.
- Significant chemical attenuation of molybdenum is expected which would affect transport and the fate and transport model likely over-estimates the time to achieve the molybdenum GWPS.
- The effect of chemical attenuation on transport rates for sulfate in groundwater is limited, and the time to achieve GWPS predicted by the fate and transport model is likely not to be affected significantly by chemical attenuation mechanisms relative to physical attenuation. Sulfate is a primary contributor to TDS at the site and declines in groundwater sulfate concentrations will result in concurrent declines in TDS concentrations.

Results of groundwater fate and transport modeling conservatively estimate that groundwater will attain the GWPS for all constituents identified as potential exceedances of the GWPS in the primary migration pathway (the MGU) within 50 years of closure implementation for all three Scenarios. The LGU, which has much lower boron concentrations (less mass), is estimated to take approximately 110 years to reach the GWPS due to the longer flow paths through low permeability deposits of the UCU before it reaches the LGU and ultimately the Middle Fork. Results of the groundwater fate and transport modeling also indicate that the flux of these constituents to the Middle Fork will reduce by 80 percent within 35 years of closure implementation for all three Scenarios. The anticipated effects of MNA on constituent behavior compared to the groundwater fate and transport model indicate the fate and transport model likely over-predicts the time to reach the GWPS for lithium and molybdenum.

8. REFERENCES

Anderson, M.P. 1979. *Using models to simulate the movement of contaminants through groundwater flow systems*. CRC Critical Rev. Environ. Control., 9(2), p. 97-156.

Anderson, M.P. 1984. *Movement of contaminants in groundwater: groundwater transport -- advection and dispersion*. Groundwater Contamination. National Academy Press, Washington, D.C. p. 37-45.

Environmental Simulations, Inc., 2017. Groundwater Vistas 7 Software.

Fetter, C.W., 1988. *Applied Hydrogeology*. Merrill Publishing Company, Columbus, Ohio.

Geosyntec Consultants, Inc. (Geosyntec), 2022a. Monitored Natural Attenuation Evaluation Vermilion Power Plant, attached to the Construction Permit Application to which this report is also attached, January 28, 2022.

Geosyntec Consultants, Inc. (Geosyntec), 2022b. CCR Final Closure Plan, attached to the Construction Permit Application to which this report is also attached, January 28, 2022.

Heath, R.C., 1983. *Basic ground-water hydrology*, U.S. Geological Survey Water-Supply Paper 2220, 86p.

Illinois Environmental Protection Agency (IEPA), 2021. *In the Matter of: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Title 35 Illinois Administration Code 845, Addendum*. April 15, 2021.

Kelron Environmental (Kelron), 2003. *Regional and Local Hydrogeology and Geochemistry, Vermilion Power Plant, Illinois, Dynegy Midwest Generation, Inc.* November 30, 2003.

Kelron Environmental (Kelron), 2012a. *Hydrogeology and Groundwater Quality of the North Ash Pond System, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC*. March 15, 2012.

Kelron Environmental (Kelron), 2012b. *Hydrogeology and Groundwater Quality of the Old East Ash Pond, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC*. March 15, 2012.

McDonald, M.G., and A.W. Harbaugh, 1988. *A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model: Techniques of Water-Resources Investigations, Techniques of Water-Resources of the United States Geological Survey*. Book 6, Chapter A1.

Morris, D.A and A.I. Johnson, 1967. *Summary of hydrologic and physical properties of rock and soil materials as analyzed by the Hydrologic Laboratory of the U.S. Geological Survey*. U.S. Geological Survey Water-Supply Paper 1839-D, 42p.

Natural Resource Technology, Inc. (NRT), 2012a. *Corrective Action Plan, North Ash Pond System, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC.* March 27, 2012.

Natural Resource Technology, Inc. (NRT), 2012b. *Corrective Action Plan, Old East Ash Pond, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC*. March 27, 2012.

Natural Resource Technology, Inc. (NRT), 2014a. *Corrective Action Plan, North Ash Pond System, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC*. April 2, 2014.

Natural Resource Technology, Inc. (NRT), 2014b. *Corrective Action Plan, Old East Ash Pond, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC.* April 2, 2014.

URS Corporation, 2013. *Geotechnical Report, North ash Pond and Old East Ash Pond, Vermilion Site, Embankment Evaluations, Oakwood, Illinois, Dynegy Midwest Generation, LLC*. November 18, 2013.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021a. *Hydrogeologic Characterization Report, North Ash Pond and Old East Ash Pond, Vermilion Power Plant, Oakwood, Illinois*. October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021b. *History of Potential Exceedances, North Ash Pond and Old East Ash Pond, Vermilion Power Plant, Oakwood, Illinois*. October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021c. *Groundwater Monitoring Plan, North Ash Pond and Old East Ash Pond, Vermilion Power Plant, Oakwood, Illinois*. October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021d. *Hydrogeologic Characterization Report, New East Ash Pond, Vermilion Power Plant, Oakwood, Illinois*. October 25, 2021.

Tolaymat, T. and Krause, M, 2020. *Hydrologic Evaluation of Landfill Performance: HELP 4.0 User Manual*. United States Environmental Protection Agency, Washington, DC, EPA/600/B 20/219.

Zheng, Z., and P.P. Wang, 1998. *MT3DMS, a Modular Three-Dimensional Multispecies Transport Model,* Model documentation and user's guide prepared by the University of Alabama Hydrogeology Group for the US Army Corps of Engineers.

TABLES

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
GROUNDWATER MODELING REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Well Number	Monitored Hydrogeologic Unit	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)
01	LGU	10/29/1982	661.69	661.69	Top of PVC	660.09	99.60	104.40	560.60	555.80	119.00	541.20	4.8	2	40.18086	-87.746898
02	LGU	11/03/1982	593.87	593.87	Top of PVC	590.39	30.10	39.70	560.30	550.70	39.70	549.40	9.6	2	40.182334	-87.743855
03R	LGU	12/07/1993	589.86	589.86	Top of PVC	587.83	29.00	34.00	558.80	553.80	35.30	551.30	5	2	40.184122	-87.746092
04	MGU	11/04/1982	590.89	590.89	Top of PVC	587.38	8.70	13.50	578.70	573.90	13.50	573.90	4.8	2	40.186394	-87.74493
05	MGU	11/04/1982	595.65	595.65	Top of PVC	592.28	9.10	13.90	583.10	578.30	13.90	578.30	4.8	2	40.187159	-87.747129
06R	UU	11/23/1999	592.43	592.43	Top of PVC	589.69	8.40	13.50	581.20	576.10	13.50	575.60	5.1	2	40.189082	-87.74491
07R	MGU	04/27/2021	594.50	594.50	Top of PVC	591.83	11.00	21.00	580.83	570.83	21.00	551.83	20	2	40.182309	-87.743853
08R	MGU	12/06/1993	589.86	589.86	Top of PVC	587.92	9.50	14.50	578.50	573.50	18.00	570.00	5	2	40.184136	-87.746095
10	UCU	04/29/1987	659.09	659.09	Top of PVC	656.33	46.60	56.60	609.70	599.70	56.60	581.40	10	2	40.178985	-87.739824
17	MGU	12/06/1993	623.19	623.19	Top of PVC	619.62	54.00	59.00	565.60	560.60	60.00	547.60	5	2	40.182087	-87.746641
19	MGU	12/10/1993	595.79	595.79	Top of PVC	593.34	10.00	15.00	583.10	578.10	16.00	576.10	5	2	40.188206	-87.747135
20	MGU	12/08/1993	592.27	592.27	Top of PVC	590.18	12.50	17.50	577.70	572.70	18.50	571.20	5	2	40.186949	-87.743335
21	LGU	12/08/1993	672.71	672.71	Top of PVC	670.69	104.00	109.00	566.40	561.40	110.00	558.40	5	2	40.179682	-87.744962
22	BCU	12/05/2001	658.62	658.62	Top of PVC	655.93	80.00	100.00	576.00	556.00	100.00	556.00	20	2	40.178997	-87.73985
34	LGU	10/21/2010	592.45	592.45	Top of PVC	590.11	49.10	54.10	540.90	535.88	54.30	535.70	5	2	40.186921	-87.743359
35S	UU	03/01/2017	584.92	584.92	Top of PVC	581.64	3.50	8.50	577.65	572.65	8.50	572.70	5	2	40.17977	-87.735586
35D	BCU	03/03/2017	584.14	584.14	Top of PVC	581.77	35.00	45.00	546.25	536.25	45.00	535.50	10	2	40.179762	-87.735575
36	MGU	03/03/2021	589.96	589.96	Top of PVC	587.82	16.00	21.00	571.82	566.82	21.00	565.80	5	2	40.183141	-87.745676
37	LGU	03/03/2021	589.71	589.71	Top of PVC	587.84	48.00	53.00	539.84	534.84	53.00	525.80	5	2	40.183133	-87.745668
38	MGU	03/02/2021	591.69	591.69	Top of PVC	589.14	21.00	31.00	568.14	558.14	31.00	552.10	10	2	40.189062	-87.744898
40	MGU	10/03/2018	592.27	592.27	Top of PVC	589.57	12.50	17.50	577.07	572.07	17.50	--	5	2	40.182269	-87.742987
41	MGU	03/04/2021	587.17	587.17	Top of PVC	585.07	21.00	31.00	564.07	554.07	31.00	548.10	10	2	40.185445	-87.745262
42	LGU	03/07/2021	608.40	608.40	Top of PVC	605.41	50.00	60.00	555.41	545.41	60.00	545.40	10	2	40.182788	-87.748374

RAMBOLL

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
GROUNDWATER MODELING REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Well Number	Monitored Hydrogeologic Unit	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)
43	LGU	03/07/2021	607.84	607.84	Top of PVC	605.30	55.00	65.00	550.30	540.30	65.00	530.30	10	2	40.184888	-87.750015
44	UCU	03/08/2021	607.89	607.89	Top of PVC	605.37	40.00	45.00	565.37	560.37	45.00	560.40	5	2	40.184879	-87.750003
101S	UCU	03/16/2021	707.21	707.21	Top of PVC	704.13	61.00	66.00	643.14	638.14	66.00	616.10	5	2	40.179169	-87.754114
101	LGU	03/05/2021	706.67	706.67	Top of PVC	704.09	141.00	151.00	563.09	553.09	151.00	544.10	10	2	40.179149	-87.754113
102S	UCU	03/16/2021	705.90	705.90	Top of PVC	702.92	72.00	77.00	630.92	625.92	77.00	612.90	5	2	40.17787	-87.750289
102	LGU	03/06/2021	589.86	589.86	Top of PVC	702.98	148.00	158.00	554.98	544.98	158.00	543.00	10	2	40.177887	-87.750283
103S	UCU	03/15/2021	721.00	721.00	Top of PVC	717.62	65.00	70.00	652.62	647.62	70.00	637.60	5	2	40.179854	-87.749047
103	LGU	03/09/2021	720.38	720.38	Top of PVC	717.38	155.00	165.00	562.38	552.38	165.00	540.40	10	2	40.179842	-87.748995
104S	UCU	03/15/2021	705.71	705.71	Top of PVC	703.10	76.00	86.00	627.10	617.10	86.00	613.10	10	2	40.17768	-87.748823
104	LGU	03/08/2021	705.88	705.88	Top of PVC	703.24	152.00	162.00	551.24	541.24	162.00	533.20	10	2	40.177681	-87.748843
105S	UCU	03/16/2021	702.10	702.10	Top of PVC	698.97	65.00	75.00	633.97	623.97	75.00	609.00	10	2	40.17853	-87.745412
105	LGU	03/05/2021	705.88	705.88	Top of PVC	698.46	129.00	139.00	569.46	559.46	139.00	538.50	10	2	40.178557	-87.745392
ND3	CCR	02/05/2019	614.55	614.55	Top of PVC	610.78	8.65	23.31	602.13	587.48	23.87	586.91	14.66	2	40.1831	-87.747349
OED1	CCR	02/06/2019	630.41	630.41	Top of PVC	627.29	23.68	43.34	603.61	583.95	43.83	583.46	19.66	2	40.181608	-87.745161
SG01	SW	04/01/2021	689.32	689.32	Top of PVC	689.32	--	--	--	--	689.30	--	0	2	40.173756	-87.745091

Notes:
All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
-- = data not available
BCU = bedrock confining unit
BGS = below ground surface
CCR = coal combustion residuals
ft = foot or feet
LGU = lower groundwater unit
MGU = middle groundwater unit
PVC = polyvinyl chloride
SW = surface water
UCU = upper confining unit
UU = upper unit
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RAMBOLL

TABLE 2-2. FLOW AND TRANSPORT MODEL CALIBRATION TARGETS

GROUNDWATER MODELING REPORT

VERMILION POWER PLANT

NORTH ASH POND AND OLD EAST ASH POND

OAKWOOD, ILLINOIS

Well ID	Monitored Hydrogeologic Unit	Modeled Target Location (Layer Number)	Flow Model Target Groundwater Elevation Median Value March 2021 to July 2021 (feet NAVD88)	Transport Model Target Boron Concentrations March 2021 to July 2021 (mg/L)		
				Minimum	Median	Maximum
01	LGU	5	582.90	1.2	3.4	4.8
02	LGU	5	575.77	0.3	0.3	0.4
03R	LGU	5	582.64	18.4	19.5	19.9
04	MGU	3	584.18	7.5	9.1	10.1
05	MGU	3	588.66	18.0	18.5	22.0
06R	UU	2	588.47	No Target		
07R	MGU	3	578.96	25.2	40.4	42.4
08R	MGU	3	577.67	8.6	35.7	37.0
17	MGU	3	585.75	1.4	4.1	6.6
18	MGU	2	598.58	11.0	11.8	15.7
19	MGU	3	589.56	No Target		
20	MGU	3	579.00	0.5	0.7	1.1
21	LGU	5	581.60	0.8	0.9	1.0
34	LGU	5	579.03	0.5	0.5	0.7
36	MGU	3	576.47	10.9	13.1	18.8
37	LGU	5	582.48	1.1	1.3	1.5
38	MGU	3	588.06	0.4	0.5	0.6
40	MGU	3	578.36	17.0	20.4	23.9
41	MGU	3	581.74	2.3	2.9	3.3
42	LGU	5	583.48	0.8	0.9	1.0
43	LGU	5	592.42	0.9	1.2	1.2
44	UCU	4	593.85	1.2	1.4	1.4
101	LGU	5	598.26	No Target		
103	LGU	5	583.27	No Target		

RAMBOLL

TABLE 2-2. FLOW AND TRANSPORT MODEL CALIBRATION TARGETS

GROUNDWATER MODELING REPORT

VERMILION POWER PLANT

NORTH ASH POND AND OLD EAST ASH POND

OAKWOOD, ILLINOIS

Well ID	Monitored Hydrogeologic Unit	Modeled Target Location (Layer Number)	Flow Model Target Groundwater Elevation Median Value March 2021 to July 2021 (feet NAVD88)	Transport Model Target Boron Concentrations March 2021 to July 2021 (mg/L)		
				Minimum	Median	Maximum
104	LGU	5	580.56	No Target		
105	LGU	5	586.01	No Target		
10	UCU	4	609.54	No Target		
22	BCU	7	603.60	No Target		
35D	BCU	7	577.51[1]	No Target		
35S	UU	6	573.12[1]	No Target		
ND3	CCR	NA	599.18[2]	28.5[2]	30.6[2]	32.0[2]
OED1	CCR	NA	589.57[2]	35.0[2]	46.1[2]	46.7[2]
SG01	SW	NA	680.77[2]	No Target		

[O: JJW 10/31/21; C: KLT 11/4/21; C: BGH 11/4/21]

Notes:

[1] Target groundwater elevations presented are from data collected on March 29, 2021, groundwater elevations collected after this date were recovering between sampling events and do not represent static groundwater conditions at wells 35S and 35D.

[2] Value not used as calibration target

ID = identification

mg/L = milligrams per liter

NA = not applicable

NAVD88 = North American Vertical Datum of 1988

Hydrogeologic Unit:

BCU = bedrock confining unit

CCR = coal combustion residuals

LGU = lower groundwater unit

MGU = middle groundwater unit

SW = surface water

UCU = upland confining unit

UU = upper unit

TABLE 5-1. FLOW MODEL INPUT AND SENSITIVITY ANALYSIS RESULTS
GROUNDWATER MODELING REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Zone	Hydrostratigraphic Unit	Materials	ft/d	cm/s	Kh/Kv	Value Source	Sensitivity[1]
Horizontal Hydraulic Conductivity			**Calibration Model**			**Calibration Model**	
1	UU (western)	mixed alluvial deposits in the vicinity of the NAP and OEAP	0.8	2.82E-04	NA	Calibrated - Within Range of Field Test Results (Kelron, 2012a and Kelron, 2012b)	moderate
2	Fill Unit	CCR	0.22	7.76E-05	NA	Geomean of Field Test Results (Ramboll, 2021a)	moderate
3	UCU	clay and silt	0.033	1.16E-05	NA	Calibrated - near Field Test Result for Upper Confining Unit at NEAP (Ramboll, 2021b)	high
4	UU (eastern)	mixed alluvial deposits in the vicinity of the NEAP	30	1.06E-02	NA	Geomean of Field Test Results at NEAP (Ramboll, 2021b)	moderate
5	MGU	alluvial deposits	20	7.06E-03	NA	Calibrated - Within Range Field Test Results and near Geomean of Field Test Results (Ramboll, 2021a)	high
6	LGU	sand, gravel, silt	4.4	1.55E-03	NA	Calibrated - Within Range Field Test Results and near Geomean of Field Test Results (Ramboll, 2021a)	moderate
7	LCU	clay and silt	0.0085	3.00E-06	NA	Calibrated	moderate
8	BCU	shale	0.003	1.06E-06	NA	Minimum of Field Test Results at NEAP (Ramboll, 2021b)	high
9	NEAP Berm	UCU borrow material	0.025	8.82E-06	NA	Field Test Result for Upper Confining Unit at NEAP (Ramboll, 2021b)	high
10	UU (western) above River Boundary Condition	NA	4	1.41E-03	NA	Calibrated - Conductivity Value to Allow Groundwater Flow from UU to River Boundary Condition	negligible
Vertical Hydraulic Conductivity			**Calibration Model**			**Calibration Model**	
1	UU (western)	mixed alluvial deposits in the vicinity of the NAP and OEAP	0.0022	7.76E-07	364	Calibrated - Within Range Laboratory Test Results and near Geomean of Laboratory Test Results (Ramboll, 2021a)	high
2	Fill Unit	CCR	0.048	1.69E-05	5	Geomean of Laboratory Test Results (Ramboll, 2021a)	negligible
3	UCU	clay and silt	0.00033	1.16E-07	100	Calibrated - Within Range Laboratory Test Results (Ramboll, 2021a)	moderate
4	UU (eastern)	mixed alluvial deposits in the vicinity of the NEAP	2.3	8.11E-04	13	Geomean of Laboratory Test Results at NEAP (Ramboll, 2021b)	low
5	MGU	alluvial deposits	0.35	1.23E-04	57	Geomean of Laboratory Test Results (Ramboll, 2021a)	low
6	LGU	sand, gravel, silt	0.03	1.06E-05	147	Calibrated - Within Range Laboratory Test Results and near Geomean of Laboratory Test Results (Ramboll, 2021a)	moderate
7	LCU	clay and silt	0.00043	1.52E-07	20	Geomean of Laboratory Test Results (Ramboll, 2021a)	negligible
8	BCU	shale	0.00014	4.94E-08	21	Maximum of Reported Laboratory Values (Kelron, 2003)	high
9	MCU	alluvial and re-worked glacial	0.0033	1.16E-06	8	Geomean of Laboratory Test Results for Upper Confining Unit (Ramboll, 2021a)	low
10	UU (western) above River Boundary Condition	NA	4	1.41E-03	1	Calibrated - Conductivity Value to Allow Groundwater Flow from UU to River Boundary Condition	negligible

TABLE 5-1. FLOW MODEL INPUT AND SENSITIVITY ANALYSIS RESULTS
GROUNDWATER MODELING REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Zone	Hydrostratigraphic Unit	Materials	ft/d	in/yr	Kh/Kv	Value Source	Sensitivity[1]
Recharge			**Calibration Model**			**Calibration Model**	
1	UU (western)	mixed alluvial deposits in the vicinity of the NAP and OEAP	1.40E-03	6.13	NA	Calibrated	high
2	Fill Unit - NAP	CCR	1.40E-03	6.13	NA	Calibrated	low
3	UCU	clay and silt	8.50E-06	0.04	NA	Calibrated	moderate
4	UU (eastern)	mixed alluvial deposits in the vicinity of the NEAP	1.68E-04	0.74	NA	Calibrated	low
5	Fill Unit - NAP Secondary Pond	CCR	6.00E-03	26.28	NA	Calibrated	low
6	Fill Unit - OEAP	CCR	1.40E-03	6.13	NA	Calibrated	low
7	Fill Unit - NEAP	CCR	4.00E-04	1.75	NA	Calibrated	high
8	Fill Unit -Area Between NAP and OEAP	CCR	6.00E-03	26.28	NA	Calibrated	moderate
9	Fill Unit - OEAP Area Underlain by UCU	CCR	1.00E-05	0.04	NA	Calibrated	negligible
Storage							
1	UU (western)	mixed alluvial deposits in the vicinity of the NAP and OEAP	*Not used in steady-state calibration model*			*Not used in steady-state calibration model*	
2	Fill Unit	CCR (all)					
3	UCU	clay and silt					
4	UU (eastern)	mixed alluvial deposits in the vicinity of the NEAP					
5	MGU	alluvial deposits					
6	LGU	sand, gravel, silt					
7	LCU	clay and silt					
8	BCU	shale					
9	NEAP Berm	alluvial and re-worked glacial					

TABLE 5-1. FLOW MODEL INPUT AND SENSITIVITY ANALYSIS RESULTS
GROUNDWATER MODELING REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

River Parameters							
	Relative Location	**River Width (feet)**	**Length of River (feet)**	**Bed Thickness (feet)**	**Hydraulic Conductivity (ft/d)**	**Stage (feet)**	**River Conductance (ft^2/d)**
Reach 1	Upstream of NEAP	100	25	1	1	578.94 - 572.62	2500
Sensitivity[1]	NA	- - -	- - -	- - -	- - -	high	negligible
Reach 2	North of NEAP and Northeastern River Meander	100	25	1	1	572.56 - 565.40	2500
Sensitivity[1]	NA	- - -	- - -	- - -	- - -	high	negligible
Reach 3	East of NEAP and Downstream (River Bottom at BCU)	100	25	1	1	565.33 - 551.79	2500
Sensitivity[1]	NA	- - -	- - -	- - -	- - -	high	negligible
Reach 4	Company Lake	1	1	1	0.0001	680	0.0001
Sensitivity[1]	NA	- - -	- - -	- - -	- - -	- - -	- - -
Value Source	NA	Calibrated	Calibrated	Calibrated	Calibrated	Calibrated - Middle Fork Stage Modified from Field Data (Kelron, 2003; and July 2021 Field Data from Geosyntec); Company Lake Stage Based on Median Elevation Collected from Staff Gage SG01 March 2021 to July 2021	Calibrated

General Head Parameters							
	Relative Location	**Width of General Head Boundary Cell (feet)**	**Distance to General Head Boundary Head (feet)**	**Saturated Thickness of Cell (feet)**	**Hydraulic Conductivity (ft/d)**	**Head (feet)**	**General Head Boundary Conductance (ft^2/d)**
Reach 0	Western Model Boundary in LGU	1	1	1	5	599	5
Sensitivity[1]	NA	- - -	- - -	- - -	- - -	moderately high	low
Reach 1	Southern Model Boundary in LGU	1	1	1	5	598.78 - 570.51	5
Sensitivity[1]	NA	- - -	- - -	- - -	- - -	high	low
Value Source	NA	Calibrated	Calibrated	Calibrated	Calibrated	Estimated based on Groundwater Elevation Targets in LGU west of NAP and OEAP	Calibrated

[O: JJW 10/31/21; C: BGH 11/04/21]

Notes:
[1] Sensitivity Explanation:
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%
SSR = sum of squared residuals
- - - = not tested
CCR = coal combustion residuals
cm/s = centimeters per second
ft/d = feet per day
ft^2/day = feet squared per day
in/yr = inches per year
Kh/Kv = anisotropy ratio
NA = not applicable
NAP = North Ash Pond
NEAP = New East Ash Pond
OEAP = Old East Ash Pond

Hydrostratigraphic Unit
BCU = bedrock confining unit
LCU = lower confining unit
LGU = lower groundwater unit
MCU = middle confining unit
MGU = middle groundwater unit
UCU = upland confining unit
UU = upper unit

References:

Kelron Environmental (Kelron), 2003, Regional and Local Hydrogeology and Geochemistry, Vermilion Power Plant, Illinois, Dynegy Midwest Generation, Inc., November 30, 2003.
Kelron Environmental (Kelron), 2012a, Hydrogeology and Groundwater Quality of the North Ash Pond System, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC, March 15, 2012.
Kelron Environmental (Kelron), 2012b, Hydrogeology and Groundwater Quality of the Old East Ash Pond, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC, March 15, 2012.
Ramboll Americas Engineering Solutions, Inc. (Ramboll), October 25, 2021a, Hydrogeologic Site Characterization Report, Vermilion Power Plant North Ash Pond and Old East Ash Pond.
Ramboll Americas Engineering Solutions, Inc. (Ramboll), October 25, 2021b, Hydrogeologic Site Characterization Report, Vermilion Power Plant New East Ash Pond.

TABLE 5-2. TRANSPORT MODEL INPUT VALUES (CALIBRATION)
GROUNDWATER MODELING REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Zone	Hydrostratigraphic Unit	Materials	Calibration Model		
			Boron Concentration (mg/L)	Value Source	Sensitivity
Initial Concentration					
Entire Domain	NA	NA	0	NA	- - -
Source Concentration (recharge)					
1	UU (western)	mixed alluvial deposits in the vicinity of the NAP and OEAP	0	NA	- - -
2	Fill Unit - NAP	CCR	45	calibrated	- - -
3	UCU	clay and silt	0	NA	- - -
4	UU (eastern)	mixed alluvial deposits in the vicinity of the NEAP	0	NA	- - -
5	Fill Unit - NAP Secondary Pond	CCR	15	calibrated	- - -
6	Fill Unit - OEAP	CCR	35	calibrated	- - -
7	Fill Unit - NEAP	CCR	0	NA	- - -
8	Fill Unit -Area Between NAP and OEAP	CCR	5	calibrated	- - -
9	Fill Unit - OEAP Area Underlain by UCU	CCR	35	calibrated	- - -
Source Concentration (constant concentration cells)					
Reach 2	Fill Unit - NAP	CCR	45	calibrated	- - -
Reach 5	Fill Unit - NAP Secondary Pond	CCR	15	calibrated	- - -
Reach 6	Fill Unit - OEAP	CCR	35	calibrated	- - -
Reach 8	Fill Unit -Area Between NAP and OEAP	CCR	5	calibrated	- - -

Storage, Specific Yield and Effective Porosity			Calibration Model				
Zone	Hydrostratigraphic Unit	Materials	Storage	Specific Yield	Effective Porosity	Value Source	Sensitivity
1	UU (western)	mixed alluvial deposits in the vicinity of the NAP and OEAP	0.003	0.175	0.175	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Effective Porosity Esitmated from Literature (Morris and Johnson, 1967; Heath, 1983)	see Table 5-3
2	Fill Unit	CCR (all)	0.003	0.2	0.2	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Effective Porosity Esitmated from Literature (Morris and Johnson, 1967; Heath, 1983)	see Table 5-3
3	UCU	clay and silt	0.003	0.135	0.135	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Effective Porosity Esitmated from Literature (Morris and Johnson, 1967; Heath, 1983)	see Table 5-3
4	UU (eastern)	mixed alluvial deposits in the vicinity of the NEAP	0.003	0.27	0.27	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Effective Porosity Esitmated from Literature (Morris and Johnson, 1967; Heath, 1983)	see Table 5-3
5	MGU	alluvial deposits	0.003	0.27	0.27	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Effective Porosity Esitmated from Literature (Morris and Johnson, 1967; Heath, 1983)	see Table 5-3
6	LGU	sand, gravel, silt	0.003	0.18	0.18	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Effective Porosity Esitmated from Literature (Morris and Johnson, 1967; Heath, 1983)	see Table 5-3
7	LCU	clay and silt	0.003	0.135	0.135	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Effective Porosity Esitmated from Literature (Morris and Johnson, 1967; Heath, 1983)	see Table 5-3
8	BCU	shale	0.003	0.1	0.1	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Effective Porosity Esitmated from Literature (Morris and Johnson, 1967; Heath, 1983)	see Table 5-3
9	NEAP Berm	alluvial and re-worked glacial	0.003	0.135	0.135	Storage Estimated from Literature (Fetter, 1988); Specific Yield Set Equal to Effective Porosity; Effective Porosity Esitmated from Literature (Morris and Johnson, 1967; Heath, 1983)	see Table 5-3
Dispersivity							
Applicable Region	Hydrostratigraphic Unit	Materials	Longitudinal (feet)	Transverse (feet)	Vertical (feet)	Value Source	Sensitivity
Entire Domain	NA	NA	3	0.3	0.03	calibrated	- - -

[O: JJW 10/31/21; C: BGH 11/04/21]

TABLE 5-2. TRANSPORT MODEL INPUT VALUES (CALIBRATION)
GROUNDWATER MODELING REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Notes:
[1] The concentrations from the end of the calibrated transport model were imported as initial concentrations for the prediction model runs.
- - - = not tested
CCR = coal combustion residuals
mg/L = milligrams per liter
NA = not applicable
NAP = North Ash Pond
NEAP = New East Ash Pond
OEAP = Old East Ash Pond

Hydrostratigraphic Unit
BCU = bedrock confining unit
LCU = lower confining unit
LGU = lower groundwater unit
MCU = middle confining unit
MGU = middle groundwater unit
UCU = upland confining unit
UU = upper unit

References:
Fetter, C.W., 1988, Applied Hydrogeology, Merrill Publishing Company, Columbis, Ohio.
Morris, D.A and A.I. Johnson, 1967. Summary of hydrologic and physical properties of rock and soil materials
as analyzed by the Hydrologic Laboratory of the U.S. Geological Survey. U.S. Geological Survey Water-Supply Paper 1839-D, 42p.
Heath, R.C., 1983. Basic ground-water hydrology, U.S. Geological Survey Water-Supply Paper 2220, 86p.

TABLE 5-3. TRANSPORT MODEL INPUT VALUES (SENSITIVITY)
GROUNDWATER MODELING REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Well ID	Calibration Concentration (mg/L)	Storage and Specific Yield				Effective Porosity			
		File Name		File Name		File Name		File Name	
		2021_VER_ConcCal_500_s_sy_low.gwv		2021_VER_ConcCal_500_s_sy_high.gwv		2021_VER_ConcCal_500_Por_low.gwv		2021_VER_ConcCal_500_Por_high.gwv	
		Concentration (mg/L)	Sensitivity [1]	Concentration (mg/L)	Sensitivity [1]	Concentration (mg/L)	Sensitivity [1]	Concentration (mg/L)	Sensitivity [1]
05	0.0	0.0	low	0.0	low	0.0	low	0.0	low
04	7.1	6.6	low	6.6	low	6.7	low	6.6	low
08R	34.5	34.3	negligible	34.3	negligible	34.6	negligible	34.1	low
17.0	5.0	5.0	negligible	5.0	negligible	5.0	negligible	5.0	negilgible
18.0	5.0	5.0	negligible	5.0	negligible	5.0	negligible	5.0	negilgible
20.0	0.0	0.0	low	0.0	low	0.0	low	0.0	low
01	3.3	3.2	low	3.2	low	3.9	moderate	2.4	moderate
21.0	0.0	0.0	low	0.0	moderate	0.1	high	0.0	moderately high
02	17.7	17.7	negligible	17.7	negligible	20.7	moderate	15.1	moderate
03R	4.2	4.3	low	4.3	low	7.3	moderately high	2.8	moderate
34.0	0.0	0.0	low	0.0	low	0.0	low	0.0	low
07R	23.1	23.4	low	23.4	low	23.7	low	23.0	negilgible
36	6.0	5.9	low	5.9	low	5.9	low	5.9	low
37	1.9	1.9	low	1.9	low	3.3	moderately high	1.2	moderate
38	0.0	0.0	low	0.0	low	0.0	low	0.0	low
40	22.7	22.3	low	22.3	low	22.7	negligible	21.9	low
41	9.8	9.7	negligible	9.7	negligible	9.8	negligible	9.7	low
42	2.2	2.1	low	2.1	low	3.3	moderate	1.5	moderate
43	5.1	5.3	low	5.3	low	6.9	moderate	4.3	moderate
44	35.6	28.9	moderate	28.8	moderate	36.9	low	22.3	moderate
		S*0.1 Sy*0.5		S*10 Sy*2[2]		Porosity-0.05		Porosity+0.05	

[O: JJW 10/31/21; C: BGH 11/04/21]

Notes:
[1] Sensitivity Explanation:
Negligible = concentration changed by less than 1%
Low = concentration change between 1% and 10%
Moderate = concentration change between 10% and 50%
Moderately High = concentration change between 50% and 100%
High = concentration change greater than 100%
[2] Transient flow model did not converge, sensitivity test used steady state flow and transient transport
ID = identification
mg/L = milligrams per liter
S = storativity
Sy = specific yield

TABLE 6-1. HELP MODEL INPUT AND OUTPUT VALUES
GROUNDWATER MODELING REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Closure Scenario Number (Drainage Length)	NAP - Removal Area	OEAP - Removal Area	NAP Secondary Pond - Removal Area	NEAP - Removal Area	Notes
Input Parameter					
Climate-General					
City	Decatur, IL	Decatur, IL	Decatur, IL	Decatur, IL	Nearby city to the Site within HELP database
Latitude	40.18	40.18	40.18	40.18	Site latitude
Evaporative Zone Depth	21	12*	21	12*	21 - fair grass (*reduced for layers less than 21 inches thick)
Maximum Leaf Area Index	2	2	2	2	2 - fair stand of grass (Schroeder, 1994)
Growing Season Period, Average Wind Speed, and Quarterly Relative Humidity	Decatur, IL	Decatur, IL	Decatur, IL	Decatur, IL	Nearby city to the Site within HELP database
Number of Years for Synthetic Data Generation	30	30	30	30	
Temperature, Evapotranspiration, and Precipitation	Precipitation, temperature, and solar radiation was simulated based on HELP V4 weather simulation for: Lat/Long: 40.18/-87.75	Precipitation, temperature, and solar radiation was simulated based on HELP V4 weather simulation for: Lat/Long: 40.18/-87.75	Precipitation, temperature, and solar radiation was simulated based on HELP V4 weather simulation for: Lat/Long: 40.18/-87.75	Precipitation, temperature, and solar radiation was simulated based on HELP V4 weather simulation for: Lat/Long: 40.18/-87.75	
Soils-General					
% where runoff possible	100	100	100	100	
Area (acres)	41	21.3	5	30	Unit area
Specify Initial Moisture Content	No	No	No	No	
Surface Water/Snow	Model Calculated	Model Calculated	Model Calculated	Model Calculated	
Soils-Layers					
1	Clay	Clay	Clay	Clay	
Soil Parameters--soil fill					
Type	1	1	1	1	vertical percolation layer
Thickness (in)	69	12	121	12	Approximated from Geosyntec provided design cross sections
Texture	43	43	43	43	defaults used
Description	Clay	Clay	Clay	Clay	
Soils--Runoff					
Runoff Curve Number	87.8	87.9	88.8	88.1	HELP-computed curve number
Slope	0.01%	0.01%	0.01%	0.01%	
Length (ft)	1582	1302	294	975	
Texture	43	43	43	43	
Vegetation	fair	fair	fair	fair	fair indicating fair stand of grass on surface of soil backfill (Hydroseed)
Execution Parameters					
Years	30	30	30	30	
Report Daily	No	No	No	No	
Report Monthly	No	No	No	No	
Report Annual	Yes	Yes	Yes	Yes	
Output Parameter					
Percolation Rate (in/yr)	**3.17**	**1.75**	**3.32**	**1.74**	

[JJW 11/1/21; C: KLT 11/5/21]

TABLE 6-1. HELP MODEL INPUT AND OUTPUT VALUES
GROUNDWATER MODELING REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Notes:
% = percent
ft = feet
HELP = Hydrologic Evaluation of Landfill Performance
in = inches
in/yr = inches per year
Lat = latitude
Long = longitude

TABLE 6-2. PREDICTION MODEL INPUT VALUES
GROUNDWATER MODELING REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Scenario 1: CBR-Onsite (trench removed at completion of CCR removal)

Prediction Model	Construction Period (years)	Hydrostratigraphic Unit	Recharge Zone	Boron Recharge Concentration (mg/L)	Recharge (ft/day)	Recharge (in/yr)	Constant Concentration (mg/L)
No Action	0	Fill Unit - NAP	2	45	1.4E-03	6.13	45
No Action	0	Fill Unit - NAP Secondary Pond	5	15	6.0E-03	26.28	15
No Action	0	Fill Unit - OEAP	6	35	1.4E-03	6.13	35
No Action	0	Fill Unit - NEAP	7	0	4.0E-04	1.75	--
No Action	0	Fill Unit -Area Between NAP and OEAP	8	5	6.0E-03	26.28	5
No Action	0	Fill Unit - OEAP Area Underlain by UCU	9	35	1.0E-05	0.04	35
Dewatering/GCT	2.5	Fill Unit - NAP	2	45	1.4E-04	0.61	45
Dewatering/GCT	2.5	Fill Unit - NAP Secondary Pond	5	15	6.0E-04	2.63	15
Dewatering/GCT	2.5	Fill Unit - OEAP	6	35	1.4E-04	0.61	35
Dewatering/GCT	2.5	Fill Unit - NEAP	7	0	4.0E-05	0.18	--
Dewatering/GCT	2.5	Fill Unit -Area Between NAP and OEAP	8	5	6.0E-04	2.63	5
Dewatering/GCT	2.5	Fill Unit - OEAP Area Underlain by UCU	9	35	1.0E-06	0.004	35
CBR-Onsite	12.5	Fill Unit - NAP	2	0	7.2E-04	3.15	--
CBR-Onsite	12.5	Fill Unit - NAP Secondary Pond	5	0	7.6E-04	3.33	--
CBR-Onsite	12.5	Fill Unit - OEAP	6	0	4.0E-04	1.75	--
CBR-Onsite	12.5	Fill Unit - NEAP	7	0	4.0E-04	1.75	--
CBR-Onsite	12.5	Fill Unit -Area Between NAP and OEAP	8	0	7.2E-04	3.15	--
CBR-Onsite	12.5	Fill Unit - OEAP Area Underlain by UCU	9	0	1.0E-05	0.04	--

Prediction Model	Construction Period (years)	Hydrostratigraphic Unit	Hydraulic Conductivity Zone	Horizontal Hydraulic Conductivity (ft/d)	Horizontal Hydraulic Conductivity (cm/s)	Vertical Hydraulic Conductivity (ft/d)	Vertical Hydraulic Conductivity (cm/s)
No Action	0	Fill Unit (CCR)	2	0.22	7.76E-05	0.048	1.69E-05
Dewatering/GCT	2.5	Fill Unit (CCR)	2	0.22	7.76E-05	0.048	1.69E-05
CBR-Onsite	12.5	Fill Unit (Soil Backfill)	2	0.033	1.16E-05	0.00033	1.16E-07

Prediction Model	Construction Period (years)	Hydrostratigraphic Unit	Storage, Specific Yield and Effective Porosity Zone	Storage	Specific Yield	Effective Porosity
No Action	0	Fill Unit (CCR)	2	0.003	0.2	0.2
Dewatering/GCT	2.5	Fill Unit (CCR)	2	0.003	0.2	0.2
CBR-Onsite	12.5	Fill Unit (Soil Backfill)	2	0.003	0.135	0.135

Prediction Model	Construction Period (years)	Drain Width (feet)	Length of Drain Cell (feet)	Drain Bed Thickness (feet)	Hydraulic Conductivity (ft/d)	Stage of Drain (feet)	Drain Conductance (ft^2/d)
No Action	0	--	--	--	--	--	--
Dewatering/GCT	2.5	2.5	10 - 32	13.8 - 25.8	10	572.93 - 566.07	11.6 - 43.3
CBR-Onsite	12.5	--	--	--	--	--	--

RAMBOLL

TABLE 6-2. PREDICTION MODEL INPUT VALUES
GROUNDWATER MODELING REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Scenario 2: CBR-Onsite (trench remains after CCR is removed)							
Prediction Model	**Construction Period (years)**	**Hydrostratigraphic Unit**	**Recharge Zone**	**Boron Recharge Concentration (mg/L)**	**Recharge (ft/day)**	**Recharge (in/yr)**	**Constant Concentration (mg/L)**
No Action	0	Fill Unit - NAP	2	45	1.4E-03	6.13	45
No Action	0	Fill Unit - NAP Secondary Pond	5	15	6.0E-03	26.28	15
No Action	0	Fill Unit - OEAP	6	35	1.4E-03	6.13	35
No Action	0	Fill Unit - NEAP	7	0	4.0E-04	1.75	--
No Action	0	Fill Unit -Area Between NAP and OEAP	8	5	6.0E-03	26.28	5
No Action	0	Fill Unit - OEAP Area Underlain by UCU	9	35	1.0E-05	0.04	35
Dewatering/GCT	2.5	Fill Unit - NAP	2	45	1.4E-04	0.61	45
Dewatering/GCT	2.5	Fill Unit - NAP Secondary Pond	5	15	6.0E-04	2.63	15
Dewatering/GCT	2.5	Fill Unit - OEAP	6	35	1.4E-04	0.61	35
Dewatering/GCT	2.5	Fill Unit - NEAP	7	0	4.0E-05	0.18	--
Dewatering/GCT	2.5	Fill Unit -Area Between NAP and OEAP	8	5	6.0E-04	2.63	5
Dewatering/GCT	2.5	Fill Unit - OEAP Area Underlain by UCU	9	35	1.0E-06	0.004	35
CBR-Onsite	12.5	Fill Unit - NAP	2	0	7.2E-04	3.15	--
CBR-Onsite	12.5	Fill Unit - NAP Secondary Pond	5	0	7.6E-04	3.33	--
CBR-Onsite	12.5	Fill Unit - OEAP	6	0	4.0E-04	1.75	--
CBR-Onsite	12.5	Fill Unit - NEAP	7	0	4.0E-04	1.75	--
CBR-Onsite	12.5	Fill Unit -Area Between NAP and OEAP	8	0	7.2E-04	3.15	--
CBR-Onsite	12.5	Fill Unit - OEAP Area Underlain by UCU	9	0	1.0E-05	0.04	--
Prediction Model	**Construction Period (years)**	**Hydrostratigraphic Unit**	**Hydraulic Conductivity Zone**	**Horizontal Hydraulic Conductivity (ft/d)**	**Horizontal Hydraulic Conductivity (cm/s)**	**Vertical Hydraulic Conductivity (ft/d)**	**Vertical Hydraulic Conductivity (cm/s)**
No Action	0	Fill Unit (CCR)	2	0.22	7.76E-05	0.048	1.69E-05
Dewatering/GCT	2.5	Fill Unit (CCR)	2	0.22	7.76E-05	0.048	1.69E-05
CBR-Onsite	12.5	Fill Unit (Soil Backfill)	2	0.033	1.16E-05	0.00033	1.16E-07
Prediction Model	**Construction Period (years)**	**Hydrostratigraphic Unit**	**Storage, Specific Yield and Effective Porosity Zone**		**Storage**	**Specific Yield**	**Effective Porosity**
No Action	0	Fill Unit (CCR)	2		0.003	0.2	0.2
Dewatering/GCT	2.5	Fill Unit (CCR)	2		0.003	0.2	0.2
CBR-Onsite	12.5	Fill Unit (Soil Backfill)	2		0.003	0.135	0.135
Prediction Model	**Construction Period (years)**	**Drain Width (feet)**	**Length of Drain Cell (feet)**	**Drain Bed Thickness (feet)**	**Hydraulic Conductivity (ft/d)**	**Stage of Drain (feet)**	**Drain Conductance (ft^2/d)**
No Action	0	--	--	--	--	--	--
Dewatering/GCT	2.5	2.5	10 - 32	13.8 - 25.8	10	572.93 - 566.07	11.6 - 43.3
CBR-Onsite	12.5	2.5	10 - 32	13.8 - 25.8	10	572.93 - 566.07	11.6 - 43.3

RAMBOLL

TABLE 6-2. PREDICTION MODEL INPUT VALUES
GROUNDWATER MODELING REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

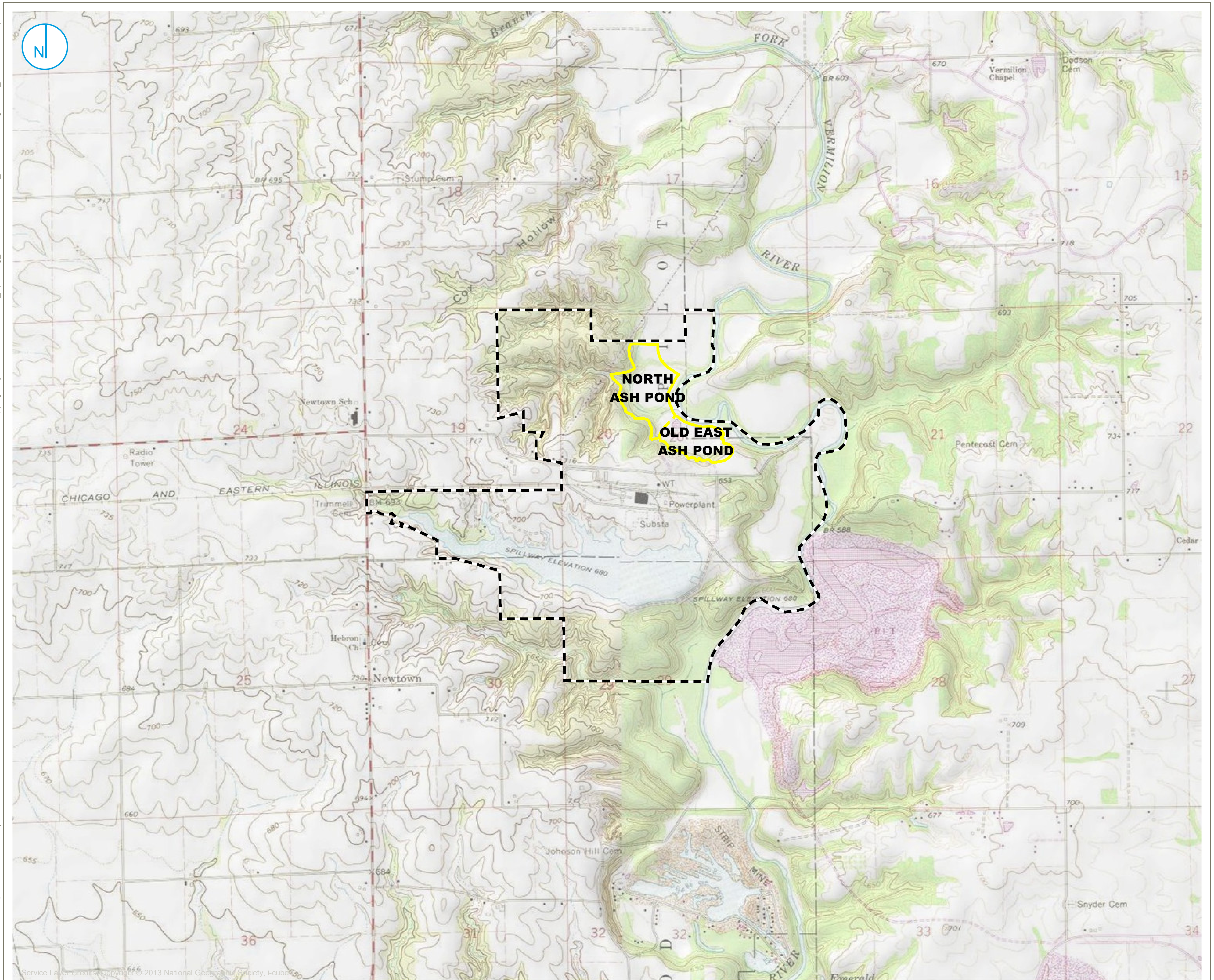
Scenario 3: CBR-Offsite (trench remains after CCR is removed)							
Prediction Model	**Construction Period (years)**	**Hydrostratigraphic Unit**	**Recharge Zone**	**Boron Recharge Concentration (mg/L)**	**Recharge (ft/day)**	**Recharge (in/yr)**	**Constant Concentration (mg/L)**
No Action	0	Fill Unit - NAP	2	45	1.4E-03	6.13	45
No Action	0	Fill Unit - NAP Secondary Pond	5	15	6.0E-03	26.28	15
No Action	0	Fill Unit - OEAP	6	35	1.4E-03	6.13	35
No Action	0	Fill Unit - NEAP	7	0	4.0E-04	1.75	--
No Action	0	Fill Unit -Area Between NAP and OEAP	8	5	6.0E-03	26.28	5
No Action	0	Fill Unit - OEAP Area Underlain by UCU	9	35	1.0E-05	0.04	35
Dewatering/GCT	2.5	Fill Unit - NAP	2	45	1.4E-04	0.61	45
Dewatering/GCT	2.5	Fill Unit - NAP Secondary Pond	5	15	6.0E-04	2.63	15
Dewatering/GCT	2.5	Fill Unit - OEAP	6	35	1.4E-04	0.61	35
Dewatering/GCT	2.5	Fill Unit - NEAP	7	0	4.0E-05	0.18	--
Dewatering/GCT	2.5	Fill Unit -Area Between NAP and OEAP	8	5	6.0E-04	2.63	5
Dewatering/GCT	2.5	Fill Unit - OEAP Area Underlain by UCU	9	35	1.0E-06	0.004	35
CBR-Offsite	6.5	Fill Unit - NAP	2	0	7.2E-04	3.15	--
CBR-Offsite	6.5	Fill Unit - NAP Secondary Pond	5	0	7.6E-04	3.33	--
CBR-Offsite	6.5	Fill Unit - OEAP	6	0	4.0E-04	1.75	--
CBR-Offsite	6.5	Fill Unit - NEAP	7	0	4.0E-04	1.75	--
CBR-Offsite	6.5	Fill Unit -Area Between NAP and OEAP	8	0	7.2E-04	3.15	--
CBR-Offsite	6.5	Fill Unit - OEAP Area Underlain by UCU	9	0	1.0E-05	0.04	--
Prediction Model	**Construction Period (years)**	**Hydrostratigraphic Unit**	**Hydraulic Conductivity Zone**	**Horizontal Hydraulic Conductivity (ft/d)**	**Horizontal Hydraulic Conductivity (cm/s)**	**Vertical Hydraulic Conductivity (ft/d)**	**Vertical Hydraulic Conductivity (cm/s)**
No Action	0	Fill Unit (CCR)	2	0.22	7.76E-05	0.048	1.69E-05
Dewatering/GCT	2.5	Fill Unit (CCR)	2	0.22	7.76E-05	0.048	1.69E-05
CBR-Offsite	6.5	Fill Unit (Soil Backfill)	2	0.033	1.16E-05	0.00033	1.16E-07
Prediction Model	**Construction Period (years)**	**Hydrostratigraphic Unit**	**Storage, Specific Yield and Effective Porosity Zone**		**Storage**	**Specific Yield**	**Effective Porosity**
No Action	0	Fill Unit (CCR)	2		0.003	0.2	0.2
Dewatering/GCT	2.5	Fill Unit (CCR)	2		0.003	0.2	0.2
CBR-Offsite	6.5	Fill Unit (Soil Backfill)	2		0.003	0.135	0.135
Prediction Model	**Construction Period (years)**	**Drain Width (feet)**	**Length of Drain Cell (feet)**	**Drain Bed Thickness (feet)**	**Hydraulic Conductivity (ft/d)**	**Stage of Drain (feet)**	**Drain Conductance (ft^2/d)**
No Action	0	--	--	--	--	--	--
Dewatering/GCT	2.5	2.5	10 - 32	13.8 - 25.8	10	572.93 - 566.07	11.6 - 43.3
CBR-Offsite	6.5	2.5	10 - 32	13.8 - 25.8	10	572.93 - 566.07	11.6 - 43.3

[JJW 11/1/21; C: BGH 11/5/21]

TABLE 6-2. PREDICTION MODEL INPUT VALUES
GROUNDWATER MODELING REPORT
VERMILION POWER PLANT
NORTH ASH POND AND OLD EAST ASH POND
OAKWOOD, ILLINOIS

Notes:
-- = boundary condition not included in prediction model
CBR-Onsite = CBR utilizing an onsite landfill
CBR-Offsite = CBR utilizing an offsite landfill
CCR = coal combustion residuals
ft/day = feet per day
in/yr = inches per year
mg/L = milligrams per liter
NAP = North Ash Pond
OEAP = Old East Ash Pond
CBR = Closure By Removal
GCT = Groundwater Collection Trench
UCU = Upper Confining Unit
cm/s = centimeters per second

FIGURES



PART 845 REGULATED UNIT (SUBJECT UNIT)

PROPERTY BOUNDARY

0 1,000 2,000 Feet

SITE LOCATION MAP

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 1-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\GWMR\Figure 1-1_Site Location Map.mxd

PROJECT: 169000XXXX | DATED: 11/1/2021 | DESIGNER: STOLZSD

PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 200 400 Feet

SITE MAP

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

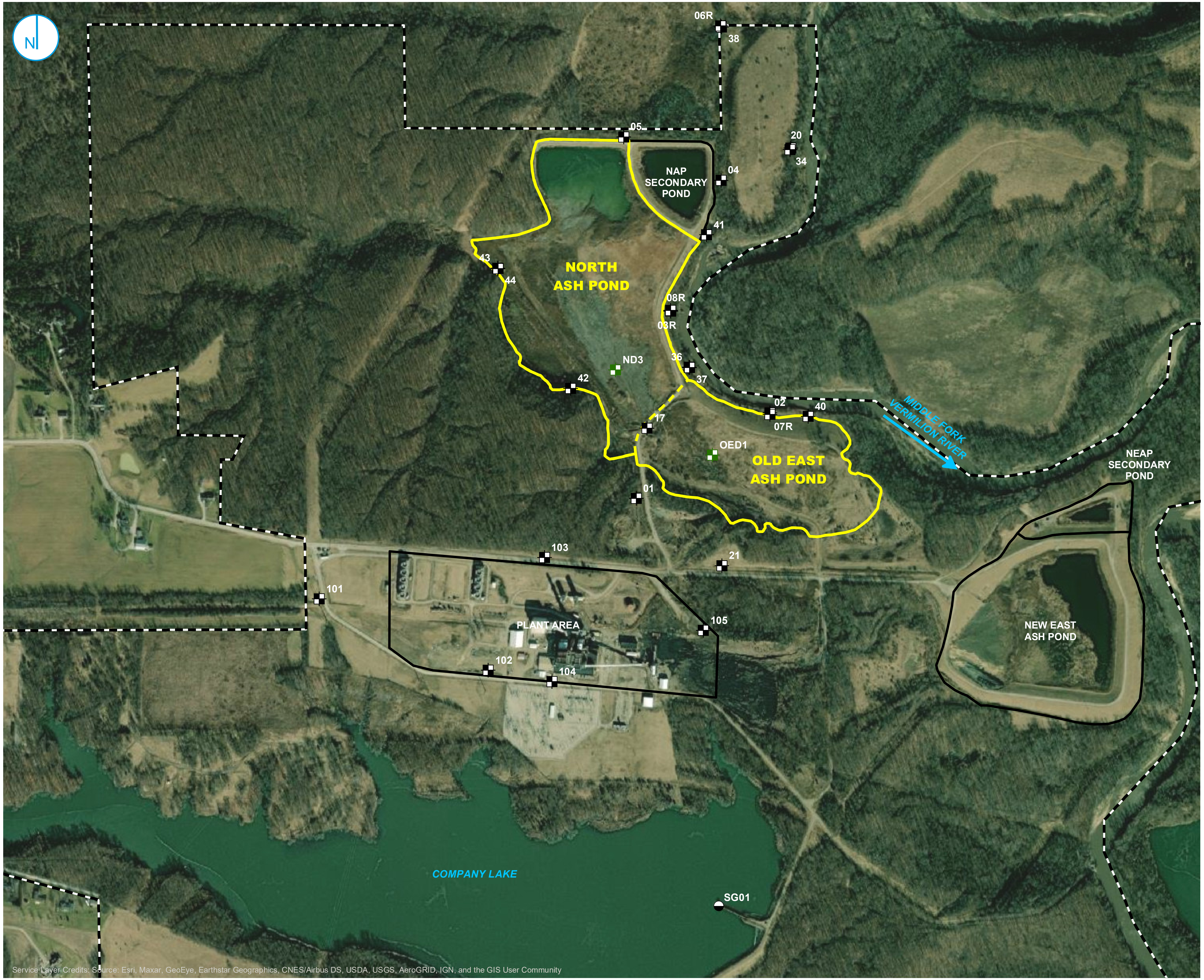
FIGURE 1-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\GWMR\Figure 1-2_Site Map.mxd

PROJECT: 169000XXXX | DATED: 11/1/2021 | DESIGNER: STOLZSD



MONITORING WELL
SOURCE SAMPLE
STAFF GAGE
PART 845 REGULATED UNIT (SUBJECT
SITE FEATURE
PROPERTY

0 300 600 Feet

MONITORING WELL LOCATION MAP

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

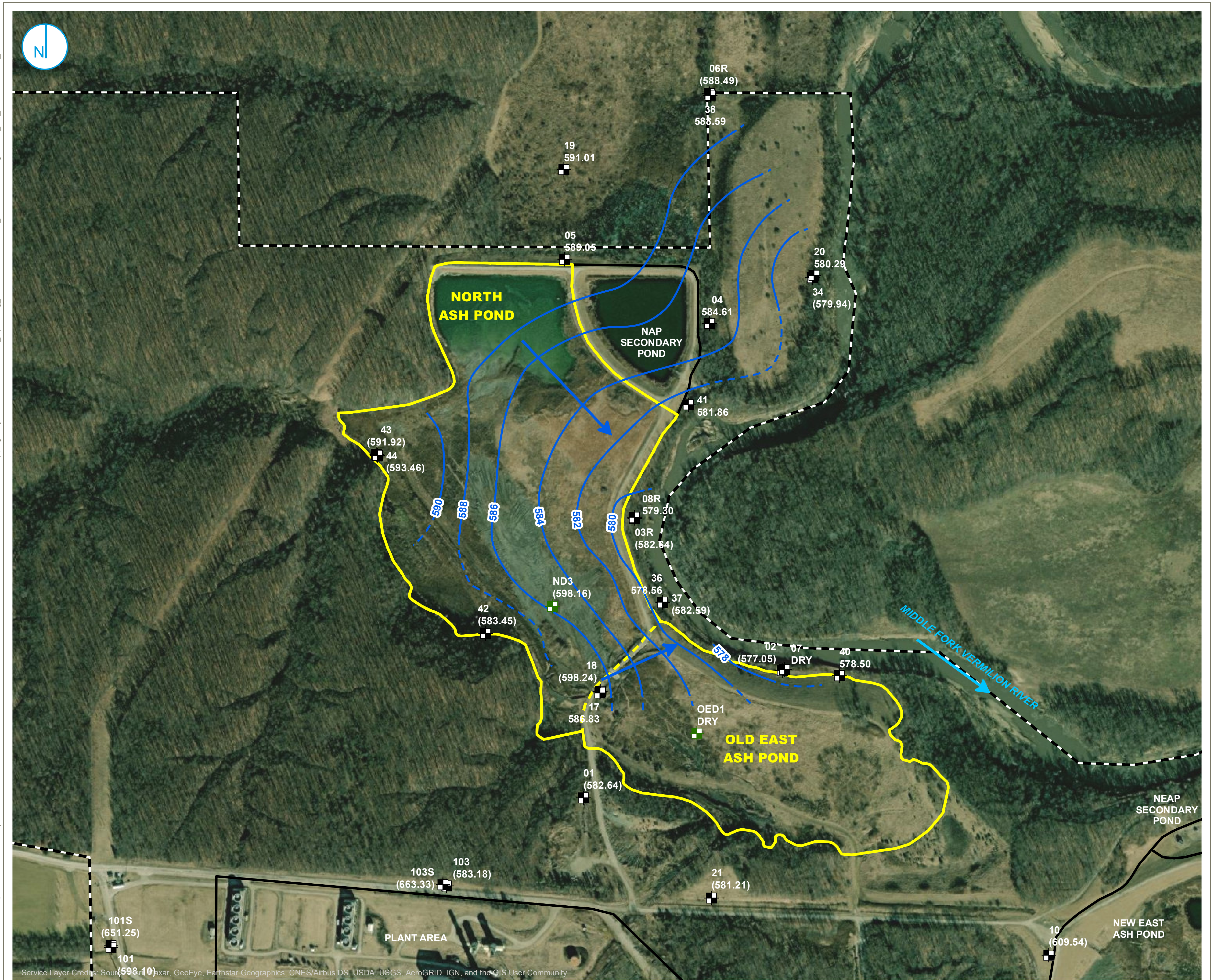
FIGURE 2-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\GWMR\Figure 2-1_Monitoring Well Location Map.mxd

PROJECT: 169000XXXX | DATED: 11/1/2021 | DESIGNER: STOLZSD



MONITORING WELL

SOURCE SAMPLE LOCATION

GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

PART 845 REGULATED UNIT (SUBJECT UNIT)

SITE FEATURE

PROPERTY BOUNDARY

NOTE:
ELEVATIONS IN PARENTHESIS WERE NOT USED FOR CONTOURING.
NM = NOT MEASURED

0 200 400 Feet

UPPERMOST AQUIFER GROUNDWATER ELEVATION CONTOURS
MARCH 29, 2021

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

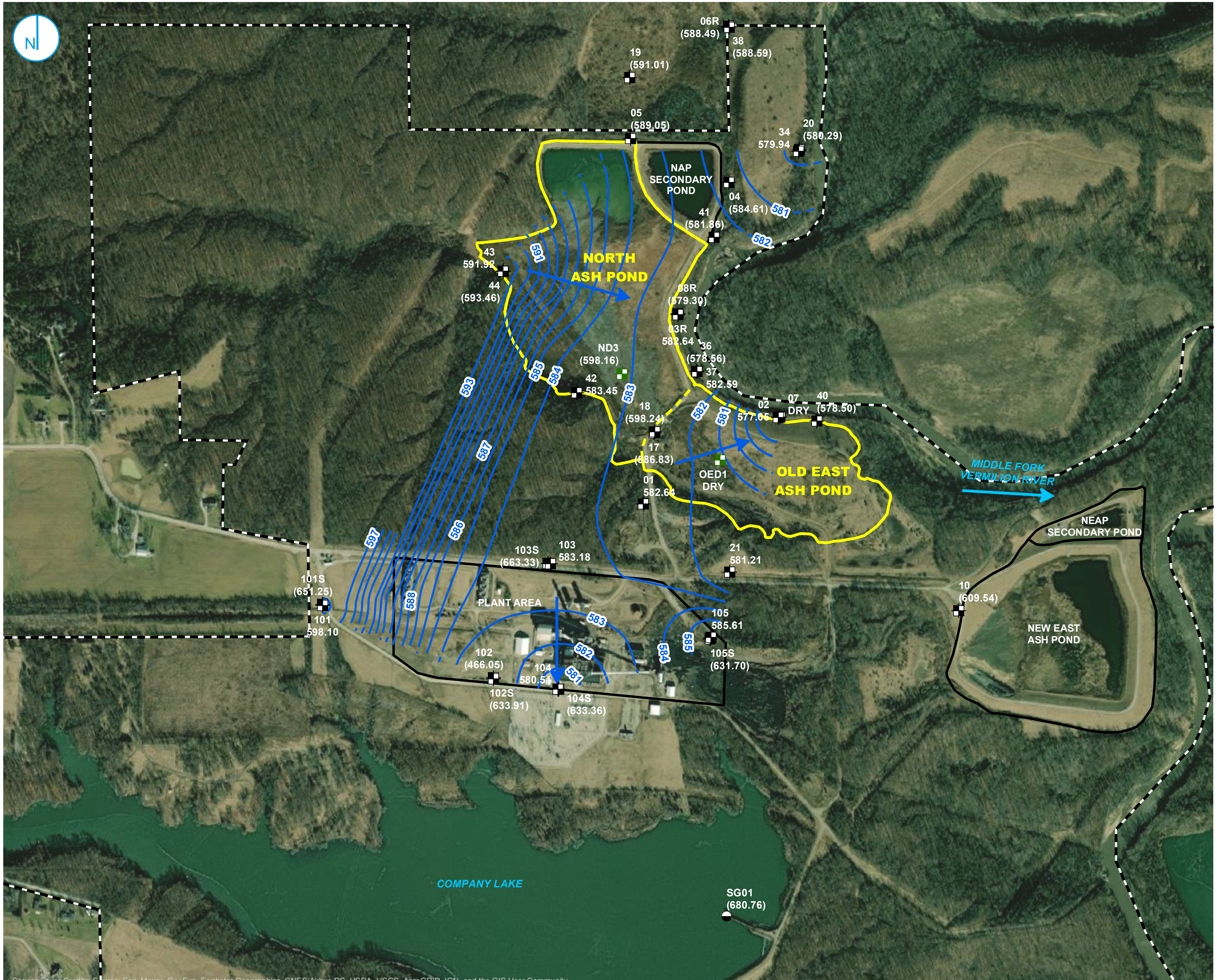
FIGURE 2-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\GWMR\Figure 2-2_UA_GWE Contours_20210329.mxd

PROJECT: 169000XXXX | DATED: 11/1/2021 | DESIGNER: STOLZSD



MONITORING WELL
SOURCE SAMPLE LOCATION
STAFF GAGE
GROUNDWATER ELEVATION CONTOUR (1-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION
GROUNDWATER FLOW
PART 845 REGULATED UNIT (SUBJECT
SITE FEATURE
PROPERTY BOUNDARY

NOTE:
ELEVATIONS IN PARENTHESIS WERE NOT USED FOR CONTOURING.
NM = NOT MEASURED

0 300 600 Feet

POTENTIAL MIGRATION PATHWAY GROUNDWATER ELEVATION CONTOURS MARCH 29, 2021

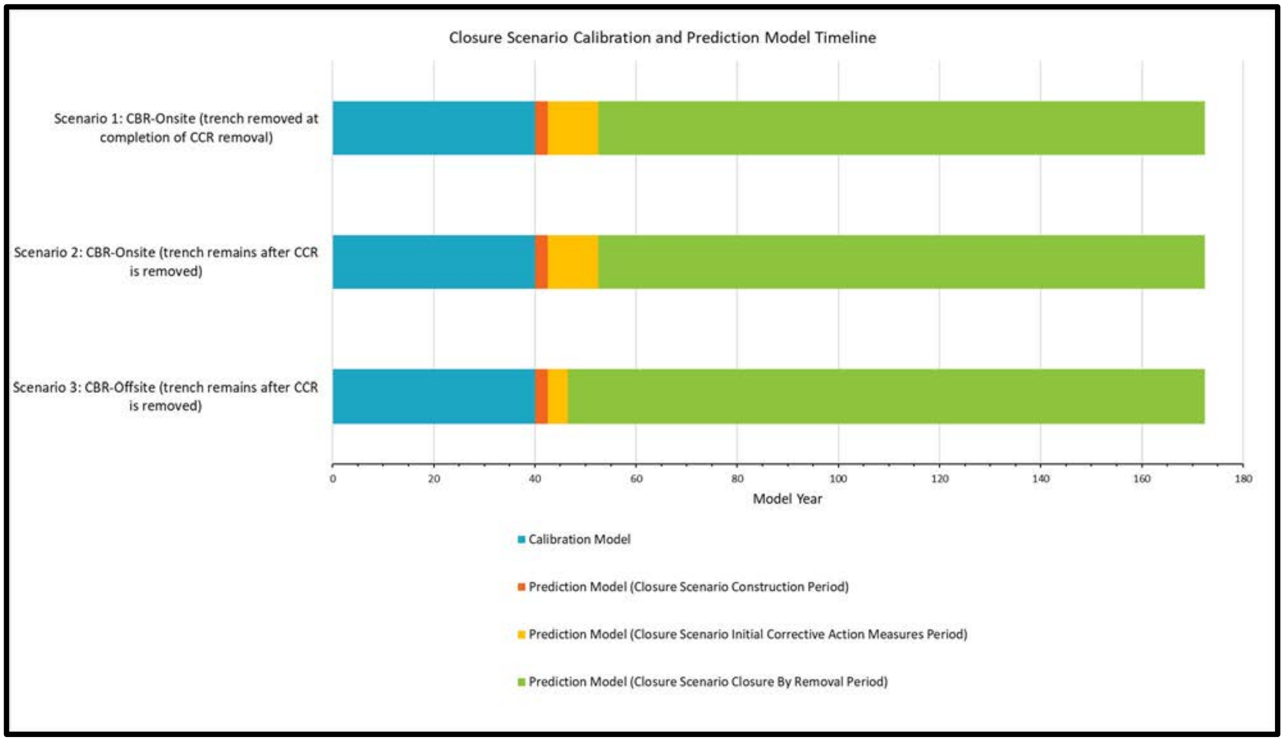
GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 2-3

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\GWMR\Figure 2-3_PMP_GWE Contours_20210329.mxd

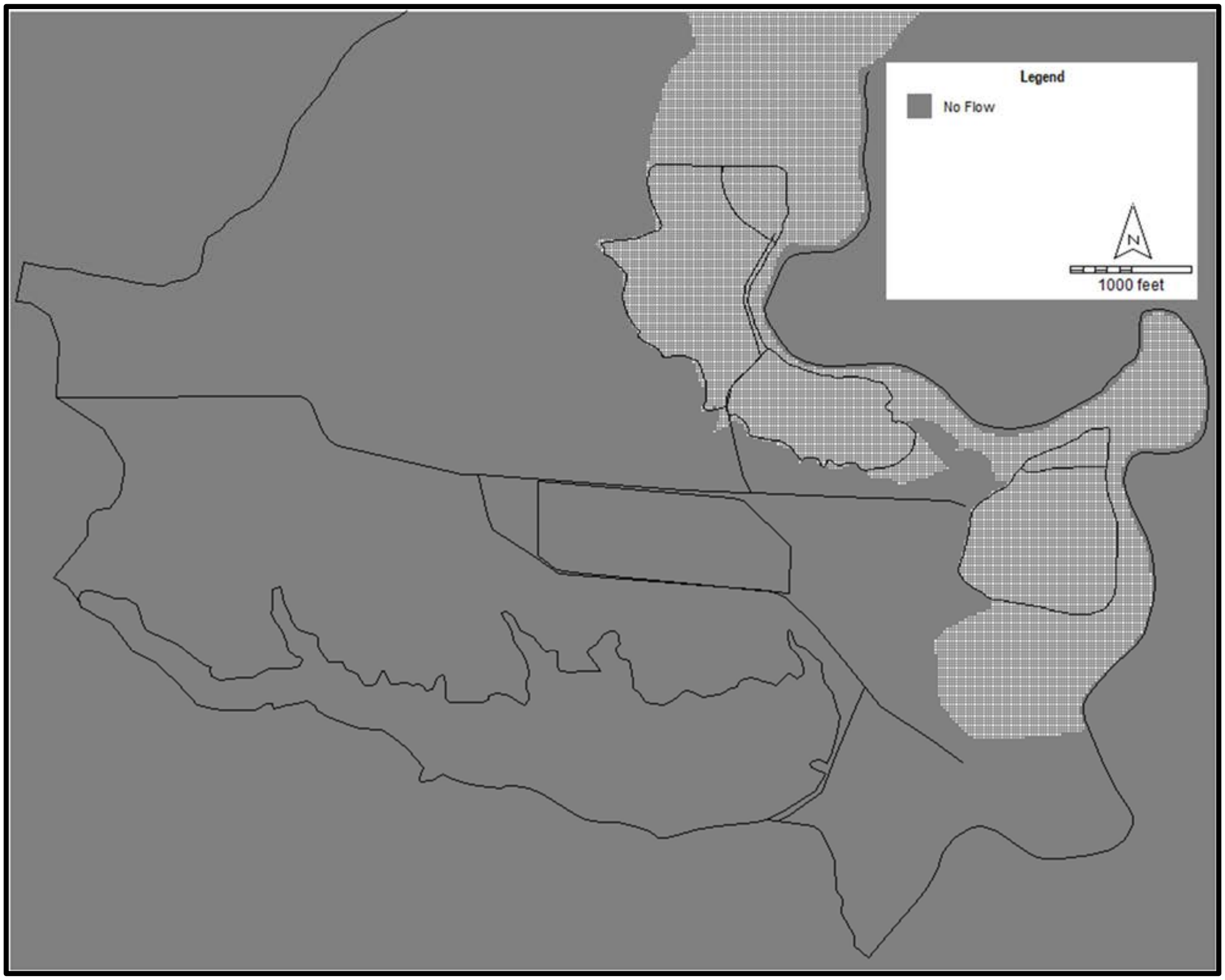
PROJECT: 169000XXXX | DATED: 11/1/2021 | DESIGNER: STOLZSD



CLOSURE SCENARIO CALIBRATION AND PREDICTION MODEL TIMELINE

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 5-1



MODEL GRID FOR LAYERS 1 THROUGH 3

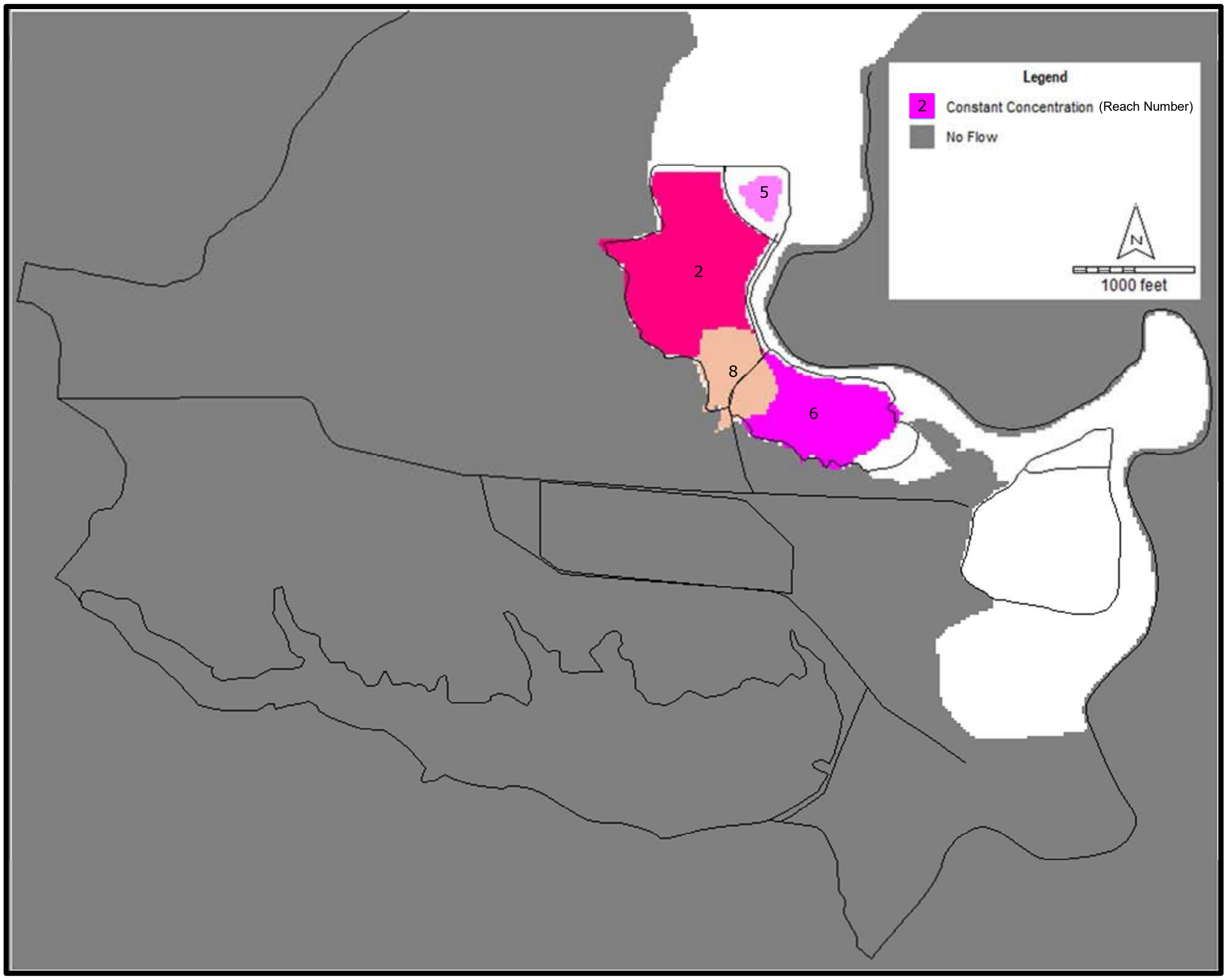
GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 5-2

MODEL GRID FOR LAYERS 4 THROUGH 7

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL

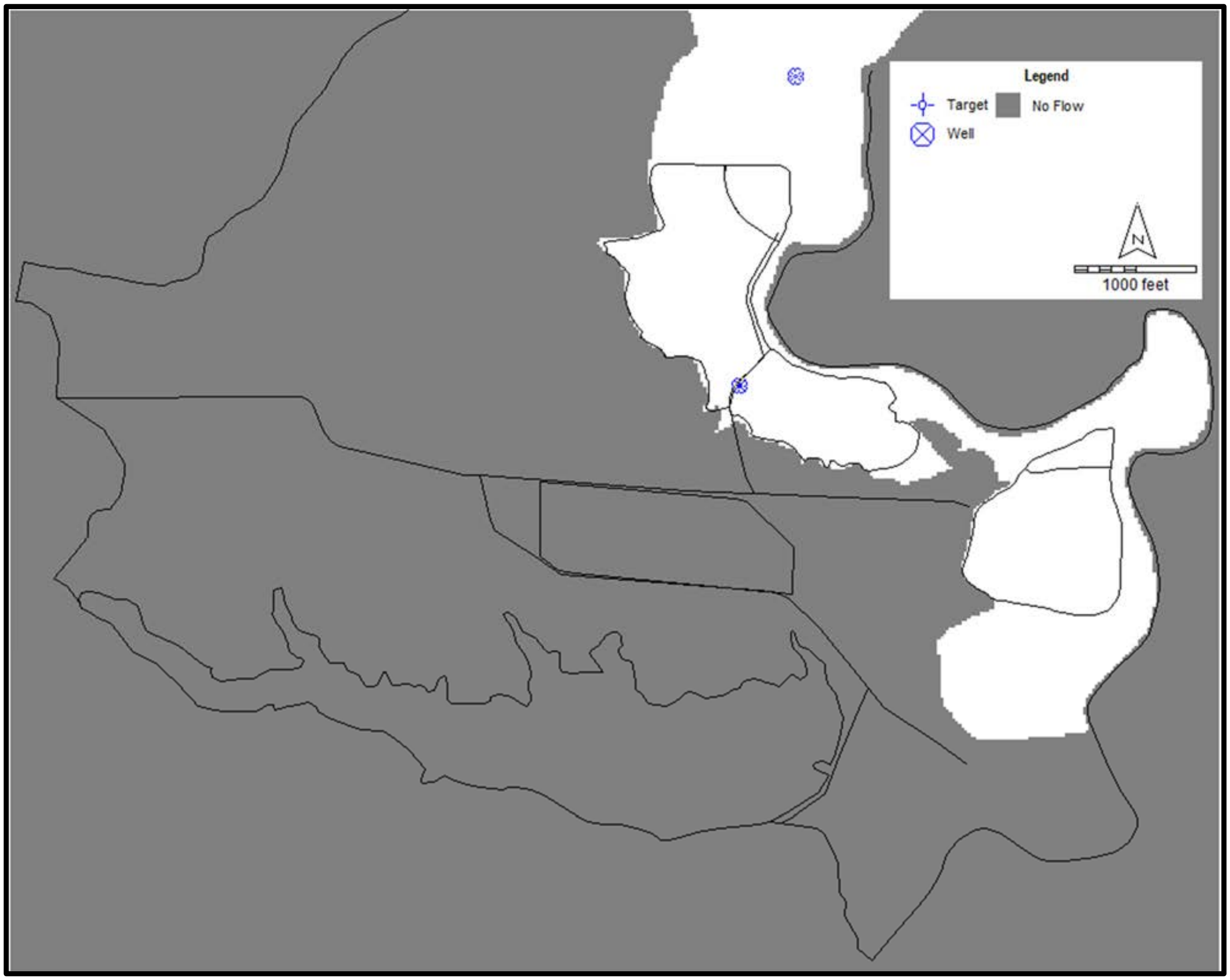


BOUNDARY CONDITIONS FOR LAYER 1

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL

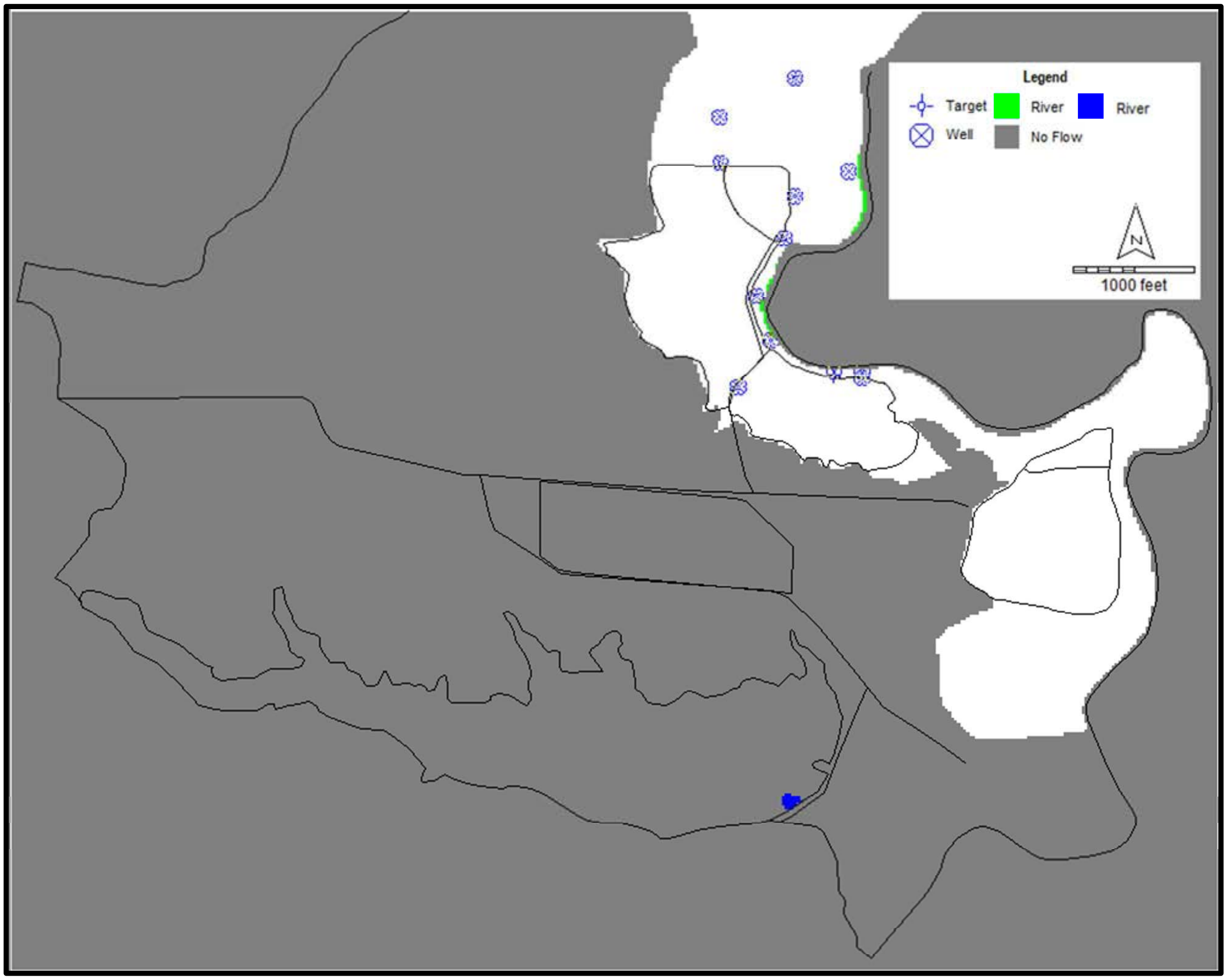
FIGURE 5-4



BOUNDARY CONDITIONS FOR LAYER 2

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

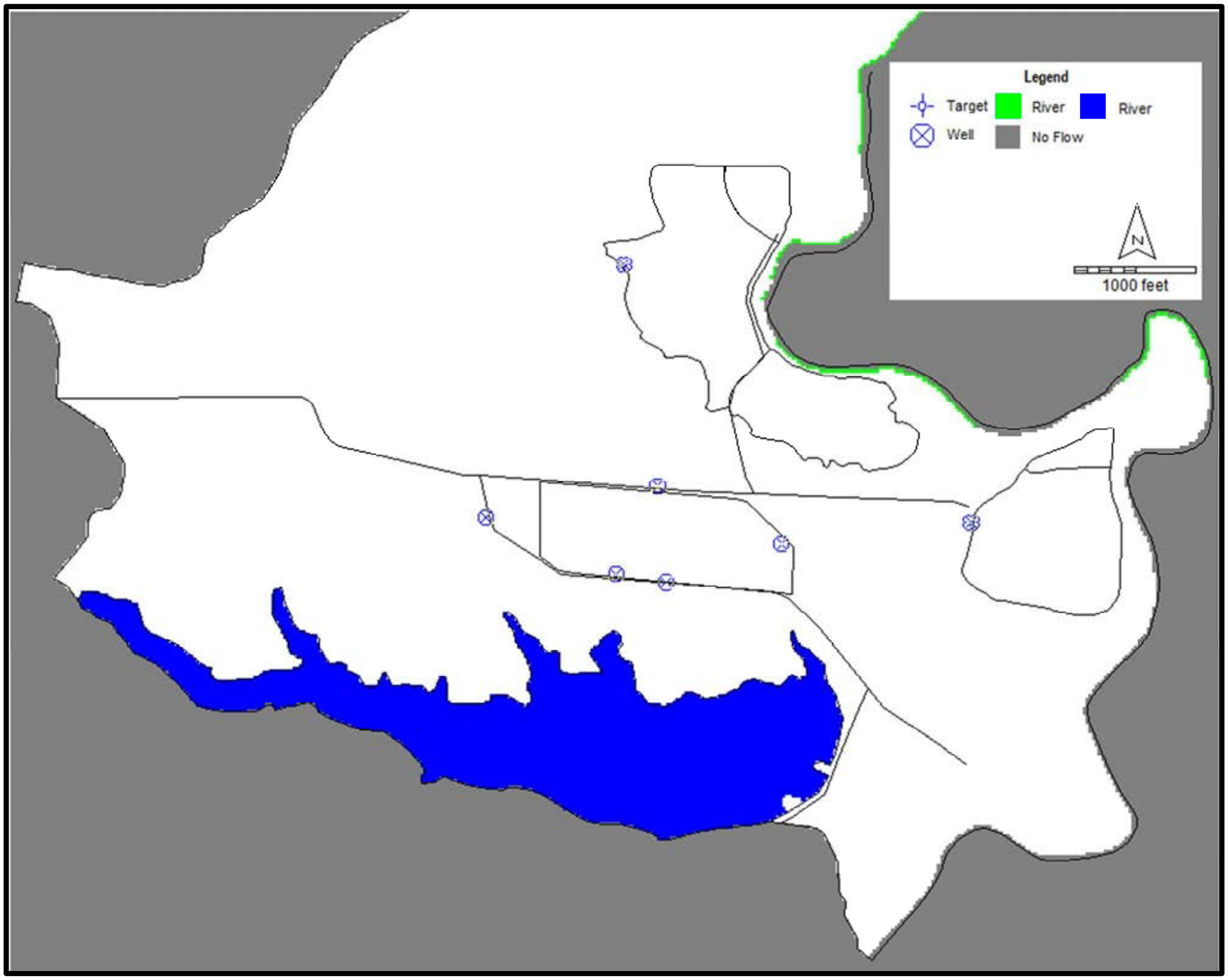
RAMBOLL



BOUNDARY CONDITIONS FOR LAYER 3

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL

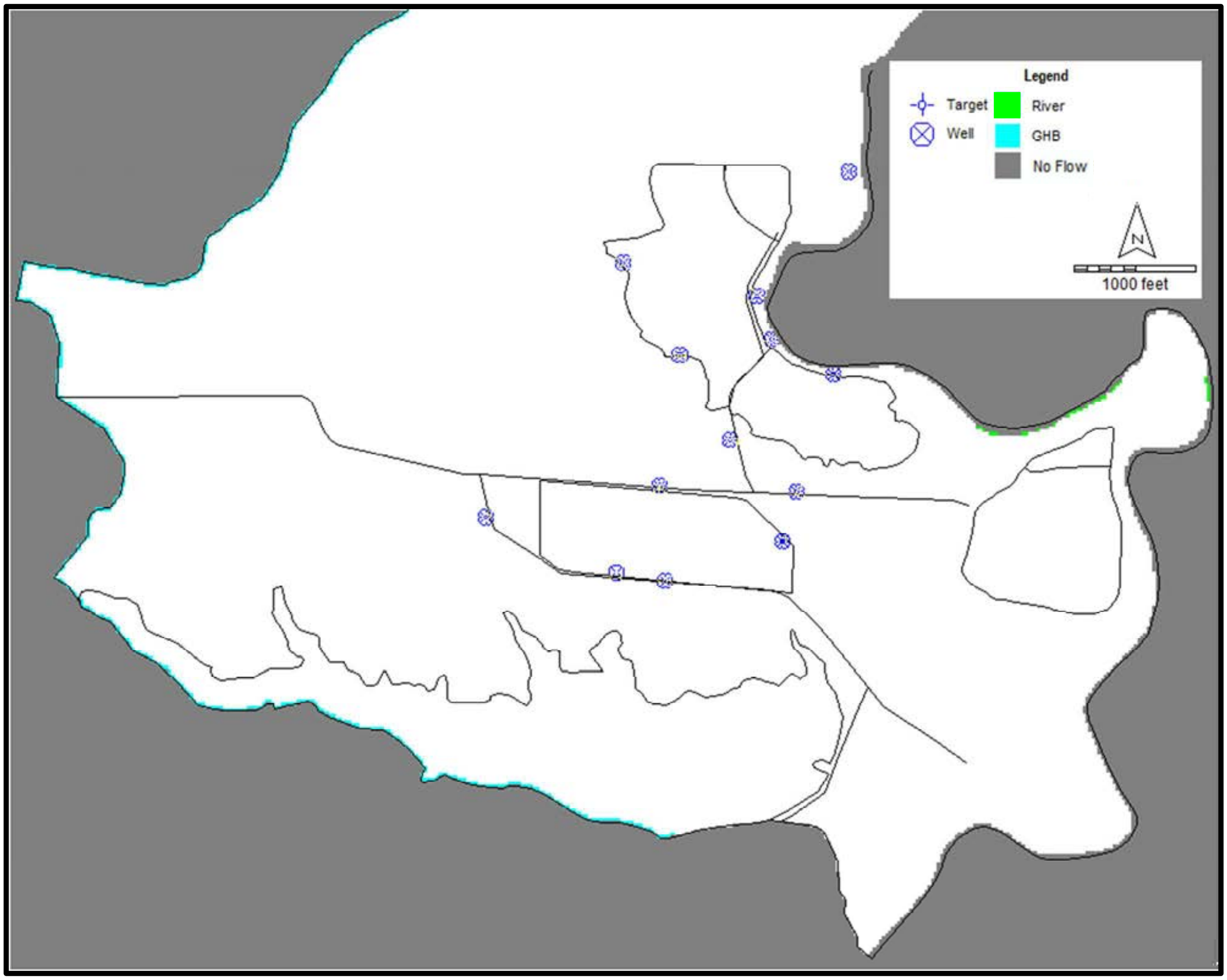


BOUNDARY CONDITIONS FOR LAYER 4

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL

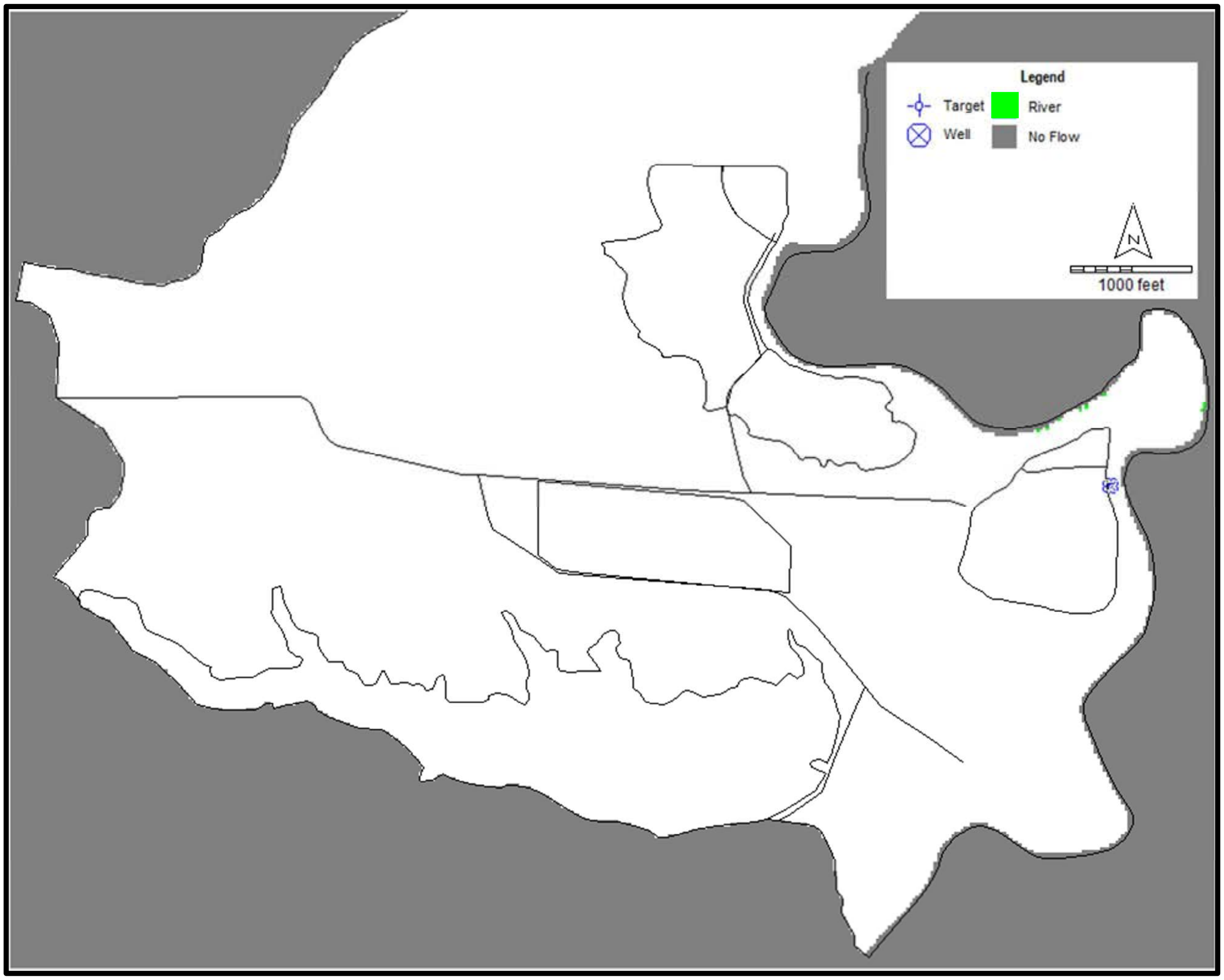
FIGURE 5-7



BOUNDARY CONDITIONS FOR LAYER 5

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

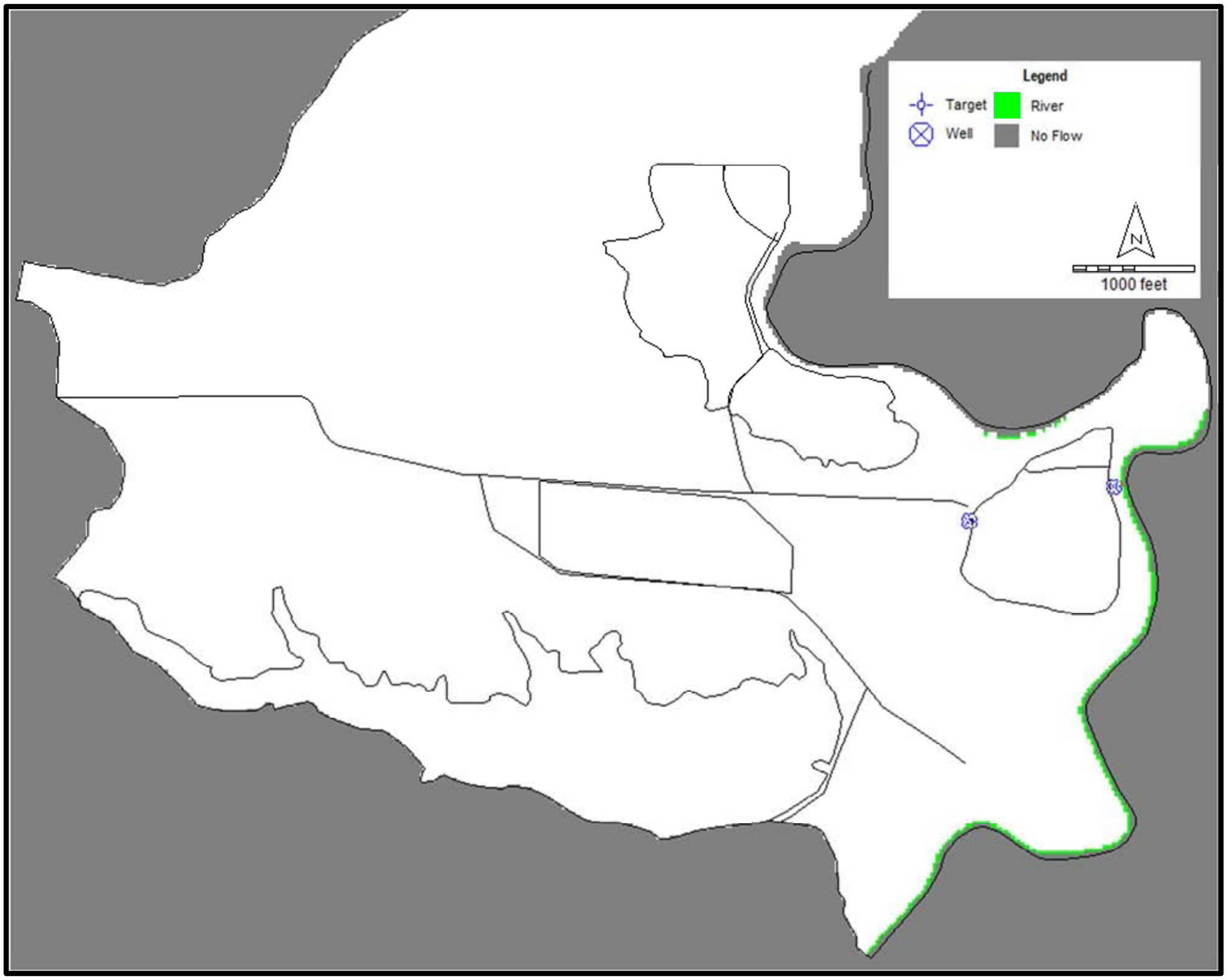
RAMBOLL



BOUNDARY CONDITIONS FOR LAYER 6

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

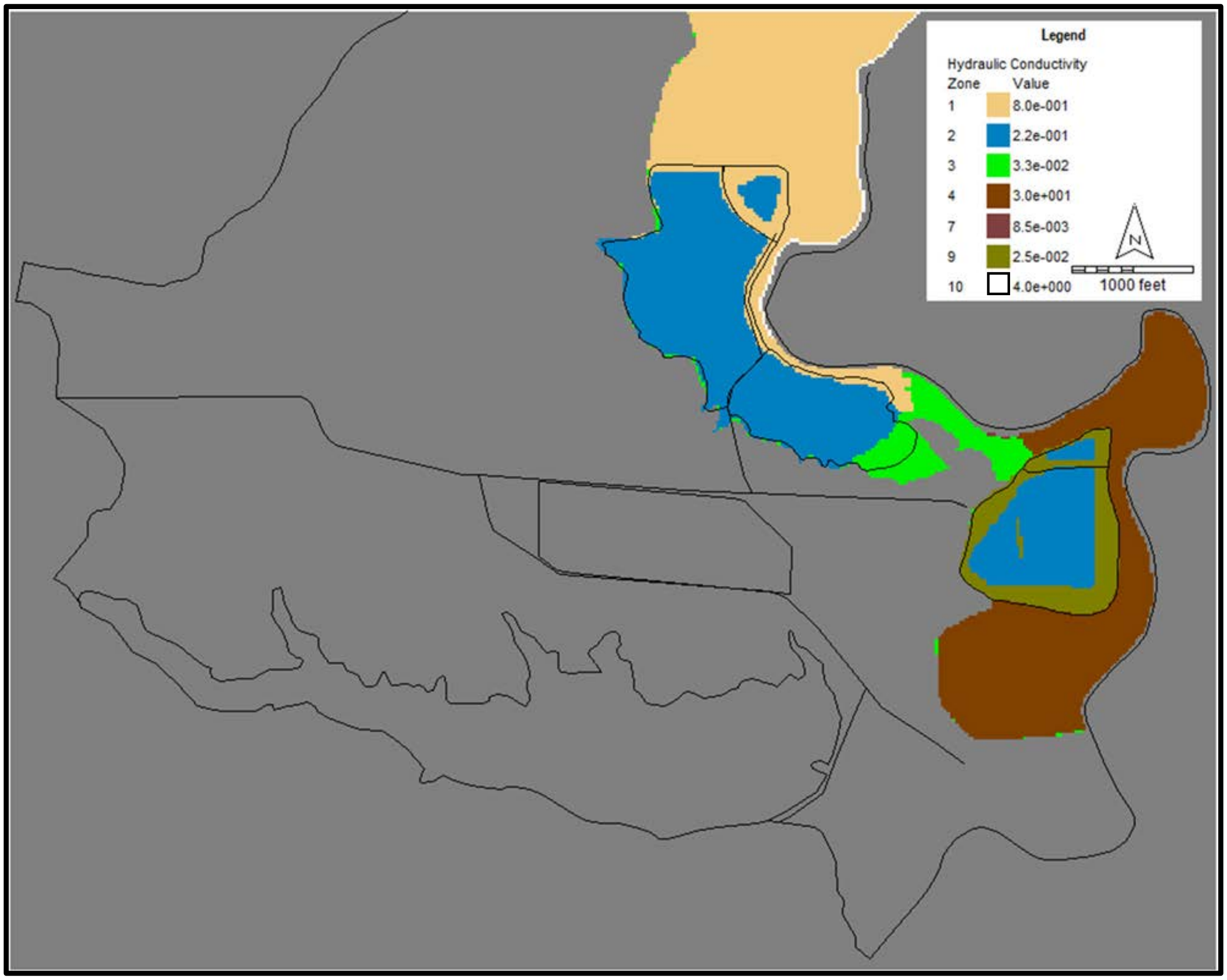
RAMBOLL



BOUNDARY CONDITIONS FOR LAYER 7

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

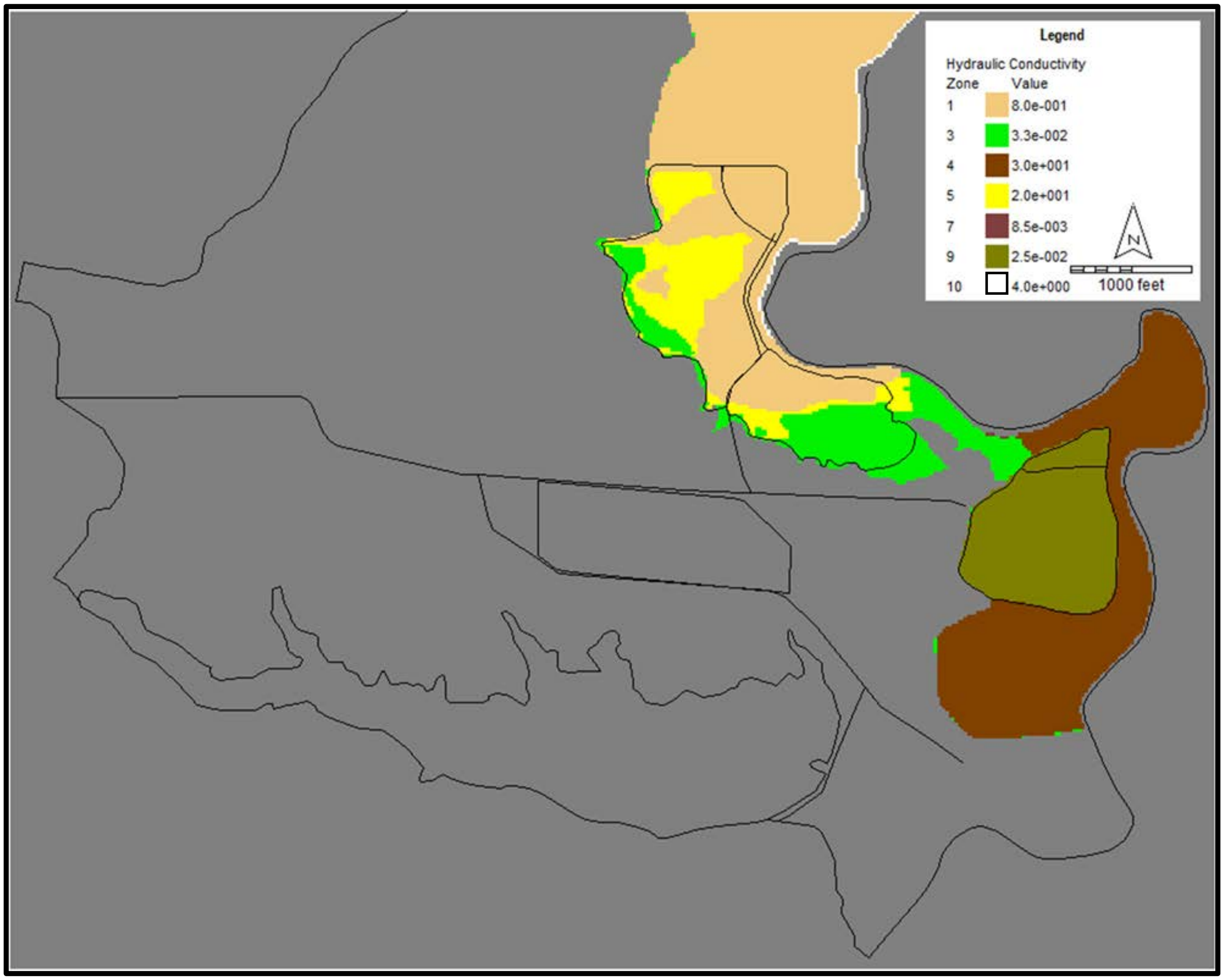
RAMBOLL



DISTRIBUTION OF HYDRAULIC CONDUCTIVITY ZONES (feet/day) FOR LAYER 1

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

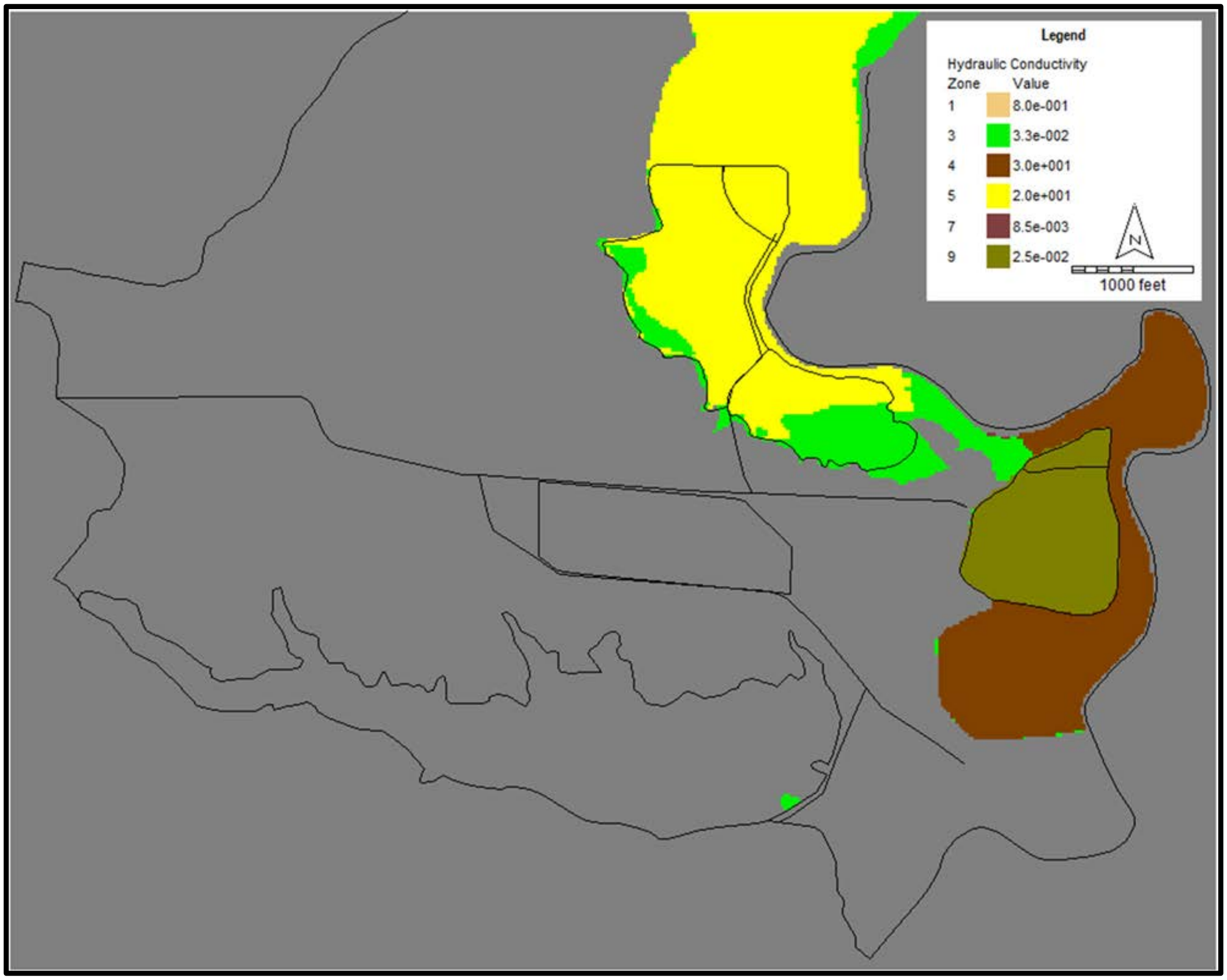
RAMBOLL



DISTRIBUTION OF HYDRAULIC CONDUCTIVITY ZONES (feet/day) FOR LAYER 2

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

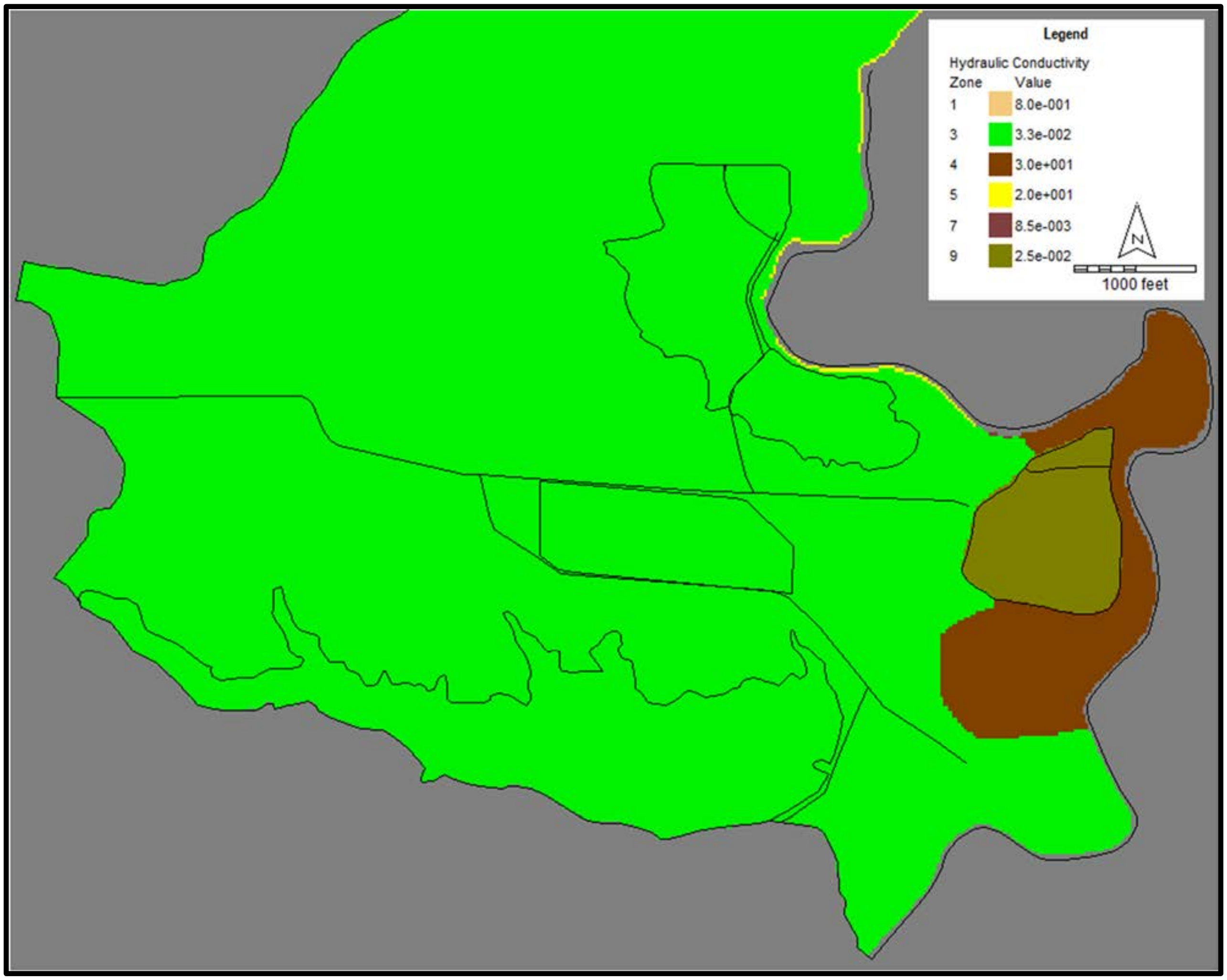
RAMBOLL



DISTRIBUTION OF HYDRAULIC CONDUCTIVITY ZONES (feet/day) FOR LAYER 3

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

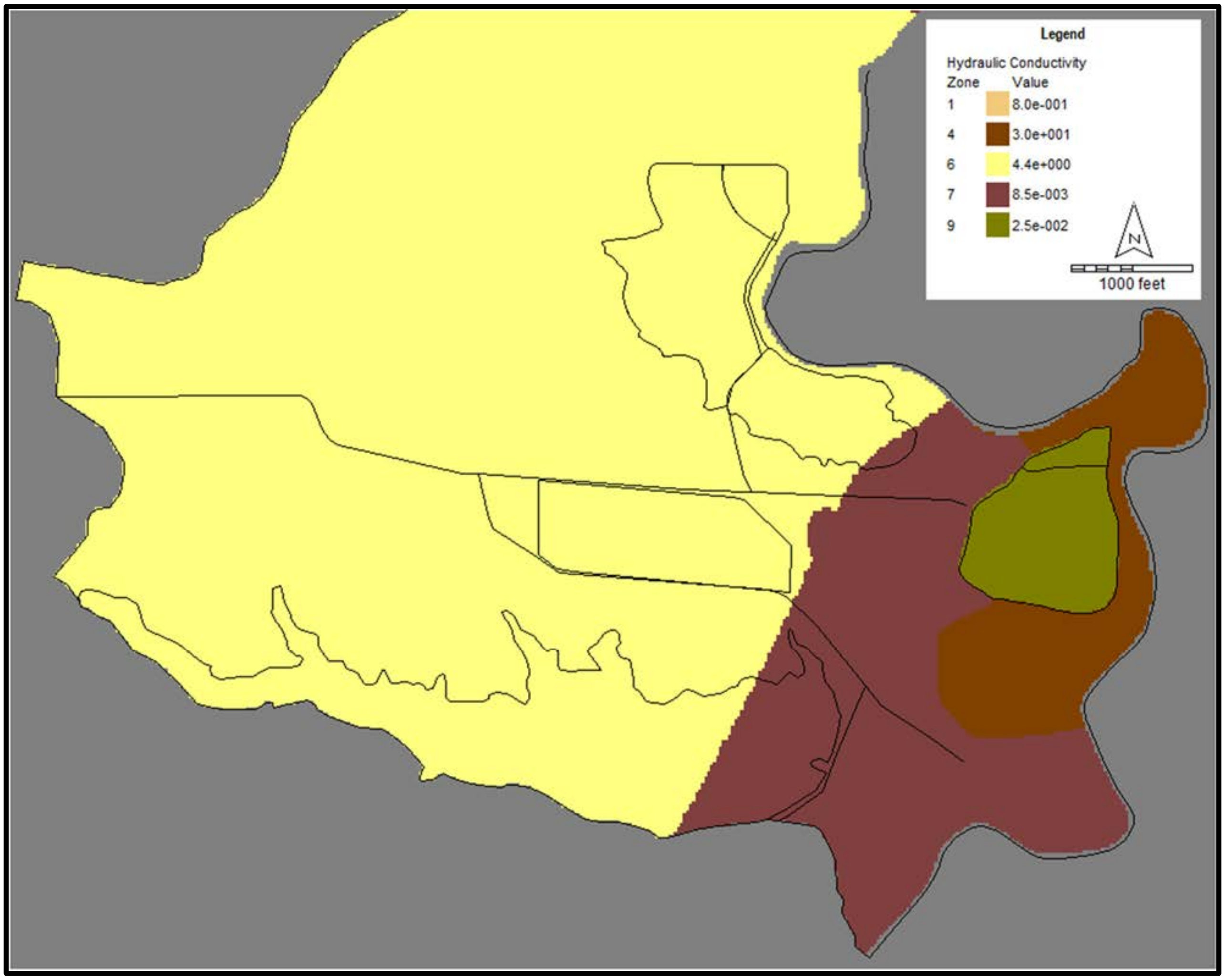
RAMBOLL



DISTRIBUTION OF HYDRAULIC CONDUCTIVITY ZONES (feet/day) FOR LAYER 4

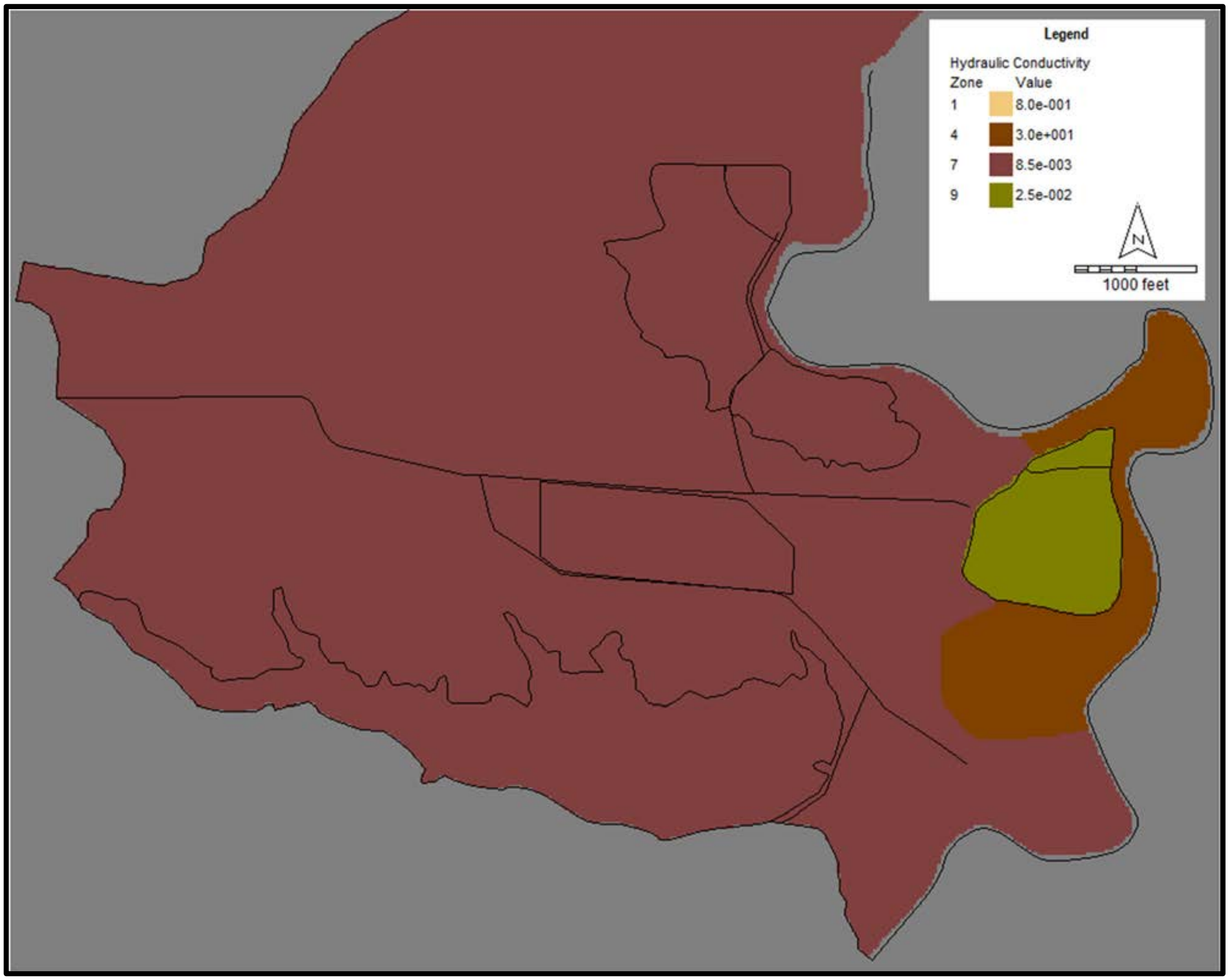
GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL



DISTRIBUTION OF HYDRAULIC CONDUCTIVITY ZONES (feet/day) FOR LAYER 5

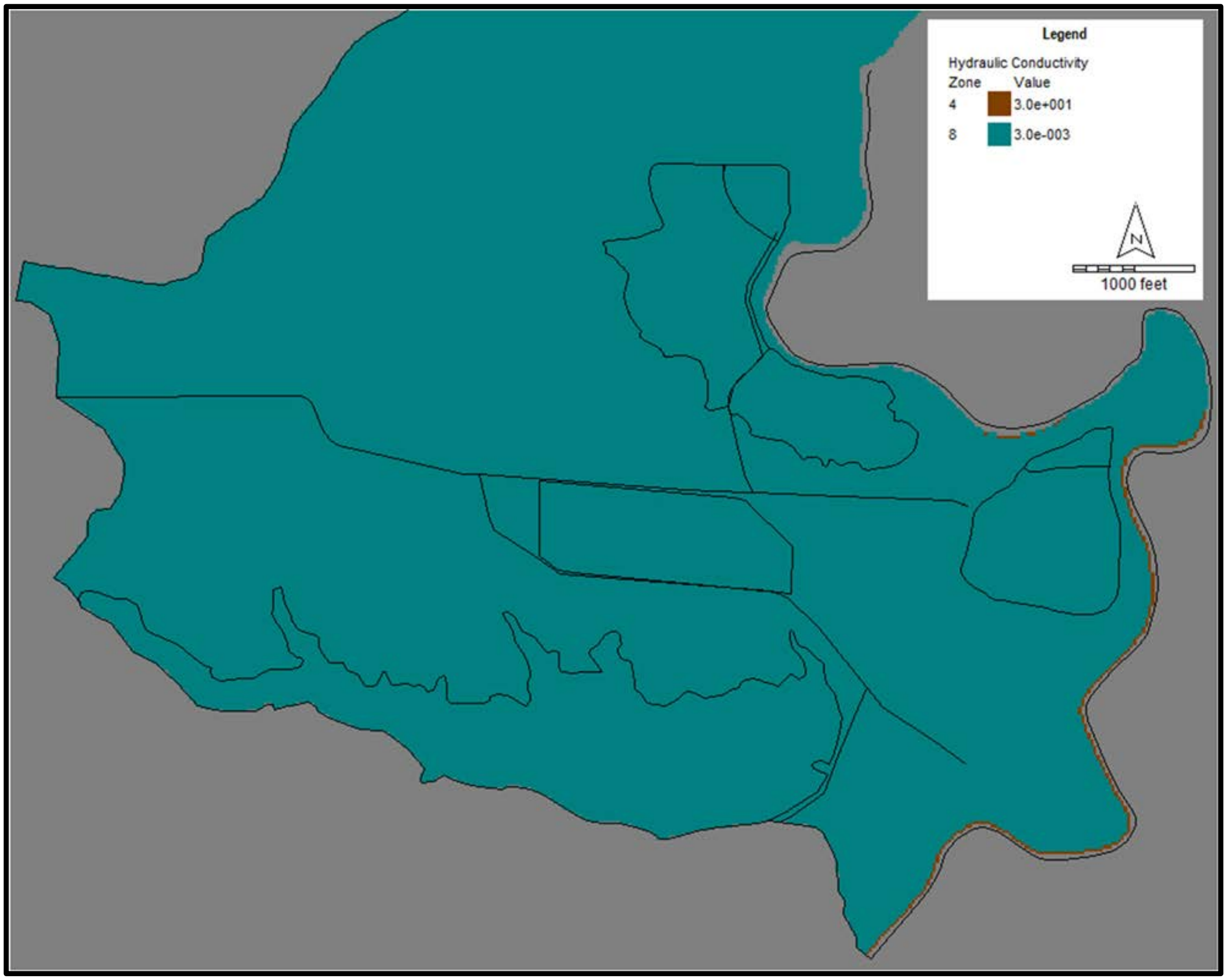
GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS



DISTRIBUTION OF HYDRAULIC CONDUCTIVITY ZONES (feet/day) FOR LAYER 6

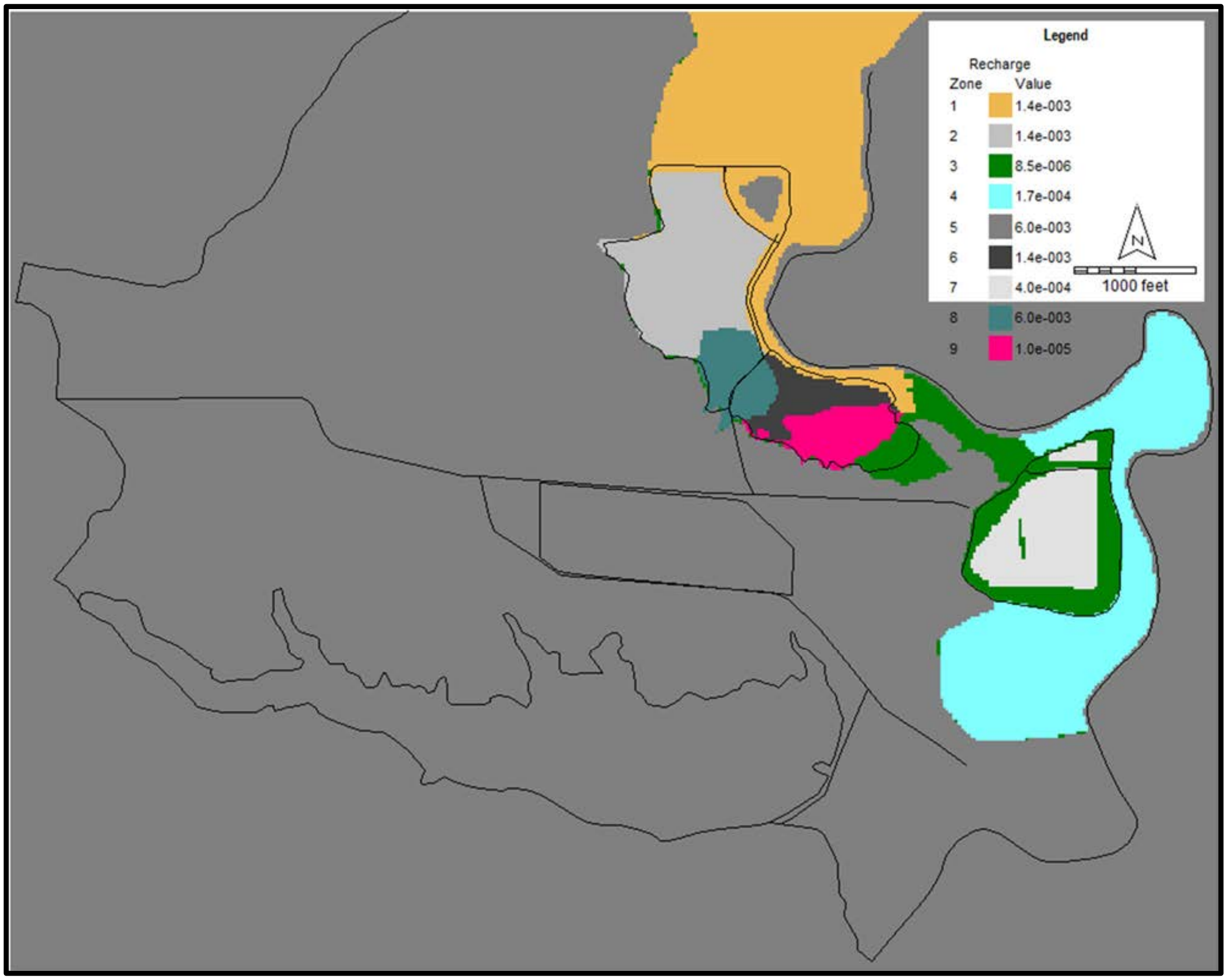
GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL



DISTRIBUTION OF HYDRAULIC CONDUCTIVITY ZONES (feet/day) FOR LAYER 7

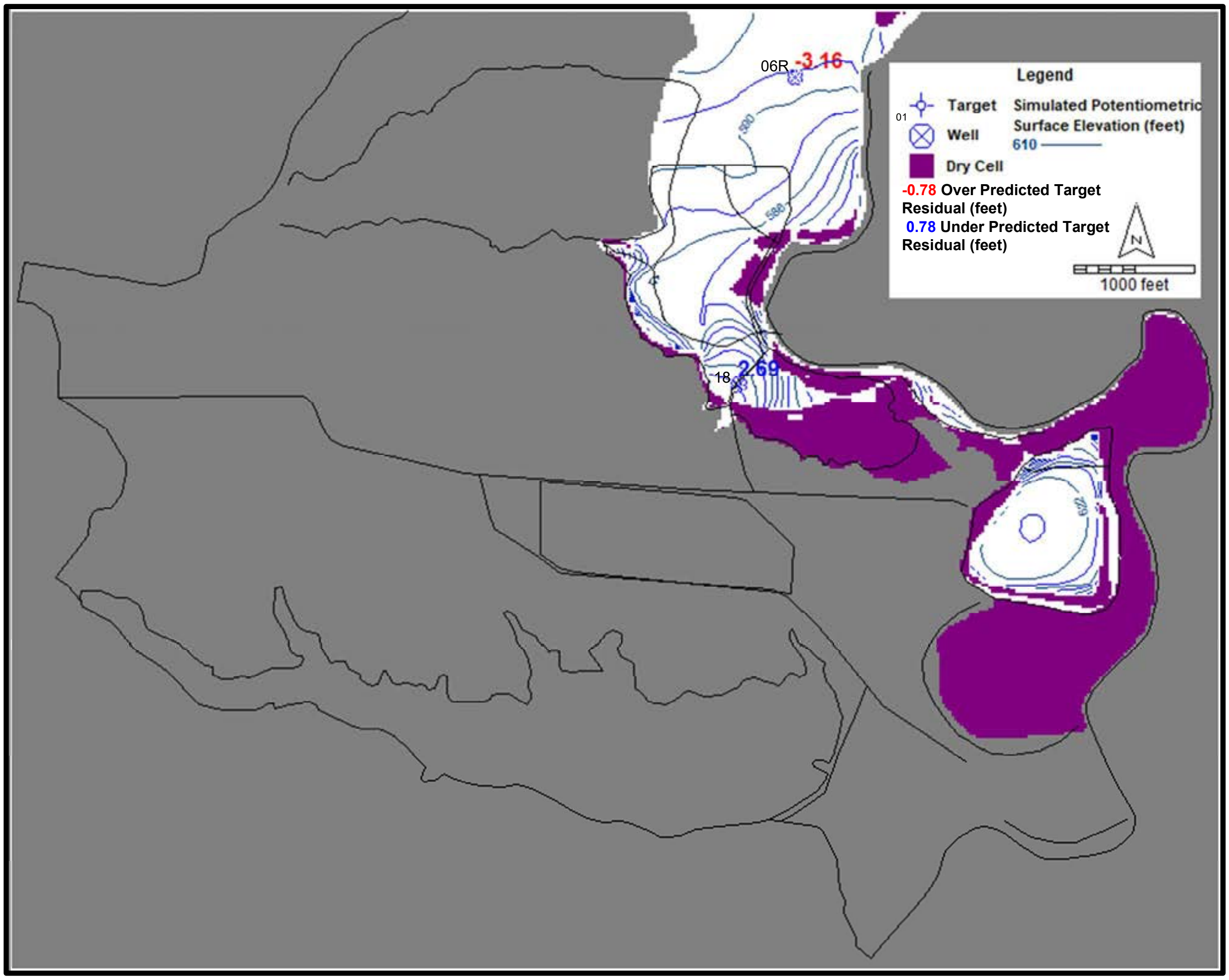
GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS



DISTRIBUTION OF RECHARGE ZONES (feet/day)

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL

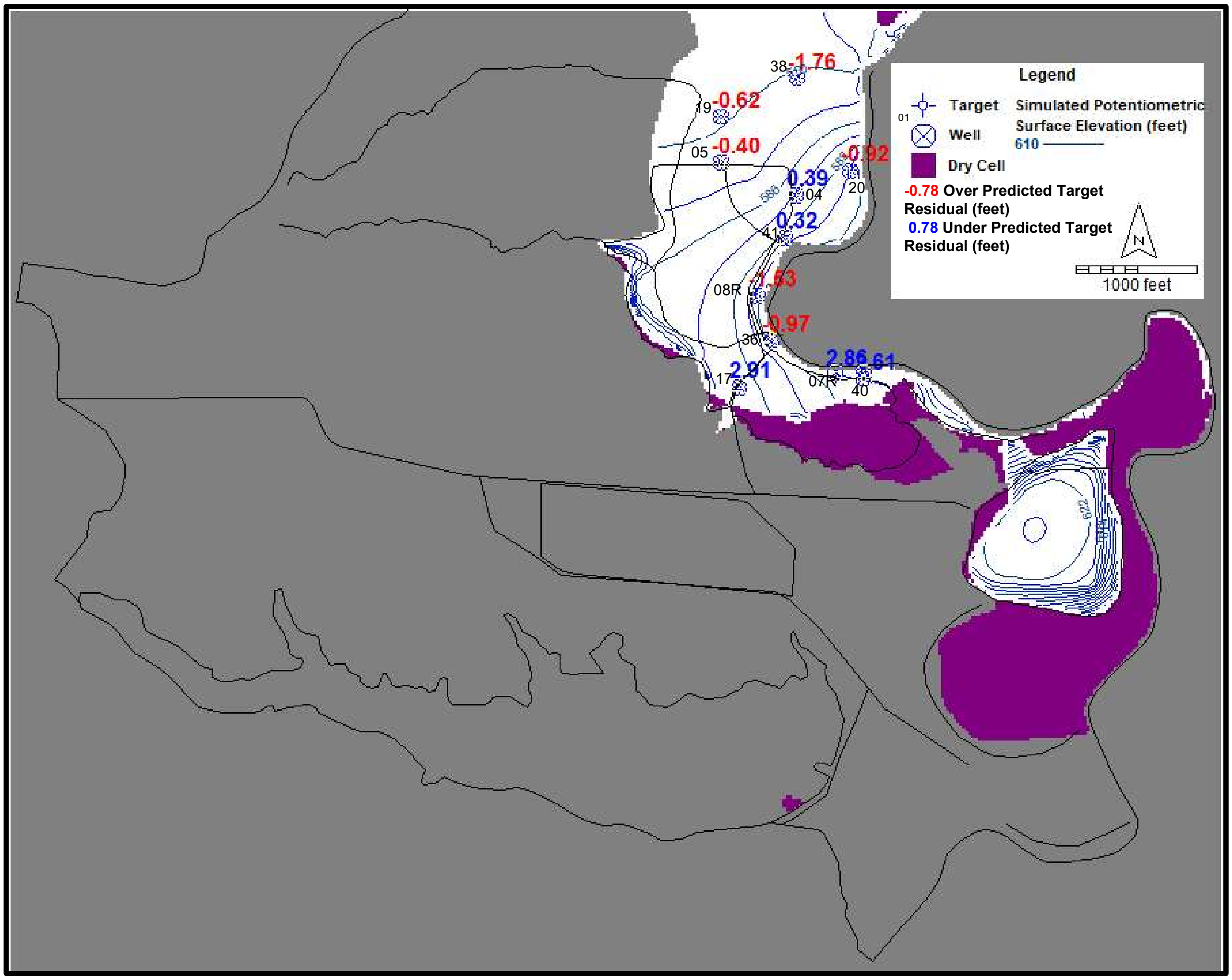


OBSERVED VERSUS SIMULATED GROUNDWATER ELEVATIONS LAYER 2

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL

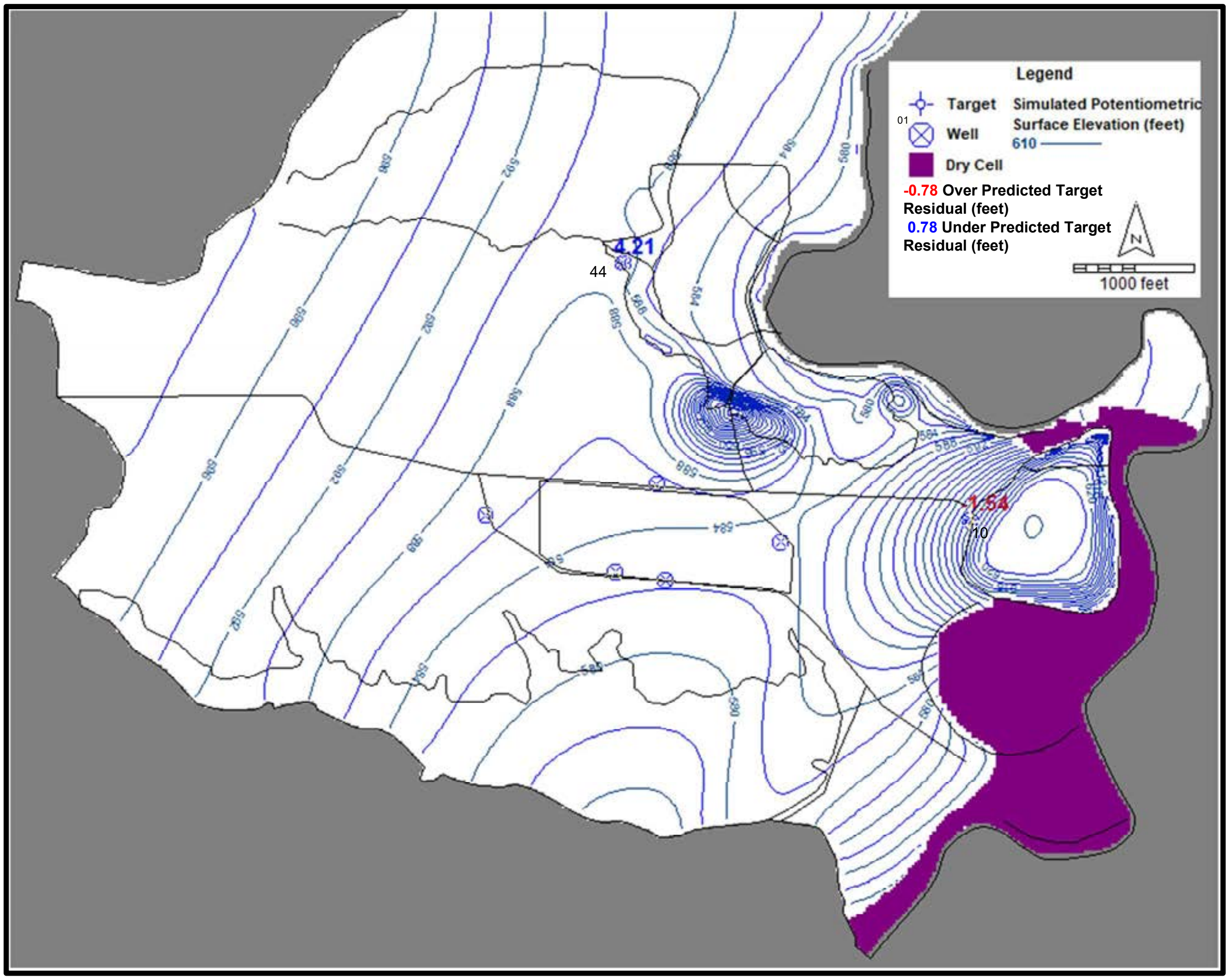
FIGURE 5-19



OBSERVED VERSUS SIMULATED GROUNDWATER ELEVATIONS LAYER 3

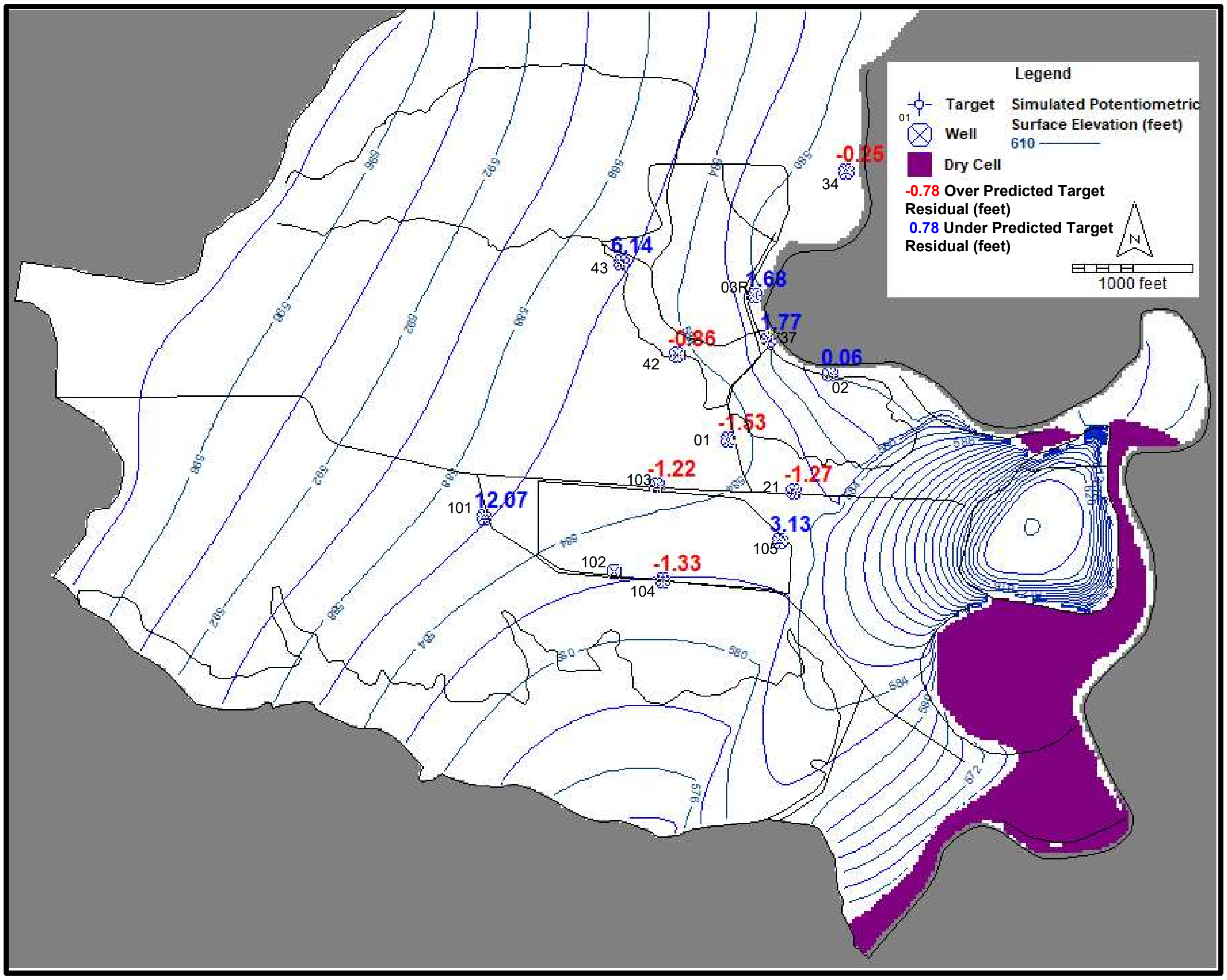
GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL



OBSERVED VERSUS SIMULATED GROUNDWATER ELEVATIONS LAYER 4

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

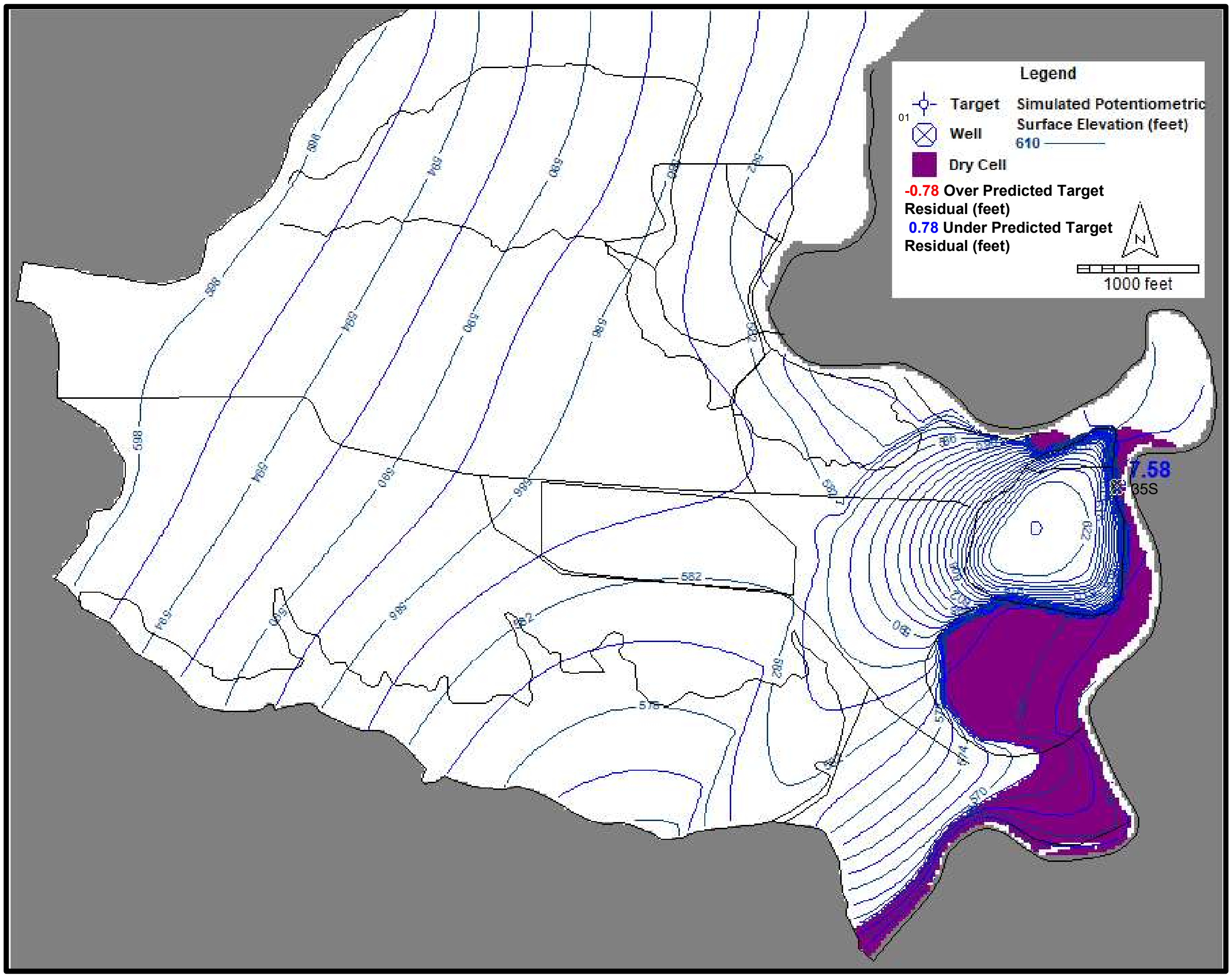


OBSERVED VERSUS SIMULATED GROUNDWATER ELEVATIONS LAYER 5

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL

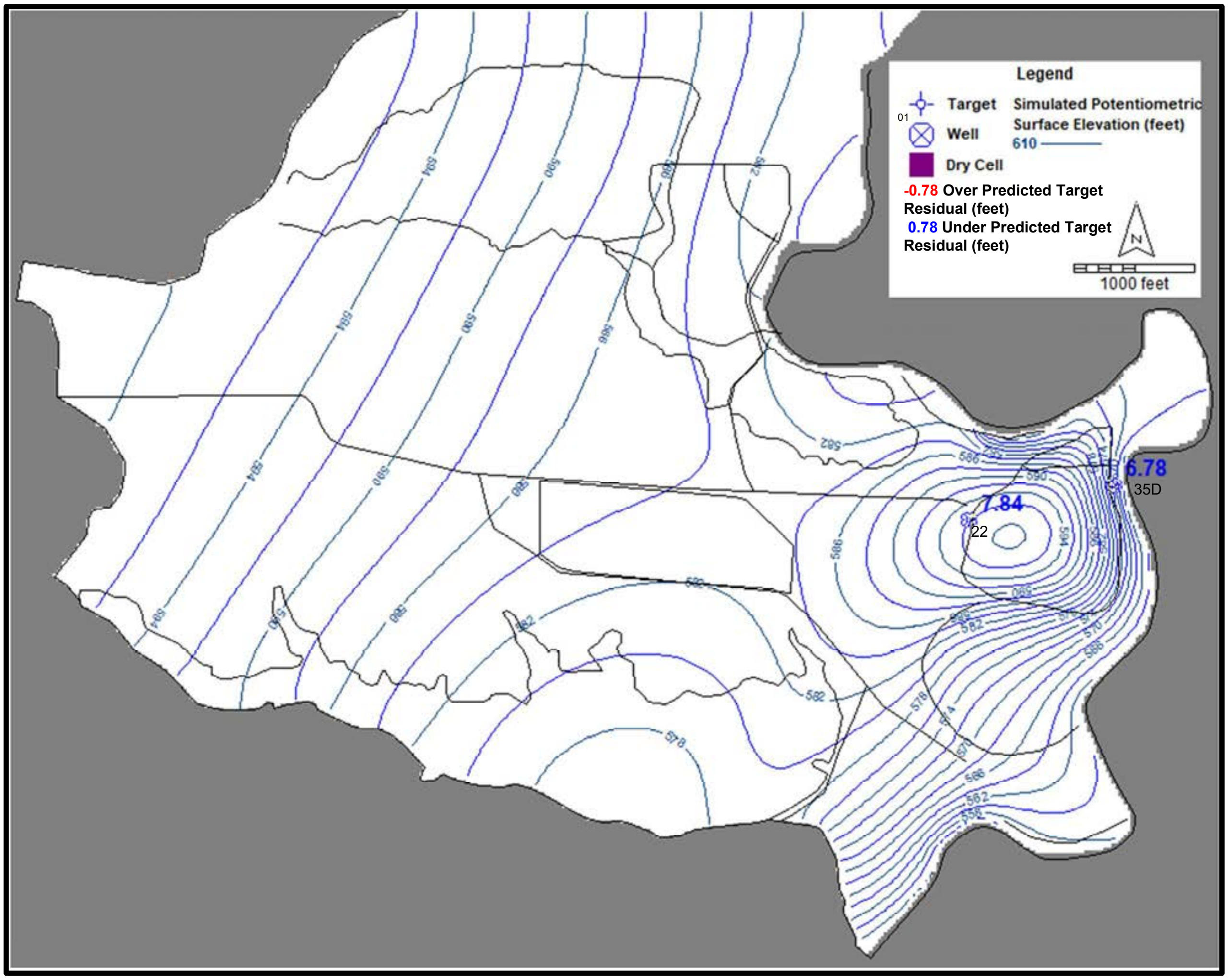
FIGURE 5-22



OBSERVED VERSUS SIMULATED GROUNDWATER ELEVATIONS LAYER 6

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

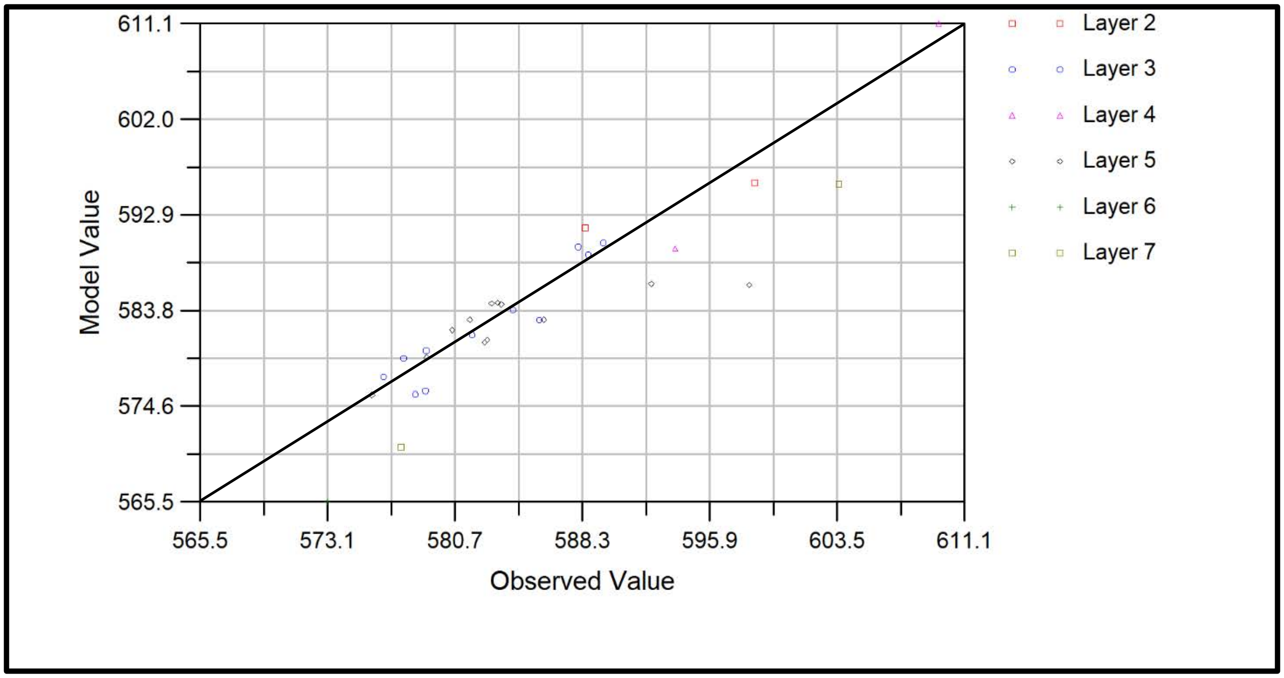
RAMBOLL



OBSERVED VERSUS SIMULATED GROUNDWATER ELEVATIONS LAYER 7

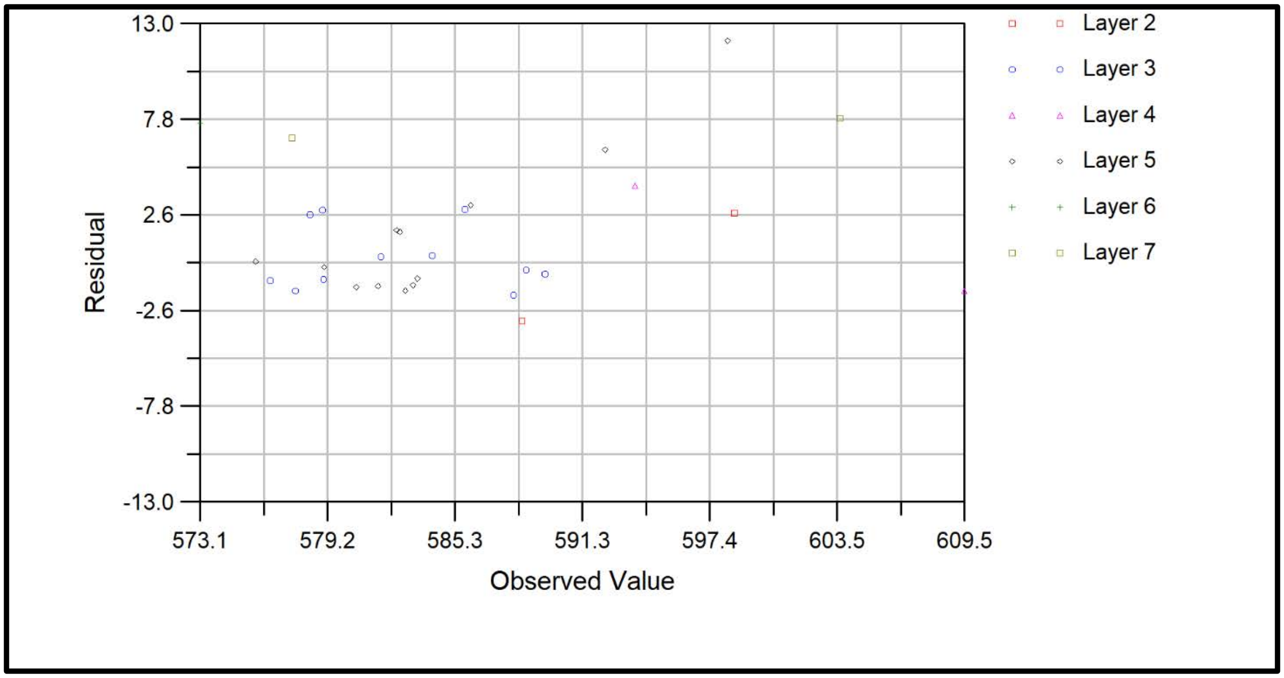
GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL



STEADY STATE MODFLOW CALIBRATION RESULTS – OBSERVED VERSUS SIMULATED (ft)

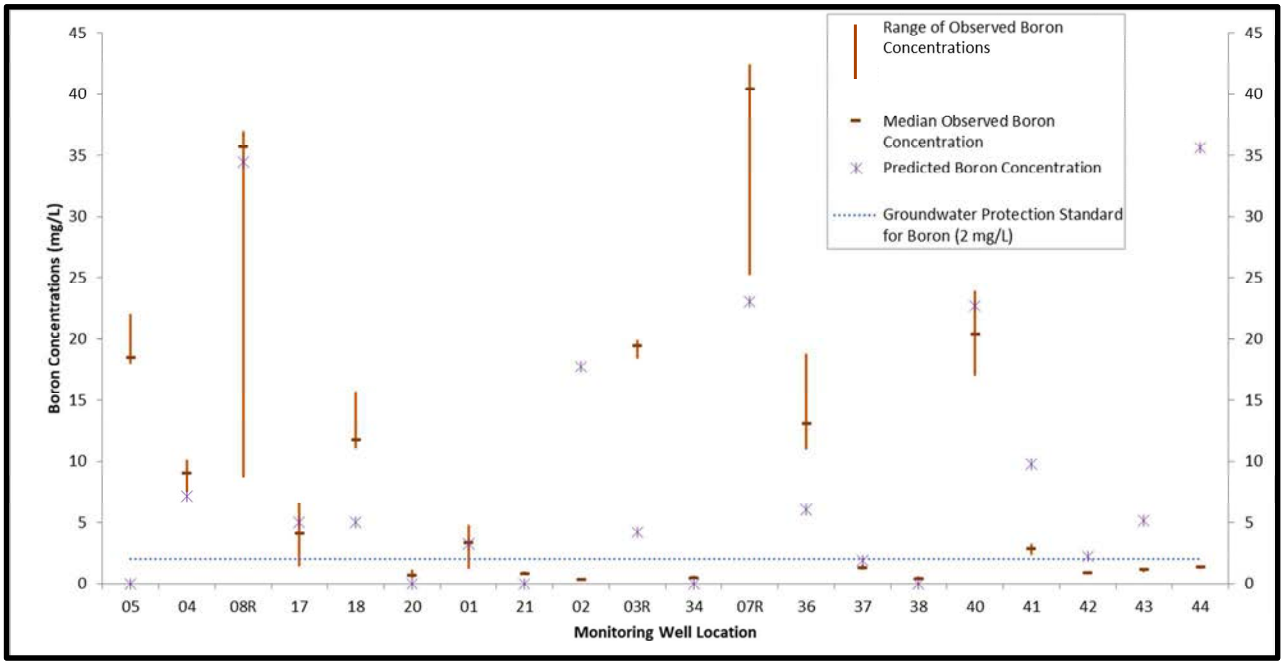
GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS



STEADY STATE MODFLOW CALIBRATION RESULTS – OBSERVED VERSUS RESIDUALS (ft)

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

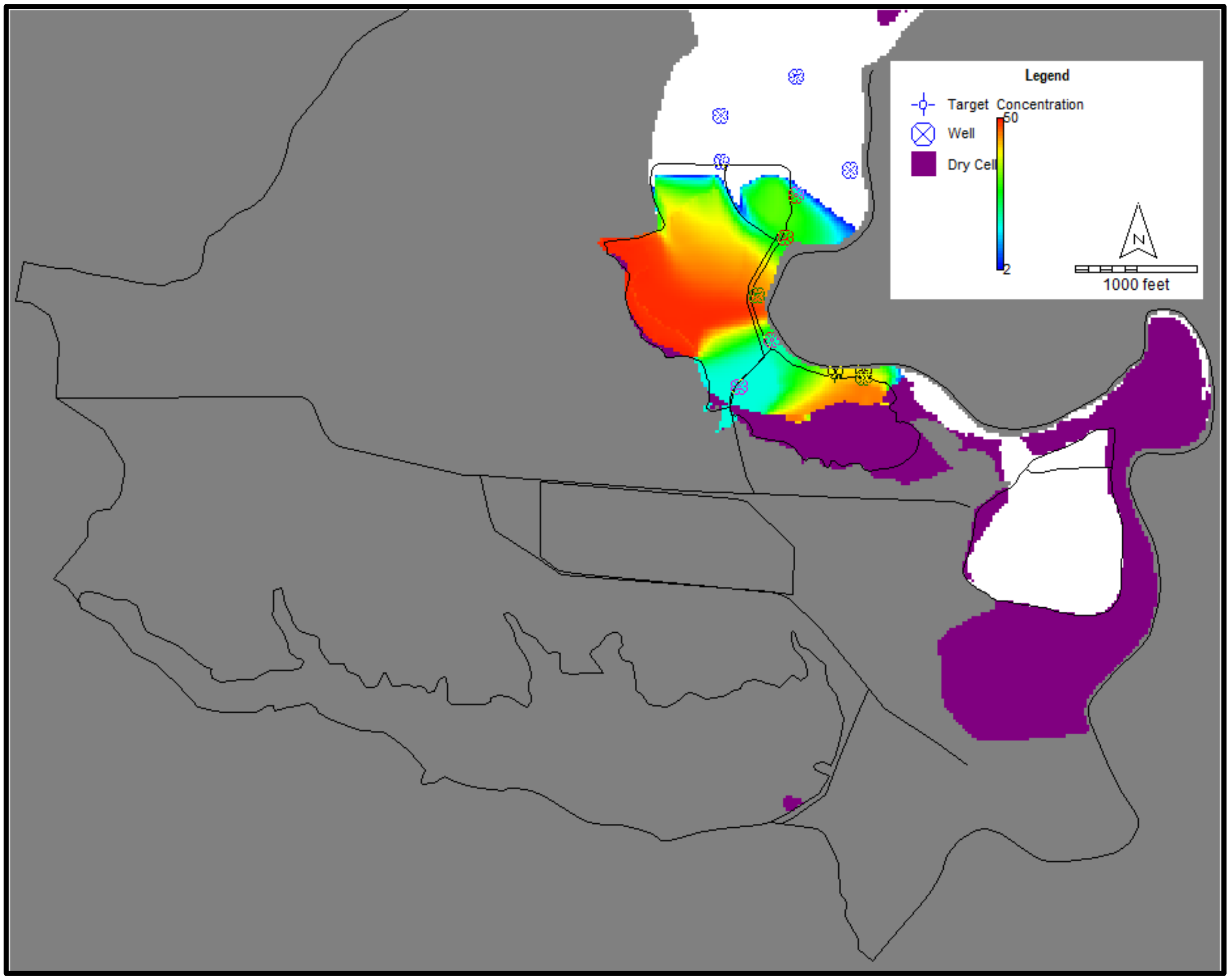
RAMBOLL



OBSERVED AND SIMULATED BORON CONCENTRATIONS (mg/L)

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

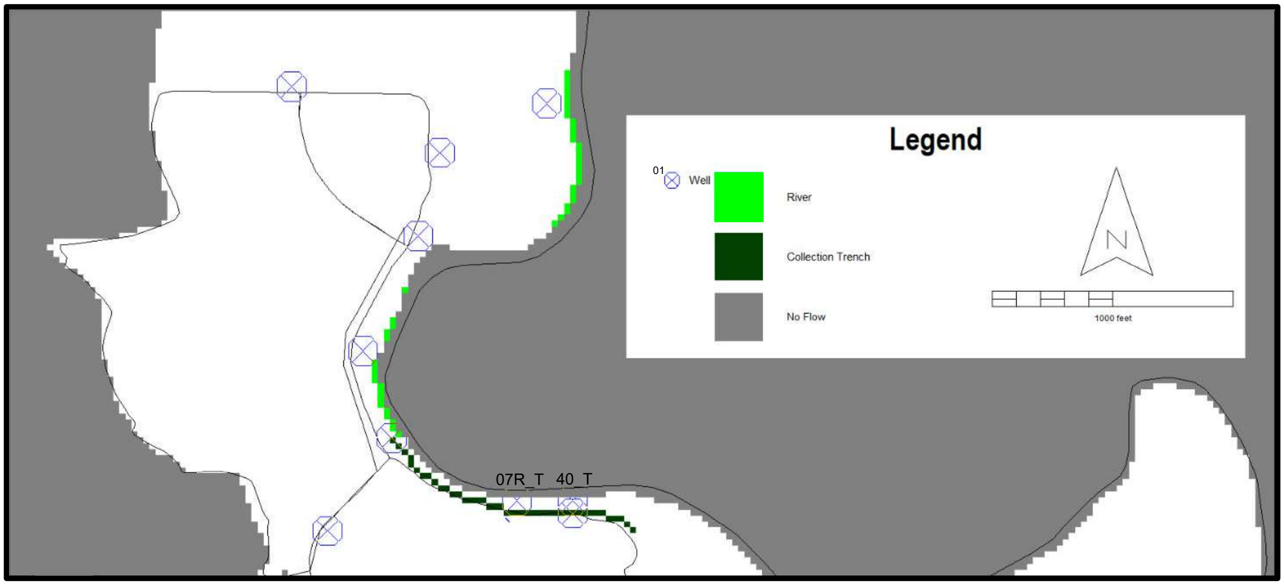
RAMBOLL



DISTRIBUTION OF BORON CONCENTRATION (mg/L) IN THE CALIBRATED MODEL (MGU)

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

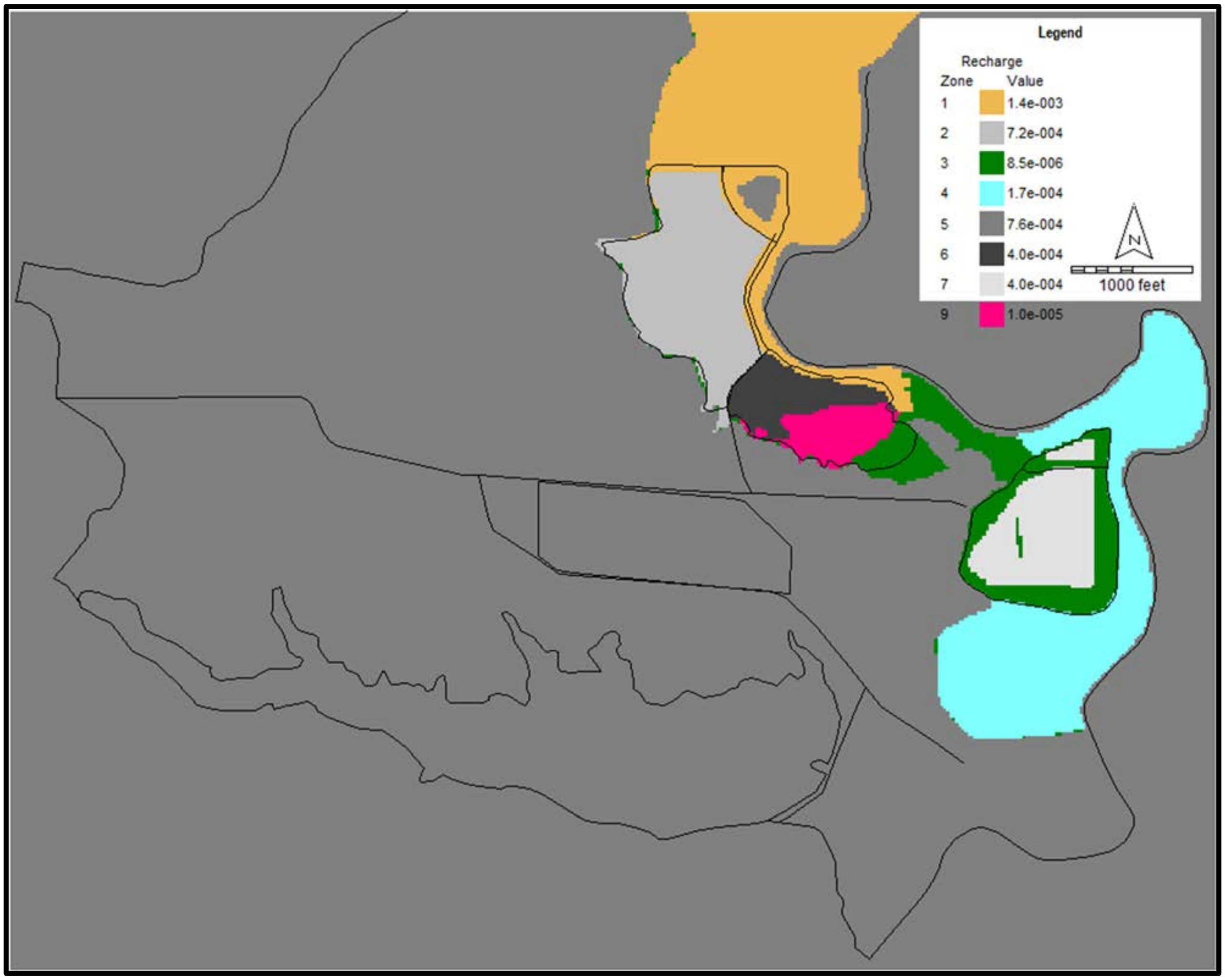
FIGURE 6-1



SEEPAGE COLLECTION TRENCH ALIGNMENT WITH REPLACEMENT OBSERVATION WELLS

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

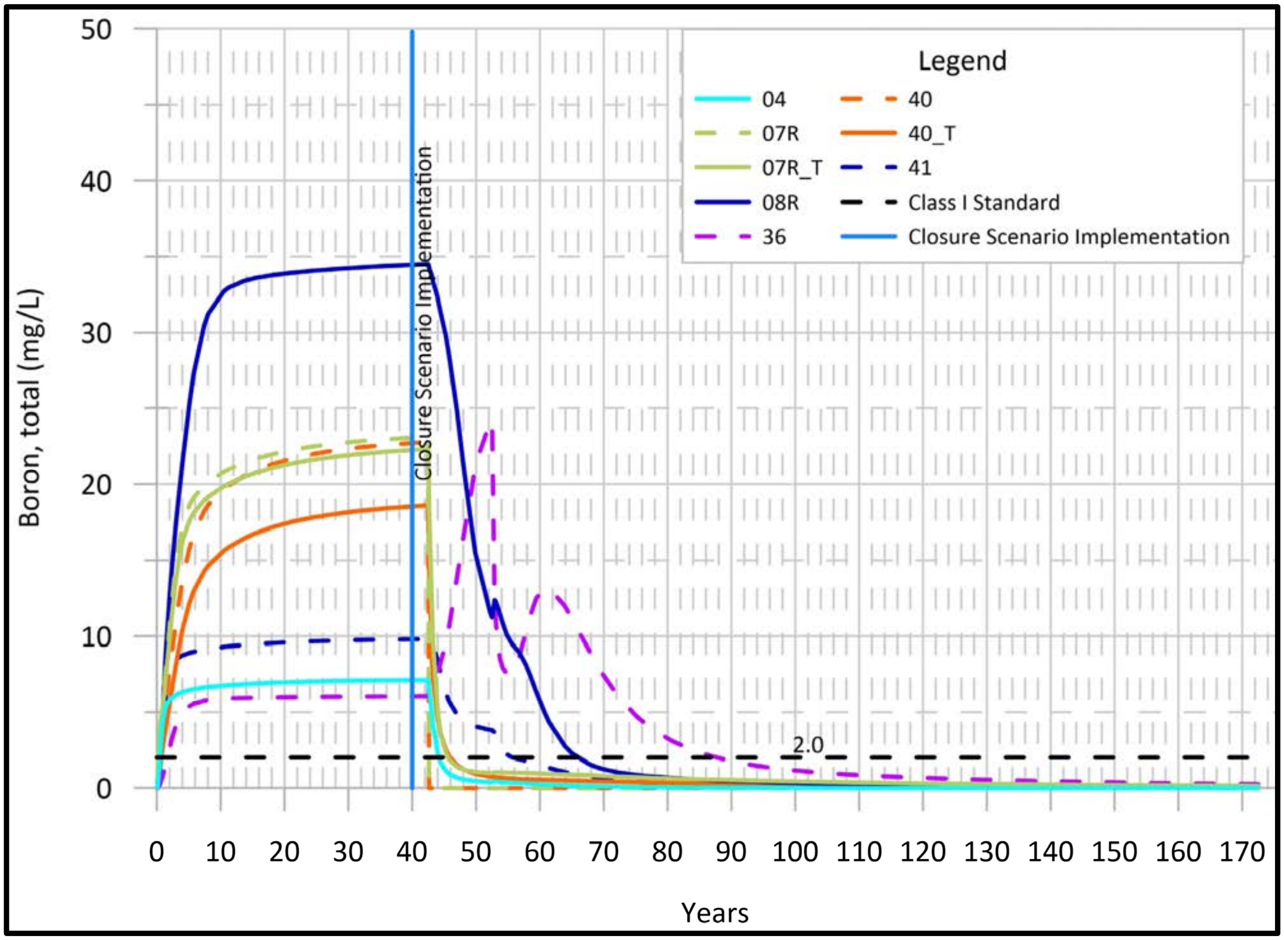
RAMBOLL



DISTRIBUTION OF RECHARGE ZONES (feet/day) FOR ALL CLOSURE SCENARIOS

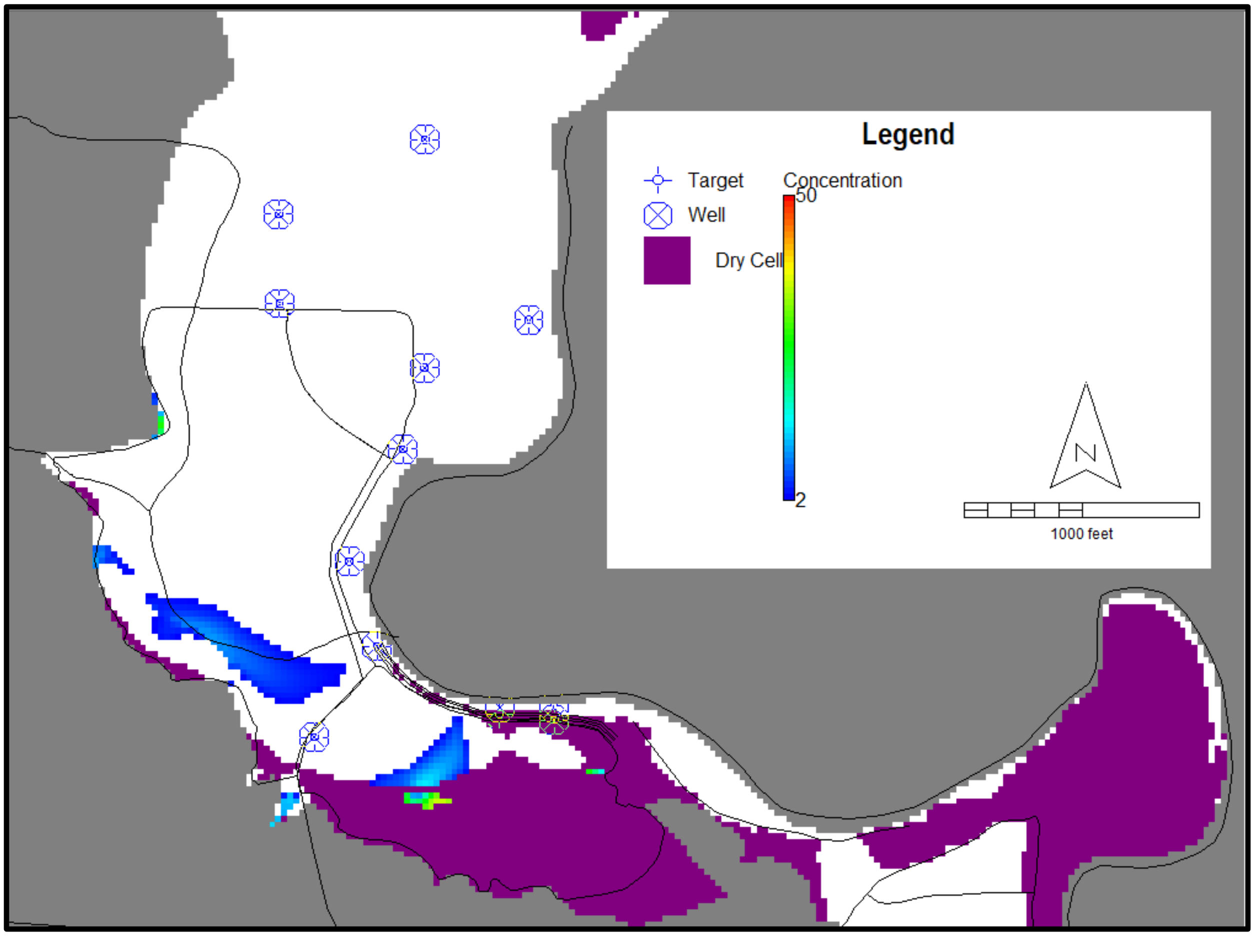
GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL



CBR-ONSITE (SCENARIO 1, MGU) - MODEL PREDICTED BORON CONCENTRATION IN MIDDLE GROUNDWATER UNIT

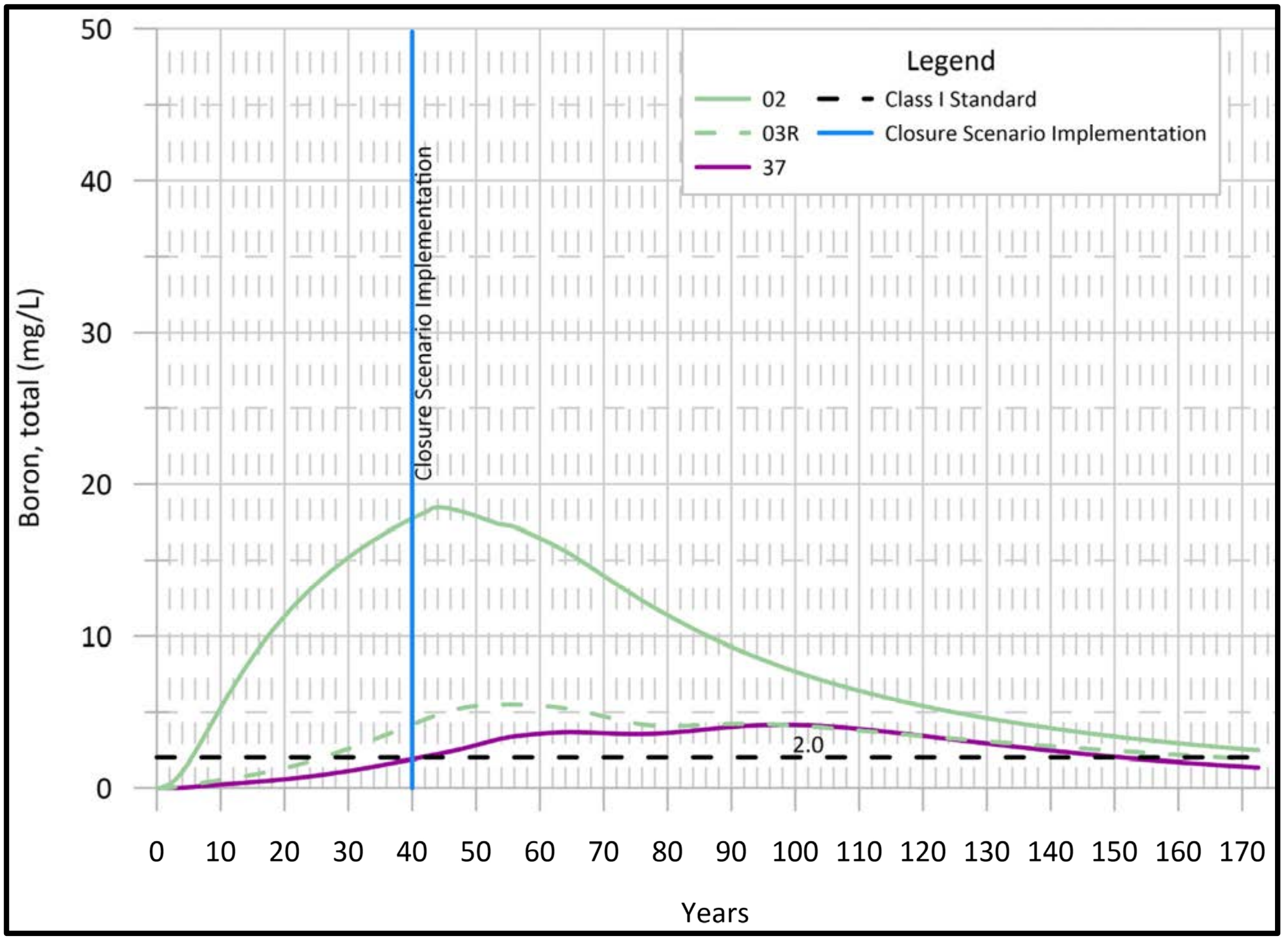
GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS



CBR-ONSITE (SCENARIO 1, MGU) – MODEL PREDICTED BORON PLUME IN MIDDLE GROUNDWATER UNIT APPROXIMATELY 50 YEARS AFTER IMPLEMENTATION

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

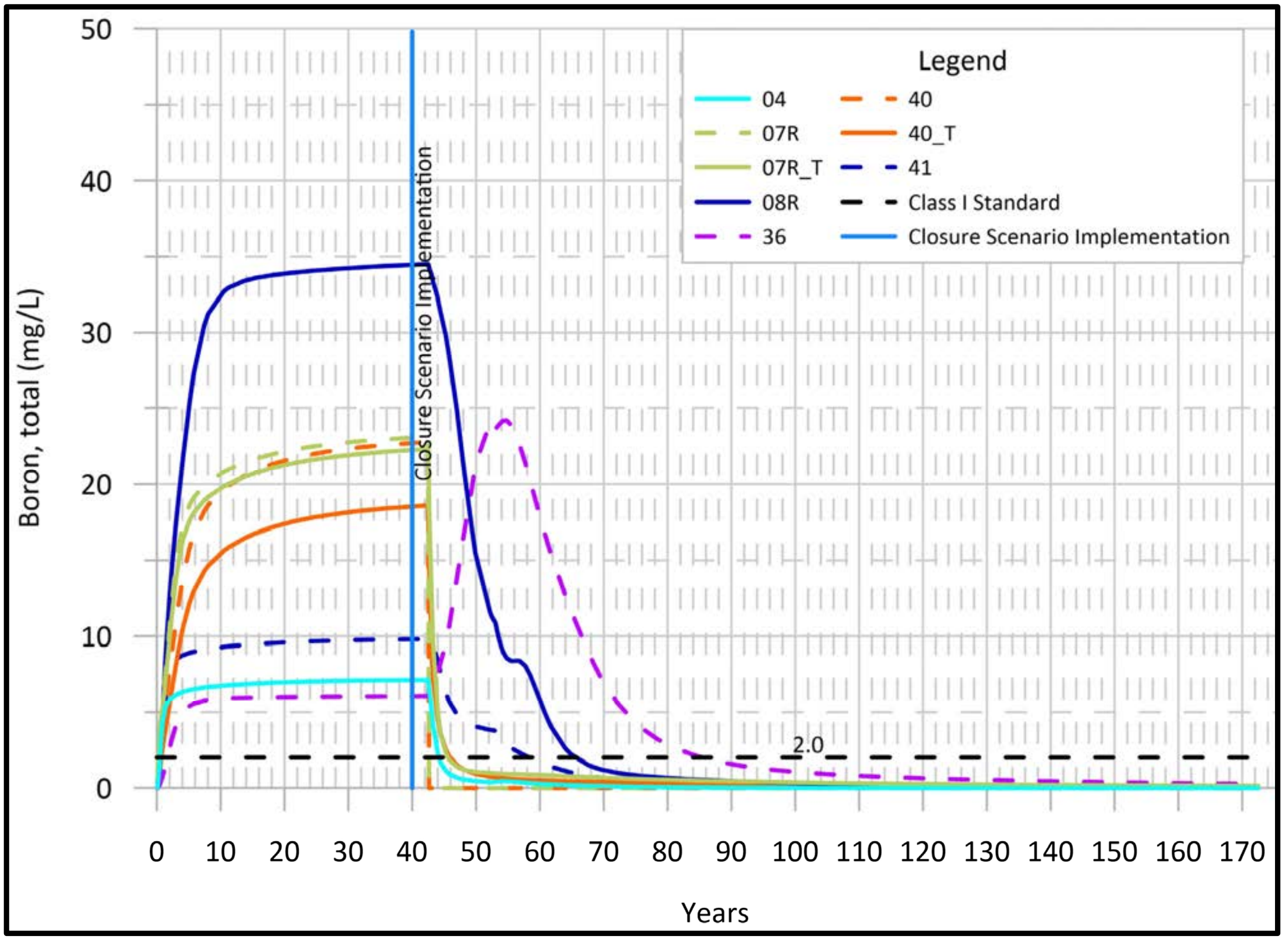
RAMBOLL



CBR-ONSITE (SCENARIO 1, LGU) - MODEL PREDICTED BORON CONCENTRATION IN LOWER GROUNDWATER UNIT

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

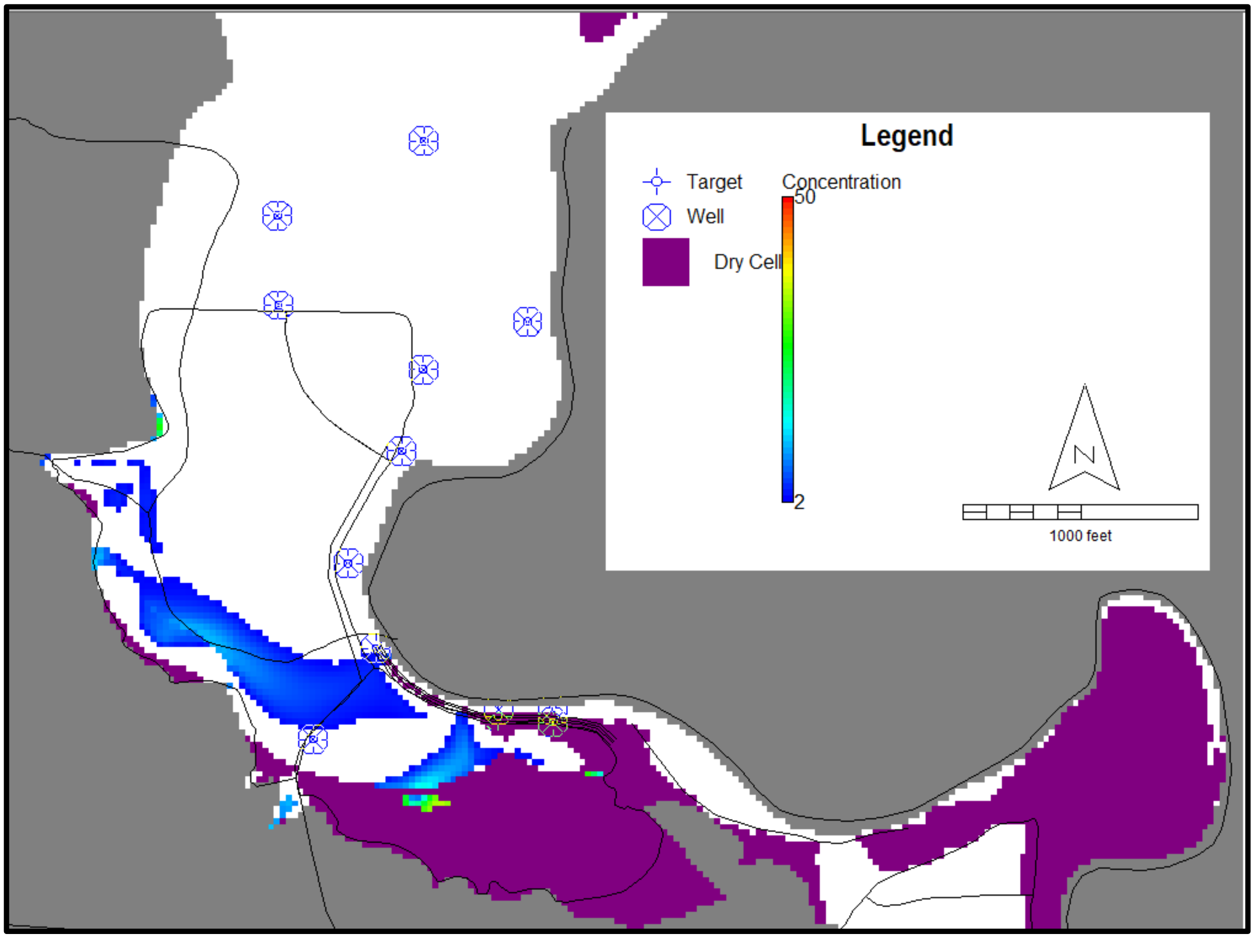
RAMBOLL



CBR-ONSITE (SCENARIO 2, MGU) - MODEL PREDICTED BORON CONCENTRATION IN MIDDLE GROUNDWATER UNIT

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

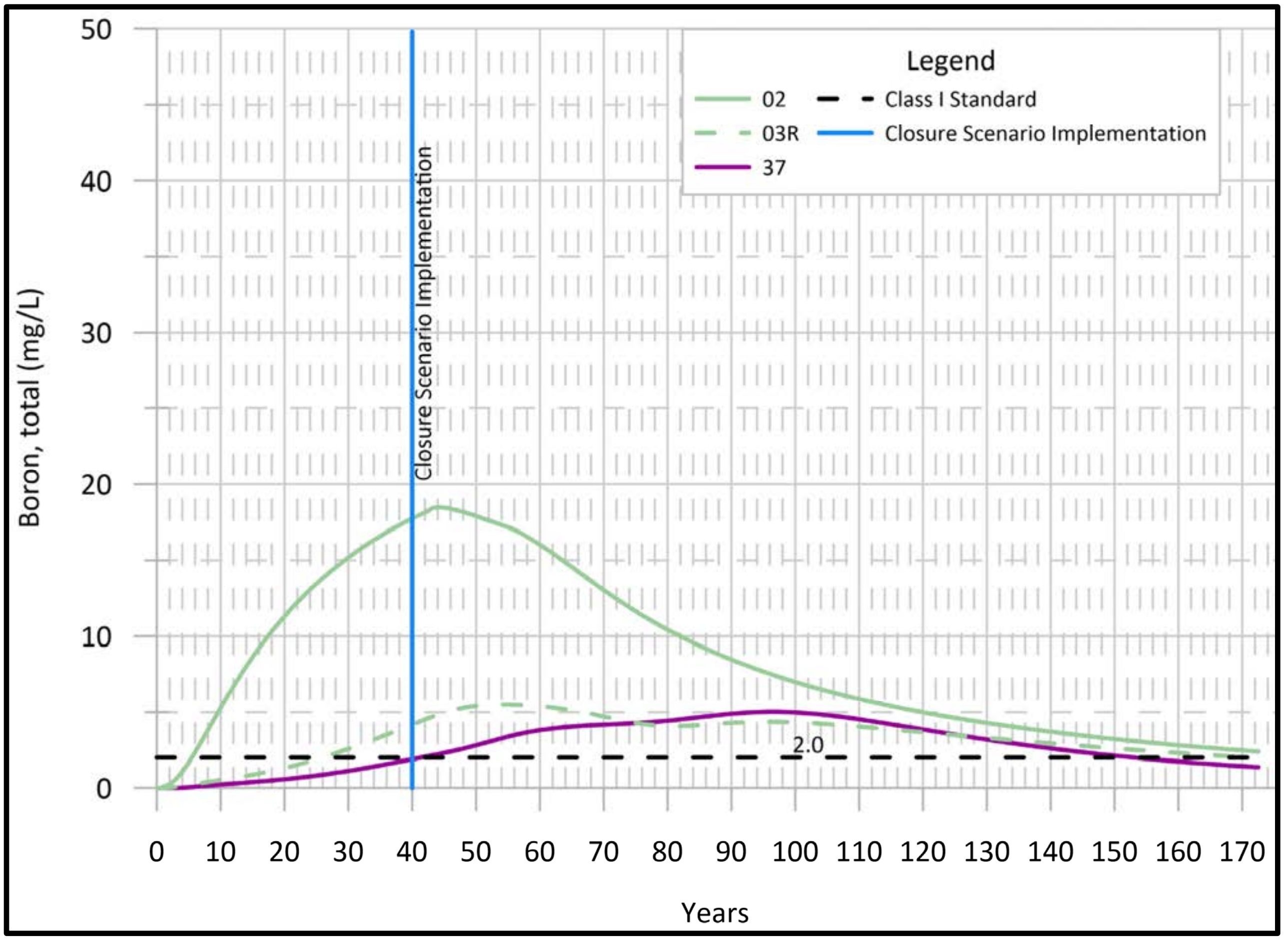
RAMBOLL



CBR-ONSITE (SCENARIO 2, MGU) - MODEL PREDICTED BORON PLUME IN MIDDLE GROUNDWATER UNIT APPROXIMATELY 47 YEARS AFTER IMPLEMENTATION

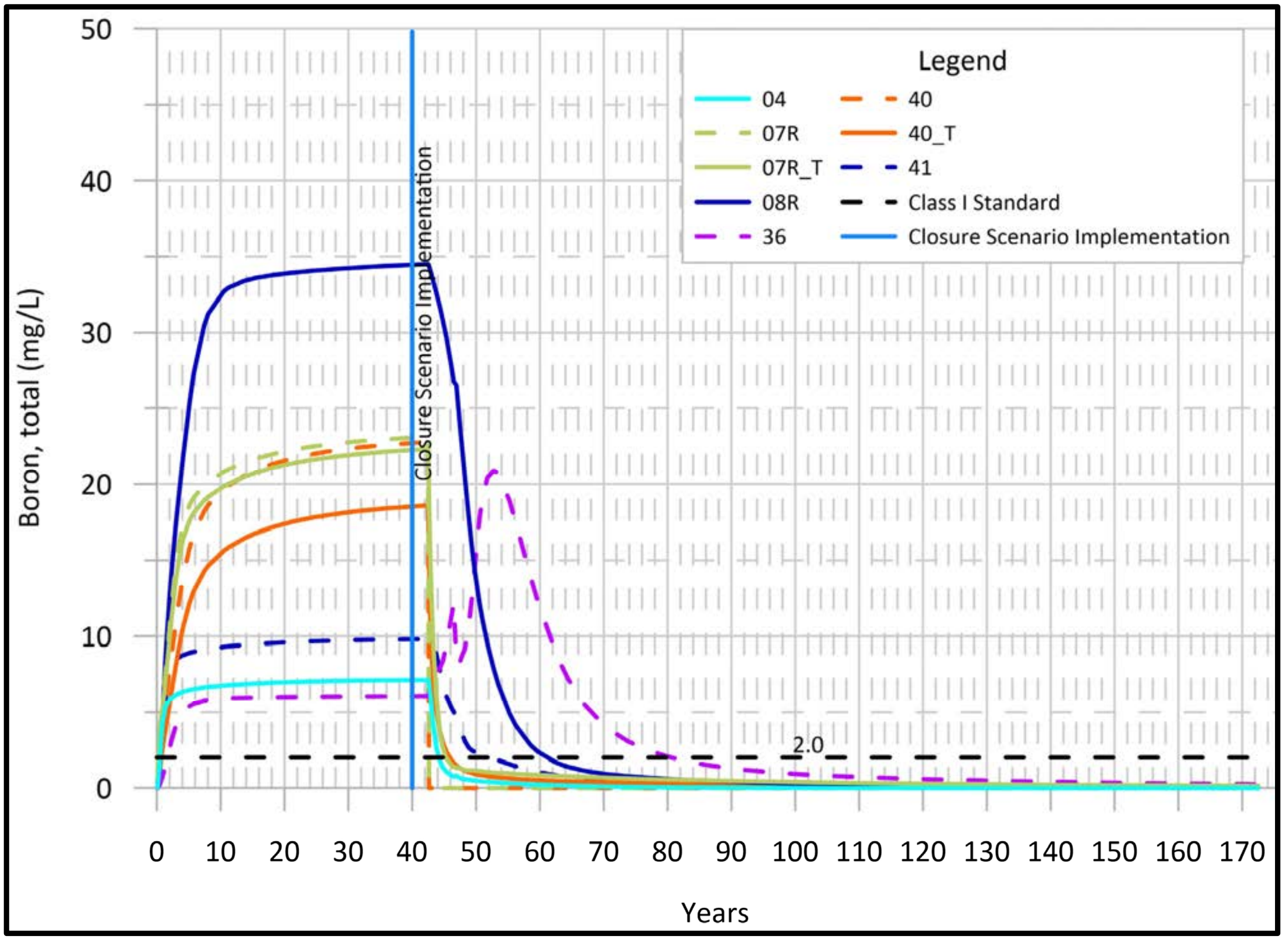
GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL



CBR-ONSITE (SCENARIO 2, LGU) - MODEL PREDICTED BORON CONCENTRATION IN LOWER GROUNDWATER UNIT

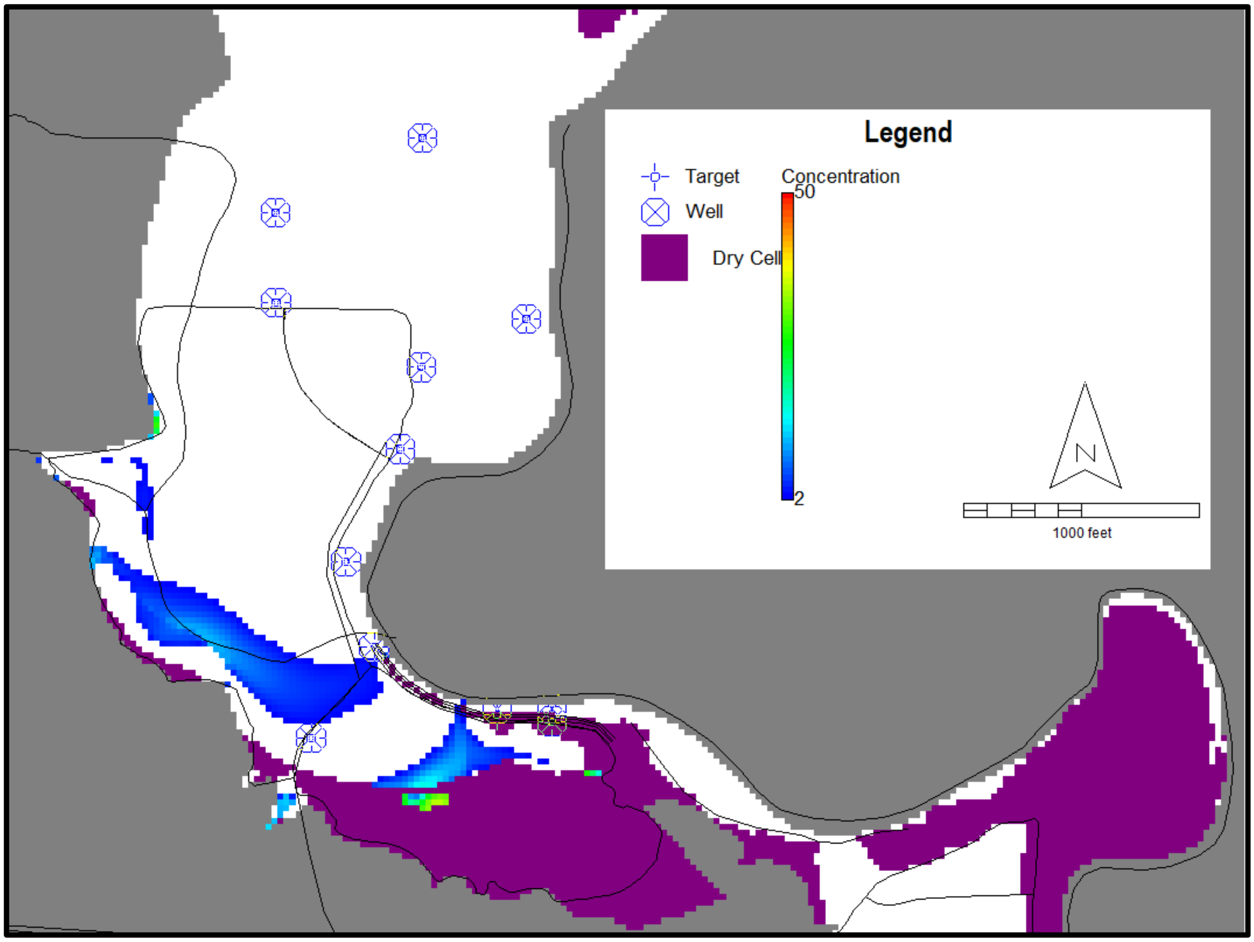
GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS



CBR-OFFSITE (SCENARIO 3, MGU) - MODEL PREDICTED BORON CONCENTRATION IN MIDDLE GROUNDWATER UNIT

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

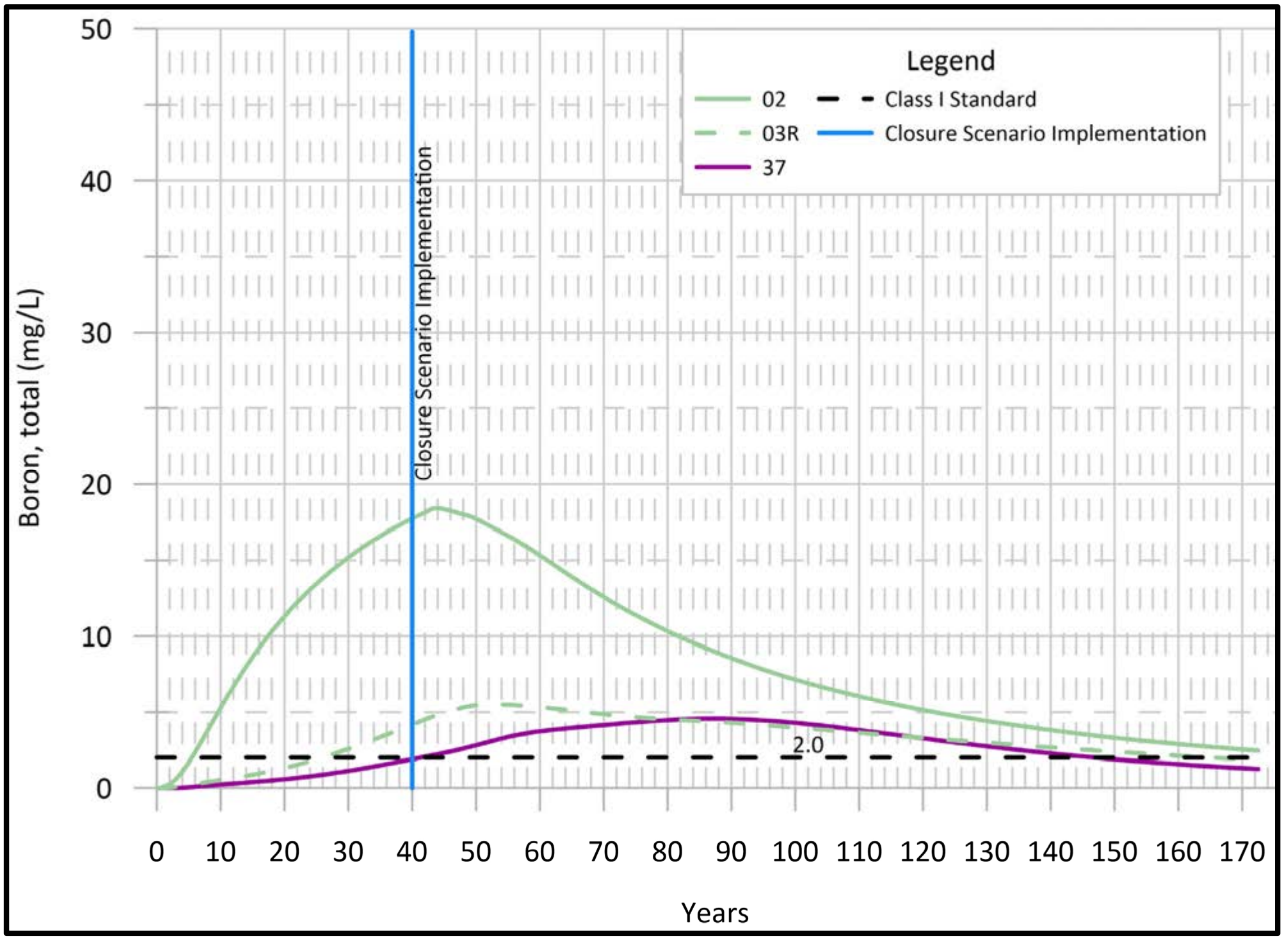
FIGURE 6-10



CBR-OFFSITE (SCENARIO 3, MGU) – MODEL PREDICTED BORON PLUME IN MIDDLE GROUNDWATER UNIT APPROXIMATELY 43 YEARS AFTER IMPLEMENTATION

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

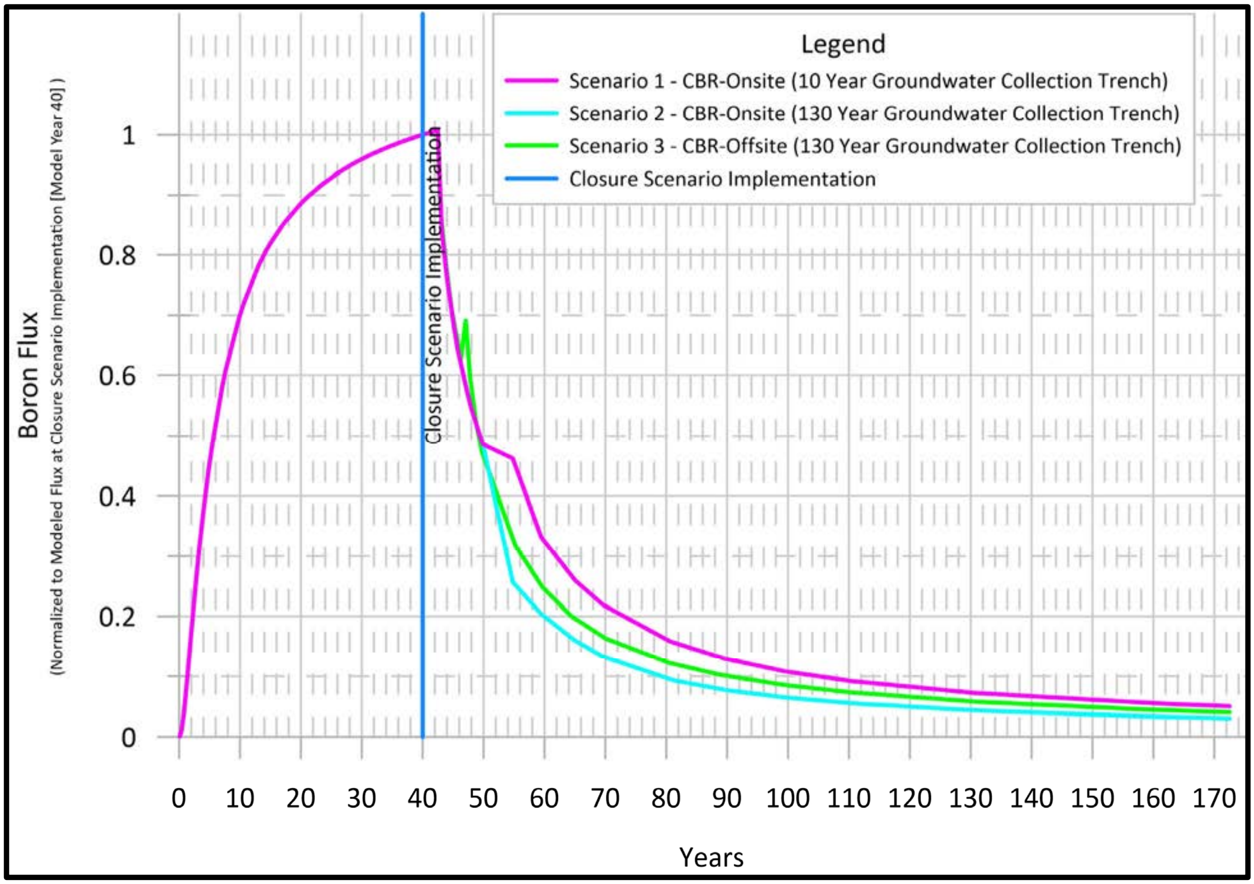
RAMBOLL



CBR-OFFSITE (SCENARIO 3, LGU) - MODEL PREDICTED BORON CONCENTRATION IN LOWER GROUNDWATER UNIT

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

RAMBOLL



NORMALIZED MODEL PREDICTED BORON FLUX TO MIDDLE FORK

GROUNDWATER MODELING REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

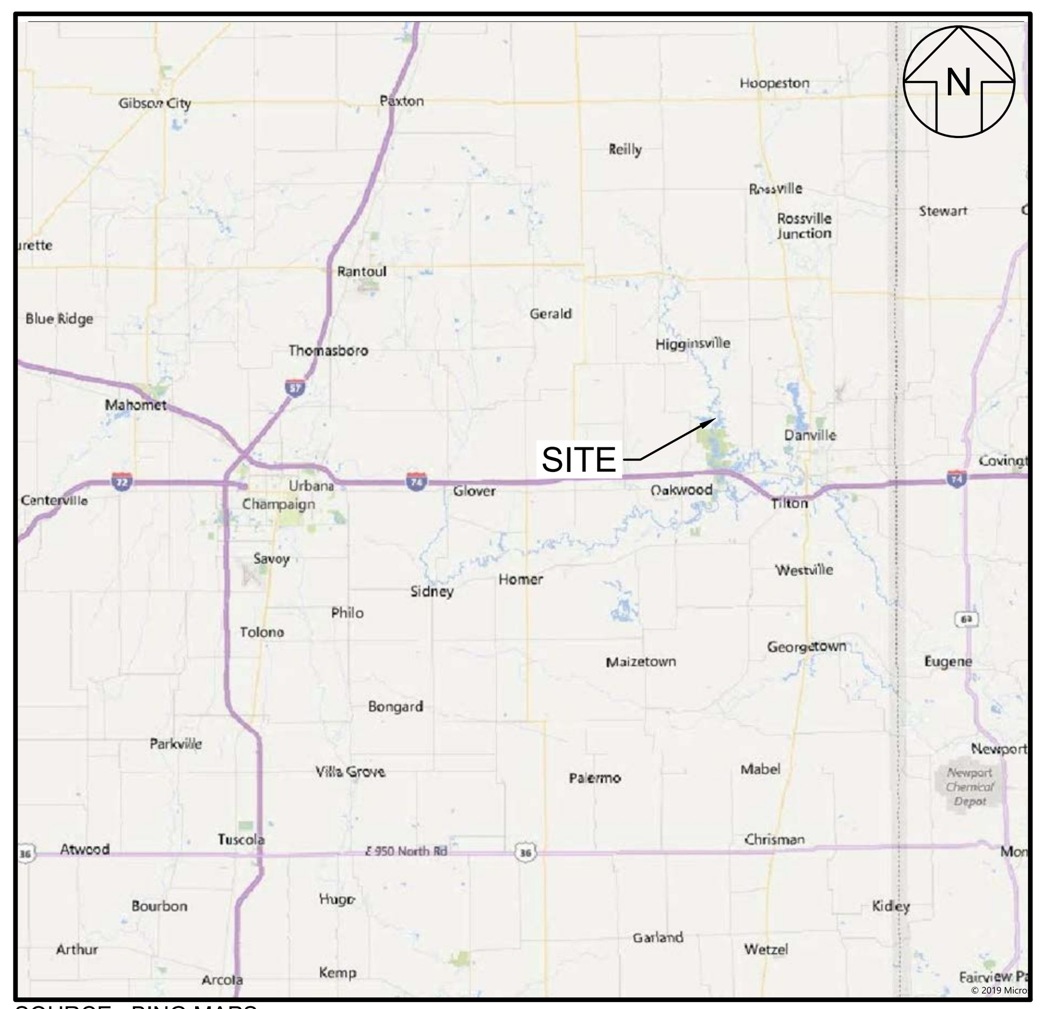
APPENDIX A
MODFLOW, MT3DMS, AND HELP MODEL FILES
(ELECTRONIC ONLY)

Geosyntec consultants

ATTACHMENT L

Groundwater Collection Trench Design Drawings

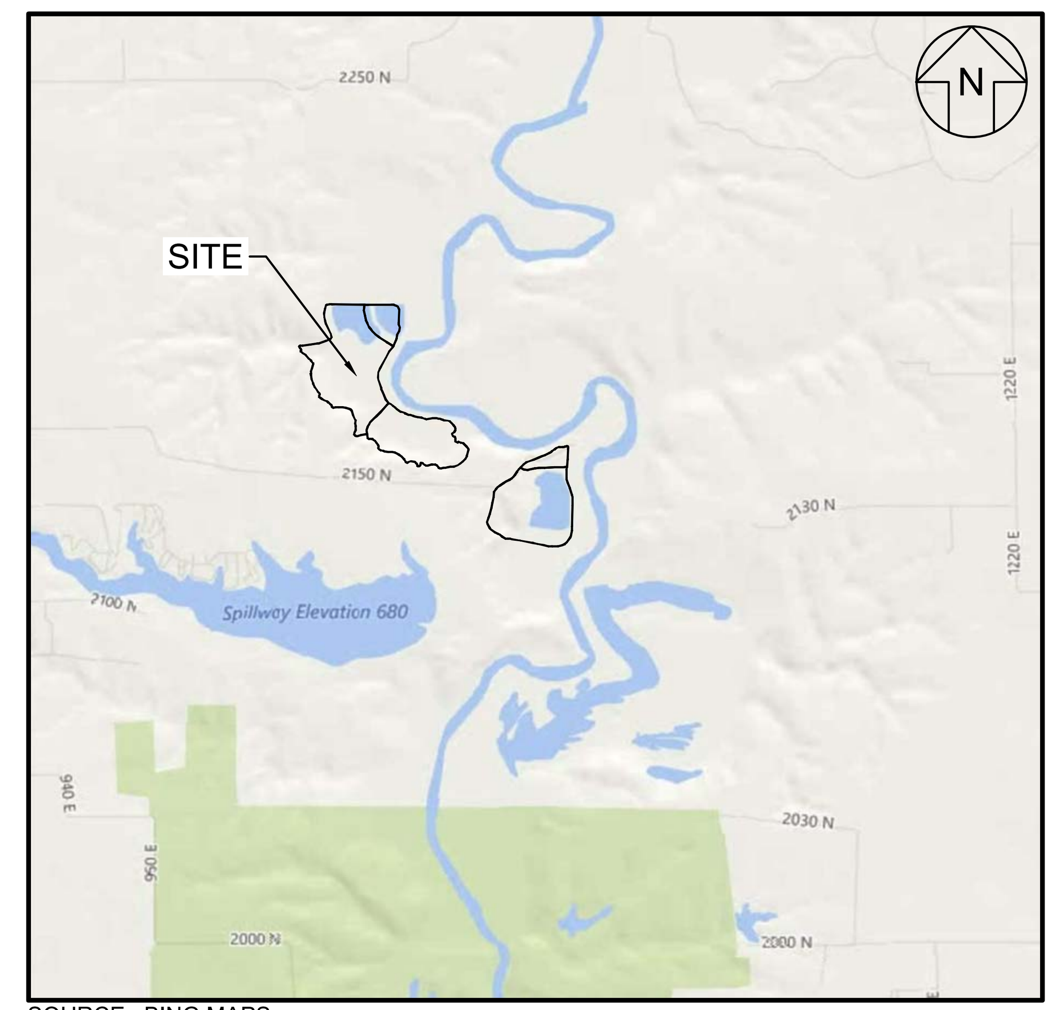
DYNEGY MIDWEST GENERATION
VERMILION POWER STATION
GROUNDWATER COLLECTION TRENCH CONSTRUCTION
VERMILION COUNTY, ILLINOIS
PROJECT NO. CHE8404
SEPTEMBER 2021



SOURCE: BING MAPS

VICINITY MAP

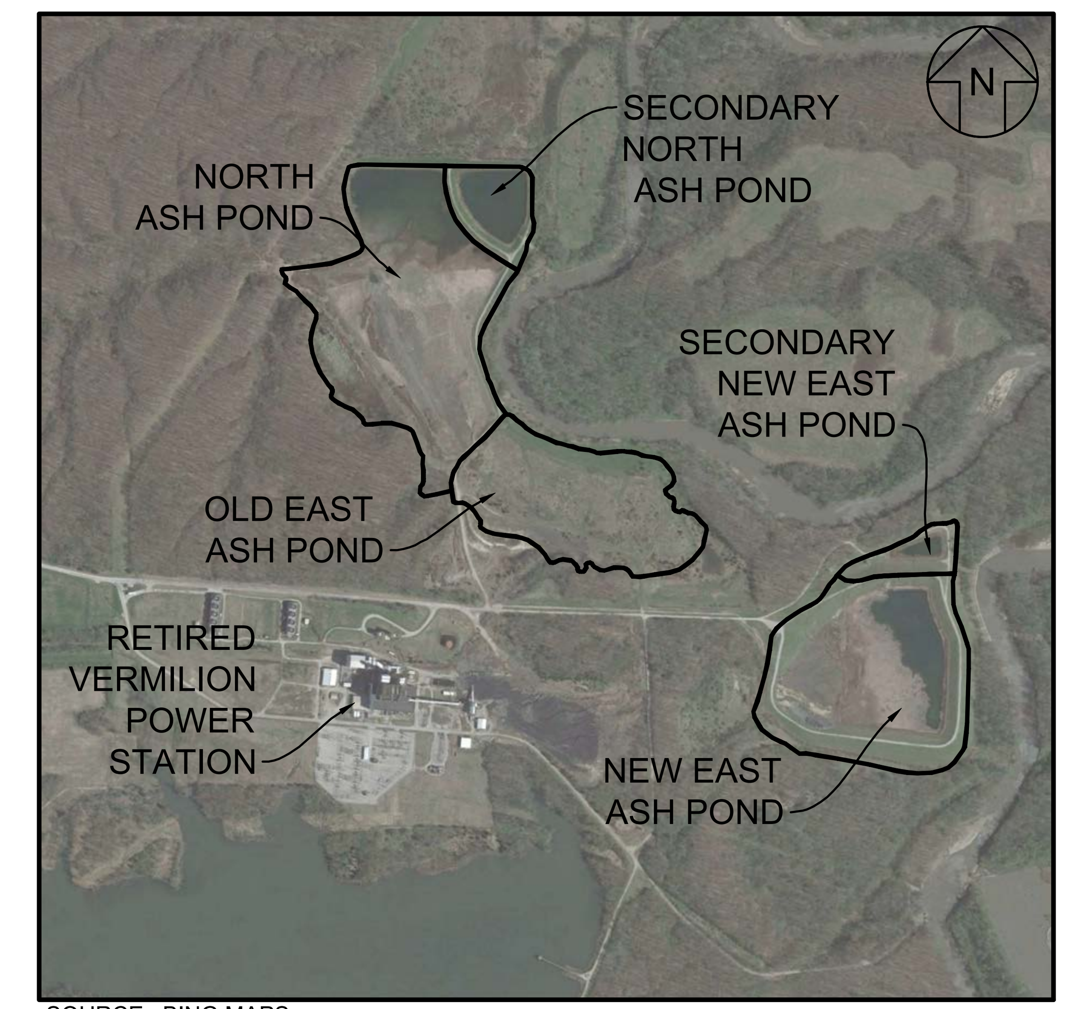
0 10 20
SCALE IN MILES



SOURCE: BING MAPS

LOCATION MAP

0 4000 8000
SCALE IN FEET



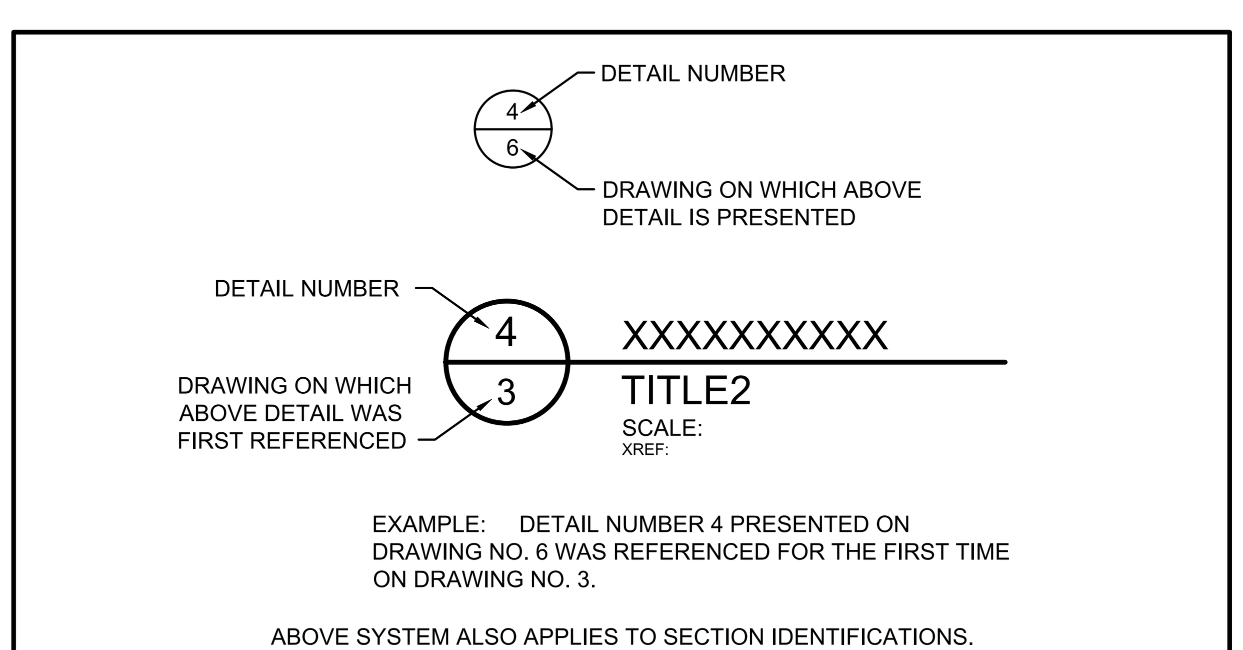
SOURCE: BING MAPS

SITE MAP

0 500 1000
SCALE IN FEET

INDEX OF SHEETS

SHEET NO.	TITLE
1	COVER SHEET
2	OVERALL PROJECT SITE PLAN VIEW
3	GROUNDWATER COLLECTION TRENCH PLAN VIEW AND PROFILE
4	DETAILS



DETAIL IDENTIFICATION LEGEND

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO IL 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: COVER SHEET

PROJECT: GROUNDWATER COLLECTION TRENCH CONSTRUCTION

SITE: VERMILION COUNTY, ILLINOIS

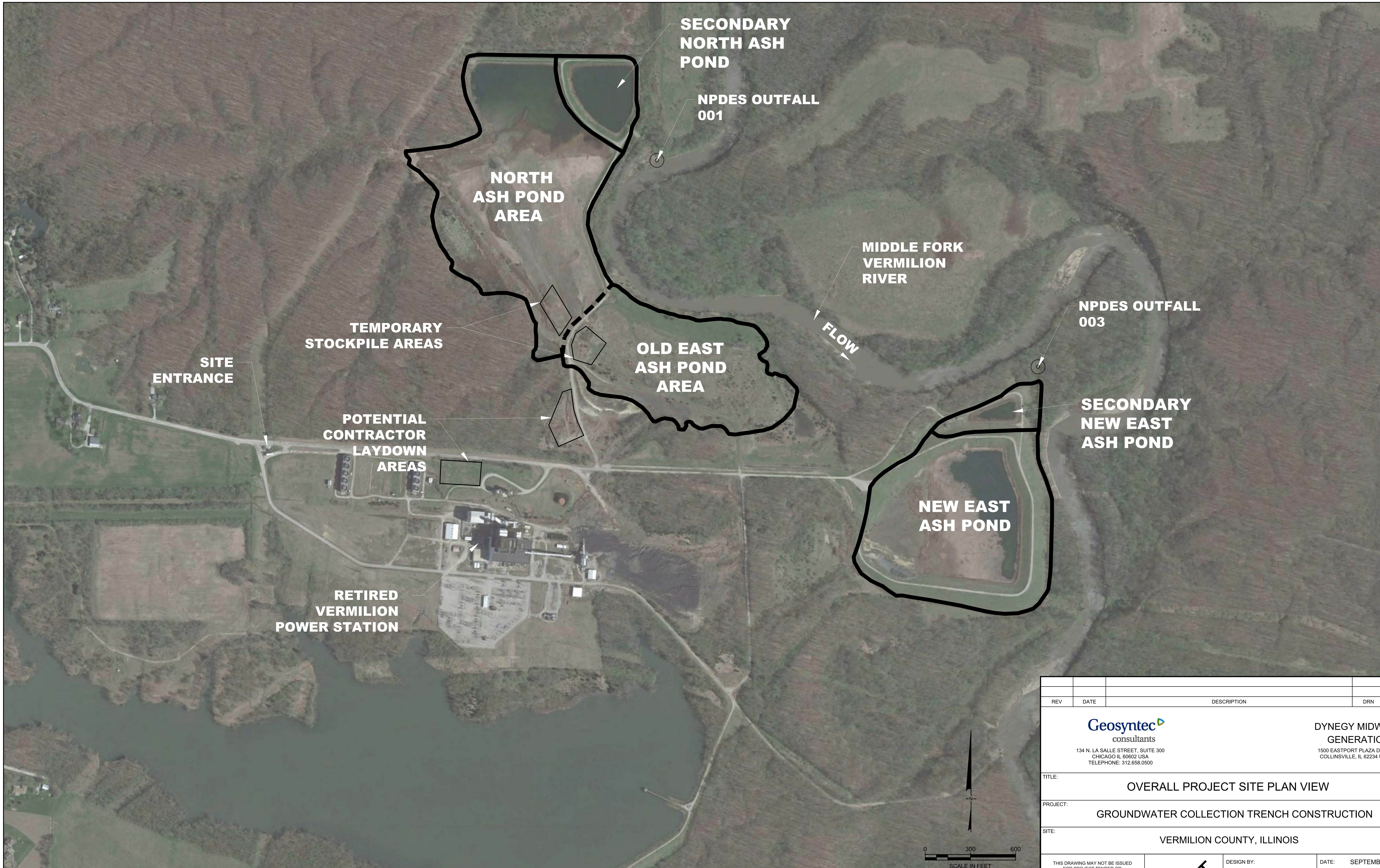
THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DRAFT

DESIGN BY:	DATE: SEPTEMBER 2021
DRAWN BY:	PROJECT NO.: CHE8404A
CHECKED BY:	FILE:
REVIEWED BY:	DRAWING NO.:
APPROVED BY:	1 OF 4



REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO IL 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: OVERALL PROJECT SITE PLAN VIEW

PROJECT: GROUNDWATER COLLECTION TRENCH CONSTRUCTION

SITE: VERMILION COUNTY, ILLINOIS

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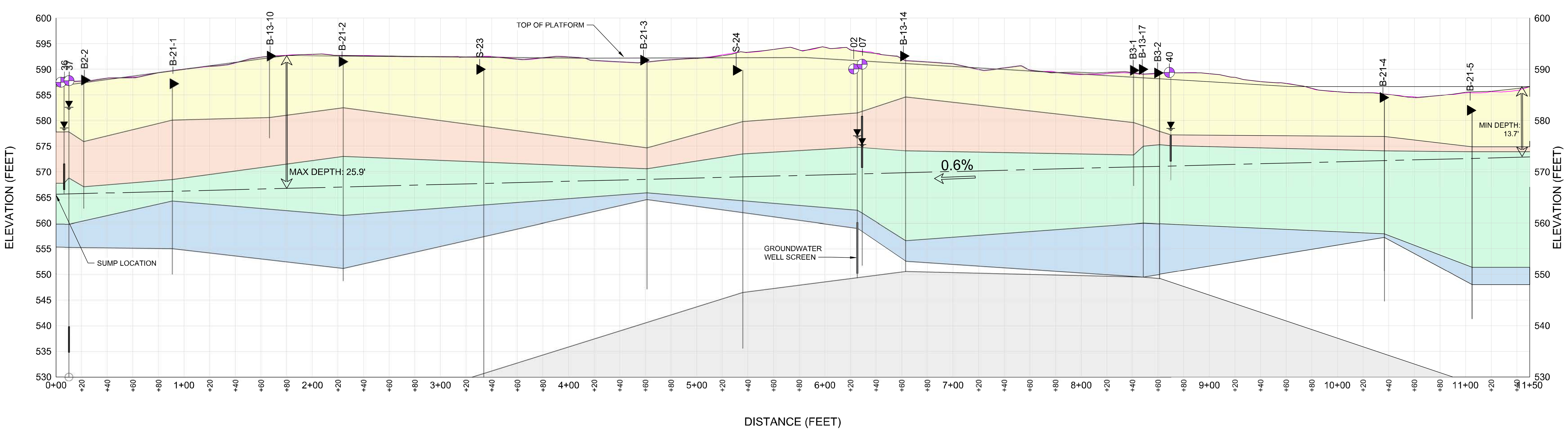
SIGNATURE

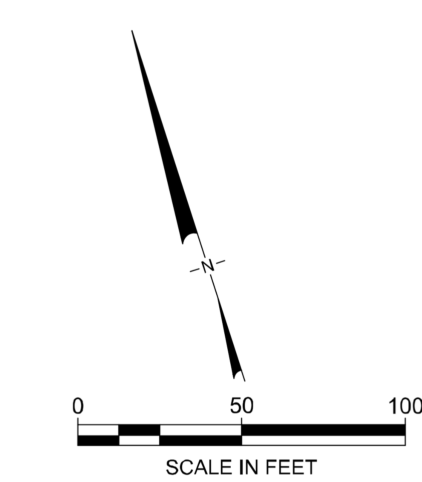
DATE

DRAFT

DESIGN BY:		DATE:	SEPTEMBER 2021
DRAWN BY:		PROJECT NO.:	CHE8404A
CHECKED BY:		FILE:	
REVIEWED BY:		DRAWING NO.:	
APPROVED BY:		2 OF 4	

\\OAKBROOK-01\DATA\DWG\V\CHE8404 VPS CLOSURE\DRAWINGS\SEEPAGE COLLECTION TRENCH\DRAWINGS\30 % SEEPAGE CONTROL DESIGN\CHE8404-002 OVERALL PROJECT SITE PLAN VIEW.DWG Last Edited by: MKatelieva on 9/14/21





LEGEND

- EXISTING MAJOR CONTOUR (5 - FT INTERVAL)
- EXISTING MINOR CONTOUR (1 - FT INTERVAL)
- GRAVEL ACCESS ROAD
- TRENCH WORK PLATFORM CENTER-LINE (APPROXIMATE)
- TRENCH WORK PLATFORM EXTENT (APPROXIMATE)
- LOD — TRENCH WORK PLATFORM LIMIT OF DISTURBANCE (APPROXIMATE)
- BOTTOM OF GROUNDWATER COLLECTION TRENCH
- UPPER GROUND UNIT
- MIDDLE GROUNDWATER UNIT (MGU)
- MIDDLE CONFINING UNIT (MCU)
- LOWER GROUNDWATER UNIT (LGU)
- ROCK
- TREE LINE
- OHE — OVERHEAD ELECTRIC LINE
- W — APPROXIMATE ORDINARY HIGH WATER MARK (OHWM)
- SUMP LOCATION
- INGENAE RIVERBANK STATIONS
- GROUNDWATER WELLS
- BORINGS
- APPROXIMATE POLE LOCATION
- GROUNDWATER LEVEL (APRIL 2021)

NOTES:

1. BASE MAP IS AN AMALGAM OF PUBLICLY AVAILABLE LIDAR DATA AND SURVEY CONDUCTED BY INGENAE ON MARCH 2018.
2. COORDINATE SYSTEM IS NORTH AMERICAN DATUM OF 1983 (NAD 83) ILLINOIS STATE PLANE EAST, AND VERTICAL DATUM IS IN NORTH AMERICAN VERTICAL DATUM OD 1988 (NAVD 88).
3. THE DATE OF AERIAL IMAGE IS APRIL 20, 2019 OBTAINED FROM GOOGLE EARTH PRO.

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO IL 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: GROUNDWATER COLLECTION TRENCH PLAN VIEW AND PROFILE

PROJECT: GROUNDWATER COLLECTION TRENCH CONSTRUCTION

SITE: VERMILION COUNTY, ILLINOIS

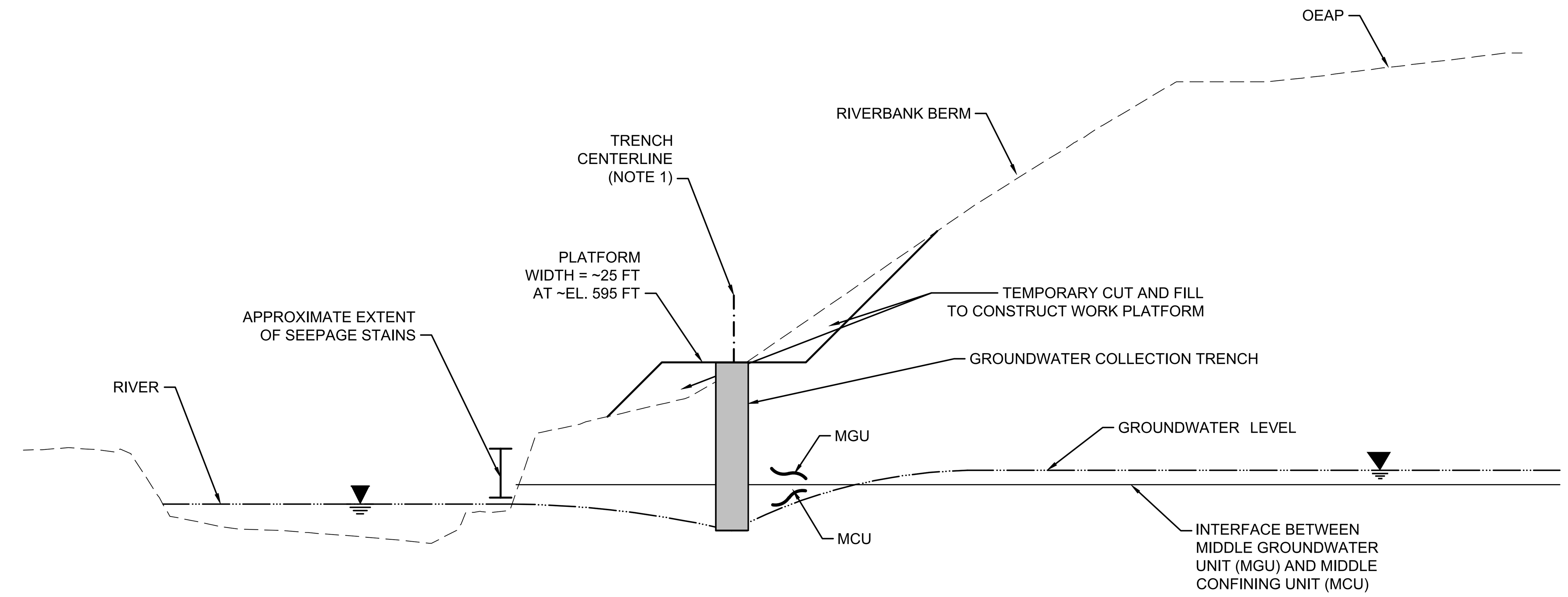
THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DRAFT

DESIGN BY:	IV/MK/OB	DATE:	SEPTEMBER 2021
DRAWN BY:	IV/MK	PROJECT NO.:	CHE8404A
CHECKED BY:	OB	FILE:	
REVIEWED BY:	OB/JS	DRAWING NO.:	3 OF 4
APPROVED BY:	JS		



NOTE:

1. THE PLATFORM WILL BE CONSTRUCTED BY FILLING AND CUTTING INTO RIVERBANK BERM AS NECESSARY.

1/3 SCHEMATIC
GROUNDWATER COLLECTION TRENCH
CROSS-SECTION
SCALE: N.T.S.

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
134 N. LA SALLE STREET, SUITE 300
CHICAGO IL 60602 USA
TELEPHONE: 312.658.0500

DYNEGY MIDWEST GENERATION
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: DETAILS

PROJECT: GROUNDWATER COLLECTION TRENCH CONSTRUCTION

SITE: VERMILION COUNTY, ILLINOIS

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SIGNATURE

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DRAFT

DESIGN BY:		DATE:	SEPTEMBER 2021
DRAWN BY:		PROJECT NO.:	CHE8404A
CHECKED BY:		FILE:	
REVIEWED BY:		DRAWING NO.:	4 OF 4
APPROVED BY:			

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Geosyntec consultants

ATTACHMENT M

Closure Prioritization Category Letter (845.700)

Phil Morris
Dynegy Midwest Generation, LLC
Luminant
1500 Eastport Plaza Drive
Collinsville, IL 62234

May 19, 2021

Mr. Darin LeCrone, P.E.
Manager, Industrial Unit
Bureau of Water, Division of Water Pollution Control, Permits Section
Illinois Environmental Protection Agency
1021 North Grand Avenue, East
Springfield, IL 62794-9276

Re: CCR Surface Impoundment Category Designation and Justification for Dynegy Midwest Generation, LLC

Dear Mr. LeCrone:

Pursuant to 35 I.A.C. 845.700(c), Dynegy Midwest Generation, LLC submits the information necessary to categorize the CCR surface impoundments located at the Baldwin Power Plant and the retired Hennepin and Vermilion Power Plants. The following parameters were used in assessing and justifying each assigned category.

- Category 1 – *Impacts to existing potable water supply well or impacts to groundwater quality within the setback of an existing potable water supply well.*
    - This review includes an assessment of potable water wells within 2,500 feet of CCR surface impoundments to determine whether any potential impacts are occurring within the setback zone of any community water supply well established under the Illinois Groundwater Protection Act.
    - This information was developed during the Part 845 rulemaking and is summarized in Attachment 1, Table 2: Impacts to Potable Water Supply.
- Category 2 – *Imminent threat to human health or the environment or have been designated by IEPA under (g)(5)*
    - The surface impoundments at Baldwin, Hennepin and Vermilion Power Plants do not pose an imminent threat to human health or the environment. There are no known conditions at or around the facility where someone or something may be exposed to contaminant concentrations reasonably expected to cause harm
- Category 3 – *Located in areas of environmental justice ("EJ") concern*
    - EJ areas were evaluated using the EJ mapping link from IEPA's webpage located at https://www2.illinois.gov/epa/topics/environmental-justice. Per the IEPA mapping tool, the EJ Status thresholds were determined as twice the state averages for Minority and Low Income consistent with 35 IAC 845.700(g)(6).
    - An EJ map denoting the facilities with impoundments is located in Attachment 3.

- Category 4-7
    - Category 4 - Inactive CCR surface impoundments that have an exceedance of the groundwater protection standards in Section 845.600
    - Category 5 - Existing CCR surface impoundments that have exceedances of the groundwater protection standards in Section 845.600
    - Category 6 - Inactive CCR surface impoundments that are in compliance with the groundwater protection standards in Section 845.600.
    - Category 7 – Existing CCR surface impoundments that are in compliance with the groundwater protection standards in Section 845.600

Based on the information above, category designations have been assigned. The category designations for each CCR impoundment are shown in Attachment 1, Table 1: Category Designations.

If you have any questions regarding this submittal, please contact Phil Morris at 618-343-7794 or phil.morris@vistracorp.com.

Sincerely,

Phil Morris
Senior Environmental Director

Attachments

Attachment 1

Table 1: Category Designation

Facility	Pond Description	Classifications	Potable Water Supply Impacts (Category 1)	Human Health or Environment Threat (Category 2)	Located within Environmental Justice Areas[1] (Category 3)	Standards Exceedances[2] (Categories 4,5,6,7)	Impoundment Category 845.700(g)
Baldwin	Bottom Ash Pond	Existing	No	No	No	No	7
Hennepin	East New Primary Pond	Inactive	No	No	Yes	NA[3]	3
Vermilion	North Pond Cell 1 & 2	Inactive	No	No	No	Yes	4
	Old East Pond	Inactive	No	No	No	Yes	4
	New East Pond Cell 1 & 2	Inactive	No	No	No	Yes	4

[1] See Attachment 3 Environmental Justice Area Map

[2] Ground water analyses for purposes of categories 4-7, assumptions have been made based on current groundwater data. However, since sampling and analysis is ongoing and subject to IEPA review and approval, IPGC reserves the right to update its category designations for Categories 4-7.

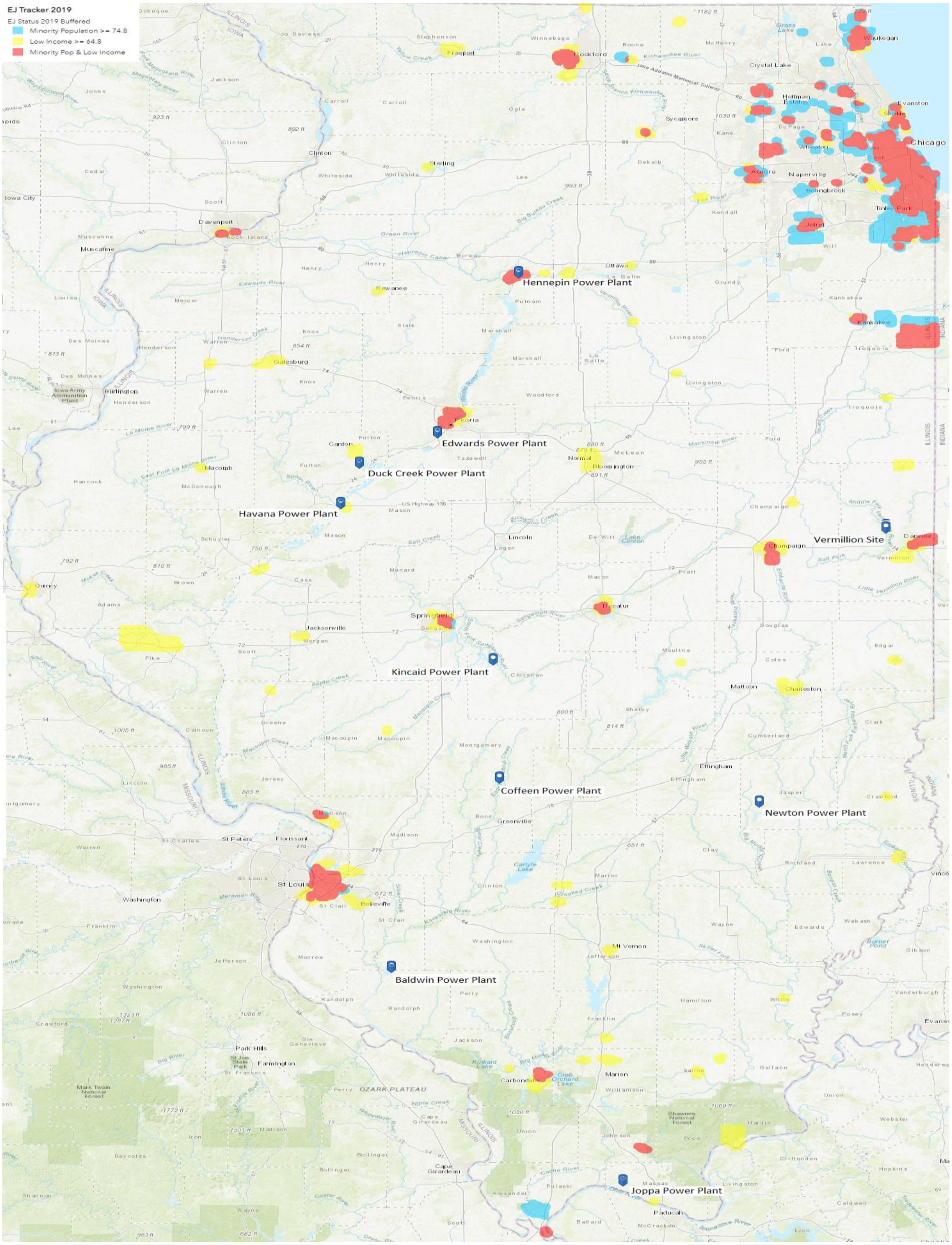
[3] NA for this determination since the CCR surface impoundment was assign a highest priority category

Attachment 2

Table 2: Impacts to Potable Water Supply

Site Name	Private and Semi-Private Wells	Non-Community Water Supply (CWS) Wells	Non-CWS Surface Water Intakes	Community Water Supply Wells	CWS Surface Water Intakes
Baldwin	**Present, but not at risk** Twenty-two (22) water wells were identified and eight (8) are located potentially downgradient of the site. Based on Ramboll's review of groundwater data, these wells are unlikely to be impacted by releases from the site.	Absent	Absent	**Present, but not at risk** Two (2) active CWS wells were identified; however, they are unlikely to be at risk because of their hydrogeologic location relative to the power plant.	**Present, but not at risk** One (1) CWS surface water intake was identified potentially downgradient of the site. Based on Ramboll's review of available information, this CWS surface water intake is unlikely to be impacted by releases from the site.
Hennepin	**Present, but not at risk** Sixteen (16) water wells were identified and one (1) is located potentially downgradient of the site. However, this well is unlikely to be present/in use based on its remote floodplain location and installation date (1884).	**Present, but not at risk** Three (3) non-CWS wells were identified; however, they are unlikely to be at risk because of their relative hydrogeologic position or inactive status.	Absent	Absent	Absent
Vermilion	**Present, but not at risk** Seventy-nine (79) water wells were identified; however, they are unlikely to be at risk because of their hydrogeologic location relative to the power plant, they are abandoned, they do not appear to be used for potable purposes, and/or they are unlikely to be present based on the mapped location. None of the off-site wells are located in a downgradient direction.	**Present, but not at risk** Two CWS wells were identified; however, they are unlikely to be at risk because of their hydrogeologic location relative to the power plant and/or their inactive status.	**Present, but inactive** One non-CWS surface water intake was identified; however, it is unlikely to be at risk because it is listed with inactive status.	Absent	Absent

Attachment 3: EJ Mapping Denoting Facilities with Impoundments



ATTACHMENT N

Final Closure Plan and Closure Schedule (845.720)

Closure Alternatives Analysis (CAA) and Corrective Measures Assessment (CMA)/Corrective Action Alternatives Analysis (CAAA)(845.710)

Prepared for

Dynegy Midwest Generation, LLC
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

CCR FINAL CLOSURE PLAN

VERMILION POWER PLANT
OLD EAST ASH POND AREA
NORTH ASH POND AREA
OAKWOOD, ILLINOIS

Prepared by

Geosyntec consultants

engineers | scientists | innovators

134 N. Lasalle Street, Suite 300
Chicago, Illinois 60602

Project Number CHE8404B

January 2022

TABLE OF CONTENTS

1. Introduction 1
1.1. Facility Information 1

2. Final Closure Plan 2
2.1. General Requirements 2
2.2. Selected Closure Method 2
2.2.1. Description of Closure 2
2.2.2. Description of Removal Plan 3
2.2.3. Estimate of the Maximum Inventory 4
2.2.4. Estimate of the Largest Area 4
2.2.5. Closure Completion Schedule 4

3. Amendments of Final Closure Plan 6

4. Closure By Removal 7
4.1. Groundwater Corrective Action 7
4.2. Post-Closure Groundwater Monitoring 7
4.3. Handle and Transport CCR 7
4.4. Monthly Reporting 9
4.5. Completion of CCR Removal 10
4.6. Completion of Groundwater Monitoring 10

5. Certification 11

TABLE OF CONTENTS (Continued)

LIST OF TABLES

Table 2-1 CCR Closure Schedule
Table 3-1 CCR Final Closure Plan Revisions

LIST OF APPENDICES

Appendix 1 Closure Alternatives Analysis (CAA) and Corrective Measures Assessment (CMA) / Corrective Action Alternatives Analysis (CAAA)

1. INTRODUCTION

Dynegy Midwest Generation, LLC (Dynegy) is the owner of the inactive coal-fired Vermilion Power Plant (Plant), also referred to as Vermilion Power Station, located approximately 13 miles Northwest of Danville, Illinois. The Old East Ash Pond Area (OEAP) and North Ash Pond Area (NAP) are inactive surface impoundments storing coal combustion residuals (CCR). The requirements for the OEAP and NAP are specified in 35 Ill. Admin. Code 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845).

This Final Closure Plan addresses the requirements of Section 845.720(b) for the Old East Ash Pond Area (OEAP) and North Ash Pond (NAP) Area. A Closure Alternatives Assessment (CAA) has been completed for the OEAP, NAP, and NEAP. Corrective action is required for OEAP and NAP. A combined Closure Alternatives Assessment (CAA) and Corrective Measures Assessment (CMA)/Corrective Action Alternatives Assessment (CAAA) has been prepared for all three impoundments. This combined CAA and CMA/CAAA is provided in **Appendix 1**. A Monitored Natural Attenuation (MNA) evaluation and corresponding report was completed to provide input to the CMA and CAAA and is provided in the Construction Permit Application. The Final Closure Plan proposes a new Onsite Landfill to receive onsite wastes. A Feasibility Study (FS) to utilize the new Onsite Landfill is provided in Attachment R of the Construction Permit Application.

1.1. Facility Information

Facility:	Vermilion Power Plant 10188 East 2150 North Rd Oakwood, IL 61858
CCR Unit:	Old East Ash Pond Area (OEAP) North Ash Pond Area (NAP)
Owner/Operator:	Dynegy Midwest Generation, LLC 1500 Eastport Plaza Drive Collinsville, IL 62234
Closure Method:	Closure by Removal

2. FINAL CLOSURE PLAN

2.1. General Requirements

Section 845.720(b)(1): The owner or operator of a CCR surface impoundment must submit to the Agency, as a part of a construction permit application for closure, a final closure plan. The plan must be submitted before the installation of a final cover system or removal of CCR from the surface impoundment for the purpose of closure.

This Final Closure Plan will be submitted with the construction permit application for closure for OEAP and NAP.

Section 845.720(b)(2): Except as otherwise provided in Section 22.59 of the Act, the owner or operator of a CCR surface impoundment must not close a CCR surface impoundment without a construction permit issued under this Part.

The owner will not close the OEAP and NAP without a construction permit issued under this Part 845.720.

Section 845.720(b)(3): The final closure plan must identify the proposed selected closure method and must include the information required in subsection (a)(1) and the closure alternatives analysis specified in Section 845.710.

The following sections describe the selected closure method for OEAP and NAP. The Closure Alternatives Analysis as specified by Section 845.710 is provided in **Appendix 1**. Based on the Closure Alternatives Analysis, closure by removal to an on-site landfill has been identified as the most appropriate closure for the OEAP and NAP.

2.2. Selected Closure Method

2.2.1. Description of Closure

Section 845.720(a)(1)(A): A narrative description of how the CCR surface impoundment will be closed in accordance with this Part.

The OEAP contains a cover of vegetated fill consisting of lean clay, silty clay, and silty sand with varying amounts of sand and gravel. The NAP is not covered and contains water in its northern sections; it has exposed coal ash above the impounded water level and coal ash below the impounded water. The OEAP and NAP overlap and will be removed as one removal action. The OEAP does not contain water. The visible CCR will be removed, as well as any pipes and discharge structures within the surface impoundment. The coal ash will be hauled to an onsite landfill that meets State requirements of IAC Part 811 and will also be compliant with 40 CFR

Part 257 for CCR landfills. The area will be graded and/or backfilled as necessary to minimize the potential for ponding and vegetated with native grasses.

In general, the NAP and OEAP will be closed as one concurrent, continuous or semi-continues operation. The closure of the NAP and OEAP will be accomplished by removal of CCR from the surface impoundment. The NAP contains water in its northern section. Water from the CCR Impoundments is required to be removed and the CCR dewatered in accordance with the Illinois Attorney General (IAG) Interim Order (Order) entered June 30, 2021. The existing coal ash will be removed from the NAP and OEAP. All areas affected by releases of CCR from the CCR surface impoundment will be decontaminated. Groundwater monitoring will be performed in accordance with Section 845.740(b).

General fill will be placed to manage stormwater following excavation of the coal ash from the OEAP and NAP. The eastern berms that do not contain coal ash will be excavated and used as low permeability soil or general fill. This will manage drainage on the final closure area to convey non-contact stormwater offsite.

2.2.2. Description of Removal Plan

<u>Section 845.720(a)(1)(B):</u> *If closure of the CCR surface impoundment will be accomplished through removal of CCR from the CCR surface impoundment, a description of the procedures to remove the CCR and decontaminate the CCR surface impoundment in accordance with Section 845.740.*

In general, the NAP and OEAP will be closed as one concurrent, continuous or semi-continues operation. The closure of the NAP and OEAP will be accomplished by removal of CCR from the surface impoundment. The NAP contains water in its northern section. Water from the CCR Impoundments is required to be removed and the CCR dewatered in accordance with the Order. The OEAP does not contain water. The existing coal ash will be consolidated and removed from the NAP and OEAP. All areas affected by releases of CCR from the CCR surface impoundment will be decontaminated. Groundwater monitoring will be performed in accordance with Section 845.740(b). All structures and conveyances used to manage CCR will be decontaminated or removed and sent to a onsite landfill.

<u>Section 845.720(a)(1)(C):</u> *If closure of the CCR surface impoundment will be accomplished by leaving CCR in place, a description of the final cover system, designed in accordance with Section 845.750, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in Section 845.750.*

Closure by Removal (CBR) is the closure method for the OEAP and NAP, and therefore, this Section is not applicable.

2.2.3. Estimate of the Maximum Inventory

Section 845.720(a)(1)(D): *An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR surface impoundment.*

Closure by removal at the facility will include removing approximately 992,000 cubic yards of coal ash from the OEAP and approximately 1,171,000 cubic yards of coal ash from the NAP.

2.2.4. Estimate of the Largest Area

Section 845.720(a)(1)(E): *An estimate of the largest area of the CCR surface impoundment ever requiring a final cover (see Section 845.750), at any time during the CCR surface impoundment's active life.*

A final cover is not required because the Closure by Removal method will be implemented.

2.2.5. Closure Completion Schedule

Section 845.720(a)(1)(F): A schedule for completing all activities necessary to satisfy the closure criteria in this Section, including an estimate of the year in which all closure activities for the CCR surface impoundment will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the CCR surface impoundment, including identification of major milestones such as coordinating with and obtaining necessary approvals and permits from other agencies, the dewatering and stabilization phases of CCR surface impoundment closure, or installation of the final cover system, and the estimated timeframes to complete each step or phase of CCR surface impoundment closure.

The closure schedule is provided for the scenario where a new on site landfill (Landfill) is provided. To construct the Landfill, the Plant will be demolished.

Table 2-1. CCR Closure Schedule

Milestone	Timeframe (all preliminary estimates)
Final Closure Plan	February 2022
Notification of Intent to Close Placed in Operating Record	By the date the owner or operator initiates closure of a CCR surface impoundment, the owner or operator must prepare a notification of intent to close a CCR surface impoundment. The

	notification must be placed in the facility's operating record as required by Section 845.800(d)(22) and Section 845.730(d).
Agency Coordination and Permit Acquisition • Coordinating with State Agencies for Compliance for Closure and On site Landfill • Acquiring various State permits	 Year 1 – 8 Year 2 – 8
Dewater and Stabilize CCR • Complete pond water removal and CCR Dewatering, as necessary • Complete Stabilization	 Year 1 - Ongoing NA
Mobilization (Plant Demolition)	Year 2
Plant Demolition (for onsite Landfill)	Year 2 through 6
Mobilization New Landfill	Year 6
Mobilization CCR Closure	Year 7
Excavate CCR and Haul to Landfill	Year 8 – 12
Estimate of Year in Which All Closure Activities Will be Completed	2033
Monitored Natural Attenuation (MNA) and Corrective Action (Long-Term) Groundwater Monitoring	2033 – Ongoing

3. AMENDMENTS OF FINAL CLOSURE PLAN

Section 845.720(b)(4): *If a final written closure plan revision is necessary after closure activities have started for a CCR surface impoundment, the owner or operator must submit a request to modify the construction permit within 60 days following the triggering event.*

If revisions are required for this Final Closure Plan, the owner will submit a request to modify the construction permit within 60 days following the triggering event.

Table 3-1. CCR Final Closure Plan Revisions

Revision Number and Date	Pages or Section	Description of Revision	Professional Engineer Certifying Plan
Version 0 January 2022	NA	Final Closure Plan	John Seymour, PE

4. CLOSURE BY REMOVAL

This section includes a description of the final closure by removal that will be completed for the NAP and OEAP surface impoundments, including principal design and construction features, material specifications, and a discussion of how each feature is in accordance with the requirements of Section 845.740. Drawings showing each design feature are provided in the OEAP and NAP Construction Permit Application.

4.1. Groundwater Corrective Action

Section 845.740(a): *Closure by Removal of CCR. An owner or operator may elect to close a CCR surface impoundment by removing all CCR and decontaminating all areas affected by releases of CCR from the CCR surface impoundment. CCR removal and decontamination of the CCR surface impoundment are complete when all CCR and CCR residues, containment system components such as the impoundment liner and contaminated subsoils, and CCR impoundment structures and ancillary equipment have been removed. Closure by removal must be completed before the completion of a groundwater corrective action under Subpart F.*

The owner has selected to close the CCR impoundments by CBR. Corrective action is required for OEAP and NAP.

4.2. Post-Closure Groundwater Monitoring

Section 845.740(b): *After closure by removal has been completed, the owner or operator must continue groundwater monitoring under Subpart F for three years after the completion of closure or for three years after groundwater monitoring does not show an exceedance of the groundwater protection standard established under Section 845.600, whichever is longer.*

The owner shall continue the groundwater monitoring under Subpart F for at least three years following the completion of closure and continue until groundwater monitoring does not show an exceedance of the groundwater protection standard.

4.3. Handle and Transport CCR

Section 845.740(c): *The owner or operator of a CCR surface impoundment removing CCR during closure must responsibly handle and transport the CCR consistent with this subsection.*

The CCR impoundments shall be closed utilizing CBR to a onsite landfill. Therefore, Section 845.740(c)(1) does not apply.

Section 845.740(c)(2): *The owner or operator of a CCR surface impoundment must develop and implement onsite dust controls, which must include: A) A water spray or other commercial dust* *suppressant to suppress dust in CCR handling areas and haul roads; and B) Handling of CCR to minimize airborne particulates and offsite particulate movement during any weather event or condition.*

The design documents will include ongoing wetting of exposed CCR materials in accordance with the site Fugitive Dust Plan.

<u>Section 845.740(c)(3):</u> *The owner or operator of a CCR surface impoundment must provide the following public notices: A) Signage must be posted at the property entrance warning of the hazards of CCR dust inhalation; and B) When CCR is transported off-site, a written notice explaining the hazards of CCR dust inhalation, the transportation plan, and tentative transportation schedule must be provided to units of local government through which the CCR will be transported.*

Signage shall be posted at the property entrance warning of the hazards of CCR dust inhalation. The language included in the signage will be specified in the Construction Bid Documents. The CCR impoundments shall be closed utilizing CBR to an onsite landfill. Therefore, Section 845.740(c)(3)(B) does not apply.

<u>Section 845.740(c)(4):</u> *The owner or operator of the surface impoundment must take measures to prevent contamination of surface water, groundwater, soil and sediments from the removal of CCR, including the following:*

A): CCR removed from the surface impoundment may only be temporarily stored, and must be stored in a lined landfill, CCR surface impoundment, enclosed structure, or CCR storage pile.

B): CCR storage piles must:

> *i) Be tarped or constructed with wind barriers to suppress dust and to limit stormwater contact with storage piles;*
>
> *ii) Be periodically wetted or have periodic application of dust suppressants;*
>
> *iii) Have a storage pad, or a geomembrane liner, with a hydraulic conductivity no greater than 1 x 10^{7} cm/sec, that is properly sloped to allow appropriate drainage;*
>
> *iv) Be tarped over the edge of the storage pad where possible;*
>
> *v) Be constructed with fixed and mobile berms, where appropriate, to reduce run-on and run-off of stormwater to and from the storage pile, and minimize stormwater-CCR contact; and*

vi) Have a groundwater monitoring system that is consistent with the requirements of Section 845.630 and approved by the Agency.

C): The owner or operator of the CCR surface impoundment must incorporate general housekeeping procedures such as daily cleanup of CCR, tarping of trucks, maintaining the pad and equipment, and good practices during unloading and loading.

D): The owner or operator of the CCR must minimize the amount of time the CCR is exposed to precipitation and wind.

E): The discharge of stormwater runoff that has contact with CCR must be covered by an individual National Pollutant Discharge Elimination System (NPDES) permit. The owner or operator must develop and implement a Stormwater Pollution Prevention Plan (SWPPP) in addition to any other requirements of the facility's NPDES permit. Any construction permit application for closure must include a copy of the SWPPP.

The final CBR design documents shall include specifications in accordance with this Section. Stockpiling of CCR materials will only be conducted within the existing surface impoundments and with the onsite Landfill. Stockpiling will not occur outside of these limits. Any stockpiling will include measures such as tarping or temporary berms to reduce wind and precipitation exposure.

The owner shall incorporate general housekeeping procedures such as daily cleanup of CCR, tarping of trucks, maintaining the pad and equipment, and good practices during unloading and loading. The design documents will include ongoing wetting of exposed CCR materials in accordance with the site Fugitive Dust Plan. The discharge of stormwater runoff that has contact with CCR shall be covered by an individual NPDES permit and copy of the Stormwater Pollution Prevention Plan (SWPPP) is included in the OEAP and NAP Construction Permit Application. Dynegy will be applying for a modification to NPDES Permit No. IL0004057 to reflect the planned physical alterations and short-term discharges of waters from the ponds.

4.4. Monthly Reporting

<u>Section 845.740(d):</u> *At the end of each month during which CCR is being removed from a CCR surface impoundment, the owner or operator must prepare a report that:*

1) Describes the weather, precipitation amounts, the amount of CCR removed from the CCR surface impoundment, the amount and location of CCR being stored on-site, the amount of CCR transported offsite, the implementation of good housekeeping procedures required by subsection (c)(4)(C), and the implementation of dust control measures; and

2) Documents worker safety measures implemented. The owner or operator of the CCR surface impoundment must place the monthly report in the facility's operating record as required by Section 845.800(d)(23).

The owner shall prepare a monthly report during construction in accordance with the Section 845.740(d).

4.5. Completion of CCR Removal

Section 845.740(e): *Upon completion of CCR removal and decontamination of the CCR surface impoundment under subsection (a), the owner or operator of the CCR surface impoundment must submit to the Agency a completion of CCR removal and decontamination report and a certification from a qualified professional engineer that CCR removal and decontamination of the CCR surface impoundment has been completed in accordance with this Section. The owner or operator must place the CCR removal and decontamination report and certification in the facility's operating record as required by Section 845.800(d)(32).*

Upon completion of CCR removal and decontamination of the CCR surface impoundment under subsection (a), the owner shall submit to the Agency a completion of CCR removal and decontamination report and a certification from a qualified professional engineer that CCR removal and decontamination of the CCR surface impoundment has been completed in accordance with this Section and place the documents in the facility's operating record.

4.6. Completion of Groundwater Monitoring

Section 845.740(f): *Upon completion of groundwater monitoring required under subsection (b), the owner or operator of the CCR surface impoundment must submit to the Agency a completion of groundwater monitoring report and a certification from a qualified professional engineer that groundwater monitoring has been completed in accordance with this Section. The owner or operator must place the groundwater monitoring report and certification in the facility's operating record as required by Section 845.800(d)(24).*

Upon completion of the groundwater monitoring program in accordance with subsection (b), the owner shall submit to the Agency a completion of groundwater monitoring report and a certification from a qualified professional engineer that groundwater monitoring has been completed in accordance with this Section and place the documents in the facility's operating record.

5. CERTIFICATION

CCR Unit: Dynegy Midwest Generation, LLC; Vermilion Power Plant, Old East Ash Pond Area and North Ash Pond Area

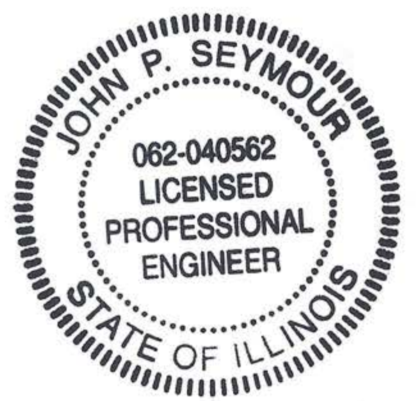
I, John Seymour, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify in accordance with Section 845.720(b)(5), to the best of my knowledge, information, and belief, that the information contained in this plan has been prepared in accordance with the accepted practice of engineering and meets the requirements of Section 845.720(b).

John Seymour
Printed Name

1/25/2022

Signature Date

062.040562 Illinois 30 November 2023
Registration Number State Expiration Date



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APPENDIX 1

Closure Alternatives Analysis (CAA) and Corrective Measures Assessment (CMA)/Corrective Action Alternatives Analysis (CAAA)

Closure Alternatives Analysis and Corrective Measures Assessment/ Corrective Action Alternatives Analysis for the North Ash Pond/Old East Ash Pond (NAP/OEAP) and New East Ash Pond (NEAP) Vermilion Power Plant Oakwood, Illinois

January 28, 2022

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www.gradientcorp.com
One Beacon Street, 17th Floor
Boston, MA 02108
617-395-5000

Table of Contents

Page

Summary of Findings ... S-1

1 Introduction ... 1
1.1 Site Description and History ... 1
1.1.1 Site Location and History ... 1
1.1.2 CCR Impoundments ... 1
1.1.3 Surface Water Hydrology ... 3
1.1.4 Hydrogeology ... 3
1.1.4.1 NAP/OEAP ... 3
1.1.4.2 NEAP ... 4
1.1.5 Site Vicinity ... 5
1.2 Part 845 Regulatory Review and Requirements ... 5

2 Closure Alternatives Analysis ... 6
2.1 Closure Alternative Descriptions (IAC Section 845.710(c)) ... 6
2.1.1 Closure-by-Removal with On-Site CCR Disposal ... 6
2.1.2 Closure-by-Removal with Off-Site CCR Disposal ... 10
2.2 Long- and Short-Term Effectiveness of Closure Alternative (IAC Section 845.710(b)(1)) ... 11
2.2.1 Magnitude of Reduction of Existing Risks (IAC Section 845.710(b)(1)(A)) ... 11
2.2.2 Likelihood of Future Releases of CCR (IAC Section 845.710(b)(1)(B)) ... 12
2.2.3 Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (IAC Section 845.710(b)(1)(C)) ... 14
2.2.4 Short-Term Risks to the Community or the Environment During Implementation of Closure (IAC Section 845.710(b)(1)(D)) ... 14
2.2.4.1 Worker Risks ... 14
2.2.4.2 Community Risks ... 16
2.2.4.3 Environmental Risks ... 21
2.2.5 Time Until Groundwater Protection Standards Are Achieved (IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3)) ... 23
2.2.6 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 845.710(b)(1)(F)) ... 23
2.2.7 Long-Term Reliability of the Engineering and Institutional Controls (IAC Section 845.710(b)(1)(G)) ... 23

2.2.8 Potential Need for Future Corrective Action Associated with the Closure (IAC Section 845.710(b)(1)(H)) 24
2.3 Effectiveness of the Closure Alternative in Controlling Future Releases (IAC Section 845.710(b)(2)) 24
2.3.1 Extent to Which Containment Practices Will Reduce Further Releases (IAC Section 845.710(b)(2)(A)) 24
2.3.2 Extent to Which Treatment Technologies May Be Used (IAC Section 845.710(b)(2)(B)) 24
2.4 Ease or Difficulty of Implementing Closure Alternative (IAC Section 845.710(b)(3)) 24
2.4.1 Degree of Difficulty Associated with Constructing the Closure Alternative 24
2.4.2 Expected Operational Reliability of the Closure Alternative 25
2.4.3 Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies 25
2.4.4 Availability of Necessary Equipment and Specialists 26
2.4.5 Available Capacity and Location of Needed Treatment, Storage, and Disposal Services 26
2.5 Impact of Closure Alternative on Waters of the State (IAC Section 845.710(d)(4)) 27
2.6 Concerns of Residents Associated with Closure Alternatives (IAC Section 845.710(b)(4)) 27
2.7 Class 4 Cost Estimate (IAC Section 845.710(d)(1)) 28
2.8 Summary 28

3 Corrective Measures Assessment 30
3.1 Corrective Measure Alternative Descriptions 31
3.1.1 Source Control with Monitored Natural Attenuation 32
3.1.2 Source Control with Groundwater Extraction 32
3.1.3 Source Control with Monitored Natural Attenuation and Groundwater Extraction 33
3.1.4 Source Control with Construction of a Cutoff Wall 33
3.1.5 Source Control with Construction of a Permeable Reactive Barrier 34
3.2 Performance, Reliability, Ease of Implementation, and Potential Impacts of the Corrective Measure Alternative (IAC Section 845.660(c)(1)) 34
3.2.1 Performance of the Corrective Measure Alternative – Controlling the Source (IAC Section 845.660(c)(1)) 34
3.2.2 Performance of the Corrective Measure Alternative – Likelihood of Future Releases of CCR (IAC Section 845.660(c)(1)) 35
3.2.3 Performance of the Corrective Measure Alternative – Long-Term Management (IAC Section 845.660(c)(1)) 36
3.2.4 Reliability of the Corrective Measure Alternative – Engineering and Institutional Controls (IAC Section 845.660(c)(1)) 37

3.2.5 Reliability of the Corrective Measure Alternative - Potential Need for Replacement of the Corrective Measure (IAC Section 845.660(c)(1)) ... 38
3.2.6 Ease of Implementation (IAC Section 845.660(c)(1)) ... 39
3.2.7 Potential Impacts – Risks to the Community or the Environment During Implementation of Remedy (IAC Section 845.660(c)(1)) ... 40
3.3 The Time Required to Begin and Complete the Corrective Action Plan (IAC Section 845.660(c)(2)) ... 42
3.4 State or Local Permit Requirements or Other Environmental or Public Health Requirements that May Substantially Affect Implementation of the Corrective Action Plan (IAC Section 845.660(c)(3)) ... 42
3.5 Summary ... 42

4 Corrective Action Alternatives Analysis ... 44
4.1 Long- and Short-Term Effectiveness and Protectiveness of Corrective Action Alternative (IAC Section 845.670(e)(1)) ... 44
4.1.1 Magnitude of Reduction of Existing Risks (IAC Section 845.670(e)(1)(A)) ... 44
4.1.2 Effectiveness of the Remedy in Controlling the Source (IAC Section 845.670(e)(2)) ... 45
4.1.3 Likelihood of Future Releases of CCR (IAC Section 845.670(e)(1)(B)) ... 45
4.1.4 Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (IAC Section 845.670(e)(1)(C)) ... 46
4.1.5 Short-Term Risks to the Community or the Environment During Implementation of Remedy (IAC Section 845.670(e)(1)(D)) ... 46
4.1.6 Time Until Groundwater Protection Standards Are Achieved (IAC Section 845.670(e)(1)(E)) ... 48
4.1.7 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)) ... 49
4.1.8 Long-Term Reliability of the Engineering and Institutional Controls (IAC Section 845.670(e)(1)(G)) ... 49
4.1.9 Potential Need for Replacement of the Remedy (IAC Section 845.670(e)(1)(H)) ... 50
4.2 The Ease or Difficulty of Implementing a Remedy (IAC Section 845.670 (e)(3)) ... 51
4.2.1 Degree of Difficulty Associated with Constructing the Remedy (IAC Section 845.670(e)(3)(A) ... 51
4.2.2 Expected Operational Reliability of the Remedy (IAC Section 845.670(e)(3)(B)) ... 51
4.2.3 Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies (IAC Section 845.670(e)(3)(C)) ... 51

4.2.4 Availability of Necessary Equipment and Specialists (IAC Sections 845.670(e)(3)(D) and 845.660(c)(1), "Ease of Implementation") 52
4.2.5 Available Capacity and Location of Needed Treatment, Storage, and Disposal Services (IAC Section 845.670(e)(3)(D)) 52
4.3 The Degree to Which Community Concerns Are Addressed by the Remedy (IAC Section 845.670(e)(4)) 52
4.4 Summary 53

References 54

Appendix A 2020 Human Health and Ecological Risk Assessment
Appendix B 2021 Update to 2020 Human Health and Ecological Risk Assessment
Appendix C Supporting Information

List of Tables

Table S.1 Comparison of Proposed Closure Scenarios

Table S.2 Comparison of Proposed Corrective Measure Alternatives with Respect to Factors Specified in IAC Section 845.660(c)

Table S.3 Comparison of Proposed Corrective Measure Alternatives with Respect to Factors Specified in IAC Section 845.670(e)

Table 2.1 Key Parameters for the Closure-by-Removal with On-Site CCR Disposal Scenario

Table 2.2 Key Parameters for the Closure-by-Removal with Off-Site CCR Disposal Scenario

Table 2.3 Expected Number of On-Site Worker Accidents Under Each Closure Scenario

Table 2.4 Expected Number of Off-Site Worker Accidents Under Each Closure Scenario

Table 2.5 Expected Number of Community Accidents Under Each Closure Scenario

Table 2.6 Expected Costs of Closure

List of Figures

Figure 1.1 Site Location Map

Figure 2.1 Environmental Justice Communities in the Vicinity of the Off-Site Landfill

Abbreviations

AACE	Association for the Advancement of Cost Engineering
BMP	Best Management Practice
CAA	Closure Alternatives Analysis
CAAA	Corrective Action Alternatives Analysis
CBR	Closure-by-Removal
CBR-Offsite	Closure-by-Removal with Off-Site CCR Disposal
CBR-Onsite	Closure-by-Removal with On-Site CCR Disposal
CCR	Coal Combustion Residual
CIP	Closure-in-Place
CMA	Corrective Measures Assessment
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CW	Cutoff Wall
CY	Cubic Yard
DMG	Dynegy Midwest Generation, LLC
EJ	Environmental Justice
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GE	Groundwater Extraction
Geosyntec	Geosyntec Consultants
GHG	Greenhouse Gas
GWPS	Groundwater Protection Standard
HDPE	High-Density Polyethylene
IAC	Illinois Administrative Code
IDNR	Illinois Department of Natural Resources
IDW	Investigation-Derived Waste
IEPA	Illinois Environmental Protection Agency
IFR	Initial Facility Report
LGU	Lower Groundwater Unit
LLDPE	Linear Low-Density Polyethylene
MCY	Million Cubic Yards
MGU	Middle Groundwater Unit
MNA	Monitored Natural Attenuation
N_2O	Nitrous Oxide
NAP	North Ash Pond
NEAP	New East Ash Pond
NID	National Inventory of Dams
NO_x	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
OEAP	Old East Ash Pond
PM	Particulate Matter
PMP	Potential Migration Pathway

PRB	Permeable Reactive Barrier
SERP	Safety Emergency Response Plan
SHPO	State Historic Preservation Office
Source Control-CW	Source Control with Construction of a Cutoff Wall
Source Control-GE	Source Control with Groundwater Extraction
Source Control-MNA	Source Control with Monitored Natural Attenuation
Source Control-MNA/GE	Source Control with Monitored Natural Attenuation and Groundwater Extraction
Source Control-PRB	Source Control with Construction of a Permeable Reactive Barrier
Stantec	Stantec Consulting Services Inc.
TVA	Tennessee Valley Authority
US DOT	United States Department of Transportation
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WPC Permit	Water Pollution Control Construction and Operating Permit

Summary of Findings

Title 35, Part 845 of the Illinois Administrative Code (IAC; IEPA, 2021a) requires the development of a Closure Alternatives Analysis (CAA) prior to undertaking closure activities at certain surface impoundments containing coal combustion residuals (CCRs) in the State of Illinois. Part 845 additionally requires that a Corrective Measures Assessment (CMA) and a Corrective Action Alternatives Analysis (CAAA) be performed prior to undertaking corrective measures/corrective actions at certain CCR surface impoundments. Pursuant to requirements under IAC Section 845.710, this report presents a CAA for the retired North Ash Pond/Old East Ash Pond (NAP/OEAP) impoundment system and the retired New East Ash Pond (NEAP) impoundment located on Dynegy Midwest Generation, LLC's (DMG) Vermilion Power Plant property near the Village of Oakwood, Illinois. This report also presents a CMA for the NAP/OEAP and the NEAP pursuant to requirements under IAC Section 845.660 and a CAAA pursuant to requirements under IAC Section 845.670 (IEPA, 2021a).

Closure Alternatives Analysis

The goal of a CAA is to holistically evaluate potential closure scenarios with respect to a wide range of factors, including the efficiency, reliability, and ease of implementation of the closure scenario; its potential positive and negative short- and long-term impacts on human health and the environment; and its ability to address concerns raised by residents (IAC Part 845; IEPA, 2021a). As mandated by the Agreed Interim Order entered on June 30, 2021 (Illinois, Attorney General, 2021), Gradient evaluated only Closure-by-Removal (CBR) as source control for the NAP/OEAP and the NEAP. Two specific closure scenarios were considered: Closure-by-Removal with On-Site CCR Disposal (CBR-Onsite) and Closure-by-Removal with Off-Site CCR Disposal (CBR-Offsite). Consistent with the Agreed Interim Order, the CAA does not address Closure-in-Place (CIP). Both of the CBR scenarios that were evaluated entail excavating all of the CCR from the former NAP/OEAP and NEAP impoundments and transporting it to a landfill for disposal. Both scenarios also include the construction and operation of a groundwater collection trench that will be installed and operated until closure has been completed, as required by the Agreed Interim Order (Illinois, Attorney General, 2021); the groundwater collection trench will prevent seeps and discolored water from reaching the Middle Fork of the Vermilion River. Under the CBR-Onsite disposal option, the Vermilion Power Plant would be demolished and a landfill will be constructed over a portion of its footprint. Under the CBR-Offsite option, CCR would instead be hauled to an off-Site landfill. DMG will also continue to evaluate potential opportunities for the beneficial re-use of CCR excavated from the NAP/OEAP and the NEAP as an alternative to disposal.

Table S.1 summarizes the expected impacts of the CBR-Onsite and CBR-Offsite closure alternatives with regards to each of the factors specified under IAC Section 845.710 (IEPA, 2021a). Based on this evaluation and the additional details provided in Section 2 of this report, CBR-Onsite has been identified as the most appropriate closure alternative for the NAP/OEAP and the NEAP. Key benefits of the CBR-Onsite scenario relative to the CBR-Offsite scenario include near-term plans for the demolition of the power plant, which will have scenic benefits along Illinois's only National Scenic River, and reduced impacts to community members and the environment due to construction activities (*e.g.*, fewer constructed-related community accidents, lower energy demands, less air pollution and greenhouse gas [GHG] emissions, less traffic, and lower impacts to environmental justice [EJ] communities).

Table S.1 Comparison of Proposed Closure Scenarios

Evaluation Factor (Report Section; Part 845 Section)	Closure Scenario	
	CBR-Onsite	**CBR-Offsite**
Closure Alternative Descriptions (Section 2.1; IAC Section 845.710(c))	The Vermilion Power Plant would be demolished and a landfill would be constructed over a portion of its footprint. All CCR would be excavated from the NAP/OEAP and NEAP and transported to the on-Site landfill for disposal. This scenario meets the requirement of IAC Section 845.710(c)(2) (IEPA, 2021a) that an assessment be conducted in the CAA regarding whether the Site has an on-Site landfill with available capacity or whether an on-Site landfill can be constructed.	All CCR would be excavated from the NAP/OEAP and NEAP and transported to an off-Site landfill for disposal.
Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (Section 2.2.3; IAC Section 845.710(b)(1)(C))	Groundwater and surface water monitoring would be performed at the closed impoundments until groundwater protection standards (GWPSs) have been achieved. A minimum of 30 years of post-closure care would be performed at the on-Site landfill, including leachate management and cap inspection, mowing and maintenance, and groundwater and surface water monitoring.	Groundwater and surface water monitoring would be performed at the closed impoundments until GWPSs have been achieved.
Magnitude of Reduction of Existing Risks (Section 2.2.1; IAC Sections 845.710(b)(1)(A) and 845.710(b)(1)(F))	There are no current risks to any human or ecological receptors. Because there are no current risks, and dissolved constituent concentrations are expected to decline post-closure, no risks to human or ecological receptors are expected post-closure.	There are no current risks to any human or ecological receptors. Because there are no current risks, and dissolved constituent concentrations are expected to decline post-closure, no risks to human or ecological receptors are expected post-closure.

Evaluation Factor (Report Section; Part 845 Section)	Closure Scenario	
	CBR-Onsite	**CBR-Offsite**
Likelihood of Future Releases of CCR (Section 2.2.2; IAC Sections 845.710(b)(1)(B) and 845.710(b)(1)(F))	During closure, there would be minimal risk of dike failure due to flooding or seismic activity and minimal risk of dike overtopping during flood conditions. Similarly, there would be minimal risk to the on-Site landfill due to flooding or seismic activity. Risk of dike failure occurring due to riverbank erosion would be managed with riverbank monitoring and, if needed, temporary riverbank maintenance measures. The risk of needing temporary riverbank maintenance measures would be slightly higher for the CBR-Onsite scenario compared to the CBR-Offsite scenario, because the excavation of CCR from the impoundments would be delayed by approximately 6 years in order to demolish the power plant and construct the landfill. However, the overall risk of dike failure would be low because of the riverbank monitoring and mitigation measures that are in place. Post-closure, there would be no risk of CCR releases due to dike failure. Furthermore, there would be no risk to the on-Site landfill associated with future meandering and erosion of the river (Geosyntec, 2022a).	During closure, there would be minimal risk of dike failure due to flooding or seismic activity and minimal risk of dike overtopping during flood conditions. Risk of dike failure occurring due to riverbank erosion would be managed with riverbank monitoring and, if needed, temporary riverbank maintenance measures. The risk of needing temporary riverbank maintenance measures would be slightly lower for the CBR-Offsite scenario compared to the CBR-Onsite scenario, because it would result in CCR being removed from the impoundments more quickly. Post-closure, there would be no risk of CCR releases due to dike failure. Overall, while the timing of various risks differs for the two closure scenarios, the magnitude of the likelihood of future releases under both scenarios would be expected to be approximately the same.
Worker Risks (Section 2.2.4.1; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F))	An estimated 0.051 fatalities and 6.4 injuries would be expected to occur to workers due to on-Site activities under this scenario. An estimated 0.061 fatalities and 4.7 injuries would be expected to occur to workers due to off-Site activities (hauling, labor and equipment mobilization and demobilization, and materials deliveries) under this scenario. In total, 0.11 worker fatalities and 11 worker injuries would be expected under this scenario.	An estimated 0.027 fatalities and 2.8 injuries would be expected to occur to workers due to on-Site activities under this scenario. An estimated 0.055 fatalities and 3.8 injuries would be expected to occur to workers due to off-Site activities (hauling, labor and equipment mobilization and demobilization, and materials deliveries) under this scenario. In total, 0.082 worker fatalities and 6.6 worker injuries would be expected under this scenario.

Evaluation Factor (Report Section; Part 845 Section)	Closure Scenario	
	CBR-Onsite	**CBR-Offsite**
Community Risks (Section 2.2.4.2; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F)) *Off-Site Impacts on Nearby Residents and Environmental Justice (EJ) Communities*	Off-Site impacts on nearby residents and EJ communities (including accidents, traffic, noise, and air pollution) would be less under this scenario, because it would only require transport of workers, equipment, and materials to and from the Site. No off-Site transport of CCR would be required. An estimated 0.031 fatalities and 2.1 injuries would be expected to occur among community members due to off-Site activities related to closure.	Off-Site impacts on nearby residents and EJ communities would be greater under this scenario, because it would require substantial off-Site CCR hauling in addition to the transport of workers, equipment, and materials to and from the Site. An estimated 0.090 fatalities and 3.3 injuries would be expected to occur among community members due to off-Site activities related to closure. A haul truck would likely pass a location near the Site every 2.5 minutes on average for the duration of excavation activities, resulting in substantial traffic demands. Additionally, the proposed off-Site landfill location would be within the buffer zone of the EJ community near Tilton, and the transport of CCR to the landfill would require hauling CCR through the EJ communities near Tilton and Danville. Oakwood Junior High School is located at 21600 North 900 East Road in Danville, at the entrance to the Vermilion Power Plant. As a result of considerable off-Site hauling activities, the CBR-Offsite scenario would create greater traffic, nuisance, and safety concerns at the school than would occur under the CBR-Onsite scenario.

Evaluation Factor (Report Section; Part 845 Section)	**Closure Scenario**	
	CBR-Onsite	**CBR-Offsite**
Impacts on Scenic, Historical, and Recreational Value	Due to (*e.g.*) noise and visual disturbances, construction activities may have short-term negative impacts on the recreational use of the Orchid Hill Natural Heritage Landmark and the Middle Fork of the Vermilion River. The overall magnitude of the short-term impacts to scenic and recreational value under both scenarios would be expected to be approximately the same. Despite causing some negative short-term impacts, this closure scenario would be expected to have long-term scenic and recreational benefits. These include near-term plans to demolish the power plant, which would have scenic benefits to the Middle Fork of the Vermilion River and increase public access to the Orchid Hill Natural Heritage Landmark. There are no historical sites in the vicinity of the NAP/OEAP or the NEAP. Thus, no impacts on historical sites are expected under either closure scenario.	Due to (*e.g.*) noise and visual disturbances, construction activities may have short-term negative impacts on the recreational use of the Orchid Hill Natural Heritage Landmark and the Middle Fork of the Vermilion River. The overall magnitude of the short-term impacts to scenic and recreational value under both scenarios would be expected to be approximately the same. Long-term scenic and recreational benefits would be less certain under this closure scenario than under the CBR-Onsite scenario. Eventually, we assume that the power plant would be demolished under this scenario, resulting in scenic benefits to the Middle Fork of the Vermilion River and increased public access to the Orchid Hill Natural Heritage Landmark. However, these benefits may not be realized for an undetermined amount of time following closure. There are no historical sites in the vicinity of the NAP/OEAP or the NEAP. Thus, no impacts on historical sites are expected under either closure scenario.
Environmental Risks (Section 2.2.4.3; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F)) *Impacts on Greenhouse Gas Emissions and Energy Consumption*	Overall (on-Site + off-Site) energy demands and GHG emissions from construction equipment and vehicles would expected to be lower under this closure scenario than under the CBR-Offsite scenario. The CBR-Onsite scenario would have an additional, unquantified carbon footprint due to the need to manufacture >50 acres of geomembranes for the on-Site landfill bottom liner and final cover system.	Overall (on-Site + off-Site) energy demands and GHG emissions from construction equipment and vehicles would be expected to be greater under this closure scenario. If expansion of the off-Site landfill becomes necessary in order to accept all of the CCR from the impoundments, then the CBR-Offsite scenario may also have an additional, unquantified carbon footprint due to the need to manufacture geomembranes for use in the expanded landfill liner.

Evaluation Factor (Report Section; Part 845 Section)	Closure Scenario	
	CBR-Onsite	**CBR-Offsite**
Impacts on Natural Resources and Habitat	Construction activities may have short-term negative impacts on terrestrial and aquatic species located near the impoundments and the on-Site landfill location. Construction would also cause a long-term shift in the habitat type atop portions of the impoundments. The overall magnitude of the short-term impacts to natural resources and habitat under both scenarios would be expected to be approximately the same. Despite causing some negative short-term impacts, this closure scenario would be expected to have long-term benefits to natural resources and habitat. These include near-term plans to demolish the power plant, which would result in the creation of new habitat atop the footprint of the impoundment (and, post-closure, atop the footprint of the new on-Site landfill).	Construction activities may have short-term negative impacts on terrestrial and aquatic species located near the impoundments, along the haul roads, and near the off-Site landfill location. Construction would also cause a long-term shift in the habitat type atop portions of the impoundments. The overall magnitude of the short-term impacts to natural resources and habitat value under both scenarios would be expected to be approximately the same. Long-term benefits to natural resources and habitat would be less certain under this closure scenario than under the CBR-Onsite scenario. Eventually, we assume that the power plant would be demolished under this scenario, resulting in the creation of new habitat atop the footprint of the power plant. However, these benefits may not be realized for an undetermined amount of time following closure.
Time Until Groundwater Protection Standards Are Achieved (Section 2.2.5; IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3))	At sites where groundwater corrective action will be implemented, it is inappropriate to evaluate the time to achieve GWPSs based on closure alone, because both closure and corrective actions will affect future groundwater concentrations. See Section 4.1.6 of the CAAA for an evaluation of the times to achieve GWPSs at the Site based both on source control and the corrective action alternatives.	At sites where groundwater corrective action will be implemented, it is inappropriate to evaluate the time to achieve GWPSs based on closure alone, since both closure and corrective actions will affect future groundwater concentrations. See Section 4.1.6 of the CAAA for an evaluation of the times to achieve GWPSs at the Site based both on source control and the corrective action alternatives.
Long-Term Reliability of the Engineering and Institutional Controls (Section 2.2.7; IAC Section 845.710(b)(1)(G))	CBR-Onsite would be expected to be a reliable closure alternative over the long term.	CBR-Offsite would be expected to be a reliable closure alternative over the long term.
Potential Need for Future Corrective Action (Section 2.2.8; IAC Section 845.710(b)(1)(H))	There would be no difference between the two closure scenarios regarding the potential need for future corrective actions (or regarding the extent to which treatment technologies may be used).	There would be no difference between the two closure scenarios regarding the potential need for future corrective actions (or regarding the extent to which treatment technologies may be used).

Evaluation Factor (Report Section; Part 845 Section)	**Closure Scenario**	
	CBR-Onsite	**CBR-Offsite**
Effectiveness of the Alternative in Controlling Future Releases (Section 2.3; IAC Section 845.710(b)(2)(A and B))	There would be no risk of CCR releases occurring post-closure under either closure scenario.	There would be no risk of CCR releases occurring post-closure under either closure scenario.
Ease or Difficulty of Implementing the Alternative (Section 2.4; IAC Section 845.710(b)(3)) *Degree of Difficulty Associated with Construction*	Excavation of the impoundments would present the same level of difficulty under both closure scenarios. Hauling would be easier to implement under the CBR-Onsite scenario than under the CBR-Offsite scenario, due to the shorter haul distance required, the larger haul truck capacity, and the lack of need to haul over public roads under this scenario. A smaller number of trucks and truck trips would also be required under the CBR-Onsite scenario than under the CBR-Offsite scenario. Constructing a new on-Site landfill under this scenario would require additional planning, design, and construction.	Excavation of the impoundments would present the same level of difficulty under both closure scenarios. Hauling would be more difficult to implement under the CBR-Offsite scenario than under the CBR-Onsite scenario, due to the longer haul distance required, the smaller haul truck capacity, and the need to haul over public roads under this scenario. A larger number of trucks and truck trips would also be required under the CBR-Offsite scenario than under the CBR-Onsite scenario. Additionally, because the CBR-Offsite scenario involves hauling ash off-Site (*i.e.*, intrastate travel), a higher level of dewatering would be required compared to the CBR-Onsite scenario. Off-Site landfilling under the CBR-Offsite scenario would require the development of a disposal plan and may raise issues related to the co-disposal of CCR and other non-hazardous wastes. The off-Site landfill may also need to be expanded to receive all of the CCR generated during excavation.
Expected Operational Reliability	Operational reliability would be expected under both closure scenarios.	Operational reliability would be expected under both closure scenarios.

Evaluation Factor (Report Section; Part 845 Section)	Closure Scenario	
	CBR-Onsite	**CBR-Offsite**
Need for Permits and Approvals	Permits required under both closure scenarios would include modifications to the existing NPDES permit, a general NPDES permit for construction activities, and a joint water pollution control construction and operating permit (WPC permit). As required by the Agreed Interim Order (Illinois, Attorney General, 2021), construction of the on-Site landfill under the CBR-Onsite scenario would also require a demolition permit and potentially a landfill permit. In addition, the new on-Site landfill would require a construction stormwater permit through IEPA, including construction stormwater controls and Best Management Practices (BMPs) such as silt fences and other measures.	Permits required under both scenarios would include modifications to the existing NPDES permit, a general NPDES permit for construction activities, and a joint water pollution control construction and operating permit (WPC permit). Additional permits and approvals may be required under the CBR-Offsite scenario if the landfill must be expanded to receive all of the CCR from the impoundments.
Availability of Equipment and Specialists	CBR-Onsite and CBR-Offsite would rely on common construction equipment and materials and typically would not require the use of specialists. However, global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be delays in construction under both scenarios if supply chain resilience does not improve by the time construction begins.	CBR-Onsite and CBR-Offsite would rely on common construction equipment and materials and typically would not require the use of specialists. However, global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be delays in construction under both scenarios if supply chain resilience does not improve by the time construction begins. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the longer hauling distance required, the smaller haul truck capacity, and the need to haul over public roads under this scenario.

Evaluation Factor (Report Section; Part 845 Section)	Closure Scenario	
	CBR-Onsite	**CBR-Offsite**
Available Capacity and Location of Treatment, Storage, and Disposal Services	The new on-Site Landfill would be designed and constructed to be able to receive all CCR that has been generated on-Site.	The capacity remaining at the chosen off-Site landfill in Danville, Illinois, would be sufficient to receive all of the CCR in the impoundments. However, due to the relatively short period over which CCR would be received at this landfill, vertical and/or lateral expansions may become necessary. Additionally, the landfill operators may need to develop a disposal plan to account for the increased volume of material that will be received and the unique CCR waste characteristics. Elements of this disposal plan might include increasing daily operational capacity and procedures, expediting planned airspace construction, and potentially expediting landfill expansion. If expansion of the Danville landfill were found to be impractical or infeasible, then an alternative landfill located farther from the Site would need to be identified.
Impact of Alternative on Waters of the State (Section 2.5; IAC Section 845.710(d)(4))	There are no current exceedances of any human health or ecological screening benchmarks in the Middle Fork of the Vermilion River (Appendices A and B). Modeling concluded that mass flux to the Middle Fork of the Vermilion River from the MGU will be reduced by approximately 50% 10 years after closure is completed and by approximately 80% 35 years after closure is completed (Ramboll, 2022). Mass flux declines will occur more slowly in the LGU, which has lower constituent concentrations, due to its lower-permeability deposits (Ramboll, 2022). Thus, no future exceedances of any screening benchmarks for surface water are anticipated and no impact on any waters of the state are expected.	There are no current exceedances of any human health or ecological screening benchmarks in the Middle Fork of the Vermilion River (Appendices A and B). Modeling concluded that mass flux to the Middle Fork of the Vermilion River from the MGU will be reduced by approximately 50% 10 years after closure is completed and by approximately 80% 35 years after closure is completed (Ramboll, 2022). Mass flux declines will occur more slowly in the LGU, which has lower constituent concentrations, due to its lower-permeability deposits (Ramboll, 2022). Thus, no future exceedances of any screening benchmarks for surface water are anticipated and no impact on any waters of the state are expected.

Evaluation Factor (Report Section; Part 845 Section)	Closure Scenario	
	CBR-Onsite	**CBR-Offsite**
Potential Modes of Transportation Associated with CBR (Section 2.1; IAC Section 845.710(c)(1))	Not relevant for this scenario.	There is no established rail terminal or railroad track near the Site. In order for CCR to be transported by rail, a new rail line would need to be constructed that extends to the Union Pacific Railroad line located more than 5 miles northwest of the Site, and a loading terminal would also need to be constructed on-Site. This is considered infeasible, because it would increase the project schedule due to the need to coordinate with the railroad, complete design and permitting, and construct the terminal, and because additional land would need to be acquired. Furthermore, CCR would still need to be hauled by truck to the on-Site loading terminal and loaded into rail cars, resulting in additional CCR exposures and potential releases. The Middle Fork of the Vermilion River is not open to barge traffic. Therefore, transporting CCR by barge is not feasible for this site. The local availability and use of natural gas-powered trucks, or other low-polluting trucks, will be evaluated prior to the start of construction.

Evaluation Factor (Report Section; Part 845 Section)	Closure Scenario	
	CBR-Onsite	**CBR-Offsite**
Concerns of Residents Associated with Alternatives (Section 2.6; IAC Section 845.710(b)(4))	Source control under this closure scenario would address the primary concerns of residents (potential impacts to groundwater and surface water quality, and the potential for dike failure to occur due to riverbank migration). Under this scenario, dewatering would commence immediately, reducing the risks of dike failure and the leaching of CCR-associated constituents from the impoundment. CCR excavation would begin once the plant is demolished and the on-Site landfill is constructed. Because this scenario does not require off-Site hauling of CCR, it presents less risks to nearby residents and EJ communities in the form of accidents, traffic, noise, and air pollution. Additionally, this scenario would more rapidly address stakeholder concerns about having an inactive power plant located along Illinois's only National Scenic River. A public meeting was held on December 9, 2021, pursuant to requirements under IAC Section 845.710(e) and the Agreed Interim Order (IEPA, 2021a; Illinois, Attorney General, 2021). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.	Source control under this closure scenario would address the primary concerns of residents (potential for CCR in the impoundments to impact groundwater and surface water, and the potential for dike failure to occur due to riverbank migration). Under this scenario, excavation can begin immediately. However, this scenario presents greater risks to nearby residents and EJ communities in the form of accidents, traffic, noise, and air pollution due to the substantial off-Site hauling of CCR required. A public meeting was held on December 9, 2021, pursuant to requirements under IAC Section 845.710(e) and the Agreed Interim Order (IEPA, 2021a; Illinois, Attorney General, 2021). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.
Class 4 Cost Estimate (Section 2.7; IAC Section 845.710(d)(1))	The CBR-Onsite scenario can be implemented at a lower total cost (approximately $122 million) than the CBR-Offsite scenario (approximately $249 million). Cost estimates were prepared consistent with a Class 4 Estimate under the AACE Classification Standard.	The CBR-Onsite scenario can be implemented at a lower total cost (approximately $122 million) than the CBR-Offsite scenario (approximately $249 million). Cost estimates were prepared consistent with a Class 4 Estimate under the AACE Classification Standard.

Notes:

AACE = Association for the Advancement of Cost Engineering; CAAA = Corrective Action Alternatives Analysis; CBR = Closure by Removal; CCR = Coal Combustion Residual; GHG = Greenhouse Gas; IAC = Illinois Administrative Code; IEPA = Illinois Environmental Protection Agency; NAP = North Ash Pond; NPDES = National Pollutant Discharge Elimination System; OEAP = Old East Ash Pond.

Corrective Measures Assessment and Corrective Action Alternatives Analysis

The goal of performing a CMA and a CAAA is to holistically evaluate proposed corrective measures/corrective action alternatives in order to remediate groundwater and achieve compliance with the groundwater protection standards (GWPSs) specified under IAC Section 845.600 (IEPA, 2021a). These analyses assess proposed corrective measures/corrective action alternatives based on a wide range of factors, including the performance, reliability, and ease of implementation of the corrective measure; its potential impacts on human health and the environment; and its ability to address concerns raised by residents (IEPA, 2021a). The CMA provides a high-level screening of potential corrective measures. This analysis determines which corrective measures are potentially viable at a site and subject to further evaluation in the CAAA. The CAAA provides a more detailed analysis of potentially viable remedies, based on results of the CMA.

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 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 US EPA refused to specify what is a reasonable *versus* an unreasonable timeframe for groundwater corrective actions at CCR sites, stating that "EPA was truly unable to establish an outer limit on the necessary timeframes—including even a presumptive outer bound" (US EPA, 2015a, p. 21419).

It is also important to note that source control, which at a CCR impoundment could include either capping or excavation, 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). As a result, the implementation of source control often has a more substantial and more immediate effect on groundwater quality improvements than other groundwater corrective measures. In this CMA and CAAA, source control is paired with other additional groundwater remediation strategies.

Five potential corrective measures were selected for consideration in the CMA for this Site. Each corrective measure includes source control based on the CBR-Onsite scenario (*i.e.*, Closure-by-Removal with CCR disposal at an on-Site landfill). Corrective measures considered in the CMA include Source Control with Monitored Natural Attenuation (Source Control-MNA), Source Control with Groundwater Extraction (Source Control-GE), Source Control with Monitored Natural Attenuation and Groundwater

Extraction (Source Control-MNA/GE), Source Control with Construction of a Cutoff Wall (Source Control-CW), and Source Control with Construction of a Permeable Reactive Barrier (Source Control-PRB). Each of these corrective measures was evaluated in the CMA for its potential viability at the Site. Under the Source Control-MNA alternative, groundwater concentrations of dissolved constituents will attenuate *via* naturally occurring physical and chemical processes in areas downgradient of the NAP/OEAP; active monitoring will be performed to verify and document the remediation processes. Under the Source Control-GE alternative, the groundwater collection trench will continue operating post-closure in the OEAP area, and an additional GE system comprised of either groundwater pumping wells or a groundwater collection trench will be installed in the NAP area in order to extract potentially impacted groundwater from the aquifer, helping to contain the contaminant plume and prevent the lateral migration of constituents off-Site. Under the Source Control-MNA/GE alternative, the groundwater collection trench will continue operating post-closure in the OEAP area, and groundwater concentrations of dissolved constituents will attenuate *via* natural physical and chemical processes in areas downgradient of the NAP. Under the Source Control-CW alternative, a trench will be dug along the downgradient perimeter of the NAP/OEAP and filled with a soil-bentonite mixture, creating a low-permeability subsurface barrier to the lateral migration of constituents off-Site. Under the Source Control-PRB alternative, a subsurface barrier of reactive materials (*e.g.*, zerovalent iron) will be placed in the path of groundwater flow downgradient of the NAP/OEAP in order to promote the *in situ* transformation and/or immobilization of CCR-associated constituents.

Table S.2 evaluates the corrective measures included in this CMA with regards to each of the factors specified under IAC Section 845.660(c) (IEPA, 2021a). Based on this evaluation and the details provided in Section 3 of this report, two corrective measures, Source Control-MNA and Source Control-MNA/GE, have been identified as potentially viable corrective actions for the Site. Source Control-GE, Source Control-CW, and Source Control-PRB were not selected as viable corrective actions for consideration in the CAAA, for the following reasons:

- It is unlikely that Source Control-PRB would perform well at this Site, because PRBs have not been proven effective for lithium and boron in groundwater (both of which are CCR-associated constituents);
- Construction of the CW and the PRB would likely be very difficult, due to the required location, length, and depth of these structures;
- Source Control-GE may have a detrimental effect on the baseflow in the Middle Fork of the Vermilion River, because the GE system may capture/intercept water from the river. Furthermore, if groundwater pumping wells were installed at the NAP, the high iron content in the formation could lead to fouling of the well screens, which would create the need for frequent maintenance and, potentially, GE well replacement. If a groundwater collection trench were instead installed at the NAP, it would need to be deeper than the trench to be installed during closure at the OEAP, because groundwater from both the middle groundwater unit (MGU) and the lower groundwater unit (LGU) would need to be intercepted. Due to limited construction area between the river and the NAP perimeter berm, installation of a groundwater collection trench through both the MGU and the LGU near the NAP is likely infeasible. Furthermore, installation of a groundwater collection trench at the NAP could create a hydraulic connection between the MGU and the LGU, which could delay cleanup times.
- Both Source Control-CW and Source Control-PRB would likely have a large potential impact on the Middle Fork of the Vermilion River due to the extent of construction required in close proximity to the river; and

- Both Source Control-CW and Source Control-PRB would likely have relatively large impacts on worker safety, air quality, surface water quality, and sediment quality compared to the other alternatives due to the substantial construction activities required.

Table S.3 evaluates the two potentially viable corrective actions included in this CAAA, Source Control-MNA and Source Control-MNA/GE, with regard to each of the factors specified under IAC Section 845.670(e) (IEPA, 2021a). Based on this evaluation and the details provided in Section 4 of this report, the most appropriate corrective action for this Site is Source Control-MNA. Source Control-MNA and Source Control-MNA/GE both have similar design, construction, and operations and maintenance (O&M) requirements and, as a result, similar expected impacts on workers, nearby communities, and the environment. Modeling has also shown that there is no material difference between the two scenarios in terms of the time to achieve the GWPSs (Ramboll, 2022). Source Control-MNA is the preferred alternative at this Site.

Table S.2 Comparison of Proposed Corrective Measure Alternatives with Respect to Factors Specified in IAC Section 845.660(c)

Evaluation Factor (Report Section; Part 845 Section)	Corrective Measure Alternative				
	Source Control-MNA	**Source Control-GE**	**Source Control-MNA/GE**	**Source Control-CW**	**Source Control-PRB**
Corrective Measure Alternative Descriptions (Section 3.1)	Source Control-MNA would rely on naturally occurring physical and chemical processes to immobilize and attenuate concentrations of CCR-associated constituents in groundwater in the OEAP and NAP areas. Active groundwater monitoring would be performed to ensure that the remedy is working as intended.	Under Source Control-GE, the groundwater collection trench would continue operating post-closure in the OEAP area. An additional GE system comprised of either groundwater pumping wells or a groundwater collection trench would be installed in the NAP area to extract potentially impacted groundwater and prevent the lateral migration of constituents off-Site. Groundwater captured by the GE system would be treated, if necessary, and discharged to the Middle Fork of the Vermilion River *via* one of the facility's NPDES-permitted outfalls. Monitoring would be performed to ensure that the remedy is working as intended.	Under Source Control-MNA/GE, the groundwater collection trench would continue operating post-closure in the OEAP area. Naturally occurring physical and chemical processes would immobilize and attenuate concentrations of CCR-associated constituents in groundwater in the NAP area. Groundwater and seep water captured by the groundwater collection trench would be treated, if necessary, and discharged to the Middle Fork of the Vermilion River *via* one of the facility's NPDES-permitted outfalls. Monitoring would be performed to ensure that the remedy is working as intended.	Under Source Control-CW, a trench would be dug along the downgradient perimeter of the former impoundments and filled with a soil-bentonite mixture, creating a low-permeability subsurface barrier that would prevent the lateral migration of constituents off-Site. Hydraulic control wells would likely be required to prevent groundwater mounding behind the CW. Groundwater captured by the hydraulic control wells would be treated, if necessary, and discharged to the Middle Fork of the Vermilion River *via* one of the facility's NPDES-permitted outfalls. Monitoring would be performed to ensure that the remedy is working as intended.	Under Source Control-PRB, a subsurface barrier of reactive materials would be placed in the path of groundwater flow in order to promote the *in situ* transformation and/or immobilization of CCR-associated constituents. Monitoring would be performed to ensure that the remedy is working as intended.
Performance – Controlling the Source (Section 3.2.1; IAC Section 845.660(c)(1))	All of the alternatives would be fully protective with regard to primary source control. Source Control-MNA would also likely be effective with regard to secondary source control (Geosyntec, 2022b).	All of the alternatives would be fully protective with regard to primary source control. Source Control-GE would also likely be effective with regard to secondary source control, although GE system performance can vary from site-to-site.	All of the alternatives would be fully protective with regard to primary source control. Source Control-MNA/GE would also likely be effective with regard to secondary source control, through the combination of MNA and operation of the groundwater collection trench.	All of the alternatives would be fully protective with regard to primary source control. Source Control-CW would also likely be effective with regard to secondary source control due to natural processes and GE (hydraulic controls), which would promote the attenuation of constituent concentrations upgradient of the CW.	All of the alternatives would be fully protective with regard to primary source control. Source Control-PRB would also likely be effective with regard to secondary source control due to natural processes, which would promote the attenuation of constituent concentrations upgradient of the PRB.
Performance – Likelihood of Future Releases of CCR (Section 3.2.2; IAC Section 845.660(c)(1))	There would be no likelihood of CCR releases occurring post-closure under any of the alternatives.	There would be no likelihood of CCR releases occurring post-closure under any of the alternatives.	There would be no likelihood of CCR releases occurring post-closure under any of the alternatives.	There would be no likelihood of CCR releases occurring post-closure under any of the alternatives.	There would be no likelihood of CCR releases occurring post-closure under any of the alternatives.

Evaluation Factor (Report Section; Part 845 Section)	Corrective Measure Alternative				
	Source Control-MNA	**Source Control-GE**	**Source Control-MNA/GE**	**Source Control-CW**	**Source Control-PRB**
Performance – Long-Term Management (Section 3.2.3; IAC Section 845.660(c)(1))	Minimal long-term O&M efforts would be required under Source Control-MNA, because it would not require the installation, operation, or maintenance of any engineered systems or structures other than monitoring wells. Groundwater sampling would continue until GWPSs have been achieved.	Long-term O&M efforts required under Source Control-GE would include the monitoring and maintenance of the GE system and the management and discharge of extracted groundwater. Treatment of extracted water may be required prior to discharge. If extraction wells were installed at the NAP, high iron concentrations in the formation could cause fouling of the well screens, which would require frequent maintenance. Additionally, iron fouling could create a need for the replacement of extraction wells over time. If a groundwater collection trench were instead installed at the NAP, a hydraulic connection may be created between the MGU and LGU, which may delay groundwater remediation times. Groundwater sampling would continue until GWPSs have been achieved. Once the remedy is complete, the system would be decommissioned in a manner that meets applicable regulatory standards.	Long-term O&M efforts required under Source Control-MNA/GE would include the monitoring and maintenance of the groundwater collection trench and the management and discharge of extracted groundwater. Treatment of extracted water may be required prior to discharge. Groundwater sampling would continue until GWPSs have been achieved.	Long-term O&M efforts required under Source Control-CW would include the monitoring and maintenance of the CW and hydraulic gradient control system and the management and discharge of extracted groundwater. Treatment of extracted water may be required prior to discharge. For extraction wells installed as part of the hydraulic gradient control system, high iron concentrations in the formation could cause fouling of the well screens, which would require frequent maintenance and potentially create a need for replacement of the wells over time. Groundwater sampling would continue until GWPSs have been achieved. Once the remedy is complete, the system would be decommissioned in a manner that meets applicable regulatory standards.	Long-term O&M efforts required under Source Control-PRB would include regular groundwater sampling downgradient of the PRB until GWPSs are achieved. The PRB would also be monitored for treatment efficacy. If necessary, the PRB media may be amended or exchanged to extend the life of the PRB.
Reliability - Engineering and Institutional Controls (Section 3.2.4; IAC Section 845.660(c)(1))	High long-term reliability would be expected for Source Control-MNA, because this alternative would rely on natural processes, rather than the installation, operation, and maintenance of engineered systems or structures.	Long-term reliability would be expected for Source Control-GE, as long as the system is designed and constructed for Site-specific conditions.	Long-term reliability would be expected for Source Control-MNA/GE, as long as the groundwater collection trench is operated and maintained appropriately.	Long-term reliability would be expected for Source Control-CW, as long as the system is designed and constructed for Site-specific conditions.	Source Control-PRB may not be reliable over the long term with respect to engineering and institutional controls, because PRBs generally have limited success at treating lithium and boron in groundwater (both of which are CCR-associated constituents). The effectiveness of the PRB would also decrease over time, resulting in a potential need for the eventual replacement of the remedy.
Reliability - Potential Need for Replacement of the Corrective Measure (Section 3.2.5; IAC Section 845.660(c)(1))	Replacement of Source Control-MNA would be unlikely. The MNA evaluation provided by Geosyntec (2022b) notes that, if MNA is selected as the remedy, a contingency plan will be developed that will identify the circumstances under which replacement of the remedy may be appropriate.	Unless groundwater flow conditions change significantly at the Site, replacement of the entire remedy would be unlikely under Source Control-GE. If extraction wells were installed at the NAP, iron fouling may reduce the system effectiveness and create a need for the replacement of extraction wells over time. Replacement pumps may also be necessary, because groundwater hydraulic controls would need to be maintained on a long-term basis.	Replacement of Source Control-MNA/GE would be unlikely, as long as the groundwater collection trench is operated and maintained appropriately. The MNA evaluation provided by Geosyntec (2022b) notes that, if MNA is selected as the remedy, a contingency plan will be developed that will identify the circumstances under which replacement of the remedy may be appropriate.	Unless groundwater flow conditions change significantly at the Site, replacement of the entire remedy would be unlikely under Source Control-CW. Replacement of individual hydraulic control wells may be necessary, because groundwater hydraulic controls would need to be maintained on a long-term basis, and because iron fouling may occur.	Given the low effectiveness of PRBs for boron and lithium in groundwater, replacement of the Source Control-PRB remedy would likely be necessary. Replacement of the remedy may also be necessary if the effectiveness of the PRB declines over time.

Evaluation Factor (Report Section; Part 845 Section)	Corrective Measure Alternative				
	Source Control-MNA	Source Control-GE	Source Control-MNA/GE	Source Control-CW	Source Control-PRB
Ease of Implementation (Section 3.2.6; IAC Section 845.660(c)(1))	Source Control-MNA would rely on natural processes and active monitoring and therefore would not pose any significant construction challenges.	Construction of the GE system under Source Control-GE at the NAP would likely be difficult, due to the proximity of the former impoundments to the Middle Fork of the Vermilion River. GE using wells may be difficult to implement, because the alluvial deposits at the NAP vary in composition laterally and vertically. Additional testing would be required to estimate the number, spacing, screened intervals, and extraction rates for capture of impacted groundwater. Additionally, due to a limited construction area between the river and the NAP perimeter berm, installation of a groundwater collection trench through both the MGU and the LGU near the NAP is likely infeasible.	Source Control-MNA/GE would rely on natural processes and a groundwater collection trench, which would already have been installed based on the Agreed Interim Order (Illinois, Attorney General, 2021). Therefore, no significant construction challenges would be expected.	Construction of the CW under Source Control-CW would likely be very difficult, due to the required location, length, and depth of the CW.	Construction of the PRB under Source Control-PRB would likely be very difficult, due to the required location, length and depth of the PRB.
Potential Impacts – Risks to the Community or the Environment During Implementation of Remedy (Section 3.2.7; IAC Section 845.660(c)(1))	Minimal impacts to worker safety, air quality, and surface water and sediment quality would be expected under Source Control-MNA, due to the minimal nature of the construction activities required under this alternative.	Modest impacts to worker safety, air quality, and surface water and sediment quality would be expected under Source Control-GE, due to the modest construction activities required for the installation of the GE system. This alternative could potentially also have a detrimental effect on the baseflow in the Middle Fork of the Vermilion River, particularly during low-flow conditions, because the GE system could capture and/or intercept water from the river.	Minimal impacts to worker safety, air quality, and surface water and sediment quality would be expected under Source Control-MNA/GE, due to the minimal nature of the construction activities required under this alternative.	Relatively large impacts to worker safety, air quality, and surface water and sediment quality would be expected under Source Control-CW, due to the substantial construction activities required for the installation of the CW. This alternative could potentially also have a detrimental effect on the baseflow in the Middle Fork of the Vermilion River, particularly during low-flow conditions, because the extraction wells comprising the hydraulic gradient control system could capture and/or intercept water from the river.	Relatively large impacts to worker safety, air quality, and surface water and sediment quality would be expected under Source Control-PRB, due to the substantial construction activities required for the installation of the PRB.
The Time Required to Begin and Complete the Corrective Action Plan (Section 3.3; IAC Section 845.660(c)(2))	A Corrective Action Plan has been completed and is being submitted to IEPA simultaneously with this CMA.	A Corrective Action Plan has been completed and is being submitted to IEPA simultaneously with this CMA.	A Corrective Action Plan has been completed and is being submitted to IEPA simultaneously with this CMA.	A Corrective Action Plan has been completed and is being submitted to IEPA simultaneously with this CMA.	A Corrective Action Plan has been completed and is being submitted to IEPA simultaneously with this CMA.
State or Local Permit Requirements or Other Environmental or Public Health Requirements that May Substantially Affect Implementation of the Corrective Action Plan (Section 3.4; IAC Section 845.660(c)(3))	Source Control-MNA would require regulatory approval prior to implementation. The approval process would not be expected to substantially affect the implementation of the Corrective Action Plan.	Source Control-GE would require regulatory approval prior to implementation, and may require modifications to the Site's NPDES permit. The approval process and, if needed, NPDES permit modification would not be expected to substantially affect the implementation of the Corrective Action Plan.	Source Control-MNA/GE would require regulatory approval prior to implementation, and may require modifications to the Site's NPDES permit. The approval process and, if needed, NPDES permit modification would not be expected to substantially affect the implementation of the Corrective Action Plan.	Source Control-CW would require regulatory approval prior to implementation, and may require modifications to the Site's NPDES permit. The approval process and, if needed, NPDES permit modification would not be expected to substantially affect the implementation of the Corrective Action Plan.	Source Control-PRB would require regulatory approval prior to implementation. The approval process would not be expected to substantially affect the implementation of the Corrective Action Plan.

Notes:
CCR = Coal Combustion Residual; CMA = Corrective Measures Assessment; Geosyntec = Geosyntec Consultants; GWPS = Groundwater Protection Standard; IAC = Illinois Administrative Code; IEPA = Illinois Environmental Protection Agency; LGU = Lower Groundwater Unit; MGU = Middle Groundwater Unit; NAP = North Ash Pond; NPDES = National Pollutant Discharge Elimination System; O&M = Operations and Maintenance; OEAP = Old East Ash Pond; Source Control-CW = Source Control with Construction of a Cutoff Wall; Source Control-GE = Source Control with Groundwater Extraction; Source Control-MNA = Source Control with Monitored Natural Attenuation; Source Control-MNA/GE = Source Control with Monitored Natural Attenuation and Groundwater Extraction; Source Control-PRB = Source Control with Construction of a Permeable Reactive Barrier.

Table S.3 Comparison of Proposed Corrective Action Alternatives with Respect to Factors Specified in IAC Section 845.670(e)

Evaluation Factor (Report Section; Part 845 Section)	Source Control-MNA	Source Control-MNA/GE
Magnitude of Reduction of Existing Risks (Section 4.1.1; IAC Section 845.670(e)(1)(A))	There are no current risks to any human or ecological receptors at the Site. Because dissolved constituent concentrations are expected to decline due to source control and corrective measures, there would also be no future risks to human and ecological receptors.	There are no current risks to any human or ecological receptors at the Site. Because dissolved constituent concentrations are expected to decline due to source control and corrective measures, there would also be no future risks to human and ecological receptors.
Effectiveness of the Remedy in Controlling the Source (Section 4.1.2; IAC Section 845.670(e)(2))	Both of the alternatives would be fully protective with regard to primary source control. Source Control-MNA would also likely be effective with regard to secondary source control (Geosyntec, 2022b).	Both of the alternatives would be fully protective with regard to primary source control. Source Control-MNA/GE would also likely be effective with regard to secondary source control, through the combination of MNA and operation of the groundwater collection trench.
Likelihood of Future Releases of CCR (Section 4.1.3; IAC Section 845.670(e)(1)(B))	There would be no likelihood of CCR releases occurring post-closure under either of the alternatives.	There would be no likelihood of CCR releases occurring post-closure under either of the alternatives.
Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (Section 4.1.4; IAC Section 845.670(e)(1)(C))	Minimal long-term O&M efforts would be required under Source Control-MNA, because it would not require the installation, operation, or maintenance of any engineered systems or structures other than monitoring wells. Groundwater sampling would continue until GWPSs have been achieved.	Long-term O&M efforts required under Source Control-MNA/GE would include the maintenance of the groundwater collection trench and discharge of extracted groundwater. Groundwater and seep water collected at the groundwater collection trench would be treated, if necessary, sent to the NAP Secondary Pond, and discharged *via* the NPDES-permitted outfall. Groundwater sampling would continue until GWPSs have been achieved.
Short-Term Risks to the Community or the Environment During Implementation of Remedy (Section 4.1.5; IAC Section 845.670(e)(1)(D))	Minimal impacts to worker safety, air quality, and surface water and sediment quality would be expected under Source Control-MNA, due to the minimal nature of the construction activities required under this alternative. Under both source control/corrective action scenarios, the constituent mass flux from groundwater into surface water would decline over time after closure has been completed (Ramboll, 2022).	Minimal impacts to worker safety, air quality, and surface water and sediment quality would be expected under Source Control-MNA/GE, due to the minimal nature of the construction activities required under this alternative. Under both source control/corrective action scenarios, the constituent mass flux from groundwater into surface water would decline over time after closure has been completed (Ramboll, 2022).

Evaluation Factor (Report Section; Part 845 Section)	Source Control-MNA	Source Control-MNA/GE
Time Until Groundwater Protection Standards Are Achieved (Section 4.1.6; IAC Section 845.670(e)(1)(E))	Results of the modeling indicate that groundwater will attain the GWPSs for all constituents identified as potential exceedances in the primary migration pathway within approximately 50 years after closure for both the Source Control-MNA and Source Control-MNA/GE scenarios (Ramboll, 2022). There is no significant difference between the two scenarios in the time to achieve the GWPSs at the Site.	Results of the modeling indicate that groundwater will attain the GWPSs for all constituents identified as potential exceedances in the primary migration pathway within approximately 50 years after closure for both the Source Control-MNA and Source Control-MNA/GE scenarios (Ramboll, 2022). There is no significant difference between the two scenarios in the time to achieve the GWPSs at the Site.
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 4.1.7; IAC Section 845.670(e)(1)(F))	There are no current or future risks to any human or ecological receptors at the Site, and there would be no risk of CCR releases occurring post-closure. Potential risks to workers that come in contact with secondary sources of CCR-associated constituents would be managed through the use of rigorous safety protocols and personal protective equipment.	There are no current or future risks to any human or ecological receptors at the Site, and there would be no risk of CCR releases occurring post-closure. Potential risks to workers that come in contact with secondary sources of CCR-associated constituents would be managed through the use of rigorous safety protocols and personal protective equipment.
Long-Term Reliability of the Engineering and Institutional Controls (Section 4.1.8; IAC Section 845.670(e)(1)(G))	High long-term reliability would be expected for Source Control-MNA, because this alternative would rely on natural processes and active monitoring.	Long-term reliability would be expected for Source Control-MNA/GE, as long as the groundwater collection trench is maintained and operated appropriately.
Potential Need for Replacement of the Remedy (Section 4.1.9; IAC Section 845.670(e)(1)(H))	Replacement of Source Control-MNA would likely be unnecessary. The MNA evaluation provided by Geosyntec (2022b) notes that, if MNA is selected as the remedy, a contingency plan will be developed that will identify the circumstances under which replacement of the remedy may be appropriate.	Replacement of Source Control-MNA/GE would likely be unnecessary. The MNA evaluation provided by Geosyntec (2022b) notes that, if MNA is selected as the remedy, a contingency plan will be developed that will identify the circumstances under which replacement of the remedy may be appropriate.
Degree of Difficulty Associated with Constructing the Remedy (Section 4.2.1; IAC Section 845.670 (e)(3)(A)	Source Control-MNA would rely on natural processes and therefore would not pose any significant construction challenges.	Source Control-MNA/GE would rely on natural processes and continued operation of the groundwater collection trench, which is required by the Agreed Interim Order (Illinois, Attorney General, 2021). Therefore, no significant construction challenges would be expected.

Evaluation Factor (Report Section; Part 845 Section)	Source Control-MNA	Source Control-MNA/GE
Expected Operational Reliability of the Remedy (Section 4.2.2; IAC Section 845.670 (e)(3)(B))	High operational reliability would be expected for Source Control-MNA, because this scenario would rely on natural processes and active monitoring.	Operational reliability would be expected for Source Control-MNA/GE, as long as the groundwater collection trench is maintained and operated appropriately.
Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies (Section 4.2.3; IAC Section 845.670 (e)(3)(C))	Source Control-MNA would require regulatory approval, but no additional permits would be needed.	Source Control-MNA/GE would require regulatory approval. Groundwater and seep water collected at the groundwater collection trench would be sent to the NAP Secondary Pond and discharged *via* the NPDES-permitted outfall.
Availability of Necessary Equipment and Specialists (Section 4.2.4; IAC Section 845.670 (e)(3)(D)	Source Control-MNA would require standard environmental monitoring equipment. Specialists would be available to evaluate the data after they are collected.	Source Control-MNA/GE would require standard remedial action and environmental monitoring equipment. The required equipment and specialists would be available.
Available Capacity and Location of Needed Treatment, Storage, and Disposal Services (Section 4.2.5; IAC Section 845.670 (e)(3)(D))	A minimal amount of investigation-derived waste would be generated under Source Control-MNA. This waste could be managed by a standard waste management contractor.	The groundwater collection system would generate water. Groundwater and seep water collected at the groundwater collection trench would be treated, if necessary, sent to the NAP Secondary Pond, and discharged *via* the NPDES-permitted outfall.
The Degree to Which Community Concerns Are Addressed by the Remedy (Section 4.3; IAC Section 845.670(e)(4))	Source control measures would address the primary concerns of residents. A public meeting was held on December 9, 2021, pursuant to requirements under IAC Section 845.710(e) and the Agreed Interim Order (IEPA, 2021a; Illinois, Attorney General, 2021). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.	Source control measures would address the primary concerns of residents. A public meeting was held on December 9, 2021, pursuant to requirements under IAC Section 845.710(e) and the Agreed Interim Order (IEPA, 2021a; Illinois, Attorney General, 2021). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.

Notes:

CCR = Coal Combustion Residual; Geosyntec = Geosyntec Consultants; IAC = Illinois Administrative Code; GWPS = Groundwater Protection Standard; NAP = North Ash Pond; NPDES = National Pollutant Discharge Elimination System; O&M = Operations and Maintenance; Source Control-MNA = Source Control with Monitored Natural Attenuation; Source Control-MNA/GE = Source Control with Monitored Natural Attenuation and Groundwater Extraction.

1 Introduction

1.1 Site Description and History

1.1.1 Site Location and History

Dynegy Midwest Generation, LLC's (DMG) Vermilion Power Plant is an electric power generating facility with coal-fired units located approximately 5 miles north of the Village of Oakwood, Illinois, along the Middle Fork of the Vermilion River. The facility began operating in the mid-1950s (OBG, 2019a) and was retired in November 2011 (IEPA, 2013). The power plant remains in place and has not yet been demolished.

1.1.2 CCR Impoundments

The Vermilion Power Plant produced and stored coal combustion residuals (CCRs) as a part of its historical operations. There are two decommissioned ash ponds at the Site, both located east of the power plant (Figure 1.1):

- Old East Ash Pond (OEAP) area (Vistra ID No. CCR Unit 911 and Illinois Environmental Protection Agency [IEPA] ID No. W1838000002-03)/North Ash Pond (NAP) area (Vistra ID No. CCR Unit 910 and IEPA ID No. W1838000002-01), including a secondary pond associated with the NAP; and
- New East Ash Pond (NEAP; Vistra ID No. CCR Unit 912, IEPA ID No. W1838000002-04, and National Inventory of Dams [NID] No. IL50291), including an associated secondary pond.

The OEAP is the oldest of the ash-receiving ponds and was put into service in the mid-1950s as part of the original plant construction. Use of the OEAP continued until the NAP, which is hydraulically connected with the OEAP, was constructed in 1977. Use of the NAP continued until 1989, after which ash was diverted to the NEAP (Geosyntec, 2021a, Appendix A; OBG, 2019a). None of the ash-receiving ponds at the Site have received CCR since the plant was retired in 2011 (Geosyntec, 2021a, Appendix A).

The OEAP is bordered on the north and northeast by the Middle Fork of the Vermilion River. Steep bluffs lie directly south, southeast, and west of the impoundment, and the NAP lies to the northwest. The groundwater elevation in the vicinity of the OEAP exceeds the base elevation of the impoundment, resulting in intersecting conditions (*i.e.*, groundwater is in direct contact with ash in the OEAP; Natural Resource Technology, Inc., 2014a). Between approximately 1986 and 1997, the OEAP was capped with soil and vegetation. The OEAP does not contain any ponded water (Geosyntec, 2021a, Appendix A).

The NAP is bordered by fallow fields to the north, the Middle Fork of the Vermilion River to the east, the OEAP to the south, and steep bluffs to the west. As with the OEAP, there are intersecting conditions in the NAP (Natural Resource Technology, Inc., 2014b). Although the NAP no longer receives ash, it does receive stormwater runoff. Currently, the NAP discharges decanted water into the NAP Secondary Pond, which subsequently discharges into the Middle Fork of the Vermilion River during heavy rainfall events, which only occur one or two times per year (OBG, 2019a). The NAP does not have a soil cover;

however, a layer of vegetation overlies the CCR throughout much of the impoundment (Geosyntec, 2021a, Appendix A). Ponded water occurs in the northern section of the impoundment (Geosyntec, 2021a, Appendix Q).

The NEAP was constructed in the bottomlands of the Middle Fork of the Vermilion River with earthen berms with a clay core. The berms are located on the north, east, and south sides of the primary cell of the NEAP, and were keyed into the underlying shale at the time of construction using 4-foot-thick soil/bentonite slurry walls (Kelron Environmental, 2003). The west side of the primary cell of the NEAP is formed by the bluff, which is composed of low-permeability clays. In 2002, the original 1989 footprint of the NEAP was expanded to form the present extent of the NEAP. The height of the berms was also raised using additional low-permeability clay, and a trench filled with low-permeability fill was keyed into the shale along the natural bluff on the west side of the NEAP (OBG, 2019b). The NEAP does not have a soil cover, and ponded water occurs in the eastern section of the impoundment. The secondary pond of the NEAP discharges to the Middle Fork of the Vermilion River (Geosyntec, 2021b, Appendix Q). The NEAP overlies a former coal mine, which has impacted groundwater quality in the area (OBG, 2019b).

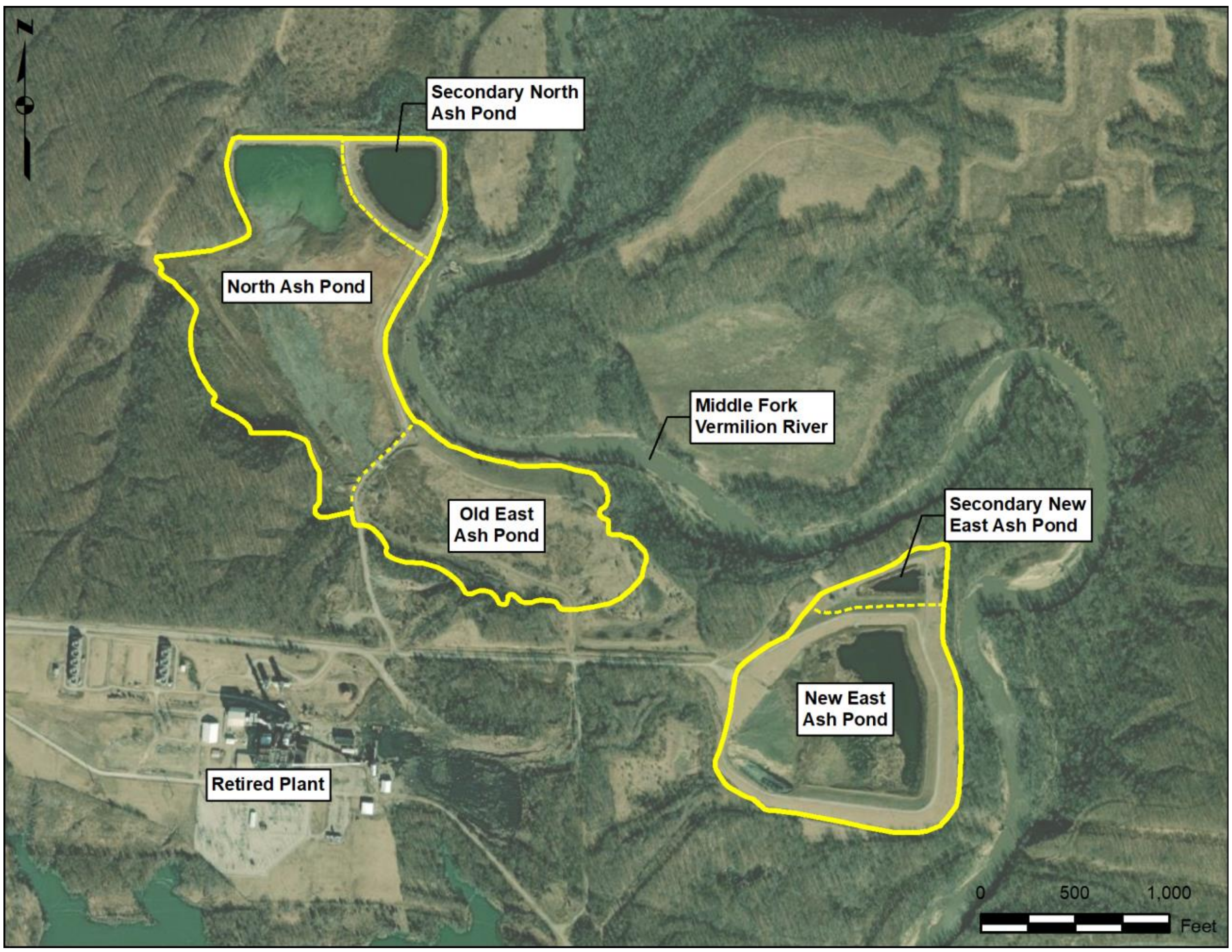


Figure 1.1 Site Location Map. Based on DMG *et al*. (2019).

1.1.3 Surface Water Hydrology

The NAP and the NEAP are both currently permitted to discharge decanted water to the Middle Fork of the Vermilion River *via* their secondary ponds (Geosyntec, 2021a, Appendix A). The 17-mile reach of the Vermilion River known as the Middle Fork is Illinois's only National Scenic River, and is protected due to its high-value historical, scenic, geologic, ecological, fish and wildlife, and recreational resources. The Middle Fork is popular for a wide range of recreational activities, including canoeing, kayaking, fishing, hiking, and wildlife viewing (US DOI, 2010; Barkley, 2012). Over recent decades, the Middle Fork has been slowly migrating towards the impoundment embankments at the Site. Riverbank migration and its potential impact on closure activities is discussed later in this report.

Surface water samples were collected from three locations in the Middle Fork of the Vermilion River in 2019 (Hanson Professional Services Inc., 2019). These data are summarized in Gradient's Human Health and Ecological Risk Assessment for the Site, which is provided as Appendix A of this report. Surface water samples were also collected and analyzed in June and July 2021 (Eurofins TestAmerica and Geosyntec, 2021).

In addition to the Middle Fork of the Vermilion River, there is an approximately 200-acre surface water reservoir (cooling pond) located on the Site called Company Lake (Ramboll, 2021a).

1.1.4 Hydrogeology

1.1.4.1 NAP/OEAP

The geology underlying the Site in the vicinity of the NAP/OEAP consists of several distinct layers (Ramboll, 2021a):

1. An upper unit composed of the clayey sands to sandy clays of the Cahokia Alluvium;
2. A middle groundwater unit (MGU) composed of the coarser-grained material encountered at the base of the Cahokia Alluvium. This unit is laterally continuous below the NAP/OEAP and is designated as the uppermost aquifer;
3. A low-permeability upper confining unit composed of clay with isolated sand lenses. This unit is present both below the NAP/OEAP and, in the uplands, limits the vertical migration of groundwater;
4. A lower groundwater unit (LGU) composed of glacial outwash and re-worked glacial deposits of the Henry formation. This unit is the lowermost, most laterally extensive coarse-grained unlithified deposit identified beneath the Site and in the uplands. Based on permeability and continuous lateral extent, this unit is identified as a Potential Migration Pathway (PMP);
5. A low-permeability lower confining unit composed of silty or sandy clay with isolated sand lenses. This unit is the lowermost unlithified deposit and limits the vertical migration of groundwater; and
6. A bedrock confining unit, the lowermost unit identified at the site, which underlies all unlithified deposits. This unit occurs within Pennsylvanian shale, which is the uppermost lithified unit at the Site.

Hydrogeologic data collected at the Site show that groundwater flow occurs in the MGU and LGU, while the upper and lower confining units act as barriers to groundwater flow (Ramboll, 2021a). Groundwater migrates within the high-permeability sands and gravels of the MGU and LGU, which flow eastward to the Middle Fork under normal river conditions. At the NAP/OEAP, potential dissolved CCR-related constituents may migrate vertically downward under the influence of gravity into the MGU and, to a lesser extent, through the middle confining unit into the LGU.

Groundwater in the MGU and the LGU flows primarily eastward toward the Middle Fork of the Vermilion River. The Middle Fork is the regional sink of shallow groundwater in the area (Kelron Environmental, 2003, 2012), *i.e.*, all of the groundwater in the MGU and LGU in this area flows upward and into the river. Groundwater modeling, potentiometric head maps, and vertical gradients confirm that groundwater in both the MGU and LGU flows into the Middle Fork of the Vermilion River (OBG, 2019a; Kelron Environmental, 2003, 2012; Ramboll, 2021a). There may be limited groundwater migration in a northerly direction; however, this groundwater flow ultimately turns eastward and flows into the river. There is no transport of CCR-related constituents toward the western and southern property boundaries.

During groundwater 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 occur naturally in sediments and surface water. As a result, their presence in the sediments and/or surface water of the Middle Fork does not necessarily signify contributions from the ash ponds.

Groundwater samples have been collected from wells in the vicinity of the NAP/OEAP since 1988. The Hydrogeologic Site Characterization Report and Groundwater Monitoring Plan prepared by Ramboll as part of the Operating Permits for the NAP/OEAP and NEAP include a summary of groundwater data collected between 2015 and 2021 at the Site (Ramboll, 2021a,b). These reports also outline the additional monitoring and analysis that will be performed at the NAP/OEAP going forward, as required under Part 845 (IEPA, 2021a).

1.1.4.2 NEAP

The geology underlying the Site in the vicinity of the NEAP is distinct from the geology in the vicinity of the NAP/OEAP. The NAP/OEAP are built atop terraces, whereas the NEAP was constructed directly atop shale bedrock in the lower-elevation bottomlands. The geology near the NEAP consists of three layers (Ramboll, 2021c):

1. An upper unit composed of mixed alluvial deposits of sand with occasional layers of silty clay. This unit is present outside of the NEAP and in the bottomlands of the Middle Fork;
2. An upper confining unit composed of predominantly low-permeability silty and clayey diamictons (glacial till) with intermittent sand layers and lenses. This unit is present outside of the NEAP and along the western bluff of the Middle Fork; and
3. A bedrock confining unit, which contains a major coal seam that was historically mined beneath the NEAP. This is the lowermost unit identified at the site and underlies all unlithified deposits; it occurs within Pennsylvanian shale, which is the uppermost lithified unit at the Site.

None of the units described above have been identified as an aquifer. However, the upper unit and bedrock confining unit have been identified as PMPs. Groundwater surrounding the NEAP flows into the Middle Fork of the Vermilion River (OBG, 2019b).

Groundwater quality data and detailed statistical analyses have demonstrated that CCR-related constituents from the NEAP have not impacted groundwater outside the low-permeability barriers and are not impacting the Middle Fork (Kelron Environmental, 2003; OBG, 2019b). These data are summarized in Gradient's Human Health and Ecological Risk Assessment for the Site, which is provided as Appendix A of this report. Additional groundwater samples collected and analyzed in 2020 and 2021 are provided by Geosyntec Consultants (Geosyntec, 2022b).

1.1.5 Site Vicinity

The Site is bordered by fallow fields owned by the Illinois Department of Natural Resources (IDNR) to the north, the Middle Fork of the Vermilion River to the east, Kickapoo State Recreation Area to the south, and steep bluffs to the west. High-value natural areas and recreational areas near the Site include the Middle Fork of the Vermilion River, the Kickapoo State Recreation Area, and the Orchid Hill Natural Heritage Landmark. As described in Section 1.1.3, the Middle Fork of the Vermilion River is Illinois's only National Scenic River and is a popular spot for canoeing and other forms of water recreation. Kickapoo State Recreation Area is one of the most popular parks in Illinois, with 1.3 million visitors in 2020 (La, 2021). This 2,842-acre park is popular for hiking, camping, hunting, fishing, canoeing, and scuba diving (IDNR, 2021). The Orchid Hill Natural Heritage Landmark is a >100-acre natural area located immediately northwest of the retired power plant. This area, which lies partially on Vermilion Power Plant property but is managed by IDNR, is notable for its high-quality barrens, which are rare in Illinois, as well as the occurrence of six species of native orchid, including the rare yellow lady's slipper (Various, 1990-2010).

1.2 Part 845 Regulatory Review and Requirements

Title 35, Part 845 of the Illinois Administrative Code (IAC; IEPA, 2021a) requires the development of a Closure Alternatives Analysis (CAA) prior to undertaking closure activities at certain CCR-containing surface impoundments in the State of Illinois. Part 845 additionally requires that a Corrective Measures Assessment (CMA) and a Corrective Action Alternatives Analysis (CAAA) be performed prior to undertaking any corrective measures at certain CCR-containing impoundments. Section 2 of this report presents a CAA for the NAP/OEAP and the NEAP pursuant to requirements under IAC Section 845.710. Based on potential groundwater exceedances identified at the Site (Ramboll, 2021a,c), Section 3 presents a CMA for the NAP/OEAP and the NEAP pursuant to requirements under IAC Section 845.660 and Section 4 presents a CAAA pursuant to the requirements under IAC Section 845.670. The goal of a CAA is to holistically evaluate each potential closure scenario with respect to a wide range of factors, including the efficiency, reliability, and ease of implementation of the closure scenario; its potential positive and negative short- and long-term impacts on human health and the environment; and its ability to address concerns raised by residents (IEPA, 2021a). The CMA/CAAA similarly evaluates a range of factors for the various corrective measures being considered at each impoundment. A CAA and CMA/CAAA are decision-making tools that are designed to aid in the selection of a closure alternative or corrective action alternatives for the impoundments at a site.

2 Closure Alternatives Analysis

This section of the report presents a CAA for the NAP/OEAP and the NEAP pursuant to requirements under IAC Section 845.710 (IEPA, 2021a). Closure is evaluated separately in this report for the combined NAP/OEAP system and the NEAP. For purposes of closure, DMG characterizes the OEAP and NAP as a single multi-unit system because (a) there is a continuous layer of ash running between the OEAP and NAP, (b) the NAP was designed such that the outer berms were an extension of the outer berms of the OEAP, (c) the NAP was designed and constructed to incorporate the ash located within the OEAP, (d) the NAP and OEAP share a groundwater monitoring network, and (e) the NAP and OEAP fall within the same areal extent of the local groundwater flow regime.

2.1 Closure Alternative Descriptions (IAC Section 845.710(c))

The two closure scenarios evaluated in this CAA are Closure-by-Removal with On-Site CCR Disposal (CBR-Onsite) and Closure-by-Removal with Off-Site CCR Disposal (CBR-Offsite). Both of these scenarios entail excavating all of the CCR from the former NAP/OEAP and NEAP impoundments and transporting it to a landfill for disposal. Under the CBR-Onsite scenario, a landfill will be constructed on the Site. Under the CBR-Offsite scenario, CCR will instead be hauled to an off-Site landfill. While Closure-in-Place (CIP) is widely recognized as another viable closure approach that can be protective of human health and the environment at many sites (US EPA, 2015a), CIP is not being evaluated as a potential closure alternative at this Site because the Agreed Interim Order dated June 30, 2021, states that the CAA for the Site "shall only consider and discuss closure by removal for the Ponds" (Illinois, Attorney General, 2021). Additionally, a groundwater collection trench will be constructed downstream of the OEAP under both closure scenarios. The groundwater collection trench, which is required by the June 2021 agreement between DMG and the Illinois Attorney General (Illinois, Attorney General, 2021), will intercept seepage and discolored water until excavation of the CCR has been completed. DMG will also continue to evaluate potential opportunities for beneficial re-use of CCR excavated from the NAP/OEAP and the NEAP as an alternative to disposal.

Sections 2.1.1 and 2.1.2 provide detailed descriptions of the CBR-Onsite and CBR-Offsite closure scenarios. These scenarios are based on detailed spreadsheets and other supporting information provided to Gradient by Geosyntec, which are attached to this report as Appendix C.

2.1.1 Closure-by-Removal with On-Site CCR Disposal

Under the CBR-Onsite scenario, all of the CCR excavated from the NAP/OEAP and the NEAP will be hauled to a landfill located on the Site. Currently, however, the Site does not have a landfill. Under this scenario, the retired power plant located on the property will be demolished, and a "state-of-the-art," lined landfill will be constructed over a portion of its footprint. The landfill will be used to contain CCR excavated from the impoundments as well as non-hazardous material arising from the demolition of the power plant and other historical plant operations. Excavation and transport of CCR from the impoundments will begin once the on-Site landfill has been constructed. CCR will be hauled to the landfill using haul trucks with a capacity of 34 cubic yards (CY). This scenario meets the requirement of IAC Section 845.710(c)(2) (IEPA, 2021a) that an assessment be conducted in the CAA regarding whether the Site has an on-Site landfill with available capacity or whether an on-Site landfill can be constructed.

This scenario includes the following work elements for the closure of both the NAP/OEAP and the NEAP (Geosyntec, 2022a,c):

- **Construction of the on-Site landfill, including:**
  - Stripping vegetation and topsoil, followed by excavation and stockpiling of soil;
  - Construction of the composite bottom liner system, which will include a minimum of 3 feet of low-permeability soil and a 60-mil high-density polyethylene (HDPE) geomembrane liner;
  - Construction of the leachate collection and management system; and
  - Construction of an access road.
- **CCR impoundment excavation and on-Site landfill operation, followed by Site restoration, including:**
  - Free water removal and dewatering of surface impoundments.
  - Excavation of cover soils. Excavated soils and topsoil will be segregated and set aside for later use during Site restoration.
  - Excavation of CCR from the impoundments and transport of CCR to the on-Site landfill. Any pipes and discharge structures within the impoundment will also be removed.
  - Construction of stormwater control structures to convey runoff away from the former impoundments.
  - Site restoration, including grading and backfilling as needed to manage stormwater, followed by revegetation with native grasses.
- **Closure of the on-Site landfill, including:**
  - Construction of the final composite cover system, which will tie into the bottom liner system and will include 1 foot of low-permeability clay/cohesive soil subgrade, a 40-mil linear low-density polyethylene (LLDPE) geomembrane liner, a geocomposite drainage layer (if needed), and 3 feet of additional protective soil cover;
  - Seeding and mulching; and
  - Stormwater management, including excavation of a detention basin.
- **Long-term (post-closure) monitoring and maintenance, including:**
  - Groundwater and surface water monitoring at the closed impoundments until groundwater protection standards (GWPSs) have been achieved.
  - A minimum of 30 years of post-closure care at the on-Site landfill, including leachate management and cap inspection, mowing and maintenance, and groundwater and surface water monitoring.

Soil for grading and revegetating the impoundment covers will be sourced from the perimeter dikes, the original ash basin covers, and the on-Site landfill excavation (Geosyntec, 2022c). Soil for the bottom liner, cover system, and daily cover at the on-Site landfill is similarly expected to be sourced from within the footprint of the on-Site landfill (Geosyntec, 2022a). As such, we assume that an off-Site borrow soil location will not need to be established.

In addition to the work elements listed above, a groundwater collection trench will be constructed downstream of the OEAP. The groundwater collection trench, which is required by the June 2021 agreement between DMG and the Illinois Attorney General (Illinois, Attorney General, 2021), will intercept seepage and discolored water until excavation of the CCR has been completed. Water collected in the trench will be sent to the NAP Secondary Pond and discharged *via* the National Pollutant Discharge Elimination System (NPDES)-permitted outfall. For the purposes of the calculations below, this activity is included as part of the construction activities for the NAP/OEAP closure (Geosyntec, 2022c).

In addition to groundwater collection trench construction, our analysis also accounts for the potential construction of a temporary riverbank maintenance measure/buttress along 1,000 feet of riverbank near the NAP/OEAP in order to arrest riverbank migration, as discussed in Section 2.2.2. This work element is tentative, because the need for the buttressing at this Site will be evaluated throughout the removal process and has not yet been determined. Ultimately, buttressing may or may not be required at the NAP/OEAP.

The existing power plant is assumed to be demolished under both scenarios; however, the timing of the demolition will likely vary. The power plant will be demolished sooner under the CBR-Onsite scenario, because the on-Site landfill will be constructed within a portion of the existing footprint of the power plant. In contrast, under the CBR-Offsite scenario, it was assumed for this analysis that the power plant would eventually be demolished at an undetermined point in the future. Therefore, we did not include the impacts of power plant demolition (worker safety, waste disposal, equipment emissions, fugitive dust emissions, *etc.*) in this assessment, because only work elements that result in differential impacts across closure scenarios are of interest for the purposes of selecting between multiple options.

Demolition of the power plant and design, permitting, and construction of the on-Site landfill will delay the start of excavation at the NAP/OEAP and NEAP under the CBR-Onsite scenario (relative to the CBR-Offsite scenario) by an estimated 6 years (Geosyntec, 2022a). Landfill permitting is a significant component of this estimated 6-year period; if IEPA is able to review and approve the on-Site landfill permit application faster than expected, then it may be possible to reduce the delay before the start of excavation. However, even though CCR excavation would not begin immediately under the CBR-Onsite scenario, dewatering of the impoundments would begin at the same time under both scenarios in accordance with the Safety Emergency Response Plan (SERP; Geosyntec, 2021c) and the requirements of the Agreed Interim Order (Illinois, Attorney General, 2021). Construction of the on-Site landfill will require approximately 1.8 years (Geosyntec, 2022c). Excavation and closure of the NAP/OEAP will take an estimated 7.1 years, excavation and closure of the NAP will take an estimated 3 years, and closure of the on-Site landfill will take an estimated 0.6 years (Geosyntec, 2022c). Key parameters for the CBR-Onsite scenario are shown in Table 2.1.

Table 2.1 Key Parameters for the Closure-by-Removal with On-Site CCR Disposal Scenario

Parameter	Value	Notes
Haul Truck Capacity (CY)	34	
NAP/OEAP Closure		
Surface Area (acres)	60	**NAP:** 40 acres **OEAP:** 20 acres
In-Place Volume of CCR (CY)	2,160,000	**NAP:** 1,170,000 CY **OEAP:** 992,000 CY
Duration of Construction Activities (years)[b]	7.1	4.8 years for the NAP and 2.3 years for the OEAP. Excludes the time required for landfill construction and closure.
Total Labor Hours	285,000	
Vehicle and Equipment On-Site Miles	229,000	
Vehicle and Equipment Off-Site Miles[a]	1,620,000	
NEAP Closure		
Surface Area (acres)	21	
In-Place Volume of CCR (CY)	376,000	
Duration of Construction Activities (years)	3	Excludes the time required for landfill construction and closure.
Labor Total Hours	94,800	
Vehicle and Equipment On-Site Travel Miles	58,900	
Vehicle and Equipment Off-Site Travel Miles[a]	443,000	
Long-Term Operations & Maintenance		
Labor Total Hours	84,800	
Vehicle and Equipment On-Site Travel Miles	9,400	
Vehicle and Equipment Off-Site Travel Miles[a]	2,570,000	
On-Site Landfill		
Surface Area (acres)	27	
Duration of Construction Activities (years)	2.4	Includes landfill construction (1.8 years) and closure (0.6 years).
Time to Place CCR in the On-Site Landfill (years)[b]	10.1	Total time required to excavate the OEAP (2.3 years), NAP (4.8 years), and NEAP (3 years).
Total On-Site Landfill Operation Time: Construction, Operation, and Closure (years)[b]	12.5	
Labor Total Hours	355,000	
Vehicle and Equipment On-Site Travel Miles	106,000	
Vehicle and Equipment Off-Site Travel Miles[a]	3,500,000	
Scenario Totals		
Total Labor Hours:	820,000	
Vehicle and Equipment On-Site Travel Miles:	403,000	
Vehicle and Equipment Off-Site Travel Miles:[a]	8,130,000	

Notes:
CCR = Coal Combustion Residual' CY = Cubic Yard; NAP = North Ash Pond; NEAP = New East Ash Pond; OEAP = Old East Ash Pond.
Source: Geosyntec (2022c).
(a) Includes Daily Labor Mobilization Miles, Vehicle and Equipment Mobilization/Demobilization Miles, and Material Delivery Miles (Loaded + Unloaded).
(b) Conservatively assumes that each impoundment is excavated sequentially, rather than simultaneously.

2.1.2 Closure-by-Removal with Off-Site CCR Disposal

Under the CBR-Offsite scenario, CCR excavated from the NAP/OEAP and NEAP will be transported to an off-Site landfill for disposal. For the purposes of this analysis, we assume that CCR will be sent to the Republic Services Brickyard Disposal Landfill in Danville, Illinois (601 E. Brickyard Road), which is approximately 15 miles from the Site (Geosyntec, 2022c). As is described below in Section 2.4.5, it is possible that the Brickyard Disposal Landfill would have to be expanded in order to accept all of the CCR from the impoundments. CCR would be hauled to the off-Site landfill using haul trucks with a capacity of 16.5 cubic yards under the CBR-Offsite scenario, which is a smaller capacity than that for the trucks that would be used to haul CCR to the on-Site landfill under the CBR-Onsite scenario (*i.e.*, 34 cubic yards), due to restrictions placed on the size of trucks that can be used on public roadways.

IAC Section 845.710(c)(1) requires CBR alternatives to consider multiple methods for transporting CCR off-site, including rail, barge, and trucks. There is no established rail terminal or railroad track near the Site. In order for CCR to be transported by rail, a new rail line would need to be constructed that extends to the Union Pacific Railroad line located more than 5 miles northwest of the Site, and a loading terminal would also need to be constructed on-Site. This is considered infeasible, because it would increase the project schedule due to the need to coordinate with the railroad, complete design and permitting, and construct the terminal, and because additional land would need to be acquired. Furthermore, CCR would still need to be hauled by truck to the on-Site loading terminal and loaded into rail cars, resulting in additional CCR exposures and potential releases. Additionally, the Middle Fork of the Vermilion River, which is the only river near the Site, is not open to barge traffic. Therefore, transporting CCR by barge is not feasible for this site. The local availability and use of natural gas-powered trucks, or other low-polluting trucks, will be evaluated prior to the start of construction.

This scenario includes the following work elements (Geosyntec, 2022c):

- Free water removal and dewatering of surface impoundments.
- Excavation of cover soils. Excavated soils and topsoil will be segregated and set aside for later use during Site restoration.
- Excavation of CCR from the impoundments and transport of CCR to the off-Site landfill. Any pipes and discharge structures within the impoundment will also be removed.
- Construction of stormwater control structures to convey runoff away from the former impoundments.
- Site restoration, including grading and backfilling as needed to manage stormwater, followed by revegetation with native grasses.
- Groundwater and surface water monitoring until GWPSs have been achieved.

As with the CBR-Onsite scenario, we assume that an off-Site borrow soil location will not be needed. Similarly, additional work elements included under this scenario include the construction of a groundwater collection trench and potential construction of a temporary riverbank maintenance measure/buttress. The impacts of power plant demolition were not quantified, because the power plant is assumed to be demolished under both scenarios. However, plant demolition may not occur until an undetermined point in the future under the CBR-Offsite scenario.

Under the CBR-Offsite scenario, the overall duration of closure activities is expected to be 7.6 years for the NAP/OEAP and 3.1 years for the NEAP. Key parameters for the CBR-Offsite scenario are shown in Table 2.2.

Table 2.2 Key Parameters for the Closure-by-Removal with Off-Site CCR Disposal Scenario

Parameter	Value	Notes
Distance to the Off-Site Landfill (miles)	15	
Haul Truck Capacity (CY)	16.5	Capacity restricted due to use of public roads.
NAP/OEAP Closure		
Surface Area (acres)	60	NAP: 40 acres OEAP: 20 acres
In-Place Volume of CCR (CYs)	2,160,000	**NAP:** 1,170,000 CY **OEAP:** 992,000 CY
Duration of Construction Activities (years)[b]	7.6	5.1 years for the NAP and 2.5 years for the OEAP.
Total Labor Hours	471,000	
Vehicle and Equipment On-Site Travel Miles	125,000	
Vehicle and Equipment Off-Site Travel Miles[a]	6,630,000	
NEAP Closure		
Surface Area (acres)	21	
In-Place Volume of CCR (cubic yards)	376,000	
Duration of Construction Activities (years)	3.1	
Labor Total Hours	125,000	
Vehicle and Equipment On-Site Travel Miles	39,000	
Vehicle and Equipment Off-Site Travel Miles[a]	1,290,000	
Long-Term Operations & Maintenance		
Labor Total Hours	85,600	
Vehicle and Equipment On-Site Travel Miles	9,490	
Vehicle and Equipment Off-Site Travel Miles[a]	2,590,000	
Scenario Totals		
Total Labor Hours:	682,000	
Vehicle and Equipment On-Site Travel Miles:	173,000	
Vehicle and Equipment Off-Site Travel Miles:[a]	10,500,000	

Notes:
CCR = Coal Combustion Residual' CY = Cubic Yard; NAP = North Ash Pond; NEAP = New East Ash Pond; OEAP = Old East Ash Pond.
Source: Geosyntec (2022c).
(a) Includes Daily Labor Mobilization Miles, Vehicle and Equipment Mobilization/Demobilization Miles, Material Delivery Miles (Loaded + Unloaded), and Daily Haul Truck Miles (Loaded + Unloaded).
(b) Conservatively assumes that each impoundment is excavated sequentially, rather than simultaneously.

2.2 Long- and Short-Term Effectiveness of Closure Alternative (IAC Section 845.710(b)(1))

2.2.1 Magnitude of Reduction of Existing Risks (IAC Section 845.710(b)(1)(A))

This section of the report addresses the potential risks to human and ecological receptors due to exposure to CCR-associated constituents in groundwater or surface water. Gradient's February 2020 Human Health and Ecological Risk Assessment (Appendix A) provides a detailed evaluation of the magnitude of existing risks to human and ecological receptors at the Site. This report concluded that there are no current unacceptable risks to any human or ecological receptors at or near the Site. An additional risk analysis performed in 2021, which included an analysis of several constituents (*i.e.*, lithium and molybdenum) that have recently been included in sampling programs but were not included in prior sampling events, also concluded that there are no unacceptable risks to any human or ecological receptors at or near the Site (Appendix B). Because there are no current risks to any human or ecological receptors, and dissolved constituent concentrations are expected to decline post-closure, no post-closure risks are expected under either closure scenario. Thus, the magnitude of reduction of existing risks is the same under both closure scenarios.

2.2.2 Likelihood of Future Releases of CCR (IAC Section 845.710(b)(1)(B))

This section of the report quantifies the risk of future releases of CCR that may occur during dike failure and storm-related events. The likelihood of future releases was evaluated both during and following closure activities at the NAP/OEAP and the NEAP under both closure scenarios.

Dike Failure Due to Riverbank Migration

The Middle Fork of the Vermilion River has been migrating towards the ash basin embankments for decades. This phenomenon presents a threat to the long-term stability of the embankments (Stantec, 2017, 2019). Dike failure could thus conceivably occur prior to or during excavation of the impoundments. However, risks related to dike failure will be minimized and managed through monitoring and inspection under both closure scenarios. Under the Agreed Interim Order that DMG entered into with the Illinois Attorney General in June 2021, DMG is required to inspect the riverbank in the vicinity of the NAP/OEAP monthly, as well as after any 25-year, 24-hour storm events, in order to determine whether damage is occurring to the dikes and whether emergency action is required to prevent dike failure (Illinois, Attorney General, 2021). The SERP submitted by DMG on August 16, 2021, details the temporary riverbank maintenance measures that will be undertaken, if needed, to ensure that dike failure does not occur (Geosyntec, 2021c).

Moreover, a reliability assessment was performed by Geosyntec (2021d) with the purpose of determining when temporary riverbank stabilization measures would be implemented, if necessary. The reliability assessment estimated "the probability of slope failure based on the variability of soil and groundwater conditions" (Geosyntec, 2021d). Geosyntec calculated a reliability index that can be used to identify when stabilization measures should be undertaken, allowing sufficient time to design, permit, and construct the stabilization measures. The reliability assessment determined, based on the best information available, that the average riverbank erosion rate along the OEAP ranges from 0.5 to 0.7 feet/year (Geosyntec, 2021d). This rate is significantly slower than prior riverbank erosion rates that have been estimated for the Site (*i.e.*, 2.3 feet/year; Stantec, 2017, 2019).

Overall, while the risk of needing temporary riverbank maintenance measures is slightly higher under the CBR-Onsite scenario compared to the CBR-Offsite scenario, because the excavation of CCR from the impoundments will be delayed by approximately 6 years in order to demolish the power plant and construct the landfill under the former scenario, the overall risk of failure is low under both scenarios because of the riverbank monitoring and mitigation measures that are already in place. Post-closure, there is no risk of CCR releases occurring due to dike failure under either closure scenario.

Storm-Related Releases and Dike Failure During Flood Conditions

Under both the CBR-Offsite scenario and the CBR-Onsite scenario, there is no post-closure risk of CCR releases occurring due to dike failure or overtopping under flood conditions, because all of the CCR will be excavated from the impoundments under both scenarios. However, as with dike failure due to riverbank encroachment, it is conceivable that flood-related releases could occur prior to or during excavation of the impoundments. We have therefore evaluated the risk of dike failure occurring during this interim period.

The risk of dike failure occurring during floods or other storm-related event is exceedingly low under both closure scenarios. Engineering analyses show that both the NAP/OEAP dikes and the NEAP dikes are expected to remain stable under static, seismic, and flood conditions (Appendix W of Geosyntec [2021a,b,e]). The risk of overtopping occurring during flood conditions is also exceedingly low under both scenarios, because dewatering of the basins can begin immediately following the start of construction activities; *i.e.*, dewatering will not be delayed by power plant demolition or construction of the on-Site landfill under the CBR-Onsite scenario. Geosyntec evaluated the risk of flood overtopping occurring at the NAP/OEAP and the NEAP after dewatering and found that the relevant spillways for each impoundment can adequately manage flow during peak discharge from even a 1,000-year storm event, thus preventing overtopping (Appendix V of Geosyntec [2021a,b,e]).

Dike Failure Due to Seismicity

Sites in Illinois may be subject to seismic risks due to their proximity to the Wabash Valley Seismic Zone and the New Madrid Seismic Zone (IEMA, 2021). However, the Vermilion property does not lie within a seismic impact zone and is also believed to have a "low risk level" for seismic risks based on the 2018 USGS National Seismic Hazard Map (Appendix G of Geosyntec [2021a,b,e]). Additionally, none of the impoundments at the Site lie within 200 feet of an active fault or fault damage zone at which displacement has occurred within the current geological epoch (*i.e.*, within the last ~11,650 years; Appendix F of Geosyntec [2021a,b,e]). Thus the risk of dike failure occurring prior to or during excavation activities due to seismic activity is low (Appendix W of Geosyntec [2021a,b,e]). Once all of the CCR has been excavated from the impoundments, there will be no risk of CCR releases occurring due to seismic conditions under either the CBR-Offsite or CBR-Onsite scenario.

Risks of Future Releases of CCR at the On-Site Landfill

The effective Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (Effective FIRM) for the Site demonstrates that the proposed on-Site landfill location, which would be located atop the bluff on the property, does not lie within the 100-year floodplain (FEMA, 2012). Inundation maps prepared by DMG (2021) demonstrate further that the on-Site landfill location also does not lie within the 500-year floodplain or the 1,000-year floodplain. Furthermore, there is no risk to the on-Site landfill associated with future meandering and erosion of the river (Geosyntec, 2022a). The river alignment and geologic floodplain have been constrained historically by the floodplain bluffs. The on-Site landfill would be located approximately 100 vertical feet above the river's 1,000-year flood event elevation and 1,400 feet horizontally from the river. Based on the geomorphology of the valley since the river channel and floodplain bluffs were formed at the end of the Pleistocene Epoch (around 11,000 years ago), there is no evidence that the river has ever flowed through the location of the proposed landfill or overtopped the valley wall. The river is not expected to ever move significantly beyond the floodplain bluffs/valley walls (Geosyntec, 2022a). Thus, there is no practical risk of CCR releases occurring at the On-Site landfill due to flood conditions or riverbank erosion. Additionally, the seismic risks at the Site are low, as described above. In summary, the overall risk of CCR escaping the on-Site landfill during flood or seismic conditions is minimal.

We did not evaluate flooding risks and seismic risks at the off-Site landfill, because it has previously been constructed and permitted and is already in operation. We assume that the off-Site landfill will operate in compliance with all state and federal regulations designed to minimize the threat of waste releases, including under seismic and flood conditions.

2.2.3 Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (IAC Section 845.710(b)(1)(C))

The long-term operation and management plans for the impoundments and the on-Site landfill under each closure scenario are described in Section 2.1 (Closure Alternatives Descriptions). In summary, under both closure scenarios, the former impoundments will undergo groundwater and surface water monitoring following the completion of excavation activities until GWPSs have been achieved. The post-closure care plan for the on-Site landfill (CBR-Onsite scenario only) additionally includes leachate management; landfill cap inspection, mowing, and maintenance; and 30 years of groundwater and surface water monitoring in the vicinity of the landfill.

2.2.4 Short-Term Risks to the Community or the Environment During Implementation of Closure (IAC Section 845.710(b)(1)(D))

2.2.4.1 Worker Risks

Best practices will 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 activities, both on- and off-Site. On-Site accidents include injuries and deaths arising from the use of heavy equipment and/or earthmoving operations during construction activities. Off-Site accidents include injuries and deaths due to vehicle accidents during labor and equipment mobilization/demobilization, materials deliveries, and transportation and offloading of CCR at the off-Site landfill.

The expected number of on-Site accidents is higher under the CBR-Onsite scenario than under the CBR-Offsite scenario. Although the time required to excavate the impoundments is shorter by 0.6 years under the CBR-Onsite scenario, the overall duration of construction activities is longer by 1.8 years under this scenario due to the need to construct and then close the On-Site landfill (estimated to take 2.4 years). Moreover, all of the CCR excavated from the impoundments under the CBR-Onsite scenario will be hauled to the on-Site landfill, resulting in continuous hauling activity on-Site. Due to CCR hauling on-Site, Geosyntec estimates that the total number of equipment and vehicles travel miles required on-Site is over two times greater under the CBR-Onsite scenario than under the CBR-Offsite scenario (Geosyntec, 2022c). Based on on-Site labor hour estimates provided to us by Geosyntec for each closure scenario (Geosyntec, 2022c) and accident rates reported by the US Bureau of Labor Statistics for laborers and supervisors at construction sites (US DOL, 2020a-c), we estimated numbers of injuries and fatalities that would occur on-Site under each closure scenario. Under the CBR-Onsite scenario, we estimate that 6.4 injuries and 0.051 fatalities will occur on-Site. Under the CBR-Offsite scenario, we estimate that 2.8 injuries and 0.027 fatalities will occur on-Site. The expected number of on-Site accidents and injuries is broken down by labor category in Table 2.3.

Table 2.3 Expected Number of On-Site Worker Accidents Under Each Closure Scenario

Labor Category	CBR-Onsite		CBR-Offsite	
	Injuries	Fatalities	Injuries	Fatalities
Laborer	5.5	0.036	2.1	0.014
Site Supervisor/ Construction Project Manager/ Construction Observation Tech/Engineer	0.89	0.015	0.77	0.013
Total:	6.4	0.051	2.8	0.027

Notes:
CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal.

Under the CBR-Offsite scenario, truck accidents may occur during the hauling of CCR from the Site to an off-Site landfill. Given the volume of CCR in the impoundments, off-Site hauling under the CBR-Offsite scenario is expected to require approximately 5,180,000 vehicle travel miles (Geosyntec, 2022c). The United States Department of Transportation (US DOT, 2020) provides an estimate of the expected number of fatalities and injuries "per vehicle mile driven" for drivers and passengers of large trucks. Based on US DOT's statistics, an estimated 0.66 injuries and 0.015 fatalities would be expected to occur among drivers and passengers of haul trucks due to hauling under the CBR-Offsite scenario.

In addition to hauling, both scenarios will also have off-Site impacts due to labor mobilization and demobilization, equipment and vehicle mobilization and demobilization, and materials delivery. When considering only CCR excavation, the magnitude of these factors is similar under both closure scenarios. However, construction and closure of the on-Site landfill requires additional mobilization/demobilization efforts and materials deliveries. Thus, the impact of these activities on the total off-Site risk to workers is greater under the CBR-Onsite scenario than under the CBR-Offsite scenario.[1] Table 2.4 shows the expected number of off-Site accidents under each closure scenario due to all categories of off-Site vehicle usage. For these calculations, we assumed that labor mobilization/demobilization relied upon passenger vehicles (cars or light trucks, including pickups, vans, and sport utility vehicles) and that hauling, equipment mobilization/demobilization, and material deliveries relied upon large trucks. Crash statistics for passenger vehicles and large trucks are reported by US DOT (2020). Summing together impacts across all forms of off-Site transport, 4.7 injuries and 0.061 fatalities would be expected under the CBR-Onsite scenario and 3.8 injuries and 0.055 fatalities would be expected under the CBR-Offsite scenario.

Table 2.4 Expected Number of Off-Site Worker Accidents Under Each Closure Scenario

Off-Site Vehicle Use Category	CBR-Onsite		CBR-Offsite	
	Injuries	Fatalities	Injuries	Fatalities
Hauling	0	0	0.66	0.015
Labor Mobilization/Demobilization	4.7	0.059	3.0	0.039
Equipment Mobilization/Demobilization	0.025	0.00056	0.014	0.00032
Materials Delivery	0.046	0.0010	0.037	0.00084
Total:	4.7	0.061	3.8	0.055

Notes:
CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal.

[1] The additional impacts of labor and equipment mobilization and materials delivery under the CBR-Onsite scenario (relative to the CBR-Offsite scenario) may be offset to an unknown degree by additional construction impacts required to expand the off-Site landfill under the CBR-Offsite scenario, if expansion of the landfill is determined to be necessary at some point in the future. However, the potential impacts of off-Site landfill expansion were not quantified in our report, because it is not known at this time whether expansion will be required.

Overall, taking into account accidents occurring both on- and off-Site, 11 injuries and 0.11 fatalities would be expected under the CBR-Onsite scenario, and 6.6 injuries and 0.082 fatalities would be expected under the CBR-Offsite scenario. Thus, overall risks to workers would be higher under the CBR-Onsite scenario and lower under the CBR-Offsite scenario.

2.2.4.2 Community Risks

Accidents

Truck accidents that occur off-Site can result in injuries or fatalities to community members as well as workers. Based on the accident statistics for large trucks reported by US DOT (2020) and the off-Site haul truck travel mileage required under the CBR-Offsite scenario (*i.e.*, 5,180,000 vehicle travel miles; Geosyntec, 2022c), haul truck accidents could result in an estimated 1.9 injuries and 0.069 fatalities among community members (*i.e.*, people involved in haul truck accidents that are neither haul truck drivers nor passengers, including pedestrians, drivers of other vehicles, *etc.*) under this scenario. No fatalities or injuries would be expected to occur among community members under the CBR-Onsite scenario due to hauling, because no CCR will be hauled off-Site under this scenario.

Because the CBR-Onsite scenario requires additional construction activities relative to the CBR-Offsite scenario (namely, construction and closure of the on-Site landfill), the CBR-Onsite scenario is associated with a higher risk of accidents occurring off-Site due to non-hauling activities, including labor and equipment mobilization/demobilization and materials delivery. However, as shown in Tables 2.1 and 2.2, when summing together all forms of off-Site transport required (labor and equipment mobilization/ demobilization, materials delivery, and off-Site hauling), the CBR-Onsite scenario requires a total of 8,130,000 off-Site vehicle and equipment travel miles and the CBR-Offsite scenario requires a total of 10,500,000 off-Site vehicle and equipment travel miles. Thus, the additional travel mileage required under the CBR-Offsite scenario to haul CCR to the off-Site landfill exceeds the additional travel mileage required under the CBR-Onsite scenario to construct and close the on-Site landfill. The risk of accidents occurring among community members is higher under the CBR-Offsite scenario than under the CBR-Onsite scenario. Overall, non-hauling activities could result in an estimated 1.4 injuries and 0.021 fatalities among community members under the CBR-Offsite scenario. Under the CBR-Onsite scenario, non-hauling activities could result in an estimated 2.1 injuries and 0.031 fatalities among community members. Summing together impacts across all forms of off-Site transport required, 2.1 community injuries and 0.031 community fatalities would be expected under the CBR-Onsite scenario, and 3.3 community injuries and 0.090 community fatalities would be expected under the CBR-Offsite scenario (Table 2.5).

Table 2.5 Expected Number of Community Accidents Under Each Closure Scenario

Off-Site Vehicle Use Category	CBR-Onsite		CBR-Offsite	
	Injuries	Fatalities	Injuries	Fatalities
Hauling	0	0	1.9	0.069
Labor Mobilization/Demobilization	1.9	0.024	1.2	0.016
Equipment Mobilization/Demobilization	0.071	0.0026	0.040	0.0015
Materials Delivery	0.13	0.0048	0.11	0.0039
Total:	2.1	0.031	3.3	0.090

Notes:
CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal; CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal.

Traffic

Haul routes would be expected to use major arterial roads and highways wherever possible, which will reduce the incidence of traffic. However, the heavy use of local roads for construction operations may result in traffic near the Site and, in the case of the CBR-Offsite scenario, near the off-Site landfill.

Traffic may increase temporarily around the Site under both closure scenarios due to the daily arrival and departure of the workforce, equipment mobilization/demobilization, and material deliveries. These demands will be greater under the CBR-Onsite scenario than under the CBR-Offsite scenario due to the additional construction activities associated with construction and closure of the on-Site landfill. However, these impacts would be expected to largely occur at the beginning or end of each work day (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 materials deliveries). These impacts will therefore likely be less disruptive to community members than the constant and steady movement of haul trucks to and from the Site under the CBR-Offsite scenario. Under the CBR-Offsite scenario, Geosyntec (2022c) estimates that approximately 173,000 truckloads will be required to transport CCR from the NAP/OEAP and the NEAP to the off-Site landfill over approximately 1,450 hauling days. Assuming a 10-hour work day, a haul truck would therefore need to pass a given location near the Site once every 2.5 minutes on average for the duration of excavation activities under the CBR-Offsite scenario. The traffic demands of the CBR-Offsite scenario would therefore be considerable. This level of traffic could potentially cause traffic delays on local roads and cause damage to local roadways.

Moreover, Oakwood Junior High School is located at 21600 North 900 East Road in Danville, at the entrance to the Vermilion Power Plant. As a result of considerable off-Site hauling activities, the CBR-Offsite scenario would create greater traffic, nuisance, and safety concerns at the school than would occur under the CBR-Onsite scenario. A haul truck would likely pass the school once every 2.5 minutes on average, for the duration of the school day, under the CBR-Offsite scenario.

Noise

Construction generates a great deal of noise, both in the vicinity of the Site and along haul routes. In a closure impact analysis performed by the Tennessee Valley Authority (TVA, 2015), the authors found that "[T]ypical noise levels from construction equipment used for closure are expected to be 85 dBA or less when measured at 50 ft. These types of noise levels would diminish with distance… at a rate of approximately 6 dBA per each doubling of distance and therefore would be expected to attenuate to the recommended EPA noise guideline of 55 dBA at 1,500 ft." Because there are no residences or businesses within 1,500 feet of planned construction areas at the Site, we do not anticipate that any residences or business will be adversely impacted by noise pollution under either closure scenario. However, recreators and wildlife could be temporarily impacted by construction noise under both scenarios. Major recreational and high-value natural areas with 1,500 feet of the impoundments include the Middle Fork and the Orchid Hill Natural Heritage Landmark. The Orchid Hill Natural Heritage Landmark is also located within 1,500 feet of the proposed location of the on-Site landfill (*i.e.*, the power plant area).

The duration of noise impacts in the immediate vicinity of the impoundments will be slightly greater under the CBR-Offsite scenario than under the CBR-Onsite scenario, because the expected duration of excavation activities is longer by 0.6 years under this scenario (due to the need to haul CCR off-Site, which requires the use of lower-capacity haul trucks). However, across the entire Site, the overall duration of noise impacts from construction is also 1.8 years longer under the CBR-Onsite scenario than under the CBR-Offsite scenario, due to the 2.4 years of construction required to construct and then close the on-Site landfill. Unlike construction activities near the impoundments (which will impact the Orchid

Hill Natural Heritage Landmark and the Middle Fork), construction activities in the vicinity of the on-Site landfill will only impact the Orchid Hill Natural Heritage Landmark. The Orchid Hill Natural Heritage Landmark has more limited foot traffic relative to the Middle Fork. Taking all these factors into account, we estimate that the noise impacts of construction in the immediate vicinity of the Site will be approximately the same under both closure scenarios.

Local roads near the Site (and the off-Site landfill, under the CBR-Offsite scenario) may also experience noise pollution due to high volumes of truck traffic. As described above (Traffic), the construction schedule for the CBR-Offsite scenario requires haul trucks to pass by a given location (including Oakwood Junior High School) every 2.5 minutes on average for 10 hours each day for years while excavation is occurring. Dump trucks generate significant noise pollution, with noise levels of approximately 88 decibels or higher expected within a 50-foot radius of the truck (Exponent, 2018). This noise level is similar to the noise level of a gas-powered lawnmower or leaf blower (CDC, 2019). Decibel levels above 80 can damage hearing after 2 hours of exposure (CDC, 2019). In addition to haul truck impacts, noise pollution may also arise from the daily arrival and departure of the workforce, equipment mobilization/demobilization, and materials deliveries. These impacts would be expected to largely occur at the beginning or end of each work day (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 materials deliveries). These impacts will therefore likely be less disruptive to community members than the constant and steady movement of haul trucks to and from the Site. Off-Site noise impacts on residents would therefore be expected to be greater under the CBR-Offsite scenario than under the CBR-Onsite scenario.

Air Quality

Construction can adversely impact air quality. Air pollution can occur both on-Site and off-Site (*e.g.*, along haul routes), potentially impacting workers as well as community members. With regard to construction activities, two categories of air pollution are of particular concern: equipment emissions and fugitive dust. The equipment emissions of greatest concern are those found in diesel exhaust. Most construction equipment is diesel-powered, including the dump trucks used to haul material to and from the Site. Diesel exhaust contains hundreds of 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). Fugitive dust, another major air pollutant at construction sites, is generated by earthmoving operations and other soil- and CCR-handling activities. Along haul routes, an additional source of fugitive dust is road dust along unpaved dirt roads. Careful planning and the use of Best Management Practices (BMPs) such as wet suppression are used to minimize and control fugitive dust during construction activities; however, it is not possible to prevent dust generation entirely.

On-Site, emissions would be expected to be significantly higher under the CBR-Onsite scenario than under the CBR-Offsite scenario. The CBR-Onsite scenario includes construction and closure of the landfill, which will add 1.8 years to the overall duration of construction activities at the Site and will also increase the overall level of construction activity occurring on the Site relative to the CBR-Offsite scenario. Moreover, under the CBR-Onsite scenario, there will be haul trucks moving CCR around the Site continuously during excavation of the impoundments. Overall, Geosyntec estimates that the total number of on-Site equipment and vehicles travel miles required under the CBR-Onsite scenario is over two times greater than the number of on-Site travel miles required under the CBR-Offsite scenario (Geosyntec, 2022c).

Off-Site, hauling CCR to the off-Site landfill under the CBR-Offsite scenario will result in approximately 5,180,000 vehicle travel miles' worth of off-Site diesel vehicle emissions that will not occur under the CBR-Onsite scenario. Other types of off-Site vehicle emissions, including those resulting from labor and equipment mobilization/demobilization and materials deliveries, would be larger under the CBR-Onsite scenario than under the CBR-Offsite scenario due to the need to construct and close the on-Site landfill. However, taking all forms of off-Site vehicle transport into account, the CBR-Offsite scenario requires more off-Site vehicle and equipment travel miles than the CBR-Onsite scenario (10,500,000 off-Site vehicle and equipment travel miles under the CBR-Offsite scenario *versus* 8,130,000 off-Site vehicle and equipment travel miles under the CBR-Onsite scenario). Off-Site, emissions would therefore be expected to be higher under the CBR-Offsite scenario than the under CBR-Onsite scenario.

Summing across all of the on-Site and off-Site vehicle and equipment demands for each scenario, as presented in Tables 2.1 and 2.2, the CBR-Onsite scenario requires 8,530,000 total vehicle and equipment travel miles, and the CBR-Offsite scenario requires 10,700,000 total vehicle and equipment travel miles. Thus, the total air emissions from construction equipment and vehicles would likely be larger under the CBR-Offsite scenario than under the CBR-Onsite scenario.

Environmental Justice

The State of Illinois defines environmental justice (EJ) communities to be those communities with a minority population above twice the state average and/or a total population below twice the state poverty rate (IEPA, 2019). Relative to other communities, EJ communities experience an increased risk of adverse health impacts due to environmental pollution and other factors associated with remediation activities (US EPA, 2016).

As shown in a map of EJ communities throughout the state (IEPA, 2019), the nearest EJ communities (near Danville/Tilton) lie approximately 4.8 miles from the Site. It is unlikely that these communities would be directly impacted by on-Site air emissions, noise pollution, traffic, accidents, or other negative impacts arising at the Site. However, they may be impacted by off-Site impacts, including CCR hauling, labor and equipment mobilization/demobilization, and material deliveries. Off-Site impacts due to labor and equipment mobilization/demobilization and material deliveries would be expected to be diffuse (*i.e.*, to span a wide range of transport routes originating over a wide area). Additionally, these impacts would be expected to largely occur at the beginning or end of each work day (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 materials deliveries). Haul truck impacts, in contrast, will rely on a single transport route and will result in significant traffic impacts on local roads throughout the entire excavation period. Therefore, off-Site hauling, which will only occur under the CBR-Offsite scenario, would more likely have a significant impact on EJ communities than other types of off-Site vehicle use. For this reason, the EJ impacts of the CBR-Onsite scenario would be expected to be relatively small. In contrast, under the CBR-Offsite scenario, EJ communities located along the haul route to the off-Site landfill or near the off-Site landfill itself may be negatively impacted throughout the excavation period by the air pollution, noise, traffic, and accidents generated by CCR-hauling activities. A review of the Illinois map of EJ communities reveals that the off-Site landfill is located within the buffer zone of the EJ community near Tilton, and that transport of CCR to the landfill will require hauling CCR through the EJ communities near Tilton and Danville (Figure 2.1).

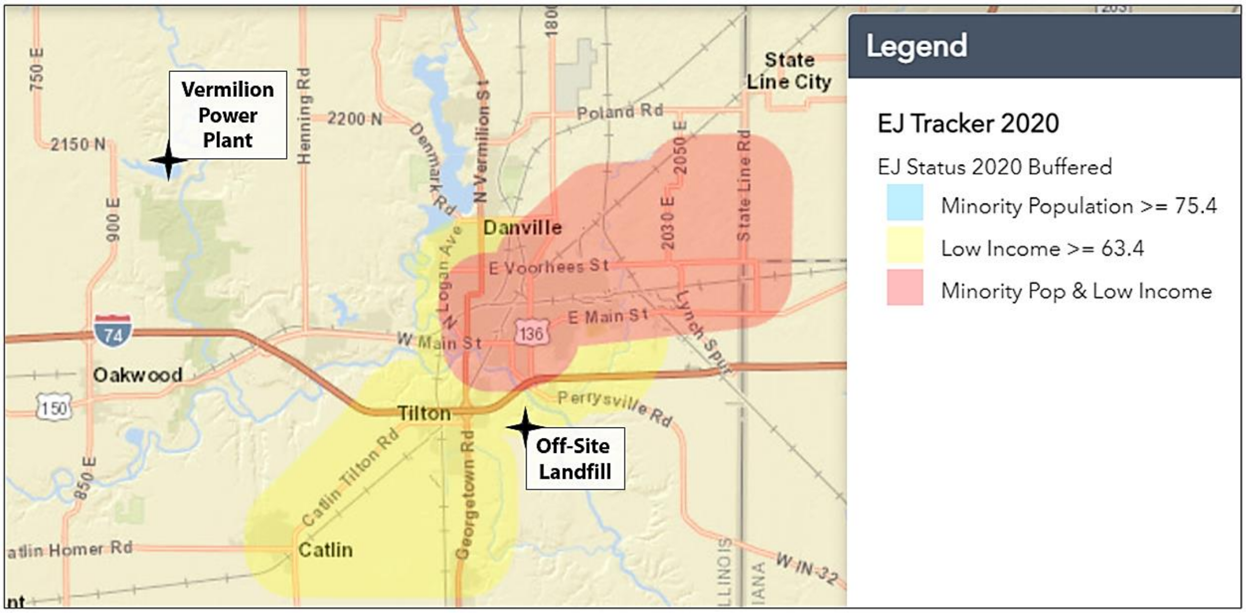


Figure 2.1 Environmental Justice Communities in the Vicinity of the Off-Site Landfill. Adapted from IEPA (2019).

Scenic, Historical, and Recreational Value

During construction activities, negative impacts on scenic and recreational value may occur at recreational areas immediately adjacent to the Site, including the Orchid Hill Natural Heritage Landmark and the Middle Fork of the Vermilion River. Noise impacts were described above. In addition, construction activities at the impoundments may be visible to recreators on the Middle Fork, potentially interfering with enjoyment of the view. Access to the Orchid Hill Natural Heritage Landmark could also potentially be restricted during the construction period, because this area borders on both the proposed on-Site landfill location and the NAP/OEAP. Unfortunately, because both closure scenarios require complete excavation of the CCR, there is no way to avoid these potential impacts under either the CBR-Onsite or CBR-Offsite scenario. The duration of excavation activities is expected to be approximately 0.6 years longer under the CBR-Offsite scenario than the under CBR-Onsite scenario; however, the CBR-Onsite scenario may have greater impacts on the Orchid Hill Natural Heritage Landmark than the CBR-Offsite scenario, because it will require 2.4 years of additional work to construct and then close the on-Site landfill. Overall, we anticipate that the short-term impacts of both closure scenarios on the scenic and recreational value of nearby recreational areas will be approximately the same.

Although there is the potential for short-term negative impacts on scenic and recreational value to occur at recreational areas near the Site under both closure scenarios, there would also be long-term positive impacts that may arise post-closure. These include:

- Demolition of the power plant, which may improve the view from the Middle Fork of the Vermilion River (known for its pristine and undeveloped landscapes). Because the CBR-Onsite scenario includes near-term plans for power plant demolition, this benefit will occur earlier and with greater certainty for that alternative compared to the CBR-Offsite alternative, for which these benefits may not be realized for years or even decades following closure; and

- Increased public access to the Orchid Hill Natural Heritage Landmark, which is located adjacent to the current power plant location (Various, 1990-2010). Because power plant demolition will occur earlier and with greater certainty under the CBR-Onsite scenario, this benefit will likely occur earlier for that scenario compared to the CBR-Offsite scenario.

Based on a review of the IDNR Historic Preservation Division database and the Illinois State Archaeological Survey database, there are no historic sites located within 1,000 meters of the NAP/OEAP or the NEAP (Ramboll, 2021a,c).

2.2.4.3 Environmental Risks

Greenhouse Gas Emissions

In addition to the air pollutants listed above in Section 2.2.4.2, construction equipment emits greenhouse gases (GHGs), including carbon dioxide (CO_2) and possibly nitrous oxide (N_2O). The potential impact of each closure scenario on GHG emissions is similar to the potential impact of each closure scenario on other emissions from construction vehicles and equipment, as described above in Section 2.2.4.2. In summary, the CBR-Onsite scenario requires 8,530,000 total on- and off-Site vehicle and equipment travel miles, and the CBR-Offsite scenario requires 10,700,000 total on- and off-Site vehicle and equipment travel miles (Tables 2.1 and 2.2). Thus, GHG emissions from construction equipment and vehicles would likely be greater under the CBR-Offsite scenario than under the CBR-Onsite scenario.

We did not quantify the carbon footprint of the composite bottom liner system and the composite final cover system that would be required for the on-Site landfill under the CBR-Onsite scenario. Each of these liner systems requires approximately 27 acres of geomembrane materials, including a 60-mil HDPE geomembrane liner for the bottom liner and a 40-mil LLDPE geomembrane liner for the final cover system (Geosyntec, 2022a). The carbon footprint of these geomembrane materials (*i.e.*, the fossil fuel emissions required to manufacture them) is an additional source of GHG emissions at the Site under the CBR-Onsite scenario. If expansion of the off-Site landfill becomes necessary in order to accept all of the CCR from the impoundments, then the CBR-Offsite scenario may also have an additional, unquantified carbon footprint due to the manufacture of geomembranes used in the expanded landfill's liner.

Energy Consumption

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 in this analysis include the burning of diesel fuel during construction activities and the carbon footprint of manufacturing geomembrane textiles. Because GHG emission impacts and energy consumption impacts both arise from the same sources at construction sites, the trends discussed above with respect to GHG emissions also apply to the evaluation of energy demands. Overall, the energy demands of construction equipment and vehicles would likely be larger under the CBR-Offsite scenario than under the CBR-Onsite scenario. We did not quantify the energy demands of the geomembranes required for the construction and closure of the on-Site landfill under the CBR-Onsite scenario or, potentially, the expansion of the off-Site landfill under the CBR-Offsite scenario.

Natural Resources and Habitat

Construction would likely have a negative short-term impact on the natural resources and habitat in the vicinity of the impoundments and the proposed on-Site landfill location. For example, excavation of the impoundments will result in the destruction of some habitat that may currently overlie impoundments under both closure scenarios. Dewatering, excavation, and Site restoration will also result in long-term shifts in the habitat overlying the impoundment (*e.g.*, areas of the impoundment that are not currently grassland will be converted to grassland).

Construction of the on-Site landfill under the CBR-Onsite scenario is not expected to result in significant habitat loss, because the landfill will be constructed over the site of the retired power plant rather than over existing high-quality habitat. Thus, the magnitude of direct impacts on habitat is expected to be approximately the same under both the CBR-Onsite and CBR-Offsite scenarios. However, the duration of time over which these direct habitat impacts occur will be slightly longer under the CBR-Offsite scenario than under the CBR-Onsite scenario, because excavation of the impoundments is expected to take 0.6 years longer under the CBR-Offsite scenario.

In addition to direct impacts to the existing habitat atop the impoundments, construction activities may have indirect impacts by causing alarm and escape behavior in wildlife found near the impoundments. In the vicinity of the impoundments, these indirect impacts will be slightly worse under the CBR-Offsite scenario than under the CBR-Onsite scenario, because the duration of CCR excavation activities is longer by 0.6 years under the former scenario. However, indirect impacts in the vicinity of the on-Site landfill location will be worse under the CBR-Onsite scenario, due to the construction and closure of the on-Site landfill. Indirect impacts on habitat would likely be somewhat worse overall under the CBR-Onsite scenario, because the overall duration of construction activities is 1.8 years longer than under the CBR-Offsite scenario.

The likelihood of negative impacts occurring to sensitive aquatic organisms is small under both closure scenarios. There is potential, however, for limited negative short-term impacts to aquatic species in the Middle Fork of the Vermilion River due to, *e.g.*, sediment runoff during construction. Although erosion prevention and sediment control measures will be undertaken under both of the closure scenarios, some small impacts could still conceivably occur. Eight state threatened or endangered aquatic species may be found in the Middle Fork of the Vermilion River near the Site, including the bluebreast darter, clubshell, little spectaclecase, northern riffleshell, purple wartyback, salamander mussel, silvery salamander, and the wavy-rayed lampmussel (Hanson Professional Services Inc., 2019, Appendix A). All but two of these species (the bluebreast darter and the silvery salamander) are freshwater mussels. Around 2010, IDNR performed a mussel survey on behalf of the National Park Service in the vicinity of the NEAP (extending approximately 200 feet upstream and 700 feet downstream) and found that the aquatic habitat in this area was not suitable for mussels due to an abundance of scoured bedrock. Only a single live mussel was found during this survey, on the opposite bank of the Middle Fork of the Vermilion River (NPS, 2010). In 2018, Stantec performed a mussel survey over a longer reach near the embankments in support of potential riverbank stabilization efforts. It similarly found that "the mussel densities within the project area were described as low and suitable habitat as sparse" (US FWS, 2019). The likelihood of negative impacts occurring to sensitive aquatic organisms is small under both closure scenarios. The duration of time over which these impacts may occur is slightly longer under the CBR-Offsite scenario than under the CBR-Onsite scenario, because excavation of the impoundments is expected to take 0.6 years longer under the former scenario.

In summary, there is some potential for short-term negative impacts to occur to terrestrial and aquatic species during construction activities under both scenarios. However, long-term positive impacts would likely also occur post-closure due to the demolition of the power plant, which will result in the establishment of new habitat atop the footprint of the plant and (in the case of the CBR-Onsite scenario) the new on-Site landfill. The long-term benefits of power plant demolition will be realized more rapidly, and potentially with greater certainty, under the CBR-Onsite scenario than under the CBR-Offsite scenario, because the CBR-Onsite scenario includes near-term plans for plant demolition. Under the CBR-Offsite scenario, demolition of the power plant may not occur for decades.

2.2.5 Time Until Groundwater Protection Standards Are Achieved (IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3))

The time horizon over which GWPSs will be exceeded at the Site is immaterial from a risk perspective, because there is no unacceptable risk associated with exceedances of a GWPS at the Site (see Section 2.2.1). Additionally, at sites where groundwater corrective action will be implemented, it is inappropriate to evaluate the time to achieve GWPSs based on closure alone, because both closure and corrective actions will affect future groundwater concentrations. See Section 4.1.6 of the CAAA for an evaluation of the times to achieve GWPSs at the Site based both on source control and the corrective action alternatives.

2.2.6 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 845.710(b)(1)(F))

Section 2.2.1 evaluates potential risks to human and ecological receptors arising from the leaching of CCR-associated constituents into groundwater during closure activities and following closure of the impoundments. Section 2.2.2 evaluates the potential for CCR releases to occur due to dike failure or overtopping during flood conditions. In summary, there is no current or future risk to any human or ecological receptors due to CCR-associated constituents leaching into groundwater at this Site. Additionally, there is no current or future risk of overtopping occurring at the embankments due to flood conditions at the Site. Dike failure due to seismic activity and flood conditions is also exceedingly unlikely. Due to the steady migration of the Middle Fork of the Vermilion River towards the embankments over time, dike failure could conceivably occur at the Site prior to the complete excavation of the basins, if no riverbank stabilization infrastructure is put in place. However, because the erosion of the riverbank is being closely monitored and an emergency response plan has recently been developed (Geosyntec, 2021c), we judge that there is little practical risk of dike failure occurring due to riverbank migration.

Section 2.2.4 provides an evaluation of several additional potential risks to human health and the environment during closure activities, including risks of accidents occurring to workers; risks to nearby residents and EJ communities related to accidents, traffic, noise, and air quality; and risks of natural resource impacts and habitat impacts occurring in the vicinity of construction areas at the Site. The findings from this section of the text are summarized in Table S.1.

2.2.7 Long-Term Reliability of the Engineering and Institutional Controls (IAC Section 845.710(b)(1)(G))

After all of the CCR has been removed from the impoundments, there will be no long-term risk of engineering or institutional failures leading to releases of CCR from the impoundments or the leaching of CCR-associated constituents from the impoundments (see Sections 2.2.1 and 2.2.2 above). Reliable engineering and institutional controls (*e.g.*, a bottom liner, a leachate management system, and groundwater monitoring) will also be implemented at the on- and off-Site landfills. The CBR-Onsite and CBR-Offsite scenarios would therefore both be reliable with respect to long-term engineering and institutional controls.

2.2.8 Potential Need for Future Corrective Action Associated with the Closure (IAC Section 845.710(b)(1)(H))

Sections 3 and 4 of this report present and evaluate the corrective measures being considered at the Site. Because both closure scenarios involve complete excavation of CCR from the impoundments, we anticipate that there will be no difference in the potential need for future corrective actions under either closure scenario.

2.3 Effectiveness of the Closure Alternative in Controlling Future Releases (IAC Section 845.710(b)(2))

2.3.1 Extent to Which Containment Practices Will Reduce Further Releases (IAC Section 845.710(b)(2)(A))

All CCR will be excavated from all of the impoundments under both closure scenarios. Both closure scenarios would therefore be expected to be fully effective in controlling future releases. Because both scenarios entail CBR, there is no expected difference between scenarios in terms of the extent to which containment practices will reduce further releases.

2.3.2 Extent to Which Treatment Technologies May Be Used (IAC Section 845.710(b)(2)(B))

All of the CCR in the impoundments will be excavated under both closure scenarios. Both closure scenarios would therefore be expected to require treatment technologies to the same extent. Sections 3 and 4 evaluate the various corrective measures being considered at the Site, including treatment technologies.

2.4 Ease or Difficulty of Implementing Closure Alternative (IAC Section 845.710(b)(3))

2.4.1 Degree of Difficulty Associated with Constructing the Closure Alternative

Excavation and landfilling are both highly reliable and well-standardized methods for managing waste that rely on common construction activities. Dewatering and excavating saturated CCR can present challenges during closure; however, those challenges will be the same for both closure scenarios. In general, complete excavation of the impoundments will present the same level of difficulty for both closure scenarios. However, the expected ease of implementation may vary between the two closure scenarios due to other factors, including the demands of on-Site landfill construction and the relative impacts of off-Site *versus* on-Site hauling and disposal of CCR.

Constructing a new on-Site landfill will require planning, design, and construction. While these elements are unique to the CBR-Onsite scenario, the tasks and processes associated with the addition of a new on-Site landfill are straightforward and standard. We anticipate that these elements of the CBR-Onsite scenario can be completed in coordination with the necessary permitting for closure of the existing CCR surface impoundments.

Hauling will be easier to implement under the CBR-Onsite scenario than under the CBR-Offsite scenario, due to the shorter haul distance required for on-Site disposal of the CCR from the impoundments than for off-Site disposal and the lack of need to haul the CCR over public roads. When using public roads, there are limits placed on the capacity of haul trucks traveling on those roads. The need to utilize only on-Site private roads will allow for the use of higher-volume haul trucks, thereby reducing the number of trucks and trips required for CCR excavation and transport. Additionally, the off-road haul trucks that will be used under the CBR-Onsite scenario can work in inclement weather, whereas the interstate vehicles that will be used under the CBR-Offsite scenario will require cleaning and preparation prior to leaving the Site in poor weather conditions. Finally, because the CBR-Offsite scenario involves hauling ash off-Site (*i.e.*, intrastate travel), a higher level of dewatering will be required compared to the CBR-Onsite scenario. As described in Section 2.2.4.2 (Community Risks), off-Site hauling may additionally have detrimental impacts due to an increased incidence of trucking accidents, truck traffic, noise, and air pollution. Extensive traffic due to hauling activity may also cause damage to public roadways.

In addition to off-Site hauling, off-Site landfilling under the CBR-Offsite scenario may pose particular challenges. A disposal plan will need to be developed between DMG and the owner/operator of the third-party landfill in order to outline acceptable waste conditions upon delivery, daily waste production rates, and the expected duration of the project. Off-Site landfilling may additionally raise issues related to the co-disposal of CCR and other non-hazardous wastes. Finally, the construction schedule for excavation may be negatively impacted if, during the course of closure, it is determined that the off-Site landfill must be expanded in order to receive all of the CCR excavated from the impoundments.

2.4.2 Expected Operational Reliability of the Closure Alternative

After all of the CCR has been removed from the impoundments, there will be no long-term risk of operational failures leading to releases of CCR from the impoundments or the leaching of CCR-associated constituents from the impoundments. Reliable operational controls (*e.g.*, a bottom liner, a leachate management system, and groundwater monitoring) will also be implemented at the on- and off-Site landfills. Thus, the operational reliability of both closure scenarios is expected to be high.

2.4.3 Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies

Permits and approvals will be needed under both closure scenarios. All permits would be expected to be approved. Components of the closure scenarios that may require a permit include the disposal of water from unwatering and dewatering of the impoundments, which will be managed under the existing NPDES permit. Additional permits addressed in this report include those associated with the on- and off-Site landfills.

As required by the Agreed Interim Order (Illinois, Attorney General, 2021), construction of the on-Site landfill under the CBR-Onsite scenario would require a demolition permit and may require a landfill permit. In addition, the new on-Site landfill would require a construction stormwater permit through IEPA, including construction stormwater controls and BMPs such as silt fences and other measures.

Under the CBR-Offsite scenario, it may be necessary to construct additional, pre-approved cells at the off-Site landfill in order to accommodate the mass of CCR to be received. It may also be necessary to modify the operating plan for the off-Site landfill in order to accommodate the increased rate of filling of the landfill and the likely need for additional equipment and personnel to manage the receipt and disposal of the CCR.

Per the Agreed Interim Order (Illinois, Attorney General, 2021), both closure scenarios will require the following permit applications.

- NPDES permit modification.
- General NPDES permit for construction activities.
  - Requires project review and approval from the State Historic Preservation Office (SHPO) and IDNR.
- Joint water pollution control construction and operating permit (WPC permit).
  - As a contingency, upon issuance of the NPDES permit modification, a revision to the existing WPC permit may be required.

The permit documents will be submitted to the Middle Fork River Corridor Advisory Committee for review.

2.4.4 Availability of Necessary Equipment and Specialists

Excavation, hauling, and landfilling are reliable and standardized methods for managing waste that rely on common construction equipment and materials and typically do not require the use of specialists, outside of typical construction labor and equipment operators. However, global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in the availability of construction equipment under both scenarios if supply chain resilience does not improve by the time construction begins. Alternatively, extended downtime may be required for equipment repairs and maintenance. A national shortage of truck drivers has also developed during the COVID-19 pandemic. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the longer hauling distance required, the smaller haul truck capacity, and the need to haul over public roads under this scenario. If sufficient trucks and truck drivers are not available, the construction schedule may lengthen based on hauling-related delays.

2.4.5 Available Capacity and Location of Needed Treatment, Storage, and Disposal Services

The new on-Site landfill would be designed and constructed to be able to receive all CCR wastes that will be generated on-Site. Treatment would consist of the removal of water from wet CCR prior to loading the CCR into haul trucks. Water from unwatering and dewatering of the impoundments would be discharged *via* the existing NPDES permit.

The volume of CCR that will be excavated from the NAP/OEAP and NEAP and require disposal is estimated to be 2.6 million cubic yards (MCY). According to the IEPA "Landfill Disposal Capacity Report" for 2020 (IEPA, 2021b), the closest nearby third-party landfill with the ability to receive and dispose of CCR from the Site is the Republic Services Brickyard Disposal Landfill in Danville, Illinois.

This facility has 5.9 MCY of remaining capacity in its current permitted footprint. It receives 0.3 MCY of waste annually, and is located 16 miles from the Site. Thus, the Republic Services Brickyard Disposal and Recycling Inc. landfill has sufficient capacity to receive CCR from the NAP/OEAP and NEAP.

Due to the relatively short period over which CCR would be received at the landfill, vertical and/or lateral expansions may become necessary. Additionally, the landfill operators may need to develop a disposal plan to account for the increased volume of material that will be received and the unique CCR waste characteristics. Elements of this disposal plan might include increasing daily operational capacity and procedures, expediting planned airspace construction, and potentially expediting landfill expansion.

If expansion of the Brickyard Disposal Landfill is impractical or infeasible, then an alternative landfill located farther from the Site would need to be identified. A likely alternative to the Brickyard Disposal Landfill is the Republic Services Illinois Landfill in Hoopeston, Illinois. It has 12.3 MCY of remaining capacity in its current permitted footprint, receives 0.06 MCY of waste annually, and is located 29 miles from the Site (IEPA, 2021b).

2.5 Impact of Closure Alternative on Waters of the State (IAC Section 845.710(d)(4))

As demonstrated in the February 2020 Human Health and Ecological Risk Assessment (Appendix A), modeled surface water concentrations in the Middle Fork of the Vermilion River are all below relevant human health and ecological screening benchmarks. Due to the complete removal of the source material from the NAP/OEAP and NEAP under both closure scenarios, surface water concentrations of CCR-associated constituents are expected to decline over time. Thus, no future exceedances of any human health or ecological screening benchmarks are anticipated under either closure scenario.

Modeling was performed to evaluate future groundwater quality in the vicinity of the NAP/OEAP resulting from source control (Ramboll, 2022). The modeling concluded that mass flux to the Middle Fork of the Vermilion River from the MGU will be reduced by approximately 50% 10 years after closure is completed and by approximately 80% 35 years after closure is completed (Ramboll, 2022). Mass flux declines will occur more slowly in the LGU, which has lower constituent concentrations, due to the presence of lower-permeability deposits (Ramboll, 2022).

The lined landfills that receive the CCR excavated from the impoundments under both closure scenarios will be managed to ensure that no surface water impacts occur in the vicinity of the landfills. In summary, no impacts on any waters of the state are expected.

2.6 Concerns of Residents Associated with Closure Alternatives (IAC Section 845.710(b)(4))

Several nonprofits representing community interests near the Site have campaigned for complete excavation of the CCR impoundments at the Site, including the Eco-Justice Collaborative, Earthjustice, American Rivers, and the Prairie Rivers Network (American Rivers, 2018; Earthjustice, 2021; Eco-Justice Collaborative, 2021; Barkley, 2012). Major concerns cited by these groups include potential impacts to groundwater and surface water quality and the potential threat to dike stability posed by riverbank migration. Because the CBR-Offsite and CBR-Onsite scenarios both involve complete excavation of the impoundments, these scenarios should address all of the major concerns raised by these groups.

Under the CBR-Offsite scenario, excavation can begin immediately. Under the CBR-Onsite scenario, dewatering can begin immediately, reducing risks of dike failure and the leaching of CCR-associated constituents from the impoundment; CCR excavation will then begin once the plant is demolished and the on-Site landfill is constructed. Because the CBR-Onsite scenario does not require off-Site hauling of CCR, it presents less risks to nearby residents and EJ communities in the form of accidents, traffic, noise, and air pollution. Additionally, this scenario will more rapidly address stakeholder concerns about having an inactive power plant located along Illinois's only National Scenic River.

A public meeting was held on December 9, 2021, pursuant to requirements under IAC Section 845.710(e) and the Agreed Interim Order (IEPA, 2021a; Illinois, Attorney General, 2021). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.

2.7 Class 4 Cost Estimate (IAC Section 845.710(d)(1))

A detailed cost estimate has been prepared for each of the closure scenarios (Appendix C). A summary of these estimates is provided in Table 2.6. The total expected cost of closure under the CBR-Onsite scenario is $121,700,000. The total expected cost of closure under the CBR-Offsite scenario is $249,000,000. Excavation and final disposal of CCR could be performed at a lower cost under the CBR-Onsite scenario, because fewer haul trucks and truck trips would be required and the length of the haul route would be considerably shorter.

Table 2.6 Expected Costs of Closure

Work Element	CBR-Onsite[a]	CBR-Offsite[a,b]
NAP/OEAP Closure-by-Removal	$63,600,000	$208,400,000
NEAP Closure-by-Removal	$14,300,000	$36,800,000
New On-Site Landfill Construction[c]	$40,000,000	$0
Groundwater Collection Trench Construction	$3,800,000	$3,800,000
Total:	**$121,700,000**	**$249,000,000**

Notes:
CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal.
Source: Appendix C.
(a) Includes a 30% contingency.
(b) Includes tipping fees.
(c) Does not include post-closure care.

Each closure scenario meets or exceeds a Class 4 estimate under the Association for the Advancement of Cost Engineering (AACE) Classification Standard (or a comparable classification practice as provided in the AACE Classification Standard), as required by IAC Section 845.710 (IEPA, 2021a).

2.8 Summary

Table S.1 summarizes the expected impacts of the CBR-Onsite and CBR-Offsite closure scenarios with regard to each of the factors specified under IAC Section 845.710 (IEPA, 2021a). Based on this evaluation and the details provided in Section 2 above, CBR-Onsite has been identified as the most appropriate closure scenario for the NAP/OEAP and the NEAP. Key benefits of the CBR-Onsite scenario relative to the CBR-Offsite scenario include near-term plans for the demolition of the power plant, which will have scenic benefits along Illinois's only National Scenic River, and reduced impacts to community members and the environment due to construction activities (*e.g.*, fewer constructed-related community accidents, lower energy demands, less air pollution and GHG emissions, less traffic, and lower impacts to EJ communities).

3 Corrective Measures Assessment

This section of the report presents a CMA pursuant to requirements under IAC Section 845.660 (IEPA, 2021a). The goal of a CMA is to provide a high-level screening of potential corrective measures based on expected remedy performance, reliability, ease of implementation, and other factors (IEPA, 2021a). A detailed analysis of potentially viable corrective actions, as identified in the CMA, is provided in the CAAA (Section 4).

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 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 time frames 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 US EPA refused to specify what is a reasonable *versus* an unreasonable timeframe for groundwater corrective actions at CCR sites, stating that "EPA was truly unable to establish an outer limit on the necessary timeframes—including even a presumptive outer bound" (US EPA, 2015a, p. 21419).

It is also important to note that source control, which at a CCR impoundment could include either capping or excavation, 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). As a result, the implementation of source control often has a more substantial and more immediate effect on groundwater quality improvements than other groundwater corrective measures. In this CMA (Section 3) and CAAA (Section 4), every scenario evaluated pairs source control with other additional groundwater remediation strategies.

3.1 Corrective Measure Alternative Descriptions

Five potential corrective measures were selected for evaluation in the CMA for this Site. Each corrective measure includes source removal based on the CBR-Onsite scenario (*i.e.*, Closure-by-Removal with CCR disposal at an on-Site landfill), as evaluated and selected in the CAA. Corrective measures considered in the CMA include Source Control with Monitored Natural Attenuation (Source Control-MNA), Source Control with Groundwater Extraction (Source Control-GE), Source Control with Monitored Natural Attenuation and Groundwater Extraction (Source Control-MNA/GE), Source Control with Construction of a Cutoff Wall (Source Control-CW), and Source Control with Construction of a Permeable Reactive Barrier (Source Control-PRB). Each of these corrective measures was evaluated in the CMA for its potential viability at the Site. Under the Source Control-MNA alternative, groundwater concentrations of dissolved constituents will attenuate *via* naturally occurring physical and chemical processes in areas downgradient of NAP/OEAP; active monitoring will be performed to verify and document the remediation processes. Under the Source Control-GE alternative, the groundwater collection trench will continue operating post-closure in the OEAP area, and an additional GE system will be installed in the NAP area in order to extract potentially impacted groundwater from the aquifer, helping to contain the contaminant plume and prevent the lateral migration of constituents off-Site. Under the Source Control-MNA/GE alternative, the groundwater collection trench will continue operating post-closure in the OEAP area, and groundwater concentrations of dissolved constituents will attenuate *via* natural physical and chemical processes in areas downgradient of the NAP. Under the Source Control-CW alternative, a trench will be dug along the downgradient perimeter of the OEAP and NAP and filled with a soil-bentonite mixture, creating a low-permeability subsurface barrier to the lateral migration of constituents off-Site. Under the Source Control-PRB alternative, a subsurface barrier of reactive materials (*e.g.*, zerovalent iron) will be placed in the path of groundwater flow downgradient of the NAP/OEAP in order to promote the *in situ* transformation and/or immobilization of CCR-associated constituents.

The performance of each of these corrective measures is influenced by the closure activities described above in Section 2, including excavation of the CCR from the impoundments (Closure-by-Removal with on-Site landfill CCR disposal, or CBR-Onsite) and construction of a groundwater collection trench, as required by the Agreed Interim Order (Illinois, Attorney General, 2021). The groundwater collection trench will be located downstream of the OEAP and will intercept seepage from the impoundment prior to and during the excavation of CCR from the impoundment. Groundwater and seep water collected in the trench will be sent to the NAP Secondary Pond and discharged *via* the NPDES-permitted outfall. For all corrective measures considered in this CMA, the groundwater collection trench will operate at least until closure has been completed. Because the impacts of the closure activities, including the construction of the groundwater collection trench, on human health and the environment, engineering reliability, and other factors were already evaluated in the CAA (Section 2), they were not re-evaluated in this section. Additionally, because complete excavation of the CCR and installation of the groundwater collection trench will occur under all the corrective measure alternatives, the impacts of source control and the trench will be the same under all the alternatives. We have therefore omitted discussion of the impacts of the closure-related activities from this section of the report.

This report evaluates the potential performance, reliability, and impacts of the various corrective measures, but does not make any judgements regarding the need for these corrective measures. It should be noted, however, that the primary pond of the NEAP was constructed atop bedrock using earthen berms that contain a low-permeability clay core keyed into the underlying shale. Constituent migration from this impoundment is therefore expected to be very limited, and there are no exceedances of the relevant GWPSs that have been attributed to the NEAP. Thus, corrective measures other than source control may not be necessary for the NEAP.

3.1.1 Source Control with Monitored Natural Attenuation

The United States Environmental Protection Agency (US EPA, 1999) defines MNA as "[t]he 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." MNA relies on naturally occurring physical and chemical processes to immobilize potentially problematic constituents in groundwater and attenuate dissolved concentrations of those constituents. Chemical processes that naturally promote the attenuation of dissolved inorganic constituent concentrations in groundwater include sorption, precipitation, and redox reactions. Physical processes that promote attenuation include dispersion and dilution (US EPA, 2015b). US EPA has determined that MNA can be a viable alternative at sites impacted by inorganic constituents such as metals and metalloids, especially when implemented alongside source control measures (US EPA, 1999, 2015b). A site-specific analysis prepared by Geosyntec for the Vermilion Site (Geosyntec, 2022b) demonstrates that MNA is a promising alternative for this Site. The following factors make the Vermilion Site well-suited to the use of MNA (Geosyntec, 2022b; US EPA, 2015b):

- MNA will be implemented in conjunction with a source control measure,
- No receptors at or near the Site are currently being exposed to a contaminant,
- The contaminant plume is not expanding,
- Contaminant immobilization is happening naturally in the subsurface, and
- GWPSs can be achieved within a reasonable timeframe.

Because MNA relies on natural processes, implementation of the Source Control with Monitored Natural Attenuation (Source Control-MNA) alternative does not require the installation, operation, or maintenance of any engineered systems or structures other than maintenance of the monitoring well network. Long-term management associated with groundwater monitoring will be undertaken to ensure that attenuation is occurring as planned. Groundwater monitoring will continue until GWPSs are achieved. Following the completion of source control measures, the Source Control-MNA remedy will require 1-2 years to design, construct, and implement, which includes any additional investigations required to characterize Site conditions and additional work related to the design and installation of the groundwater monitoring system.

3.1.2 Source Control with Groundwater Extraction

Under the Source Control with Groundwater Extraction (Source Control-GE) alternative, the groundwater collection trench will continue to operate post-closure downgradient of the OEAP, and an additional GE system will be installed downgradient of the NAP to extract potentially impacted groundwater from the aquifer. The GE system at the NAP will either be comprised of groundwater pumping wells or a groundwater collection trench. Extraction will help contain the contaminant plume and prevent the lateral migration of constituents off-Site. If groundwater monitoring reveals a need for treatment of extracted groundwater prior to discharge, then a treatment system will be designed and implemented at the Site. Water treatment, if needed, will include a settling pond and possibly pH adjustment. Under this scenario, groundwater captured by the GE system will be discharged to the Middle Fork of the Vermilion River *via* one of the facility's NPDES-permitted outfalls.

GE using wells may be difficult to implement, because the alluvial deposits at the NAP vary in composition laterally and vertically. Additional testing would be required to estimate the number, spacing, screened intervals, and extraction rates for capture of impacted groundwater. Additionally, due to a limited construction area between the river and the NAP perimeter berm, the installation of a groundwater collection trench through both the MGU and the LGU near the NAP is likely to be an infeasible alternative to GE using wells.

In total, following the completion of source control measures, the Source Control-GE remedy will require 2-3 years to design and construct. Long-term management of the GE system will include periodic inspections and routine maintenance, including the replacement of worn or damaged parts. Monitoring will also be undertaken to ensure that the GE system is working as intended and will continue until GWPSs are achieved.

3.1.3 Source Control with Monitored Natural Attenuation and Groundwater Extraction

The Source Control with Monitored Natural Attenuation and Groundwater Extraction (Source Control-MNA/GE) alternative is a combination of the MNA and GE corrective measures. Specifically, the groundwater collection trench will continue operating post-closure in the OEAP area and groundwater concentrations of dissolved constituents will attenuate *via* natural physical and chemical processes (*i.e.*, MNA) in areas downgradient of the NAP. Groundwater and seep water collected by the groundwater collection trench will be routed to the NAP Secondary Pond and discharged to the Middle Fork of the Vermilion River *via* one of the facility's NPDES-permitted outfalls. If monitoring reveals a need for treatment of collected groundwater and seep water prior to discharge, then a treatment system will be designed and implemented at the Site. Water treatment, if needed, will include a settling pond and possibly pH adjustment.

Because MNA relies on natural attenuation processes and the groundwater collection trench will already have been installed as required by the Agreed Interim Order (Illinois, Attorney General, 2021), this alternative does not require the installation, operation, or maintenance of any additional engineered systems or structures, unless a treatment system is found to be required for the treatment of collected groundwater. The only long-term management activity required under this alternative is groundwater monitoring and maintenance of the groundwater collection trench (and, if needed, maintenance of the treatment system). Groundwater monitoring will continue until GWPSs are achieved. Following the completion of source control measures, the Source Control-MNA/GE remedy will require 1-2 years to design, construct, and implement, which includes any additional investigations required to characterize Site conditions and additional work related to the design and installation of the groundwater monitoring system.

3.1.4 Source Control with Construction of a Cutoff Wall

Under the Source Control with Construction of a Cutoff Wall (Source Control-CW) alternative, a trench will be dug along the downgradient perimeter of the former impoundments and filled with a soil-bentonite mixture. This process will create a low-permeability subsurface barrier to the lateral migration of constituents off-Site. The slurry wall will extend all the way down to the underlying bedrock, creating a barrier to constituent transport both immediately beneath the impoundment and at depth.

In the absence of additional hydraulic controls, CWs can unintentionally function as subsurface dams, routing groundwater around the wall rather than preventing its lateral migration. In order to ensure that this does not occur, a series of hydraulic control wells will be installed in the vicinity of the CW. These wells will serve as a "hydraulic gradient control system," ensuring that groundwater flows inward through the wall, rather than flowing outward (thus containing any potentially impacted groundwater behind the wall). If groundwater monitoring reveals a need for treatment of extracted groundwater prior to discharge, then a treatment system will be designed and implemented at the Site. Water treatment, if needed, will include a settling pond and possibly pH adjustment.

Site investigations and engineering analyses must be conducted prior to designing a CW system. In total, following the completion of source control measures, the Source Control-CW remedy will require 2-3 years to design, construct, and implement. Long-term management under the Source Control-CW alternative will include periodic inspections and routine maintenance of the CW and the hydraulic gradient control system. Monitoring will also be undertaken to ensure that the corrective measure is working as intended and will continue until GWPSs are achieved.

3.1.5 Source Control with Construction of a Permeable Reactive Barrier

Under the Source Control with Construction of a Permeable Reactive Barrier (Source Control-PRB) alternative, a subsurface barrier of reactive materials will be placed in the path of groundwater flow in order to promote the *in situ* transformation and/or immobilization of CCR-associated constituents. A permeable barrier is used so that the barrier does not hinder groundwater flow. At the Vermilion Site, the PRB would extend all the way down to the underlying bedrock.

One potential reactive material that can effectively immobilize many CCR-associated constituents is zerovalent iron. Zerovalent iron is effective at immobilizing arsenic, chromium, cobalt, molybdenum, selenium, and sulfate. However, zerovalent iron has not been proven effective for boron, antimony, or lithium (EPRI, 2006).

Site investigations and engineering analyses must be conducted prior to designing a PRB. In total, following the completion of source control measures, the Source Control-PRB remedy will require 2-3 years to design, construct, and implement. Long-term management under the Source Control-PRB alternative will include periodic maintenance and possibly replacement of the reactive media in order to extend the life of the PRB. Monitoring will also be undertaken to ensure that the corrective measure is working as intended and will continue until GWPSs are achieved.

3.2 Performance, Reliability, Ease of Implementation, and Potential Impacts of the Corrective Measure Alternative (IAC Section 845.660(c)(1))

3.2.1 Performance of the Corrective Measure Alternative – Controlling the Source (IAC Section 845.660(c)(1))

"Primary source control" means the prevention of CCR-associated constituents leaching from the impoundments into underlying groundwater. Because source control will be undertaken at the Site prior to the implementation of any corrective measures, all corrective measure alternatives will eliminate the potential for CCR within the impoundments to impact groundwater. All of the corrective measure alternatives would be equally and fully protective with regard to primary source control. However, impacted soils underlying the impoundments can potentially act as a secondary source of CCR-associated impacts to groundwater even after the primary source (CCR) has been excavated and hauled to a landfill for disposal.

The effectiveness of the various corrective measure alternatives with respect to secondary source control are summarized as follows:

- Under the Source Control-MNA alternative, the attenuation of dissolved constituent concentrations remaining after source control would be achieved through natural processes. An analysis by Geosyntec (2022b) demonstrates that MNA would likely perform well at this Site, both within the secondary source area and downgradient.
- Under the Source Control-GE alternative, GE would be used to capture dissolved constituent concentrations emanating from secondary source areas and prevent lateral migration off-Site. GE is a widely used corrective measure. However, its performance can vary from site to site. Although good performance would generally be expected for this alternative, additional Site investigations and engineering analyses may be required to design the GE system.
- Under the Source Control-MNA/GE alternative, source control would be achieved by GE at the groundwater collection trench near the OEAP and *via* the natural attenuation of dissolved constituent concentrations near the NAP. An analysis by Geosyntec (2022b) demonstrates that MNA would likely perform well at this Site, both within the secondary source area and downgradient. Additionally, GE is a widely used corrective measure. While its performance can vary from site to site, good performance would generally be expected for continued operation of the groundwater collection trench.
- Under the Source Control-CW alternative, a low-permeability subsurface barrier would prevent the lateral migration of constituents off-Site. This barrier, which would extend all the way down to the bedrock, is expected to be highly effective at preventing lateral constituent migration. Although the CW would not be designed to promote the attenuation of dissolved constituent concentrations within the secondary source area (*i.e.*, under the former impoundment and upgradient of the CW), some attenuation would nonetheless occur in this area due to natural processes. Additional Site investigations and engineering analyses may be required to design the CW and associated hydraulic control system.
- Under the Source Control-PRB alternative, a PRB would be placed into the path of groundwater flow in order to promote the transformation and immobilization of constituents. The ability of this barrier to prevent the lateral migration of constituents would depend on Site-specific factors, such as Site hydrogeology and geochemical conditions. Moreover, the effectiveness of the barrier would vary by constituent. PRBs generally have limited success at treating lithium and boron in groundwater, for example, which may limit the effectiveness of PRB at the Vermilion Site (because both of these are CCR-related constituents). Although the PRB would not be designed to promote the attenuation of dissolved constituent concentrations within the secondary source area (*i.e.*, under the former impoundment and upgradient of the PRB), some attenuation would nonetheless occur in this area due to natural processes. Additional Site investigations and engineering analyses may be required to design the PRB.

3.2.2 Performance of the Corrective Measure Alternative – Likelihood of Future Releases of CCR (IAC Section 845.660(c)(1))

All corrective measure alternatives include source control. There would be no risk of accidental CCR releases occurring post-closure under any of the corrective measure alternatives.

3.2.3 Performance of the Corrective Measure Alternative – Long-Term Management (IAC Section 845.660(c)(1))

The type and degree of long-term management under each corrective measure alternative are summarized as follows:

- The Source Control-MNA alternative would not require the installation, operation, or maintenance of any engineered systems or structures, other than maintenance of the monitoring well network. Long-term management associated with groundwater sampling would continue until GWPSs had been achieved or until it was determined that the measure is not meeting the requirements of IAC Section 845.670(d).
- The Source Control-GE alternative would require the management and discharge of extracted groundwater. Treatment may also be required prior to discharge. Water treatment, if necessary, would be expected to potentially include a settling pond and pH adjustment. Operations and maintenance (O&M) under this scenario would include routine groundwater sampling and hydraulic gradient monitoring to ensure that the GE system is working as intended. O&M would continue until GWPSs had been achieved or until it was determined that the measure is not meeting the requirements of IAC Section 845.670(d). If extraction wells were installed at the NAP, high iron concentrations in the formation could cause fouling of the well screens, which would require frequent maintenance. Additionally, iron fouling could create a need for the replacement of extraction wells over time. If a groundwater collection trench were instead installed at the NAP, a hydraulic connection may be created between the MGU and LGU, which may delay groundwater remediation times. The GE and (if necessary) treatment systems would also need to be regularly inspected and maintained to prevent fouling and scaling issues from impacting the effectiveness of the remedy. Any sediments generated by the treatment system, if one is required, would periodically have to be removed and brought to a solid waste landfill for disposal. Once the remedy is complete, the system would need to be decommissioned in a manner that meets applicable regulatory standards.
- The Source Control-MNA/GE alternative would not require the installation of any new engineered systems or structures, because the groundwater collection trench would already have been installed as required by the Agreed Interim Order (Illinois, Attorney General, 2021). The groundwater collection trench would have to be operated and maintained appropriately beyond the closure of the impoundments. Groundwater and seep water collected at the groundwater collection trench would be sent to the NAP Secondary Pond and discharged *via* the NPDES-permitted outfall. Treatment may be required prior to discharge. Water treatment, if necessary, would be expected to potentially include a settling pond and pH adjustment. Any sediments generated by the treatment system, if one is required, would periodically have to be removed and brought to a solid waste landfill for disposal. Additionally, routine groundwater sampling would continue until GWPSs had been achieved or until it was determined that the measure is not meeting the requirements of IAC Section 845.670(d).
- Long-term O&M efforts under the Source Control-CW scenario would include periodic maintenance of the CW and hydraulic gradient control system and the management and discharge of groundwater extracted by the hydraulic gradient control system. Extracted groundwater may need to be treated prior to discharge. Water treatment, if necessary, would be expected to include a settling pond and possibly pH adjustment. Once the cutoff wall is constructed and the necessary extraction well installations are complete, O&M would include long-term groundwater flow monitoring and periodic inspections and routine maintenance of the hydraulic gradient control system, including the replacement of worn or damaged parts. Any sediments generated by the treatment system, if one is required, would periodically have to be removed and brought to

a solid waste landfill for disposal. For extraction wells installed as part of the hydraulic gradient control system, high iron concentrations in the formation could cause fouling of the well screens. Iron fouling could create a need for the replacement of the extraction wells over time. The hydraulic gradient control system and (if necessary) treatment systems would need to be regularly inspected and maintained to prevent fouling and scaling issues from impacting the effectiveness of the remedy. Routine groundwater sampling would also need to be performed downgradient of the CW until GWPSs had been achieved or until it was determined that the measure is not meeting the requirements of IAC Section 845.670(d). Once the remedy is complete, the system would need to be decommissioned in a manner that meets applicable regulatory standards.

- Long-term O&M efforts under the Source Control-PRB scenario would include routine groundwater sampling downgradient of the PRB until GWPSs had been achieved or until it was determined that the measure is not meeting the requirements of IAC Section 845.670(d). The PRB will also be monitored for treatment efficacy. If necessary, the PRB media may be amended or exchanged to extend the life of the PRB.

3.2.4 Reliability of the Corrective Measure Alternative – Engineering and Institutional Controls (IAC Section 845.660(c)(1))

The long-term reliability of the corrective measure alternatives is summarized as follows:

- The Source Control-MNA alternative would be expected to be reliable over the long term at this Site, because it would rely on natural 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). A review of Site conditions performed by Geosyntec finds that, in combination with source control measures, MNA would likely result in the reduction of groundwater concentrations downgradient of the Site to below GWPSs (Geosyntec, 2022b).
- The Source Control-GE alternative would be expected to be reliable over the long term at this Site, as long as the system is designed and constructed for Site-specific conditions. The long-term reliability of this alternative would depend on the management and maintenance of the GE system and (if necessary) the treatment system for extracted groundwater. However, maintenance of these systems would most likely be relatively straightforward to implement and therefore would be unlikely to have a negative impact on the reliability of this alternative.
- The Source Control-MNA/GE alternative would be expected to be reliable over the long term at this Site, because it relies on a combination of natural processes at the NAP and a groundwater collection trench at the OEAP. Under this alternative, no additional engineering structures, other than what is required by the Agreed Interim Order (Illinois, Attorney General, 2021), would require design or installation, unless a treatment system is found to be required for the treatment of groundwater and seep water collected in the trench. Maintenance of a treatment system, if one is required, would be expected to be relatively straightforward. A review of Site conditions performed by Geosyntec finds that, in combination with source control measures, MNA would likely result in the reduction of groundwater concentrations downgradient of the Site to below GWPSs (Geosyntec, 2022b).
- The Source Control-CW alternative would be expected to be reliable over the long term at this Site, as long as the system is designed and constructed for Site-specific conditions. Because implementation of the CW would require the installation of hydraulic controls *via* a GE system, the long-term reliability of this alternative would also depend on the management and

maintenance of the GE system and (if necessary) the treatment system for extracted groundwater. However, maintenance of these systems would be expected to be relatively straightforward to implement and therefore would be unlikely to have a negative impact on the reliability of this alternative.

- The Source Control-PRB alternative may not be reliable over the long term at this Site. The reliability of this alternative would depend on Site-specific groundwater hydraulics and geochemical conditions, including the behavior of the constituents of concern. PRBs generally have limited success at treating lithium and boron in groundwater (both of which are CCR-related constituents). The effectiveness of the PRB would also decrease over time, resulting in a potential need for the eventual replacement of the remedy.

3.2.5 Reliability of the Corrective Measure Alternative - Potential Need for Replacement of the Corrective Measure (IAC Section 845.660(c)(1))

The potential need for the eventual replacement of each corrective measure alternative is summarized as follows:

- Source Control-MNA would rely on natural processes to achieve reductions in groundwater concentrations to below GWPSs. Without the installation, operation, and maintenance of engineered systems or structures, it would be unlikely that the Source Control-MNA remedy would need to be replaced. The MNA evaluation provided by Geosyntec (2022b) notes that, if MNA is selected as the remedy, a contingency plan will be developed that will identify the circumstances under which replacement of the remedy may be appropriate.
- For the Source Control-GE alternative, implementation of the GE system would rely on physical management of the groundwater flow path. If extraction wells were installed at the NAP, iron fouling may reduce the system effectiveness and create a need for the replacement of extraction wells over time. Replacement of pumps would also be likely under this alternative, because groundwater hydraulic controls would need to be maintained on a long-term basis. However, it is unlikely that the entire remedy would need to be replaced; this would only be necessary if groundwater flow conditions changed significantly at the Site.
- Source Control-MNA/GE would rely on a combination of natural processes at the NAP and a groundwater collection trench at the OEAP to achieve reductions in groundwater concentrations to below GWPSs. While the groundwater collection trench would need to be maintained, no additional engineering structures will require design, installation, or replacement. It is therefore unlikely that the remedy would need to be replaced. The MNA evaluation provided by Geosyntec (2022b) notes that, if MNA is selected as the remedy, a contingency plan will be developed that will identify the circumstances under which replacement of the remedy may be appropriate.
- Like the Source Control-GE alternative, the Source Control-CW alternative would rely on physical management of the groundwater flow path. Replacement of individual GE wells and pumps would likely be necessary under this alternative, because groundwater hydraulic controls would need to be maintained on a long-term basis, and pumps and well screens would ultimately need to be replaced. However, it would be unlikely that the entire remedy would need to be replaced; this would only be necessary if groundwater flow conditions changed significantly at the Site.

- PRBs would rely on the chemical treatment of groundwater along the flow path. Given the low effectiveness of PRBs for boron and lithium, replacement of the PRB remedy would be likely. Replacement of this remedy would also be necessary if the effectiveness of the PRB declined over time or if groundwater flow conditions changed at the Site.

3.2.6 Ease of Implementation (IAC Section 845.660(c)(1))

The expected degree of difficulty associated with implementing the corrective measure alternatives is summarized as follows:

- The Source Control-MNA alternative would rely entirely on natural processes and therefore should not pose any significant construction challenges. This alternative would only require the installation of monitoring wells.
- Construction under the Source Control-GE alternative would be limited to the installation of the GE system and monitoring wells. However, construction of the GE system at the NAP would likely be difficult, due to the proximity of the former impoundments to the Middle Fork of the Vermilion River, which may restrict access to the Site. Design of this remedy would also require a good understanding of groundwater flow conditions at the Site, including an evaluation of the ability to capture groundwater effectively and an evaluation of the relationship between groundwater and the Middle Fork of the Vermilion River. GE using wells may be difficult to implement, because the alluvial deposits at the NAP vary in composition laterally and vertically. Additional testing would be required to estimate the number, spacing, screened intervals, and extraction rates for capture of impacted groundwater. Additionally, due to a limited construction area between the river and the NAP perimeter berm, installation of a groundwater collection trench through both the MGU and the LGU near the NAP is likely to be an infeasible alternative to GE using wells.
- The Source Control-MNA/GE alternative relies on natural processes downgradient of the NAP and a groundwater collection trench downgradient of the OEAP, which would already have been installed as required by the Agreed Interim Order (Illinois, Attorney General, 2021). Therefore, no significant construction challenges are expected. This alternative would only require the additional installation of monitoring wells.
- Construction of a CW under the Source Control-CW scenario would likely be highly difficult due to the required location, length, and depth of the CW. The CW would be constructed along the bank of the Middle Fork of the Vermilion River. Construction of the CW, which would be on the order of 40 feet deep, would entail excavating into the low-permeability bedrock unit underlying the NAP/OEAP and then backfilling the excavated trench. Specialized equipment may be required. Access ramps, roads, and the CW itself would have to be constructed using controlled practices that avoid potential flood impacts to construction materials and equipment, such as equipment washing into the river. Design of the hydraulic control system would also require a good understanding of groundwater flow conditions at the Site, including an evaluation of the ability to contain groundwater effectively and an evaluation of the relationship between groundwater and the adjacent river system.
- Construction of the PRB under the Source Control-PRB alternative would likely be highly difficult due to the required location, length, and depth of the PRB. The PRB would be constructed along the bank of the Middle Fork of the Vermilion River. The PRB may need to be extended down to the low-permeability bedrock unit underlying the NAP/OEAP, which is approximately 40 feet below ground surface. Access ramps, roads, and the PRB itself would

have to be constructed using controlled practices that avoid potential flood impacts to construction materials and equipment, such as equipment washing into the river.

3.2.7 Potential Impacts – Risks to the Community or the Environment During Implementation of Remedy (IAC Section 845.660(c)(1))

Safety Impacts

Best practices will 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 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. The safety impacts of construction under each corrective measure alternative are summarized as follows:

- The Source Control-MNA alternative would not require the construction of any engineered systems or structures other than monitoring wells. Construction activity would not be expected to result in any significant negative safety impacts under this alternative.
- A moderate level of construction activity would be required under the Source Control-GE alternative. Construction activities under this alternative would include the construction of the GE system and monitoring wells. Therefore, the construction-related safety impacts of this alternative would be modest. Impacts would largely be limited to workers, rather than community members, because construction activities would largely be limited to the Site.
- The Source Control-MNA/GE alternative would rely on natural processes and a groundwater collection trench, which would already have been installed as required by the Agreed Interim Order (Illinois, Attorney General, 2021). No additional construction of any engineered systems or structures other than monitoring wells would be required. Construction activity would not be expected to result in any significant negative safety impacts under this alternative.
- The construction requirements of the Source Control-CW alternative would be considerable due to the planned extent of construction activities (*i.e.*, excavation and backfilling of an approximately 40-foot-deep earthen trench). The Source Control-CW alternative therefore would pose relatively significant construction-related safety risks to workers. The negative impacts of construction activities would largely be limited to workers, rather than community members, because construction activities would largely be limited to the Site.
- The construction requirements of the Source Control-PRB alternative would be similar to those of the Source Control-CW alternative. Relatively intensive construction activities would be required, including the excavation of an approximately 40-foot-deep earthen trench. The Source Control-CW scenario therefore would pose relatively significant construction-related safety risks to workers. The negative impacts of construction activities would largely be limited to workers, rather than community members, because construction activities would largely be limited to the Site.

Cross-Media Impacts to Air

Diesel emissions are a major source of air pollutants and GHG emissions at construction sites. Corrective measures that require a greater level of construction activity will result in larger overall air impacts in the form of diesel emissions. The Source Control-MNA and Source Control-MNA/GE alternatives would be expected to have minimal air impacts, because they would not require the construction of any engineered systems or structures (other than monitoring wells and the groundwater collection trench, which is required by the Agreed Interim Order [Illinois, Attorney General, 2021]). The Source Control-GE alternative would be expected to have moderate air impacts, because it would have modest construction requirements. The Source Control-CW and Source Control-PRB alternatives would be expected to have the most considerable air impacts across all the corrective measure alternatives, because they would have the most significant construction requirements.

Cross-Media Impacts to Surface Water and Sediments

Due to erosion and runoff, construction can have short-term negative impacts on surface water and sediment quality immediately adjacent to a site. These impacts are of particular concern at the Vermilion Site, due to the proximity of the former impoundments to the Middle Fork of the Vermilion River, Illinois's only National Scenic River. Minimal surface water or sediment impacts due to erosion and runoff during construction would be expected under the Source Control-MNA and Source Control-MNA/GE alternatives, because they would not require the construction of any engineered systems or structures (other than monitoring wells and the groundwater collection trench, which is required by the Agreed Interim Order [Illinois, Attorney General, 2021]). In contrast, the Source Control-GE, Source Control-CW, and Source Control-PRB alternatives may have short-term negative impacts on the Middle Fork of the Vermilion River due to erosion and sediment runoff during construction. These impacts would be greater under the Source Control-CW and Source Control-PRB alternatives than under the Source Control-GE alternative, due to the greater extent and duration of construction activities required for the former alternatives relative to the latter alternative (*i.e.*, excavation of a 40-foot-deep earthen trench).

Under the Source Control-MNA/GE, Source Control-GE, and Source Control-CW alternatives, extracted groundwater would be discharged to the Middle Fork of the Vermilion River *via* one of the facility's NPDES-permitted outfalls. If necessary, extracted groundwater would be treated prior to discharge to ensure compliance with water quality standards. Thus, no surface water or sediment impacts would be expected under any of the corrective measure alternatives due to the discharge of extracted groundwater into the Middle Fork of the Vermilion River.

Source Control-GE and Source Control-CW (which includes hydraulic gradient control) could also have a detrimental effect on the baseflow in the Middle Fork of the Vermilion River, particularly during low-flow conditions, because the GE and hydraulic gradient control systems could capture and/or intercept water from the river.

Control of Exposure to Any Residual Contamination During Implementation of the Remedy

Source control and the installation of the groundwater trench will be undertaken at the Site prior to the implementation of any of the corrective measure alternatives. Thus, no residual CCR exposures would be expected to occur during the implementation of any corrective measure alternative. However, impacted soils and groundwater underlying the impoundments can act as a secondary source of CCR-associated constituent exposures for workers even after the primary source (CCR) has been excavated and hauled to a landfill for disposal. Risks to workers arising from potential contact with secondary sources during construction, operation, and maintenance activities (*e.g.*, contact with impacted groundwater extracted by the GE system under the Source Control-MNA/GE and Source Control-GE alternatives or extracted by the hydraulic gradient control system under the Source Control-CW alternative) would be managed through the use of rigorous safety protocols and personal protective equipment.

Other Identified Impacts

In addition to safety impacts, cross-media impacts, and the potential for workers to be exposed to residual contamination, construction activities can have significant energy demands and can cause nuisance impacts such as traffic and noise. Moreover, construction activities can negatively impact natural resources and habitat near the Site, as well as scenic, historical, and recreational value. There are no historic sites in the immediate vicinity of the former impoundments; however, high-quality natural areas and recreational areas in the immediate vicinity of the former impoundments include the Orchid Hill Natural Heritage Landmark and the Middle Fork of the Vermilion River. The magnitude of all construction-related impacts would be expected to increase with the duration and intensity of construction activities. Because the Source Control-MNA and Source Control-MNA/GE alternatives would not require any significant construction activity, the construction-related impacts listed above would not be a concern under this alternative. In contrast, moderate construction-related impacts would be expected under the Source Control-GE alternative. The most significant construction-related impacts would be expected to occur under the Source Control-CW and Source Control-PRB alternatives, both of which would require excavation of an approximately 40-foot-deep earthen trench.

3.3 The Time Required to Begin and Complete the Corrective Action Plan (IAC Section 845.660(c)(2))

IAC Section 845.670 states that a Corrective Action Plan must be submitted to the Agency within 1 year of submission of a CMA. A draft version of this CMA was provided to the public on November 9, 2021, *via* DMG's CCR Rule Compliance Data and Information website (Luminant, 2022), as Appendix 1 of the Draft Final Closure Plans for the NAP/OEAP and the NEAP (Geosyntec, 2021f,g). Work began on the Corrective Action Plan following the completion of a public meeting, which was held on December 9, 2021, pursuant to requirements under IAC Section 845.710(e) and the Agreed Interim Order (IEPA, 2021a; Illinois, Attorney General, 2021). The Corrective Action Plan has now been completed and is being submitted to IEPA simultaneously with this CMA.

3.4 State or Local Permit Requirements or Other Environmental or Public Health Requirements that May Substantially Affect Implementation of the Corrective Action Plan (IAC Section 845.660(c)(3))

All of the corrective measure alternatives would require regulatory approvals prior to implementation. The Source Control-GE, Source Control-MNA/GE, and Source Control-CW alternatives may also require modifications to the Site's existing NPDES permit in order to manage groundwater extracted by the GE system (Source Control-GE alternative), collected by the groundwater collection trench (Source Control-MNA/GE alternative), or extracted by the hydraulic gradient control system (Source Control-CW alternative). However, these requirements would not be expected to substantially affect the implementation of the Corrective Action Plan.

3.5 Summary

Table S.2 evaluates the five corrective measures included in this CMA with regards to each of the factors specified under IAC Section 845.660(c) (IEPA, 2021a). Based on this evaluation and the details provided above, two corrective measures have been identified as potentially viable technologies for further consideration pursuant to IAC Section 845.670 (CAAA): Source Control-MNA and Source Control-

MNA/GE. Source Control-GE, Source Control-CW, and Source Control-PRB were not selected as viable corrective measures for further consideration, for the following reasons:

- It is unlikely that Source Control-PRB would perform well at this Site, because PRBs have not been proven effective for lithium and boron in groundwater (both of which are CCR-associated constituents);
- Construction of the CW and the PRB would likely be very difficult, due to the required location, length, and depth of these structures;
- Source Control-GE may have a detrimental effect on the baseflow in the Middle Fork of the Vermilion River, because the GE system may capture/intercept water from the river. Furthermore, if groundwater pumping wells were installed at the NAP, the high iron content in the formation could lead to fouling of the well screens, which would create the need for frequent maintenance and, potentially, GE well replacement. If a groundwater collection trench were instead installed at the NAP, it would need to be deeper than the trench to be installed during closure at the OEAP, because groundwater from both the MGU and the LGU would need to be intercepted. Due to limited construction area between the river and the NAP perimeter berm, the installation of a groundwater collection trench through both the MGU and the LGU near the NAP is likely infeasible. Furthermore, installation of a groundwater collection trench at the NAP could create a hydraulic connection between the MGU and the LGU, which could delay cleanup times.
- Both Source Control-CW and Source Control-PRB would likely have a large potential impact on the Middle Fork of the Vermilion River due to the extent of construction required in close proximity to the river; and
- Both Source Control-CW and Source Control-PRB would likely have relatively large impacts on worker safety, air quality, surface water quality, and sediment quality compared to the other remedies, due to the substantial construction activities required.

4 Corrective Action Alternatives Analysis

This section of the report presents a CAAA pursuant to requirements under IAC Section 845.670 (IEPA, 2021a). The goal of a CAAA is to more 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 residents (IEPA, 2021a).

Per IAC Section 845.670(d), any corrective actions selected under a Corrective Action Plan must (IEPA, 2021a):

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, taking into account 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).

Two potential corrective actions were selected for consideration under IAC Section 845.670 for this Site, based on the evaluation presented in the CMA: Source Control-MNA and Source Control-MNA/GE. These corrective actions are described above in Section 3.1.

This report evaluates the potential performance, reliability, and impacts of the various corrective actions, but does not make any judgements regarding the need for these corrective actions. It should be noted, however, that the primary pond of the NEAP was constructed atop bedrock using earthen berms that contain a low-permeability clay core keyed into the underlying shale. Constituent migration from this impoundment is therefore expected to be very limited, and there are no exceedances of the relevant GWPSs that have been attributed to the NEAP. Thus, corrective actions other than source control may not be necessary for the NEAP.

4.1 Long- and Short-Term Effectiveness and Protectiveness of Corrective Action Alternative (IAC Section 845.670(e)(1))

4.1.1 Magnitude of Reduction of Existing Risks (IAC Section 845.670(e)(1)(A))

As described in Section 2.2.1 of the CAA (Magnitude of Reduction of Existing Risks), there are no current unacceptable risks to human or ecological receptors at this Site (Appendices A and B). Both corrective actions considered here include source control. Moreover, both corrective actions would reduce the concentrations of dissolved constituents in the vicinity of the impoundments post-closure. Because current conditions do not present any existing risks at the Site and dissolved constituent concentrations would be expected to decline over time with the implementation of the corrective actions being considered, there would be no future risks to human and ecological receptors under either of the corrective action alternatives.

4.1.2 Effectiveness of the Remedy in Controlling the Source (IAC Section 845.670(e)(2))

Extent to Which Containment Practices Will Reduce Further Releases (IAC Section 845.670(e)(2)(A))

"Primary source control" means the prevention of CCR-associated constituents leaching from the impoundments into underlying groundwater. Because source control will be undertaken at the Site prior to the implementation of any corrective actions, both corrective action alternatives would eliminate the potential for CCR within the impoundments to impact groundwater. Both corrective action alternatives would therefore be equally and fully protective with regard to primary source control. However, impacted soils underlying the impoundments can potentially act as a secondary source of CCR-associated impacts to groundwater even after the primary source (CCR) has been excavated and hauled to a landfill for disposal. The effectiveness of the corrective action alternatives with respect to secondary source control are summarized as follows:

- Under the Source Control-MNA alternative, the attenuation of dissolved constituent concentrations remaining after source control would be achieved through natural processes. An analysis by Geosyntec (2022b) demonstrates that MNA would likely perform well at this Site, both within the secondary source area and downgradient.
- Under the Source Control-MNA/GE alternative, source control would be achieved by GE at the groundwater collection trench near the OEAP and *via* the natural attenuation of dissolved constituent concentrations near the NAP. An analysis by Geosyntec (2022b) demonstrates that MNA would likely perform well at this Site, both within the secondary source area and downgradient. Additionally, GE is a widely used corrective measure. While its performance can vary from site to site, good performance would generally be expected for continued operation of the groundwater collection trench.

Extent to Which Treatment Technologies May Be Used (IAC Section 845.670(e)(2)(B))

Because Source Control-MNA would rely on natural attenuation processes, no treatment technologies would be required under this alternative. Treatment would be not an integral part of the Source Control-MNA/GE alternative; however, it may be necessary to treat groundwater and seep water extracted from the groundwater collection trench prior to discharge. Water treatment, if necessary, could potentially include a settling pond and pH adjustment.

4.1.3 Likelihood of Future Releases of CCR (IAC Section 845.670(e)(1)(B))

Both corrective action alternatives include source control. There would therefore be no risk of accidental CCR releases occurring post-closure under either of the corrective action alternatives.

4.1.4 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 management under each corrective action alternative are summarized as follows:

- The Source Control-MNA 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 routine groundwater sampling, which would continue until GWPSs had been achieved or until it was determined that the measure is not meeting the requirements of IAC Section 845.670(d).
- The Source Control-MNA/GE alternative would not require the installation of any new engineered systems or structures, because the groundwater collection trench would already have been installed as required by the Agreed Interim Order (Illinois, Attorney General, 2021). Under this alternative, the groundwater collection trench would have to be operated and maintained appropriately beyond the closure of the impoundments. Groundwater and seep water collected at the groundwater collection trench would be sent to the NAP Secondary Pond and discharged *via* the NPDES-permitted outfall. Treatment of this groundwater and seep water may be required prior to discharge. Water treatment, if necessary, could potentially include a settling pond and pH adjustment. Any sediments generated by the treatment system, if one is required, would periodically have to be removed and brought to a solid waste landfill for disposal. Additionally, routine groundwater sampling would continue until GWPSs had been achieved or until it was determined that the measure is not meeting the requirements of IAC Section 845.670(d).

4.1.5 Short-Term Risks to the Community or the Environment During Implementation of Remedy (IAC Section 845.670(e)(1)(D))

Safety Impacts

Best practices will 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 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. The safety impacts of construction under each corrective action alternative are summarized as follows:

- The Source Control-MNA alternative would not require the construction of any engineered systems or structures other than monitoring wells. Construction activity would not be expected to result in any significant negative safety impacts under this alternative.
- The Source Control-MNA/GE alternative would rely on natural processes and a groundwater collection trench, which would already have been installed as required by the Agreed Interim Order (Illinois, Attorney General, 2021). No additional construction of any engineered systems or structures other than monitoring wells would be required. Construction activity would not be expected to result in any significant negative safety impacts under this alternative. Furthermore, impacts would largely be limited to workers, rather than community members, because construction activities would largely be limited to the Site.

Cross-Media Impacts to Air

Diesel emissions are a major source of air pollutants and GHG emissions at construction sites. Corrective actions that require a greater level of construction activity will result in larger overall air impacts in the form of diesel emissions. The Source Control-MNA and Source Control-MNA/GE alternatives would be expected to have minimal air impacts, because they would not require the construction of any engineered systems or structures (other than monitoring wells and the groundwater collection trench, which is required by the Agreed Interim Order [Illinois, Attorney General, 2021]).

Cross-Media Impacts to Surface Water and Sediments

Under both source control/corrective action scenarios, the constituent mass flux from groundwater into surface water would decline over time after closure has been completed (Ramboll, 2022). Modeling was performed to evaluate future groundwater quality in the vicinity of the NAP/OEAP under each of the proposed source control and corrective action alternatives (Ramboll, 2022). The modeling concluded that mass flux to the Middle Fork of the Vermilion River from the MGU will be reduced by approximately 50% 10 years after closure is completed and by approximately 80% 35 years after closure is completed (Ramboll, 2022). Mass flux declines will occur more slowly in the LGU, which has lower constituent concentrations, due to the presence of lower-permeability deposits (Ramboll, 2022).

Due to erosion and runoff, construction can have short-term negative impacts on surface water and sediment quality immediately adjacent to a site. These impacts are of particular concern at the Vermilion Site, due to the proximity of the former impoundments to the Middle Fork of the Vermilion River, Illinois's only National Scenic River. However, minimal surface water and sediment impacts would be expected under the Source Control-MNA and Source Control-MNA/GE alternatives, because they would not require the construction of any engineered systems or structures (other than monitoring wells and the groundwater collection trench, which is required by the Agreed Interim Order [Illinois, Attorney General, 2021]).

Under the Source Control-MNA/GE alternative, groundwater and seep water collected by the groundwater collection trench would be discharged to the Middle Fork of the Vermilion River *via* one of the facility's NPDES-permitted outfalls. If necessary, collected groundwater would be treated prior to discharge to ensure compliance with water quality standards. Thus, no surface water or sediment impacts are expected due to the discharge of extracted groundwater into the Middle Fork of the Vermilion River under the Source Control-MNA/GE alternative.

Control of Exposure to Any Residual Contamination During Implementation of the Remedy

Source control and the installation of the groundwater trench will be undertaken at the Site prior to the implementation of any of the corrective action alternatives. Thus, no residual CCR exposures would be expected to occur during the implementation of either corrective action alternative. However, impacted soils and groundwater underlying the impoundments can act as a secondary source of CCR-associated constituent exposures for workers even after the primary source (CCR) has been excavated and hauled to a landfill for disposal. Risks to workers arising from potential contact with secondary sources during construction, operation, and maintenance activities (*e.g.*, contact with impacted groundwater or seep water collected by the groundwater collection trench under the Source Control-MNA/GE alternative) would be managed through the use of rigorous safety protocols and personal protective equipment.

Other Identified Impacts

In addition to safety impacts, cross-media impacts, and the potential for workers to be exposed to residual contamination, construction activities can have significant energy demands and can cause nuisance impacts such as traffic and noise. Moreover, construction activities can negatively impact natural resources and habitat near the Site, as well as scenic, historical, and recreational value. However, because the Source Control-MNA and Source Control-MNA/GE alternatives would not require any significant construction activity, the construction-related impacts listed above would not be expected to be a concern under this alternative.

4.1.6 Time Until Groundwater Protection Standards Are Achieved (IAC Section 845.670(e)(1)(E))

The time required to achieve GWPSs is immaterial from a risk to human health or the environment perspective, because there are currently no unacceptable risks to human or ecological receptors at this Site (see Section 2.2.1 of the CAA, Magnitude of Reduction of Existing Risks). Nonetheless, this section of the report evaluates the time required to achieve GWPSs, pursuant to requirements under IAC Section 845.670(e)(1)(E) (IEPA, 2021a).

At the NAP/OEAP, potential dissolved CCR-related constituents may migrate vertically downward under the influence of gravity into the MGU. The MGU is the primary conduit for groundwater flow at the Site. Groundwater flow in the MGU is primarily eastward, toward the Middle Fork of the Vermilion River. Some potentially dissolved CCR-related constituents may migrate downward through the middle confining unit into the LGU. Groundwater flow rates are lower in the LGU relative to the MGU, due to the difference in the hydraulic conductivities of the two units. Groundwater flow in the LGU is also primarily eastward, toward the Middle Fork of the Vermilion River. CCR-related constituents in both the MGU and LGU may potentially flow into the Middle Fork of the Vermilion River (Ramboll, 2021a). Based on Site-specific numerical groundwater modeling performed at the Site (OBG, 2018; Ramboll, 2022), all groundwater impacted with potential CCR-related constituents is ultimately discharged into the Middle Fork of the Vermilion River, and no CCR-related constituents migrate away from the Site underneath the river. Similarly, there is no transport of CCR-related constituents toward the western or southern property boundaries. There may be limited groundwater migration in a northerly direction; however, this groundwater flow ultimately also turns eastward and flows into the river (Ramboll, 2021a).

At the NEAP, because the pond is built atop low-permeability shale and surrounded by low-permeability clay/bentonite layers, limited or negligible constituent migration is expected out of the pond. There is no or negligible impact of CCR-related constituents from the NEAP on groundwater quality. Additionally, while groundwater underlying the NEAP migrates toward and discharges into the Middle Fork of the Vermilion River, there is no evidence of CCR-related impacts from the NEAP in surface water (Kelron Environmental, 2003; OBG, 2019b).

Groundwater modeling was performed to evaluate future groundwater quality in the vicinity of the NAP/OEAP under each of the proposed source control and corrective action alternatives (Ramboll, 2022). The model assumed that seasonal fluctuations in groundwater and river elevations do not affect groundwater flow and transport over the long term (Ramboll, 2022). The results of the modeling indicate that groundwater will attain the GWPSs for all constituents identified as having potential exceedances in the primary migration pathway (the MGU) within approximately 50 years after closure for both the Source Control-MNA and Source Control-MNA/GE scenarios. Furthermore, flux to the Middle Fork of the Vermilion River from the MGU will be reduced by approximately 50% 10 years after closure is completed and by approximately 80% 35 years after closure is completed (Ramboll, 2022). The LGU, which has much lower constituent concentrations, is estimated to take approximately another 50 years to reach GWPSs due to the presence of lower-permeability deposits, which result in longer flow paths (Ramboll, 2022).

From a modeling perspective, differences between the predicted times to reach the GWPSs in the MGU under the Source Control-MNA scenario *versus* the Source Control-MNA/GE scenario were negligible (Ramboll, 2022). These results indicate that, with regard to the time required to reach GWPSs, there is no significant benefit to the continued operation and maintenance of the GE (*i.e.*, groundwater collection trench at the OEAP) beyond the completion of closure activities (Ramboll, 2022).

4.1.7 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 4.1.1 describes the magnitude of reduction of existing risks under each corrective action alternative. Section 4.1.2 describes the effectiveness of the remedy in controlling the source, including the extent to which containment practices will reduce further releases. Section 4.1.3 describes the likelihood of future releases of CCR occurring under each corrective action alternative, and Section 4.1.5 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 (CBR with construction of a groundwater collection trench) will be undertaken at the Site prior to the implementation of either of the corrective action alternatives. Thus, both corrective action alternatives would completely eliminate the potential for a sudden CCR release to occur post-closure (due, *e.g.*, to flooding or a dike failure event). Similarly, due to the source control common to both of the corrective action alternatives, both alternatives would completely eliminate the potential for CCR within the impoundments to impact groundwater post-closure. Both corrective action alternatives would therefore be equally and fully protective with regard to exposure to residual CCR. For construction workers, impacted soils and groundwater underlying the impoundments can potentially act as a secondary source of CCR-associated constituent exposures even after the primary source (CCR) has been excavated and hauled to a landfill for disposal. During the implementation of the selected corrective action, exposure potential would be managed through the use of rigorous safety protocols and personal protective equipment.

Some changes in groundwater flow (*i.e.*, reduction in groundwater flow into the river) may occur under the Source Control-MNA/GE alternative, due to the operation of the groundwater collection trench. However, changes to groundwater flow would not be expected to have an effect on the potential for exposure of humans and environmental receptors to remaining wastes.

4.1.8 Long-Term Reliability of the Engineering and Institutional Controls (IAC Section 845.670(e)(1)(G))

The long-term reliability of the engineering and institutional controls of the corrective action alternatives are summarized as follows:

- The Source Control-MNA alternative would be expected to be reliable over the long term with respect to engineering and institutional controls, because it would rely on natural 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). A review of Site conditions performed by Geosyntec finds that, in combination with source control measures, MNA would likely result in the reduction of groundwater concentrations downgradient of the Site to below GWPSs (Geosyntec, 2022b).

- The Source Control-MNA/GE alternative would be expected to be reliable over the long term at this Site, because it would rely on a combination of natural processes at the NAP and a groundwater collection trench at the OEAP. Under this alternative, no additional engineering structures, other than what is required by the Agreed Interim Order (Illinois, Attorney General, 2021), would require design or installation, unless a treatment system is found to be required for the treatment of groundwater and seep water collected in the trench. Maintenance of a treatment system, if one is required, would be expected to be relatively straightforward. A review of Site conditions performed by Geosyntec finds that, in combination with source control measures, MNA would likely result in the reduction of groundwater concentrations downgradient of the Site to below GWPSs (Geosyntec, 2022b).

4.1.9 Potential Need for Replacement of the Remedy (IAC Section 845.670(e)(1)(H))

The potential need for the eventual replacement of each corrective action alternative is summarized as follows:

- Source Control-MNA would rely on natural processes to achieve reductions in groundwater concentrations to below GWPSs. Without the installation, operation, and maintenance of engineered systems or structures, it would be unlikely that the Source Control-MNA remedy would need to be replaced. The MNA evaluation provided by Geosyntec (2022b) notes that, if MNA is selected as the remedy, a contingency plan will be developed that will identify the circumstances under which replacement of the remedy may be appropriate.
- Source Control-MNA/GE would rely on a combination of natural processes at the NAP and a groundwater collection trench at the OEAP to achieve reductions in groundwater concentrations to below GWPSs. While the groundwater collection trench would need to be maintained, no additional engineering structures would require design, installation, or replacement. It is therefore unlikely that the remedy would need to be replaced. The MNA evaluation provided by Geosyntec (2022b) notes that, if MNA is selected as the remedy, a contingency plan will be developed that will identify the circumstances under which replacement of the remedy may be appropriate.

4.2 The Ease or Difficulty of Implementing a Remedy (IAC Section 845.670 (e)(3))

4.2.1 Degree of Difficulty Associated with Constructing the Remedy (IAC Section 845.670(e)(3)(A)

The expected degree of difficulty associated with constructing each corrective action alternative is summarized as follows:

- The Source Control-MNA alternative would rely on natural processes and therefore would not pose any significant construction challenges. This alternative would only require the installation of monitoring wells.
- The Source Control-MNA/GE alternative would rely on natural processes downgradient of the NAP and a groundwater collection trench downgradient of the OEAP, which would already have been installed as required by the Agreed Interim Order (Illinois, Attorney General, 2021). Therefore, no significant construction challenges would be expected. This alternative only requires the installation of additional monitoring wells.

4.2.2 Expected Operational Reliability of the Remedy (IAC Section 845.670(e)(3)(B))

Both corrective action alternatives would likely be highly reliable with respect to operational controls. MNA would be highly reliable because it would rely on natural processes, rather than the installation, operation, and maintenance of engineered systems or structures (other than monitoring wells). Under the Source Control-MNA alternative, engineering failure would not occur and no O&M activities would be required to ensure the success of the alternative. The Source Control-MNA/GE alternative would also be highly reliable, as long as the groundwater collection trench is maintained appropriately in accordance with standard practices.

4.2.3 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. No additional permits would be needed for Source Control-MNA. If groundwater and seep water collected from the groundwater collection trench under the Source Control-MNA/GE alternative need to be treated prior to discharge, then the Source Control-MNA/GE alternative may require modification of the Site's existing NPDES permit. However, if needed, NPDES permit modifications related to the operation of the trench would likely be undertaken during closure activities, rather than during the implementation of corrective measures (*i.e.*, the ongoing operation of the trench post-closure).

4.2.4 Availability of Necessary Equipment and Specialists (IAC Sections 845.670(e)(3)(D) and 845.660(c)(1), "Ease of Implementation")

The availability of equipment and specialists for each corrective action alternative is summarized as follows:

- The Source Control-MNA alternative would require standard environmental monitoring equipment. MNA specialists would be available to evaluate the data, once they are collected.
- The Source Control-MNA/GE alternative would require standard remedial action and environmental monitoring equipment. The required equipment and specialists for implementation of this remedy would be available.

4.2.5 Available Capacity and Location of Needed Treatment, Storage, and Disposal Services (IAC Section 845.670(e)(3)(D))

The available capacity and location of needed treatment, storage, and disposal services under each corrective action alternative is summarized as follows:

- The Source Control-MNA remedy would generate a minimal amount of investigation-derived waste (IDW) that could be managed by a standard waste management contractor.
- The Source Control-MNA/GE alternative would generate water. Groundwater and seep water collected from the groundwater collection trench would be discharged to the Middle Fork of the Vermilion River. If treatment of the groundwater and seep water is found to be necessary prior to discharge, then a treatment pond would need to be constructed. Any sediments generated by the treatment system, if one is required, would periodically have to be removed and brought to a licensed disposal facility.

4.3 The Degree to Which Community Concerns Are Addressed by the Remedy (IAC Section 845.670(e)(4))

Several citizen action groups representing community members near the Site have campaigned for complete excavation of the CCR impoundments at the Site, including the Eco-Justice Collaborative, Earthjustice, American Rivers, and the Prairie Rivers Network (American Rivers, 2018; Earthjustice, 2021; Eco-Justice Collaborative, 2021; Barkley, 2012). Both corrective action alternatives evaluated here would include source control *via* CCR excavation and construction of a groundwater collection trench, thereby addressing the major concerns raised by these groups.

A public meeting was held on December 9, 2021, pursuant to requirements under IAC Section 845.710(e) and the Agreed Interim Order (IEPA, 2021a; Illinois, Attorney General, 2021). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.

4.4 Summary

Table S.3 evaluates both corrective action alternatives included in this CAAA with regards to each of the factors specified in IAC Section 845.670(e) (IEPA, 2021a). Based on this evaluation and the details provided in Section 4 of this report, Source Control-MNA has been identified as the most appropriate corrective action at this Site. Source Control-MNA and Source Control-MNA/GE both have similar design, construction, and O&M requirements and, as a result, also have similar expected impacts on workers, nearby communities, and the environment. Modeling has also shown that there is no material difference between the two scenarios in terms of the time to achieve the GWPSs (Ramboll, 2022). Source Control-MNA is the preferred alternative at this Site.

References

American Rivers. 2018. "Middle Fork of the Vermilion River [IL]." Accessed on July 22, 2019 at https://www.americanrivers.org/endangered-rivers/middle-fork-of-the-vermilion-river-il.

Barkley, T. [Prairie Rivers Network]. 2012. Letter to B. Buscher (IEPA) re: Dynegy Midwest Generation's Vermilion Power Station Proposed Action Plan. Submitted to Illinois Environmental Protection Agency (IEPA), September 10.

Centers for Disease Control and Prevention (CDC). 2019. "What noises cause hearing loss?" National Center for Environmental Health (NCEH), October 7. Accessed on April 30, 2021 at https://www.cdc.gov/nceh/hearing_loss/what_noises_cause_hearing_loss.html.

Dynegy Energy Services (DMG). 2021. "Inundation Map, Vistra Vermilion Power Station, Vermilion County, IL (Draft)." 19E0096C, August 17.

Dynegy Midwest Generation, LLC (DMG); Stantec Consulting Services Inc.; OBG, Part of Ramboll. 2019. "Closure and Post-Closure Care Plan for North Ash Pond, Old East Ash Pond, and New East Ash Pond at the Vermilion Site (Draft)." June 28.

Earthjustice. 2021. "Interim agreement reached on protecting the Middle Fork of the Vermilion." June 23. Accessed on August 25, 2021 at https://earthjustice.org/news/press/2021/interim-agreement-reached-on-protecting-the-middle-fork-of-the-vermilion.

Eco-Justice Collaborative. 2021. "Dynegy's coal ash threat." Accessed on August 25, 2021 at https://ecojusticecollaborative.org/dynegys-coal-ash-threat.

Electric Power Research Institute (EPRI). 2006. "Groundwater Remediation of Inorganic Constituents at Coal Combustion Product Management Sites: Overview of Technologies, Focusing on Permeable Reactive Barriers (Final Report)." 1012584, October.

Eurofins TestAmerica; Geosyntec Consultants (Geosyntec). 2021. "June and July 2021 surface water sampling results, Vermilion Power Station, Illinois."

Exponent. 2018. "Community Impact Analysis of Ash Basin Closure Options at the Allen Steam Station." Report to Duke Energy Carolinas, LLC, November 15.

Federal Emergency Management Agency (FEMA). 2012. "FIRM Flood Insurance Rate Map, Vermilion County, Illinois and Incorporated Areas." National Flood Insurance Program (NFIP). Map Number 17183C0275D, May 16.

Geosyntec Consultants (Geosyntec). 2021a. "Initial Operating Permit, Vermilion Power Plant North Ash Pond, Oakwood, Illinois." Submitted to Dynegy Midwest Generation.

Geosyntec Consultants (Geosyntec). 2021b. "Initial Operating Permit, Vermilion Power Plant New East Ash Pond, Oakwood, Illinois." Submitted to Dynegy Midwest Generation.

Geosyntec Consultants (Geosyntec). 2021c. "Safety Emergency Response Plan, Vermilion Power Plant, Oakwood, Illinois." Report to Dynegy Midwest Generation.

Geosyntec Consultants (Geosyntec). 2021d. Letter to Dynegy Midwest Generation re: Summary of Old East Ash Pond Area Slope Stability Reliability Assessment, Vermillion Power Plant. [Provided in Appendix C]

Geosyntec Consultants (Geosyntec). 2021e. "Initial Operating Permit, Vermilion Power Plant Old East Ash Pond, Oakwood, Illinois." Submitted to Dynegy Midwest Generation.

Geosyntec Consultants (Geosyntec). 2021f. "CCR Final Closure Plan, Vermilion Power Plant Old East Ash Pond and North Ash Pond, Oakwood, Illinois (Draft)." Report to Dynegy Midwest Generation, November.

Geosyntec Consultants (Geosyntec). 2021g. "CCR Final Closure Plan, Vermilion Power Plant New East Ash Pond, Oakwood, Illinois (Draft)." Report to Dynegy Midwest Generation, November.

Geosyntec Consultants (Geosyntec). 2022a. "Proposed On-Site Landfill Feasibility Study, Vermilion Power Plant, Oakwood, Illinois." Report to Dynegy Midwest Generation.

Geosyntec Consultants (Geosyntec). 2022b. "Monitored Natural Attenuation Evaluation, Vermilion Power Plant North Ash Pond (CCR Unit #910) and Old East Ash Pond (CCR Unit #911) Areas." Report to Dynegy Midwest Generation.

Geosyntec Consultants (Geosyntec). 2022c. "Construction schedule; labor, vehicle, and equipment demands; and cost estimates for closure of the North Ash Pond/Old East Ash Pond and the New East Ash Pond, Vermilion Power Station, Illinois." [Provided in Appendix C]

Hanson Professional Services Inc. 2019. "Antidegradation Assessment for Management of Waters from Closure and Post-Closure Care of Ash Ponds, Vermilion Site, Dynegy Midwest Generation, LLC, NPDES Permit No. IL0004057." Report to Dynegy Midwest Generation, LLC, June 1.

Hesterberg, TW; Valberg, PA; Long, CM; Bunn, WB III; Lapin, C. 2009. "Laboratory studies of diesel exhaust health effects: Implications for near-roadway exposures." *EM Mag*. August:12-16. Accessed on March 05, 2014 at http://pubs.awma.org/gsearch/em/2009/8/hesterberg.pdf.

Illinois Dept. of Natural Resources (IDNR). 2021. "Kickapoo State Recreation Area." Accessed on August 25, 2021 at https://www2.illinois.gov/dnr/Parks/Pages/Kickapoo.aspx.

Illinois Emergency Management Agency (IEMA). 2020. "Earthquake preparedness." Accessed on September 7, 2021 at https://www2.illinois.gov/iema/Preparedness/Pages/Earthquake.aspx.

Illinois Environmental Protection Agency (IEPA). 2013. "Dynegy Midwest Generation, L.L.C., Vermilion Power Station Public Hearing, Tuesday, August 6, 2013 (Notice of Water Discharge Permit Public Hearing)." July 29.

Illinois Environmental Protection Agency (IEPA). 2019. "Illinois EPA Environmental Justice (EJ) Start." Accessed on April 30, 2021 at https://illinois-epa.maps.arcgis.com/apps/webappviewer/index.html?id=f154845da68a4a3f837cd3b880b0233c.

Illinois Environmental Protection Agency (IEPA). 2021a. "Standards for the disposal of coal combustion residuals in surface impoundments." Accessed on October 4, 2021 at https://www.ilga.gov/commission/jcar/admincode/035/03500845sections.html.

Illinois Environmental Protection Agency (IEPA). 2021b. "Illinois Landfill Disposal Capacity Report." August. Accessed on October 4, 2021 at https://www2.illinois.gov/epa/topics/waste-management/landfills/landfill-capacity/Documents/landfill-capacity-report-2021.pdf.

Illinois, Attorney General. 2021. "Plaintiff's motion to enter agreed interim order [re: People of the State of Illinois, ex rel. Kwame Raoul, Attorney General of the State of Illinois, and ex re. Jacqueline M. Lacy, State's Attorney of Vermilion County, Illinois v. Dynegy Midwest Generation, LLC, a Delaware limited liability co.]." Submitted to Illinois Circuit Court, Fifth Judicial Circuit, Vermilion County, Chancery Division. No. 2021CH000024, June 23.

Kelron Environmental. 2003. "Regional and Local Hydrogeology and Geochemistry: Vermilion Power Plant, Illinois. Volumes 1-2 (Draft)." Report to Dynegy Midwest Generation, Inc., November 30.

Kelron Environmental. 2012. "Hydrogeology and Groundwater Quality of the North Ash Pond System, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC." Report to Dynegy Operating Co., March 15.

La, V. 2021. "State parks officials see increase in visitors amid understaffing, encourage compliance with rules." *Illinois Newsroom* July 29. Accessed on August 25, 2021 at https://illinoisnewsroom.org/state-parks-officials-see-increase-in-visitors-amid-understaffing-encourage-compliance-with-rules.

Luminant. 2022. "Illinois CCR Rule Compliance Data and Information." Accessed on January 11, 2022 at https://www.luminant.com/illinois-ccr.

Mauderly, JL; Garshick, E. 2009. "Diesel exhaust." In *Environmental Toxicants: Human Exposures and Their Health Effects (Third Edition)*. (Ed.: Lippmann, M), John Wiley & Sons, Inc., Hoboken, NJ, p551-631.

National Research Council. 2013. "Alternatives for Managing the Nation's Complex Contaminated Groundwater Sites." Division of Earth and Life Sciences, Water Science and Technology Board, Committee on Future Options for Management in the Nation's Subsurface Remediation Effort. National Academies Press, Washington, DC. Accessed on April 17, 2014 at http://www.nap.edu/catalog.php?record_id=14668.

Natural Resource Technology, Inc. 2014a. "Corrective Action Plan, Old East Ash Pond, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC." Report to Dynegy Operating Co., April 2.

Natural Resource Technology, Inc. 2014b. "Corrective Action Plan, North Ash Pond System, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC." Report to Dynegy Operating Co., April 2.

US Dept. of the Interior (US DOI). 2010. "Eading Section 7(a) Final Review and Determination, Vermilion Power Station Bank Stabilization Project - Location 2, Middle Fork Vermilion National Scenic River, Vermilion County, Illinois." National Park Service, August.

OBG. 2018. "2018 Groundwater Monitoring and Modeling Report, Vermilion Site North Ash Pond System and Old East Ash Pond System Coal Combustion Residual Units, Vermilion, Illinois (Draft)." Report to Dynegy Midwest Generation, LLC, October.

OBG. 2019a. "Update to the Hydrogeology and Groundwater Quality of the North Ash Pond and Old East Ash Pond, Vermilion Site North Ash Pond and Old East Ash Pond, Oakwood, Illinois (Draft)." Report to Dynegy Midwest Generation, LLC, June.

OBG. 2019b. "Update to the Regional and Local Hydrogeology and Geochemistry: New East Ash Pond, Vermilion Site New East Ash Pond, Oakwood, Illinois (Draft)." Report to Dynegy Midwest Generation, LLC, June.

Ramboll. 2021a. "Hydrogeologic Site Characterization Report, Vermilion North Ash Pond and Old East Ash Pond, Vermilion Power Plant, Oakwood, Illinois." Report to Dynegy Midwest Generation, LLC.

Ramboll. 2021b. "Groundwater Monitoring Plan, Vermilion North Ash Pond and Old East Ash Pond, Vermilion Power Plant, Oakwood, Illinois." Report to Dynegy Midwest Generation, LLC.

Ramboll. 2021c. "Hydrogeologic Site Characterization Report, New East Ash Pond, Vermilion Power Station, Illinois." Report to Dynegy Midwest Generation, LLC.

Ramboll. 2022. "Groundwater Modeling Report, Vermilion Power Plant North Ash, Vermilion Power Plant, Oakwood, Illinois." Report to Dynegy Midwest Generation, LLC.

Stantec Consulting Services Inc. (Stantec). 2017. "Vermilion Site Riverbank Assessment." Report to Dynegy Midwest Generation, LLC. Submitted to Illinois Environmental Protection Agency (IEPA), Bureau of Water; Division of Public Water Supplies, November 2.

Stantec Consulting Services Inc. (Stantec). 2019. "Technical Memorandum to V. Modeer (Dynegy Midwest Generation, LLC) re: Reliability Analysis for Slope Stability with Assumed Riverbank Erosion, Dynegy Midwest Generation Vermilion Site." Submitted to US Army Corps of Engineers, Louisville District, March 11.

Tennessee Valley Authority (TVA). 2015. "Draft Ash Impoundment Closure Environmental Impact Statement. Part I - Programmatic NEPA Review." December.

US Dept. of Labor (US DOL). 2020a. "Employer-Reported Workplace Injuries and Illnesses - 2019." Bureau of Labor Statistics. USDL-20-2030, November 4.

US Dept. of Labor (US DOL). 2020b. "Fatal occupational injuries, total hours worked, and rates of fatal occupational injuries by selected worker characteristics, occupations, and industries, civilian workers, 2019." Bureau of Labor Statistics, December. Accessed on October 5, 2021 at https://www.bls.gov/iif/oshwc/cfoi/cfoi_rates_2019hb.xlsx.

US Dept. of Labor (US DOL). 2020c. "Table R100. Incidence rates for nonfatal occupational injuries and illnesses involving days away from work per 10,000 full-time workers by occupation and selected events or exposures leading to injury or illness, private industry, 2019." Bureau of Labor Statistics, October. Accessed on October 5, 2021 at https://www.bls.gov/iif/oshwc/osh/case/cd_r100_2019.xlsx.

US Dept. of Transportation (US DOT). 2020. "Large Truck and Bus Crash Facts 2018." Federal Motor Carrier Safety Administration, Analysis Division. FMCSA-RRA-19-018, September.

US EPA. 1999. "Use of monitored natural attenuation at Superfund, RCRA corrective action and underground storage tank sites (Final)." Office of Solid Waste and Emergency Response (OSWER). OSWER Directive 9200.4-17P, April 21.

US EPA. 2014. "Human and Ecological Risk Assessment of Coal Combustion Residuals (Final)." Office of Solid Waste and Emergency Response (OSWER), Office of Resource Conservation and Recovery, December. Accessed on October 16, 2015 at http://www.regulations.gov/#!documentDetail;D=EPA-HQ-RCRA-2009-0640-11993.

US EPA. 2015a. "Hazardous and solid waste management system; Disposal of coal combustion residuals from electric utilities (Final rule)." *Fed. Reg.* 80(74):21302-21501. 40 CFR 257; 40 CFR 261, April 17.

US EPA. 2015b. "Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER Directive 9200.1-36, August.

US EPA. 2016. "Technical Guidance for Assessing Environmental Justice in Regulatory Analysis." June.

US Fish and Wildlife Service (US FWS). 2019. "Biological Opinion: Effects to the Clubshell and Northern Riffleshell Mussels from the proposed Dynegy Midwest Generation Streambank Stabilization Project in Vermilion County, Illinois." Southern Illinois Sub-Office, July.

Various. 1990-2010. "Compilation of files related to Orchid Hill Natural Heritage Landmark, Illinois."

Appendix A

2020 Human Health and Ecological Risk Assessment

Human Health and Ecological Risk Assessment
Vermilion Generating Station
Oakwood, Illinois

Prepared for

Schiff Hardin LLP
233 South Wacker Drive, Suite 7100
Chicago, IL 60606

February 27, 2020

GRADIENT

www.gradientcorp.com
One Beacon Street, 17th Floor
Boston, MA 02108
617-395-5000

Table of Contents

Page

Executive Summary ES-1

1 Introduction 1

2 Site Overview 3
2.1 Site Description 3
2.2 Conceptual Site Model 5
2.3 Human Conceptual Exposure Model 7
2.3.1 Groundwater as a Drinking Water/Irrigation Source 8
2.3.2 Recreational Exposures 9
2.4 Ecological Conceptual Exposure Model 10

3 Data Summary 12
3.1 Groundwater Data 12
3.2 Surface Water Data 14
3.3 Surface Water and Sediment Modeling 16
3.4 Exposure Estimates 19
3.4.1 Surface Water 19
3.4.2 Sediment 20

4 Risk Evaluation 21
4.1 Risk Evaluation Process 21
4.2 Human Health Risk Evaluation 22
4.2.1 Recreators Exposed to Surface Water While Swimming or Tubing 22
4.2.2 Recreators Exposed to Surface Water While Boating 23
4.2.3 Recreators Exposed to Sediment While Swimming or Boating 24
4.2.4 Recreators Consuming Fish Caught Near the Site 26
4.3 Ecological Risk Evaluation 27
4.3.1 Ecological Receptors Exposed to Surface Water 27
4.3.2 Ecological Receptors Exposed to Sediment 28
4.3.3 Ecological Receptors Exposed to Bioaccumulative COIs 30
4.4 Uncertainties and Conservatisms 31

5 Summary and Conclusions 34

References 36

Appendix A	Data Summary
Appendix B	Screening Benchmarks
Appendix C	Surface Water and Sediment Modeling

List of Tables

Table 3.1 Constituents Analyzed in Groundwater (2011-2019) – Based on IEPA-approved Monitoring Plan

Table 3.2 Groundwater Data Summary (2011-2019)

Table 3.3 Constituents Analyzed in Surface Water (2019)

Table 3.4 Surface Water Data Summary

Table 3.5 Groundwater and Surface Water Properties Used in Modeling

Table 3.6 Sediment Properties Used in Modeling

Table 3.7 Surface Water Exposure Estimates

Table 3.8 Sediment Exposure Estimates

Table 4.1 Risk Evaluation of Recreators Exposed to Surface Water While Swimming

Table 4.2 Risk Evaluation of Recreators Exposed to Surface Water While Boating

Table 4.3 Risk Evaluation of Recreators Exposed to Sediment

Table 4.4 Risk Evaluation of Recreators Consuming Locally Caught Fish

Table 4.5 Risk Evaluation of Ecological Receptors Exposed to Surface Water

Table 4.6 Risk Evaluation of Ecological Receptors Exposed to Sediment

List of Figures

Figure ES.1	Site Location Map
Figure 2.1	Site Location Map
Figure 2.2	Conceptual Site Model for OEAP/NAP
Figure 2.3	Conceptual Site Model for NEAP
Figure 2.4	Human Conceptual Exposure Model
Figure 2.5	Ecological Conceptual Exposure Model
Figure 3.1	Groundwater Monitoring Well Locations
Figure 3.2	Surface Water Sample Locations
Figure 4.1	Overview of Risk Evaluation Methodology

Abbreviations

ADI	Acceptable Daily Intake
BCF	Bioconcentration Factor
CCR	Coal Combustion Residual
CEM	Conceptual Exposure Model
COI	Constituent of Interest
Cr	Chromium
Cr(VI)	Hexavalent Chromium
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
ESV	Ecological Screening Value
GWPS	Groundwater Protection Standard
K_d	Equilibrium Partitioning Coefficient
K_p	Permeability Coefficient
HTC	Human Threshold Criteria
IEPA	Illinois Environmental Protection Agency
IL SWQS	Illinois Surface Water Quality Standards
ISGS	Illinois State Geologic Survey
LGU	Lower Groundwater Unit
MCL	Maximum Contaminant Level
MGU	Middle Groundwater Unit
NAP	North Ash Pond
NEAP	New East Ash Pond
NOEC	No Observed Effect Concentration
NPDES	National Pollutant Discharge Elimination System
OEAP	Old East Ash Pond
RfD	Reference Dose
RME	Reasonable Maximum Exposure
RSL	Regional Screening Level
TEC	Threshold Effect Concentration
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VGS	Vermilion Generating Station

Executive Summary

Dynegy Midwest Generation Company's Vermilion Generating Station (VGS or the Site) is an electric power generating facility with coal fired units in Oakwood, Illinois. The facility began operations in the mid-1950s (OBG, 2019a) and was retired in November 2011 (IEPA, 2013). The VGS produced and stored coal combustion residuals (CCRs) as a part of its historical operations in several CCR ash ponds located east of the power plant (North Ash Pond [NAP], Old East Ash Pond [OEAP], New East Ash Pond [NEAP]) (Figure ES.1).

This report presents the results of a human health and ecological risk evaluation for potential CCR constituents in environmental media at the Site. The groundwater monitoring data indicate that groundwater beneath the ash ponds may be impacted by potential CCR-related constituents. The Conceptual Site Model (CSM) developed for the Site indicates that groundwater beneath the former CCR ash ponds flows into the Middle Fork of the Vermilion River adjacent to the Site and may potentially impact surface water and sediment (OBG, 2019a,b). Key observations and conclusions of the risk evaluation are highlighted below.

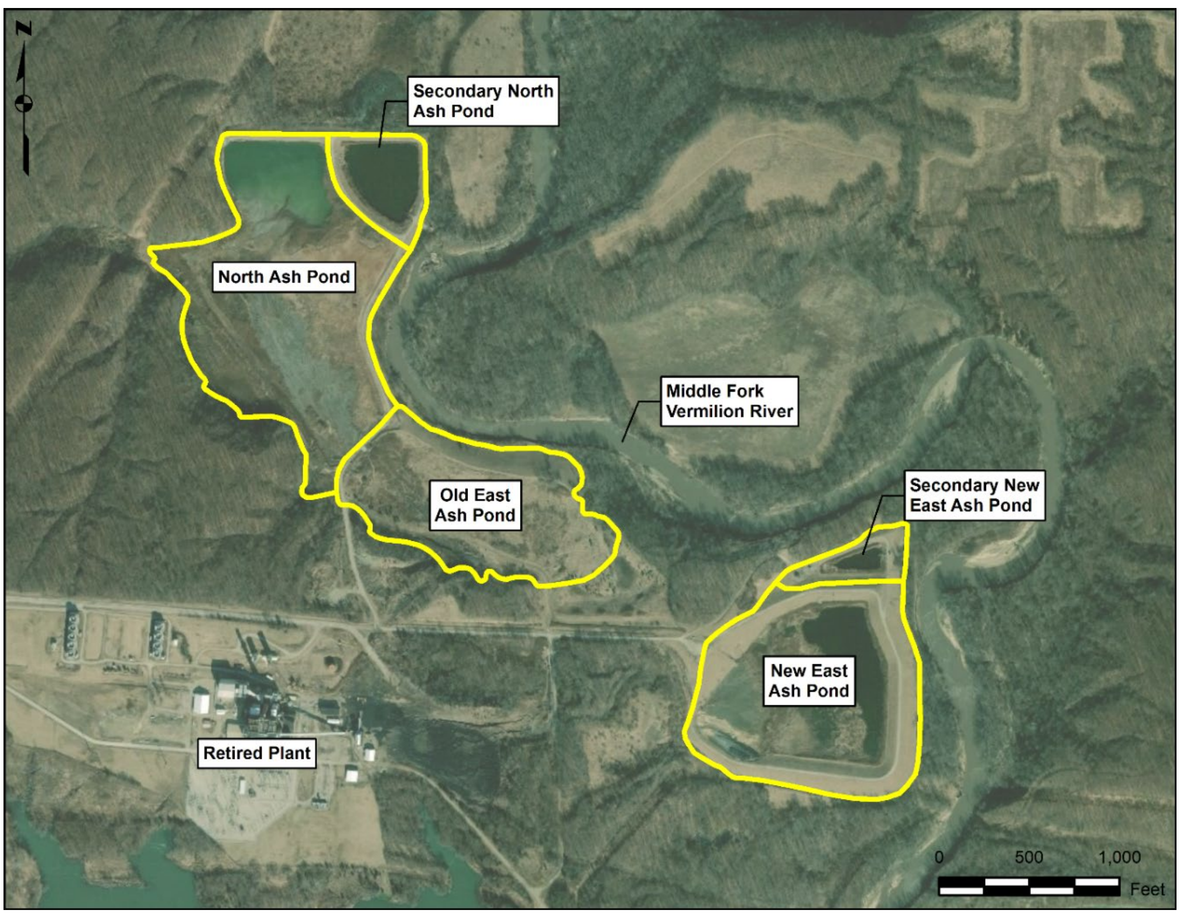


Figure ES.1 Site Location Map. (Based on Dynegy Midwest Generation, LLC, *et al.*, 2019.)

Regarding the Conceptual Site Model:

- The CSM describes how potential CCR constituents in the ash ponds may have come into contact with groundwater and migrated off-Site into other media such as surface water and sediment. The CSM is informed by the hydrogeology of the Site, including information on groundwater depth, groundwater flow, and the characteristics of nearby surface water bodies. Site documents, including original site investigations (*e.g.*, Kelron Environmental, 2003) and site-specific numerical groundwater modeling reports (OBG, 2018) were reviewed to develop the CSM.
- There are two groundwater units below the site in the vicinity of the NAP/OEAP: the Middle Groundwater Unit (MGU) and Lower Groundwater Unit (LGU). The MGU is the primary conduit for groundwater flow at the Site. Groundwater flow in the MGU is primarily eastward toward the Middle Fork of the Vermilion River. Groundwater flow in the LGU is also primarily eastward toward the Middle Fork of the Vermilion River. CCR-related constituents in both the MGU and LGU may potentially discharge *via* groundwater into the Middle Fork of the Vermilion River.
- The effect of the NEAP on groundwater quality in the unlithified materials and bedrock is either negligible or not present as a result of limited or no hydraulic connection.
- Potentiometric groundwater elevation data indicate that groundwater in the bedrock aquifer flows upward into the unlithified materials rather than downward into the bedrock aquifer (Kelron Environmental, 2003). Isotopic radiocarbon dating of the groundwater also confirms that the ash ponds are not a source of recharge to the bedrock aquifer (Kelron Environmental, 2003; OBG, 2019b).
- Based on site-specific numerical groundwater modeling (OBG, 2018) and potentiometric groundwater elevation data (Kelron Environmental, 2003; Kelron Environmental, 2012a), all groundwater potentially impacted with CCR-related constituents discharges into the Middle Fork of the Vermilion River. Thus, there is no migration of potentially impacted groundwater beneath the river, and there are no human or environmental exposures to potential CCR-related constituents on the opposite side of the Middle Fork of the Vermilion River.
- Groundwater is not used for any purpose at the Site. Based on a well survey (Kelron Environmental, 2012b), private residential wells are only located hydraulically upgradient of the Site and, thus, cannot plausibly be impacted by any CCR-related constituents. Also, there is no off-Site migration of CCR-related constituents in groundwater to the south or west of the Site because all shallow groundwater at the NEAP and NAP/OEAP discharges to the Middle Fork of the Vermilion River (OBG, 2019a; Kelron Environmental, 2003, 2012a).
- Groundwater samples from both the MGU and the LGU were collected from a total of 34 monitoring wells between 1998 and 2019. The analyses presented in this report relied on groundwater data collected from 20 monitoring wells between 2011 and 2019, which is the dataset considered to be representative of current conditions at the Site. Surface water samples were collected from three locations in the Middle Fork of the Vermilion River, in February and March 2019, providing a total of six samples. Surface water concentrations were modeled for two analytes (beryllium and cobalt) that were detected in groundwater, but not analyzed in surface water. In addition, to supplement the measured surface water data, we modeled the Site-related contributions to surface water for all constituents detected in groundwater at the Site. Sediment sampling has not been conducted in the Middle Fork of the Vermilion River. Sediment concentrations were modeled for all constituents that were detected in groundwater at the Site.
- Many CCR-related constituents are naturally occurring in the environment. Thus detected concentrations of these constituents in surface water or groundwater do not necessarily indicate that these media have been impacted by CCR.

Regarding the Potential Risk to Human Health:

- An exposure pathway is the way a person is exposed to constituents in environmental media. Exposure pathways consist of the following four elements: (1) a source; (2) a mechanism of release, retention, or transport of a constituent to a given medium (*e.g.*, groundwater, surface water, sediment, or fish); (3) a point where a person can contact the medium (*i.e.*, exposure point); and (4) a route of exposure at the point of contact (*e.g.*, incidental ingestion, dermal contact). If any of these elements is missing, the pathway is considered incomplete (*i.e.*, it does not present a means of exposure). Only those exposure pathways judged to be complete are of concern for human exposure and were evaluated further at the Site.
- The Site-related constituents of interest (COIs) for surface water included all analytes detected in surface water, or analytes detected in groundwater but not analyzed in surface water. The COIs for sediment included all analytes that were detected in groundwater.
- Based on the local hydrogeology, a private well survey, and the location of residences relative to the Site, residential exposure to groundwater used for drinking water or irrigation is not a complete exposure pathway and was not evaluated.
- The following complete exposure pathways for humans were identified and evaluated at the Site: recreators in the Vermilion River who are exposed to surface water and sediment (boaters and swimmers), and anglers who consume locally caught fish.
- None of the complete human exposure pathways at the Site are expected to pose an unacceptable risk, for the following reasons.
  - For recreators exposed to surface water, all the maximum measured or modeled concentrations of COIs in surface water were below the conservative risk-based screening values derived for this assessment. Therefore, none of the COIs evaluated for surface water are expected to pose an unacceptable risk to recreators swimming or boating or tubing in the Middle Fork of the Vermilion River adjacent to the Site.
  - For recreators exposed to sediment, the modeled maximum sediment concentrations of COIs were well below their respective recreational sediment benchmark. Therefore, exposure to sediment is not expected to pose an unacceptable risk to recreators while swimming or boating.
  - For anglers consuming locally caught fish, the maximum concentrations for all COIs in surface water were below risk-based concentrations derived to be protective of fish consumption. Therefore, none of the COIs evaluated are expected to pose an unacceptable risk to recreators consuming fish caught in the Middle Fork of the Vermilion River.

Regarding the Potential Risk to Ecological Receptors:

- The following complete exposure pathways for ecological receptors in the Middle Fork of the Vermilion River were identified and evaluated: 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. None of the complete ecological exposure pathways at the Site are expected to pose an unacceptable risk.
  - The maximum measured or modeled concentrations for all COIs in surface water were below conservative risk-based surface water benchmarks. Therefore, none of the COIs evaluated for

surface water are expected to pose an unacceptable risk to ecological receptors in the Middle Fork of the Vermilion River.

- The maximum modeled concentrations for all COIs in sediment were below conservative risk-based sediment screening benchmarks. Therefore, none of the COIs evaluated for sediment are expected to pose an unacceptable risk to ecological receptors in the Middle Fork of the Vermilion River.

- 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). None of the COIs were identified to have potential bioaccumulative effects. Overall, this evaluation demonstrated that none of the COIs evaluated are expected to pose an unacceptable risk to ecological receptors.

Regarding Overall Risk Conclusions and Health-protective Assumptions:

- Our overall conclusion is that groundwater from the ash ponds at the VGS and potential groundwater contributions to surface water and sediment COI concentrations in the Middle Fork of the Vermilion River pose no unacceptable risks to human health or the environment. We reach this conclusion because modeled or detected maximum concentrations of all COIs in surface water and sediment in the Middle Fork of the Vermilion River were below conservative risk-based screening benchmarks. This conclusion was reached using methodology consistent with applicable US EPA risk assessment principles (*e.g.*, US EPA, 1989). The assessment relied on conservative assumptions meant to overestimate possible exposures and risks and provide an additional level of certainty in the conclusions. Some of the key health-protective assumptions used in the assessment are as follows:

  - We assumed that CCR constituents in groundwater could migrate into surface water and sediment. Where measured surface water data were available, these were used in the risk assessment, but for analytes where surface water data were not available and which were detected in groundwater, surface water concentrations were modeled and evaluated using the maximum detected concentrations in groundwater.

  - In our assessment we assumed that measured or modeled COI concentrations were from the site. Reliance on the maximum detected COI concentration is not representative of conditions across the entire Site and resulted in overestimates of potential human and ecological exposures.

  - While measured surface water concentrations were used for the risk assessment, surface water concentrations were also modeled to estimate the impact of Site-related COIs on surface water, and to supplement available surface water data. The modeled surface water concentrations demonstrated that Site-related COIs were in agreement with the measured surface water concentrations and further demonstrated that Site-related COIs do not pose an unacceptable risk to human health and the environment..

  - We conservatively assumed that human and ecological receptors would be exposed to the maximum modeled or measured concentration for the entire exposure period regardless of location, even though the average concentration is more representative of exposures within an exposure area over a long period of time. Ignoring the variability in exposure over time and location may result in a substantial overestimation of actual risk.

- For the human health evaluation, we used conservative exposure assumptions that likely overestimate actual exposures. For example, we assumed that children and adults would swim or go tubing for 4 hours/day for 40 days/year for 26 years. For perspective, according to the US EPA "Exposure Factors Handbook," which provides guidance on values to use in a risk assessment, a high-end estimate of swimming activities for adults and children is under 3.3 hours per month, on average (US EPA, 2011a).

- For the ecological evaluation, we conservatively assumed all constituents to be 100% bioavailable. However, several metal COIs (*e.g.*, cadmium, copper, lead, nickel, and zinc) form insoluble metal sulfides in sediment in the presence of sulfide or bind to organic carbon, reducing their bioavailability and toxicity to benthic invertebrates. Similarly, depending on the mineralogy and chemical form, the oral bioavailability to wildlife of several metals (*e.g.*, cadmium, lead) has been shown to be much lower than 100%.

▪ 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 ash ponds have been 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. Moreover, the modeled time horizon to achieving the groundwater protection standards (GWPSs) under the various closure alternatives (OBG, 2018) is immaterial from a risk perspective since there is no unacceptable risk associated with exceedances of the GWPSs. Because of this, other factors, such as the impact to the environment and nearby communities and worker safety should be considered when evaluating closure options.

1 Introduction

Dynegy Midwest Generation Company's Vermilion Generating Station (VGS or the Site) is an electric power generating facility with coal fired units in Oakwood, Illinois. The facility began operations in the mid-1950s (OBG, 2019a) and was retired in November 2011 (IEPA, 2013). The VGS produced and stored coal combustion residuals (CCRs) as a part of its historical operations in several CCR ash ponds located east of the power plant (North Ash Pond, Old East Ash Pond, New East Ash Pond). The CCR ash ponds are planned for closure.

An alternatives analysis was performed to select an optimal closure plan (OBG, 2018). This analysis included construction of a numerical model in order to evaluate future groundwater impacts under different closure scenarios. Specifically, groundwater flow hydraulics and the future boron concentrations in groundwater[1] were evaluated using the numerical model for different closure scenarios, including closure in place, closure by removal (on-site and off-site), beneficial reuse with monitored natural attenuation (MNA), and the selected hybrid closure plan (known as Scenario 4A). Scenario 4A entails excavating and consolidating the OEAP to the NAP, consolidating ash to the west end of the NEAP, closing the consolidated NAP and NEAP in place, and using existing or new subsurface barrier walls around each former pond to limit any additional potential impacts to groundwater. Scenario 4A was selected because it was determined to be as protective of groundwater as closure by removal, but does not require off-site transportation of the ash that could generate additional negative impacts (OBG, 2018).

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. While this report specifically evaluates current risks, it also informs what potential risks may be under the different closure scenarios. Human and ecological risks were evaluated for Site-specific constituents of interest (COIs), which included all constituents detected in groundwater or surface water. The conceptual site model (CSM) assumed that Site-related COIs in groundwater may migrate to the 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 used a tiered approach to evaluate potential risks, which included the following steps:

1. Identify complete exposure pathways and develop a conceptual exposure model (CEM).
2. Identify Site-related COIs: All constituents detected in groundwater or surface water.
3. 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. Refined Risk Analysis: If COPCs are identified, perform a refined analysis to evaluate potential risks for the COPCs.
5. Formulate risk conclusions and discuss any associated uncertainties.

[1] Boron was selected as a representative analyte for coal ash impacts to groundwater due to its common, unique presence at coal ash sites, its observed exceedance of groundwater protection standards at the VGS Site, and its high mobility in groundwater (OBG, 2018, p. 2).

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 relied on US EPA's Regional Screening Levels (RSLs) User's Guide (US EPA, 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, 2014a).

Section 2 of this report presents a description and CSM for the Site, and the human and ecological conceptual exposure models. Section 3 presents the groundwater and surface water data used in the risk evaluation, and the methodology used for modeling surface water and sediment concentrations. Section 4 describes the human health and ecological risk evaluations and associated uncertainties. Section 5 presents the overall conclusions of the risk evaluation.

2 Site Overview

2.1 Site Description

The VGS is located approximately five miles north of the Village of Oakwood, Illinois, along the Middle Fork of the Vermilion River. The Site includes a retired plant and multiple decommissioned ash ponds (Figure 2.1):

- Old East Ash Pond (OEAP);
- North Ash Pond (NAP), including an associated secondary pond; and
- New East Ash Pond (NEAP), including an associated secondary pond.

The OEAP is the oldest of the ash receiving ponds and was put into service in the mid-1950s as part of the original plant construction. Use of the OEAP continued until the NAP, which is hydraulically connected with the OEAP, was constructed and put into service in the mid-1970s. For purposes of closure, the company characterizes the OEAP and NAP as a single multi-unit system because (a) there is a continuous layer of ash running between the OEAP and NAP, (b) the NAP was subsequently designed such that the outer berms were an extension of the outer berms of the OEAP, (c) the NAP was designed and constructed to incorporate the ash located within the OEAP, (d) they share a groundwater monitoring network, (e) they fall within the same areal extent of the local groundwater flow regime, and (f) they are covered by a single closure plan. Use of the NAP continued until 1989-1990, after which ash was diverted to the NEAP (OBG, 2019a).

The IEPA approved NEAP was constructed in the bottomlands of the Middle Fork of the Vermilion River with low permeability clay earthen berms built with an eight-foot thick low permeability core on the north, east, and south sides that were keyed into the underlying shale with four-foot thick soil/bentonite slurry walls (Kelron Environmental, 2003). The west side of the NEAP is formed by a cut into the bluff and capped with a six-foot thick low permeability clay keyed at the base of the bluff into the underlying shale. The original 1989 footprint of the NEAP was expanded in 2002 to form the present extent of the NEAP. The height of the berms surrounding the NEAP was raised with more low permeability clay in 2002, and a trench filled with low permeability fill was keyed into the shale along the natural bluff on the west side of the NEAP (OBG, 2019b). The NEAP overlies a historical coal mine, which has impacted groundwater quality in the area (OBG, 2019b).

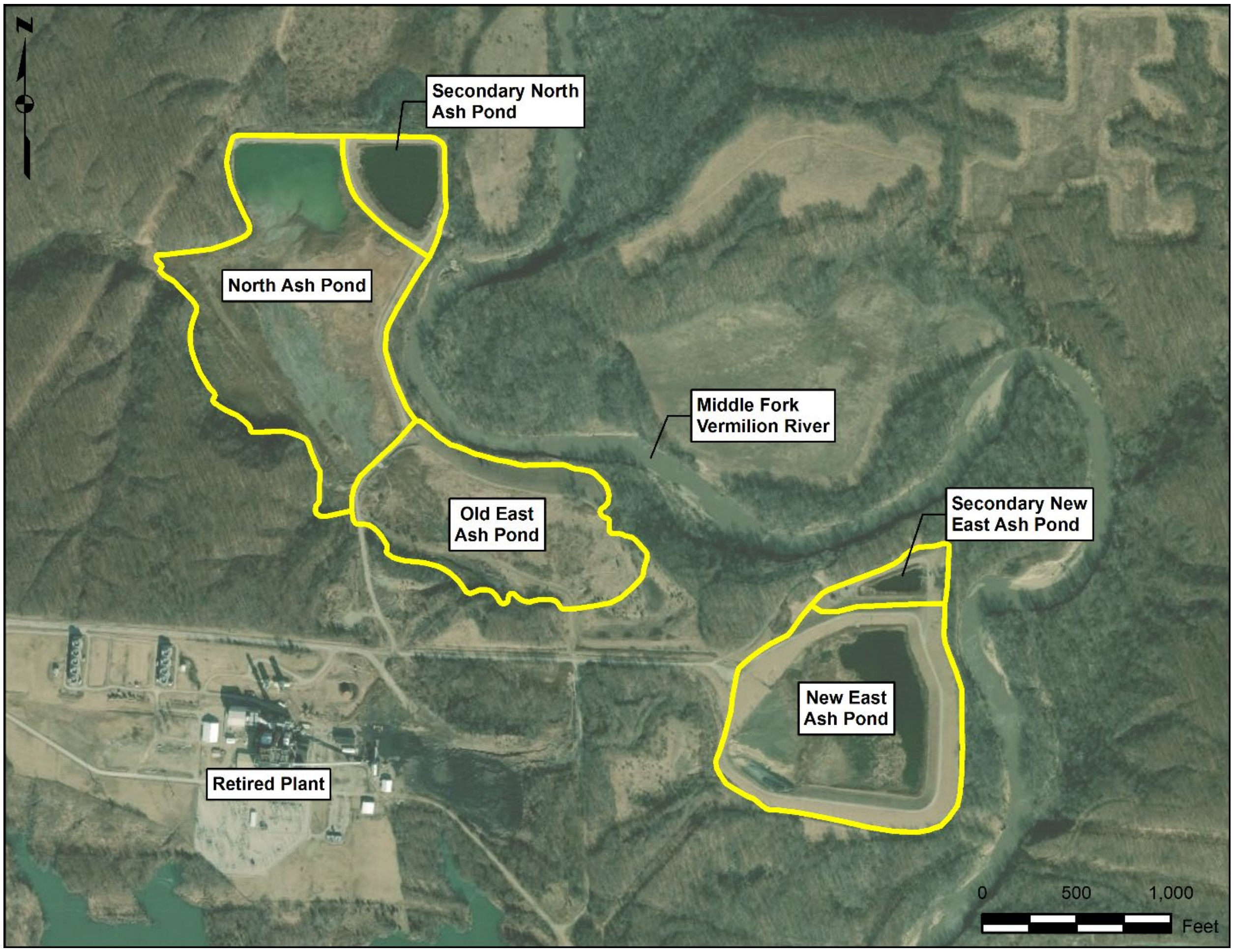


Figure 2.1 Site Location Map. (Based on Dynegy Midwest Generation, LLC, *et al.*, 2019.)

1. An upper unit composed of silt deposits and alluvium;
2. A Middle Groundwater Unit (MGU) composed of alluvial sand and gravel with some silt;
3. A middle confining unit composed of alluvial and re-worked glacial deposits, clay, and silty clay with occasional sand lenses;
4. A Lower Groundwater Unit (LGU) composed of glacial outwash and re-worked glacial deposits of sand, silty sand, and clayey sand;
5. A lower confining unit composed of till, primarily clay, silty clay, and sandy clay with occasional sand lenses; and
6. Bedrock composed of shale with deep coal seams and occasional layers of limestone and sandstone.

Hydrogeologic data collected at the site show that groundwater flow occurs in the MGU and LGU, while the middle and lower confining units act as barriers to groundwater flow (OBG, 2019a). The MGU is more conductive than the LGU and is the primary conduit for groundwater flow at the Site. Groundwater in both the MGU and LGU flows to the east toward the Middle Fork of the Vermilion River. Potentiometric head maps, vertical gradients, and geochemistry data confirm that groundwater in both the MGU and LGU discharge into the Middle Fork of the Vermilion River (OBG, 2019a; Kelron Environmental, 2003, 2012a).

The geology underlying the Site in the vicinity of the NEAP is distinct from the geology in the vicinity of the NAP/OEAP because the NAP/OEAP are built atop terraces, while the NEAP was constructed in the lower elevation bottomlands directly atop shale bedrock. The geology near the NEAP consists of three layers: (OBG, 2019b).

1. Alluvial deposits of sand with occasional layers of silty clay;
2. Glacial deposits of low plasticity silty to sandy clays with occasional silt, sand, and gravel layers; and
3. Bedrock, which contains a major coal seam.

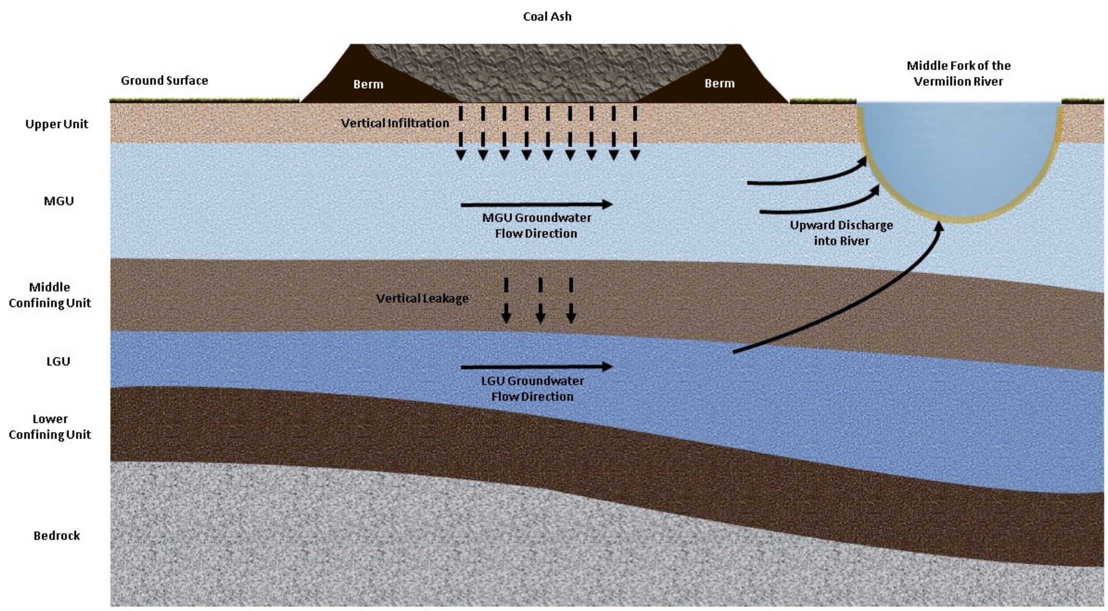
The NEAP is hydraulically isolated from the alluvial deposits by low permeability clay/bentonite barriers installed along its boundaries and keyed into the underlying low permeability shale (OBG, 2019b). Groundwater surrounding the NEAP discharges into the Middle Fork of the Vermilion River (OBG, 2019b). Groundwater quality data have demonstrated that CCR-related constituents from the NEAP have negligible or no impact on groundwater outside the low permeability barriers and are not impacting the Middle Fork of the Vermilion River (OBG, 2019b).

2.2 Conceptual Site Model

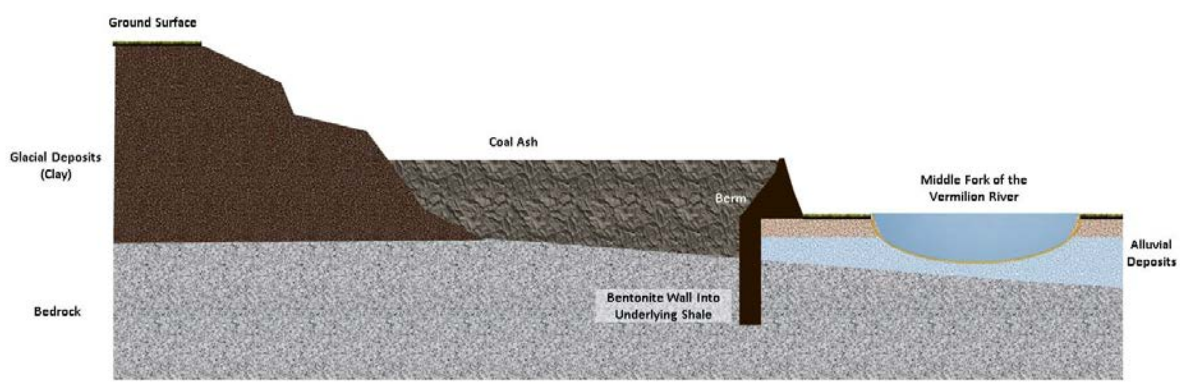
A conceptual site model (CSM) describes the sources of contamination, the hydrogeologic units, and the physical processes that control the transport of constituents in and between environmental media. In this case, the CSM describes how CCR constituents in the ash ponds may have come into contact with groundwater and migrated off-Site into other media such as surface water and sediment. The CSM was developed using historical hydrogeologic and groundwater quality data (OBG, 2019a,b). The CSM is informed by the hydrogeology of the Site, including information on groundwater depth, groundwater flow, and the characteristics of nearby surface water bodies. At the OEAP/NAP, potential dissolved CCR-related constituents may migrate vertically downward under the influence of gravity into the MGU (Figure 2.2). The MGU is the primary conduit for groundwater flow at the Site. Groundwater flow in the MGU is primarily eastward toward the Middle Fork of the Vermilion River. Some potentially dissolved CCR-related constituents may migrate downward through the middle confining unit into the LGU. Groundwater flow rates are lower in the LGU relative to the MGU due to the difference in the hydraulic conductivities of the two units. Groundwater flow in the LGU is also primarily eastward toward the Middle Fork of the Vermilion River. CCR-related constituents in both the MGU and LGU may potentially discharge with groundwater into the Middle Fork of the Vermilion River. Based on site-specific numerical groundwater modeling performed at the Site (OBG, 2018), all groundwater impacted with potential CCR-related constituents is ultimately discharged into the Middle Fork of the Vermilion River and no CCR-related constituents migrate away from the Site underneath the river. Similarly, there is no transport of CCR-related constituents toward the northern, western, and southern property boundaries.

There have been either no observed or negligible CCR-related impacts in the bedrock aquifer, which underlies the NEAP and OEAP/NAP. Hydraulic head data indicate that groundwater in the bedrock aquifer flows upward into the overlying unlithified deposits rather than downward into the bedrock aquifer. Isotopic radiocarbon dating of the groundwater also confirms that the ash ponds are not a source of recharge to the bedrock aquifer (Kelron Environmental, 2003; OBG, 2019b).

During groundwater discharge into the river, CCR-related constituents may partition between sediments and surface water. It should be noted that many of the CCR-related constituents occur naturally in sediments and surface water. As a result, their presence in sediments and/or surface water of the Vermilion River does not necessarily signify contributions from the ash ponds.



At the NEAP, since the pond is built atop low permeability shale and surrounded by low permeability clay/bentonite layers (Figure 2.3), no constituent migration is expected out of the pond. There is no or negligible impact of CCR-related constituents from the NEAP on groundwater quality. Additionally, while groundwater underlying the NEAP migrates toward and discharges into the Middle Fork of the Vermilion River, there is no evidence of CCR-related impacts from the NEAP in surface water (OBG, 2019b, discussed further in Section 2.3.1).



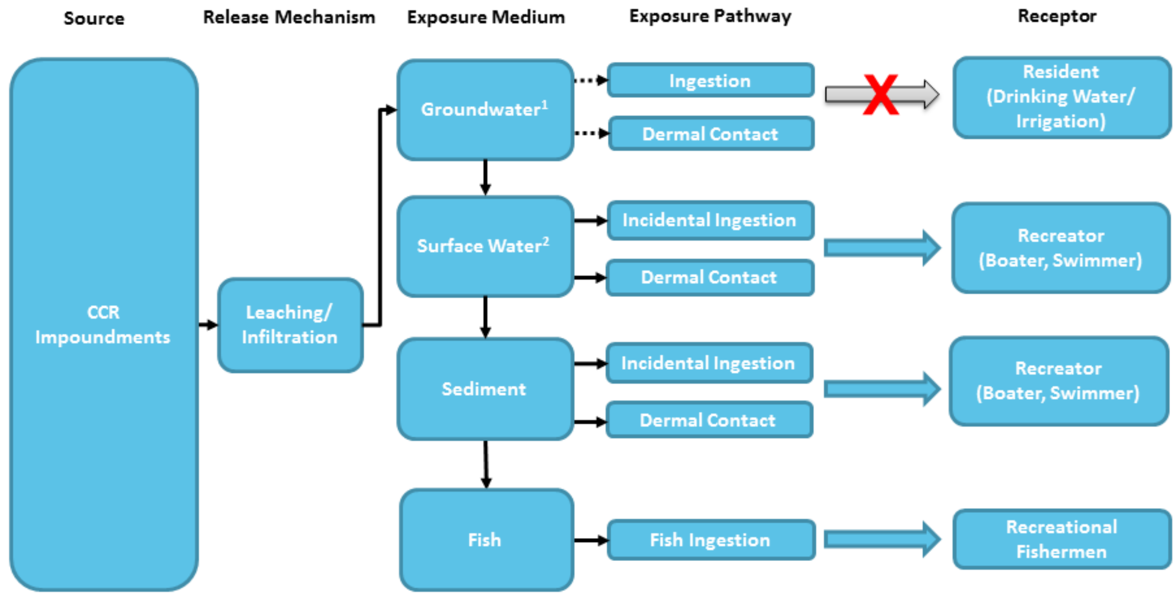
2.3 Human Conceptual Exposure Model

A Conceptual Exposure Model (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.

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 2.4 presents a human CEM for the Site. It considers a human receptor who could be exposed to COIs hypothetically released from the ash ponds into groundwater, surface water, sediment, and fish. The following human receptors and exposure pathways were evaluated for inclusion in the site-specific CEM.

- 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 or tubing;
    - 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 2.3.1 (below) explains why the residential drinking water and irrigation pathways are incomplete, and Section 2.3.2 provides additional description of the recreational exposures.



2.3.1 Groundwater 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 OEAP/NAP, or the NEAP. Although the OEAP/NAP may be the source of several CCR constituents that were detected above the Illinois Class I Potable standard in shallow groundwater (*i.e.*, the MGU and LGU) (OBG 2018; Kelron Environmental, 2012a,b), shallow groundwater in the Site vicinity is not used as a source of drinking water. Hydrogeological and geochemical evidence indicate that potential CCR-impacted groundwater near the ponds cannot plausibly impact distant and hydraulically upgradient residential wells that may be used as sources of drinking water or irrigation. Further, the NEAP is not a source of impacts to groundwater, based on the hydrogeological studies of groundwater underlying and adjacent to the NEAP. A summary of the evidence supporting the conclusion that CCR-related constituents originating from the ash ponds do not impact residential wells is presented below.

- **Groundwater for residential use is limited in the vicinity of the ash ponds**. Based on a water well survey conducted in 2009, only one drinking water well was identified within a 750-meter radius of the ash ponds (Kelron Environmental, 2012b). This non-community well, as well as several other drinking water sources identified in the upland areas (outside the 750-meter radius) are all located hydraulically upgradient of the ash ponds. This means that groundwater underlying and near the ash ponds migrates in the opposite direction of the residential drinking water sources that were identified. Therefore, pond-derived CCR constituents in groundwater cannot impact these hydraulically upgradient residential wells (Kelron Environmental, 2012b).
- **There is no off-Site migration of CCR-related constituents to residential wells because all shallow groundwater discharges to the Middle Fork of the Vermilion River**. The Middle Fork of the Vermilion River is the regional sink of shallow groundwater in the area (Kelron Environmental, 2003, 2012a), *i.e.*, all of the groundwater in the MGU and LGU in this area

discharges to the river. Potentiometric surface maps using wells on both sides of the Middle Fork of the Vermilion River show that groundwater discharge from the underlying shale is toward the river (Kelron Environmental, 2003). Potentiometric surface maps for the MGU and the LGU similarly show groundwater flow toward the river (Kelron Environmental, 2012a). Hydraulic head measurements show that the surface water elevation in the Middle Fork of the Vermilion River is about 1.5 to 4 feet lower than the head in wells screened in the alluvium across the river from the NEAP portion of the Site (MW26 and MW28) (Kelron Environmental, 2003). Based on this site data, the Middle Fork is the discharge point for groundwater at the Site (OBG, 2018). In sum, this evidence confirms that CCR-related constituents in MGU and LGU groundwater will discharge to the Middle Fork and will not migrate off-Site.

- **The NEAP is not hydraulically connected to shallow groundwater**. Since the expansion of the NEAP in 2002, changes in the pond stage elevation in the NEAP have been shown to not impact surrounding groundwater levels, as the pond is hydraulically isolated by soil/bentonite slurry walls and a compacted clay core (Kelron Environmental, 2003). The hydraulic separation between the pond water and shallow groundwater suggests that the groundwater in the vicinity of the pond is not impacted by pond-derived CCR constituents.
- **Water quality data in the vicinity of the NEAP confirm that pond water and shallow groundwater are not connected**. Water quality data collected for both groundwater and NEAP water indicate that trace metals (*e.g.*, molybdenum, selenium, and vanadium) that were elevated above background levels in pond water were at background levels in both the alluvium and in the bedrock groundwater (Kelron Environmental, 2003). Detailed statistical analyses (box-whisker plots, cluster analyses, stiff diagrams, piper diagrams) were performed to compare groundwater chemical measurements to background concentrations (Kelron Environmental, 2003). No NEAP-derived impacts were identified in the surrounding groundwater. Moreover, hydrochemical facies analyses indicate that water from the alluvial aquifer (MW26 and MW28) represents a Ca-Mg-HCO_3 water-type, whereas the NEAP water represents a distinct Ca-SO_4 water-type (Kelron Environmental, 2003). The different chemical compositions of the NEAP pond water and groundwater confirm that CCR-related constituents in the NEAP are not migrating to surrounding groundwater (OBG, 2019b).
- **Isotopic measurements confirm the bedrock aquifer did not receive recharge from the ash ponds at the Site**. Isotopic data from the Site were analyzed by the Illinois State Geologic Survey (ISGS).[2] Based on carbon-14 (^{14}C) and tritium (^{3}H) data, groundwater in the bedrock aquifer is thousands of years older than groundwater in the alluvium. In the NEAP area, radiocarbon (^{14}C) ages of groundwater in the bedrock aquifer ranged between 13,000 and 35,000 years old. In the same subset of bedrock groundwater samples, no detectable tritium was observed, confirming a longer residence time (more than 50 years) for groundwater in the bedrock aquifer (Kelron Environmental, 2003; OBG, 2019b). The observations of ^{14}C and ^{3}H data confirm that the ash ponds are not a source of recharge to the bedrock aquifer.

2.3.2 Recreational Exposures

The Middle Fork of the Vermilion River flows south past the Site and into the Kickapoo State Recreation Area approximately 4.5 miles downstream of the site (Hanson Professional Services Inc., 2019). The river is used for recreational activities and is the only federally designated Wild and Scenic River in Illinois (Hanson Professional Services Inc., 2019, American Rivers, 2018). Recreational activities that occur on

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[2] The atmospheric testing of nuclear weapons released tritium (^{3}H), a radioactive isotope of hydrogen that peaked in the 1960s, and since then has made it possible to track recently recharged groundwater (*e.g.*, Schlosser *et al*., 1989). Carbon-14 ($^{14}C/^{12}C$) isotopic analysis of dissolved inorganic carbon in groundwater allows the dating of old groundwater (Fontes and Garnier, 1979).

the Middle Fork of the Vermilion River include fishing, paddling, canoeing, tubing, and camping in the state park (Illinois Department of Natural Resources, 2018; Kickapoo Adventures, 2017). The Middle Fork of the Vermilion River is designated by the IEPA as a primary contact recreation site and is not designated for public and food processing water supplies (IEPA, 2018). Therefore, it was concluded that this river is not used as a public drinking water supply.

Recreational exposure to surface water and sediment may occur during boating and swimming/tubing activity along the river. The Middle Fork of the Vermilion River is shallow enough to walk in during low flow periods, and there are sediment deposition areas along the shoreline adjacent to and near the Site that could be accessible by boat. Risks were evaluated separately for boaters and swimmers, as boaters were assumed to have a higher exposure frequency than swimmers (*i.e.*, exposure more days/year), due to temperature constraints that favor a longer boating season. Exposure estimates for swimmers provide a health protective means to evaluate exposure during other recreational activities.

2.4 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 2.5 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).

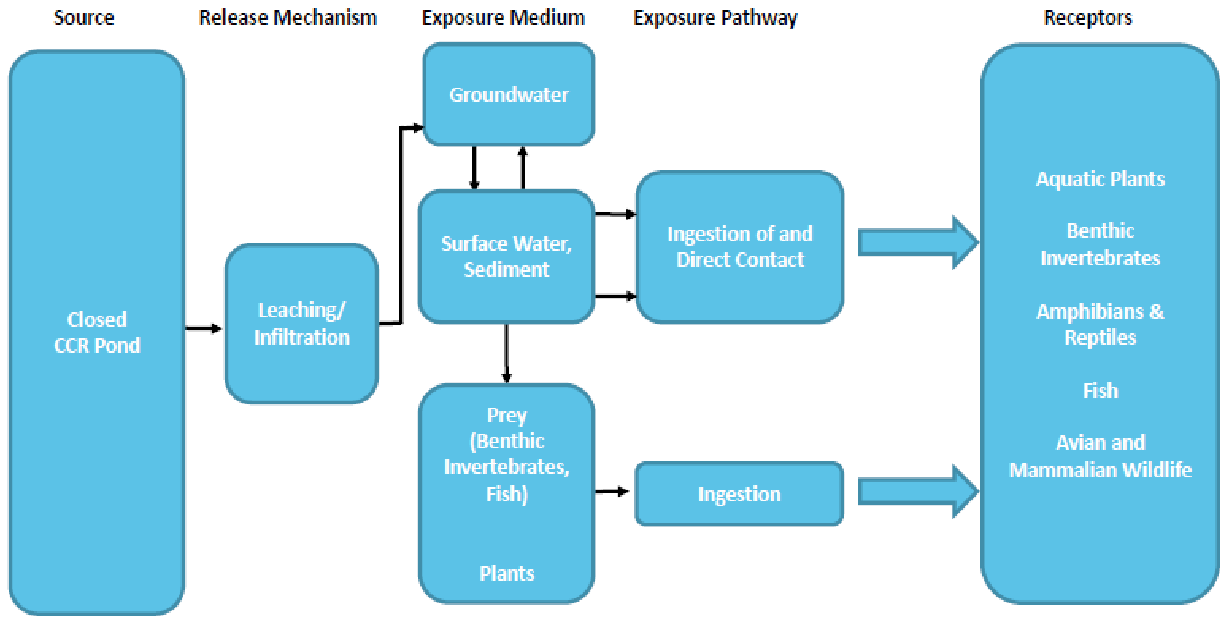


Figure 2.5 Ecological Conceptual Exposure Model. CCR = Coal Combustion Residual.

3 Data Summary

3.1 Groundwater Data

Groundwater samples at the Site were collected from a total of 34 monitoring wells between 1998 and 2019, and the data were provided to Gradient in electronic files that were imported to a project database. The analyses presented in this report relied upon the more recent groundwater data collected from 20 monitoring wells between 2011 and 2019, which is a dataset considered to be representative of current conditions at the Site (Figure 3.1). The chemical constituents that were analyzed in groundwater samples (Table 3.1) were based on the Illinois Environmental Protection Agency (IEPA)-approved analyte list presented in the Site's groundwater monitoring plan (OBG, 2019c) and National Pollutant Discharge Elimination System (NPDES) Permit (IEPA, 2012).

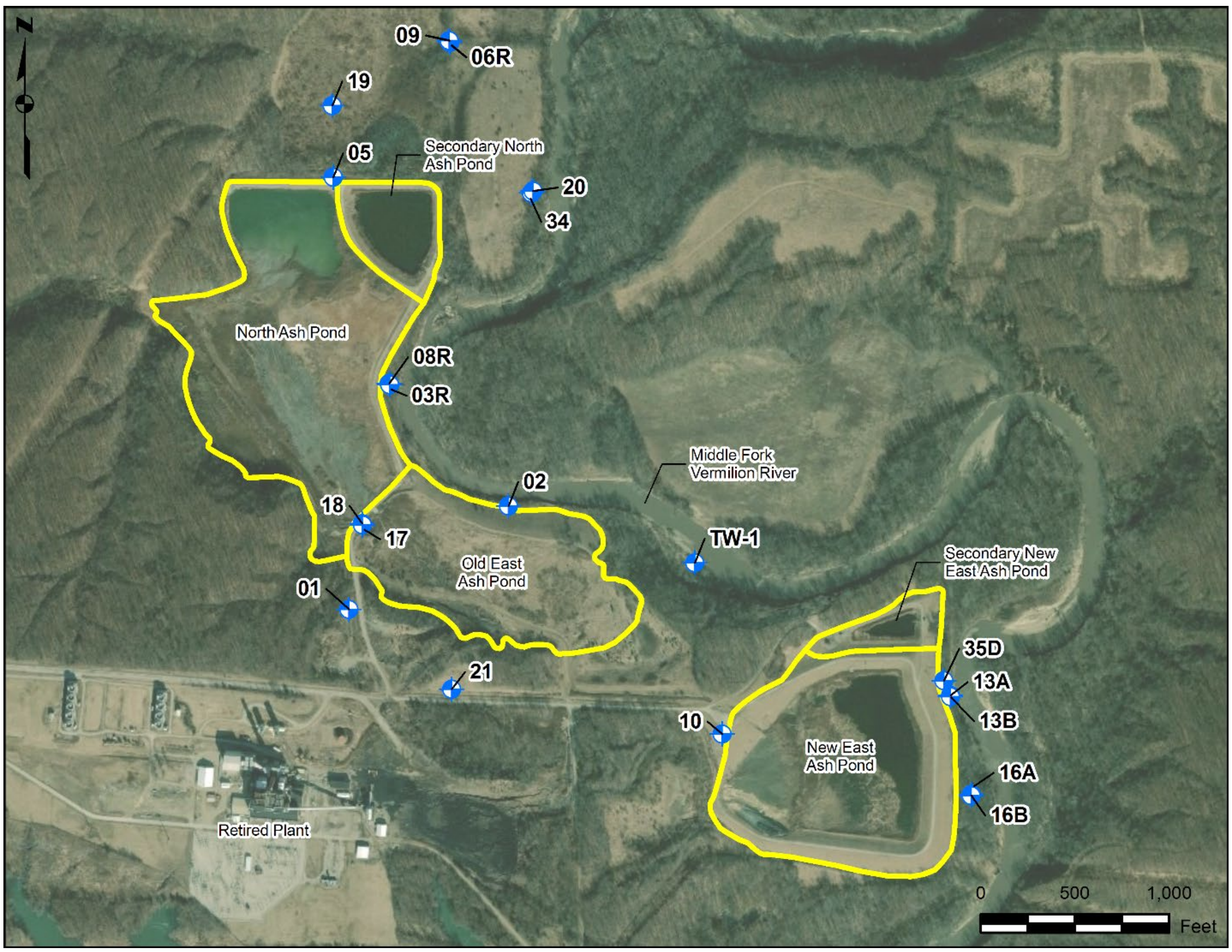


Table 3.1 Constituents Analyzed in Groundwater (2011-2019) – Based on IEPA-approved Monitoring Plan

Analyte	
Antimony	Lead
Arsenic	Magnesium
Barium	Manganese
Beryllium	Mercury
Boron	Nickel
Cadmium	Potassium
Chromium	Selenium
Chromium, Hexavalent	Silver
Cobalt	Sodium
Copper	Thallium
Fluoride	Zinc
Iron	

Notes:
IEPA = Illinois Environmental Protection Agency.
General water quality parameters were also analyzed, but not evaluated in the risk evaluation, including alkalinity, calcium, chloride, nitrate nitrogen, nitrite nitrogen, total Kjeldahl nitrogen, phosphorus, sulfate, total dissolved solids, and total suspended solids.

Table 3.2 Groundwater Data Summary (2011-2019)

Analyte	Samples with Constituent Detected	Samples Collected	Minimum Detect (mg/L)	Maximum Detect (mg/L)	Maximum Detection Limit (mg/L)
Dissolved Metals					
Antimony	0	50			0.0050
Arsenic	64	122	0.00050	0.073	0.073
Barium	122	122	0.0097	0.19	0.19
Beryllium	1	50	0.0084	0.0084	0.0084
Boron	206	212	0.030	53	53
Cadmium	1	50	0.0024	0.0024	0.0024
Calcium	13	13	69	390	390
Chromium	1	50	0.0066	0.0066	0.0066
Chromium, Hexavalent	0	1			0.0050
Cobalt	1	50	0.021	0.021	0.021
Copper	1	52	0.079	0.079	0.079
Fluoride	106	122	0.060	1.2	1.2
Iron	101	124	0.010	8.6	8.6
Lead	0	50			0.0050
Magnesium	13	13	23	150	150
Manganese	204	212	0.0052	1.6	1.6
Mercury	0	50			0.0020
Nickel	2	52	0.0081	0.073	0.073
Potassium	13	13	1.1	10	10
Selenium	13	122	0.00090	0.026	0.026
Silver	0	50			0.0050
Sodium	13	13	3.4	75	75
Thallium	0	50			0.0020
Zinc	4	52	0.0055	0.36	0.36

Analyte	Samples with Constituent Detected	Samples Collected	Minimum Detect (mg/L)	Maximum Detect (mg/L)	Maximum Detection Limit (mg/L)
Total Metals					
Arsenic	0	2			0.025
Barium	2	2	0.11	0.12	0.12
Boron	2	2	31	38	38
Cadmium	0	2			0.00100
Chromium	0	2			0.0050
Chromium, Hexavalent	0	1			0.0050
Cyanide	0	52			0.0080
Fluoride	0	2			0.100
Iron	1	2	0.15	0.15	0.15
Lead	0	2			0.0150
Manganese	2	2	0.033	0.073	0.073
Mercury	0	2			0.00000080
Nickel	0	2			0.0050
Selenium	0	2			0.00100
Silver	0	2			0.0030
Zinc	0	2			0.0100

Note:
The maximum detection limit is the highest detection limit reported for the groundwater samples from 2011-2019.

3.2 Surface Water Data

Surface water samples have been collected from the Middle Fork of the Vermilion River, which flows adjacent to the ash ponds at the Site (Figure 3.2) (Hanson Professional Services Inc., 2019). Surface water samples from the river were collected from three locations (VR1, VR2, and VR3), in February and March 2019. Sample location VR1 is located upstream of the Site, VR2 is located adjacent to the Site, and VR3 is located adjacent and downstream of the Site (Figure 3.2). Constituents that were analyzed in surface water samples are summarized in Table 3.3. Table 3.4 presents a summary of the surface water data at the Site.

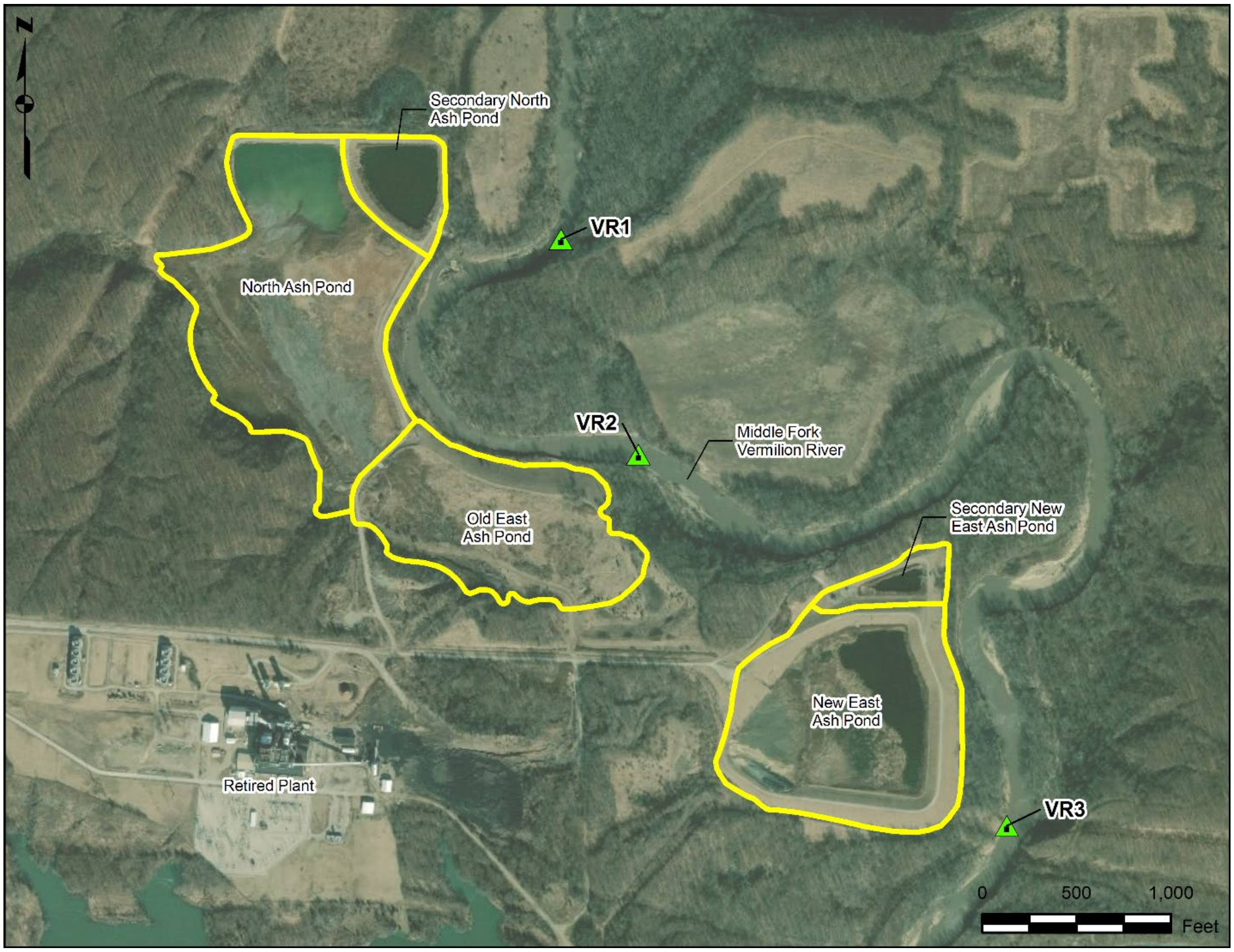


Figure 3.2 Surface Water Sample Locations. (Based on Hanson Professional Services Inc., 2019.)

Table 3.3 Constituents Analyzed in Surface Water (2019)

Analyte	
Arsenic	Iron*
Barium	Lead
Boron	Manganese
Cadmium	Mercury
Chromium	Nickel*
Chromium, Hexavalent*	Selenium
Copper*	Silver
Cyanide	Zinc*
Fluoride	

Notes:
General water quality parameters were also analyzed, but not evaluated further in the risk evaluation, including ammonia, nitrogen, chloride, nitrate nitrogen, nitrite nitrogen, total Kjeldahl nitrogen, phosphorus, sulfate, total dissolved solids, and total suspended solids.
*Metal also analyzed as dissolved metals.

Table 3.4 Surface Water Data Summary

Analyte	Samples Detected	Samples Collected	Minimum Detect (mg/L)	Maximum Detect (mg/L)	Maximum Detection Limit (mg/L)
Dissolved Metals					
Chromium, Hexavalent	0	3			0.0050
Copper	0	6			0.0050
Iron	0	6			0.040
Nickel	0	6			0.0050
Zinc	0	6			0.010
Total Metals					
Arsenic	0	6			0.025
Barium	6	6	0.036	0.040	0.040
Boron	6	6	0.041	0.17	0.17
Cadmium	0	6			0.0010
Chromium	0	6			0.0050
Chromium, Hexavalent	0	3			0.0050
Cyanide	0	6			0.0050
Fluoride	6	6	0.15	0.17	0.17
Iron	6	6	0.34	0.65	0.65
Lead	0	6			0.015
Manganese	6	6	0.023	0.045	0.045
Mercury	3	6	0.0000012	0.0000013	0.0000013
Nickel	0	6			0.0050
Selenium	0	6			0.0010
Silver	0	6			0.0030
Zinc	0	6			0.010

3.3 Surface Water and Sediment Modeling

Sediment sampling has not been conducted in the Middle Fork of the Vermilion River. Many of the COIs are expected to be present in sediment from natural or non-site related anthropogenic sources. It would be difficult to attribute concentrations of these COIs to a particular source given the dynamic nature of river systems and the multitude of potential sources. In the absence of sediment data, Gradient modeled concentrations in river sediments as a result of groundwater discharge to the Middle Fork of the Vermilion River for all constituents that were detected in groundwater. Similarly, surface water modeling was conducted for all constituents detected in groundwater, in order to supplement the dataset of measured surface water concentrations. Surface water and sediment were modeled based on the maximum detected dissolved concentration in groundwater, since the dissolved concentration represents the mobile portion of a constituent that could likely discharge into surface water and 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, 2014a). 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 (dilution) at the point of discharge of groundwater to the surface water.

The maximum detected dissolved concentrations in groundwater (from 2011 to 2019, regardless of well location) were conservatively used to model COI concentrations in surface water and sediment.

The aquifer and surface water properties used to estimate the volume of groundwater flowing into the Middle Fork of the Vermilion River and surface water concentrations are presented in Table 3.5. The COI concentrations in sediment were modeled using the COI-specific sediment-to-water partition coefficients and the sediment properties presented in Table 3.6. In the absence of site-specific information for the Middle Fork of the Vermilion River, we used default assumptions (*e.g.*, depth of the upper benthic layer, bed sediment particulate concentration, and bed sediment porosity) to model sediment concentrations. A description of the sediment modeling and the detailed results are presented in Appendix C.

The modeled surface water and sediment concentrations are discussed in Section 3.4. As described earlier, the modeled concentrations reflect conservative contributions from groundwater discharge.

Table 3.5 Groundwater and Surface Water Properties Used in Modeling

Parameter	Unit	Value	Notes/Source
Groundwater			
COI Concentration	mg/L	Constituent specific	Maximum detected dissolved concentration in groundwater
Cross Section Area for the MGU Layer	m^2	3,931	Estimated using the thickness of the MGU layer (5.2 m) and the length of the river intersected by the modeled plume of Boron in the MGU (756 m; OBG [2018])
Cross Section Area for the LGU Layer	m^2	978	Estimated using the thickness of the LGU layer (3 m) and the length of the river intersected by the modeled plume of Boron in the LGU (326 m; OBG [2018])
Aquifer Hydraulic Gradient in the MGU Layer	m/m	0.0093	Average of the hydraulic gradients measured in the MGU (OBG, 2018)
Aquifer Hydraulic Gradient in the LGU Layer	m/m	0.0075	Average of the hydraulic gradients measured in the LGU (OBG, 2018)
Aquifer Hydraulic Conductivity in the MGU Layer	cm/s	0.00215	As reported in OBG (2018)
Aquifer Hydraulic Conductivity in the LGU Layer	cm/s	0.000847	As reported in OBG (2018)
Surface Water			
Surface Water Flow Rate	L/yr	1.52×10^{10}	Representative low flow discharge rate for the Middle Fork of the Vermilion River (17 cfs), as reported in OBG (2019b)
Total Suspended Solids (TSS)	mg/L	6	Representative average river concentration (Hanson Professional Services Inc., 2019)
Depth of the Water Column	m	0.5	Conservative estimate. Variations in the parameter were tested and did not produce a significant change in the results.
Suspended Sediment to Water Partition Coefficients	mg/L	Constituent specific	Values based on US EPA (2014a)

Notes:

COI = Constituent of Interest; LGU = Lower Groundwater Unit; MGU = Middle Groundwater Unit; US EPA = United States Environmental Protection Agency.

Table 3.6 Sediment Properties Used in Modeling

Parameter	Unit	Value	Notes/Source
Sediment			
Depth of Upper Benthic Layer	m	0.03	Default (US EPA, 2014a)
Depth of Water Body	m	0.53	Depth of water column plus depth of upper benthic layer
Bed Sediment Particle Concentration	g/cm^3	1	Default (US EPA, 2014a)
Bed Sediment Porosity	-	0.6	Default (US EPA, 2014a)
TSS Mass per Unit Area	kg/m^2	0.003	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 (2014a)

Notes:
TSS = Total Suspended Solids; US EPA = United States Environmental Protection Agency.

3.4 Exposure Estimates

3.4.1 Surface Water

As noted in Section 3.2, six surface water samples were collected in 2009. Samples were analyzed for total metals, five dissolved metals (hexavalent chromium, copper, iron, nickel, and zinc) and other field parameters that more generally characterize water chemistry. While total metal concentrations are typically used to quantify human exposures (US EPA, 1989) and dissolved metals are a better indicator of toxicity for ecological receptors (US EPA, 1993), the maximum detected concentrations (regardless of total or dissolved) were conservatively used to quantify exposures for both types of receptors. Calcium, magnesium, potassium, and sodium were also detected in surface water. However, these analytes are essential nutrients with low toxicity for both human and ecological receptors and typically not evaluated in a risk assessment (US EPA, 1989). Therefore, they were not carried forward in the risk evaluation. Arsenic, cadmium, chromium, hexavalent chromium, copper, cyanide, lead, nickel, selenium, silver, and zinc were not detected in surface water, and thus were not carried forward in the risk evaluation. In addition, surface water modeling was conducted for two analytes that were detected in groundwater but not analyzed in surface water (beryllium and cobalt). The surface water COIs include the constituents detected in surface water (barium, boron, fluoride, iron, manganese, and mercury) plus two constituents (beryllium and cobalt) that were detected in groundwater but were not analyzed in surface water. Table 3.7 presents the surface water concentration estimates used in both the human health and ecological risk evaluation.

In addition, to supplement the measured surface water data, we modeled the contributions to surface water of all Site-related COIs in groundwater. The modeled concentrations for all constituents modeled in surface water were below the screening benchmarks for ecological and human receptors (swimmer/tuber, boater, and angler) (see Table C.6 in Appendix C).

Table 3.7 Surface Water Exposure Estimates

COI	Measured Concentration	Modeled[a] Concentration	Surface Water Exposure Concentration	Basis
Barium	0.040	--	0.040	Measured
Beryllium	--	0.000016	0.000016	Modeled
Boron	0.17	--	0.17	Measured
Cobalt	--	0.000039	0.000039	Modeled
Fluoride	0.17	--	0.17	Measured
Iron	0.65	--	0.65	Measured
Manganese	0.045	--	0.045	Measured
Mercury	0.0000013	--	0.0000013	Measured

Notes:
All concentrations reported in mg/L.
-- = Not analyzed; COI = Constituent of Interest.
(a) Modeled data presented for analytes that were not analyzed in surface water, but detected in groundwater. Surface water was modeled using the maximum dissolved concentration in groundwater.

3.4.2 Sediment

Sediment COIs included the metals detected in groundwater (arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, fluoride, iron, manganese, nickel, selenium, and zinc). Sediment concentrations were modeled for these COIs as described in Section 3.3. Table 3.8 presents the modeled sediment concentrations used to estimate exposure in both the human health and ecological risk evaluation.

Table 3.8 Sediment Exposure Estimates

COI	Measured Groundwater Dissolved Concentration (mg/L)	Modeled Sediment Concentration (mg/kg)
Arsenic	0.073	0.033
Barium	0.19	0.11
Beryllium	0.0084	0.0090
Boron	53	0.65
Cadmium	0.0024	0.0060
Chromium	0.0066	0.55
Cobalt	0.021	0.036
Copper	0.079	0.36
Fluoride	1.2	0.35
Iron	8.6	0.41
Manganese	1.6	71
Nickel	0.073	0.94
Selenium	0.026	0.00021
Zinc	0.36	5.3

Note:
COI = Constituent of Interest.

4 Risk Evaluation

4.1 Risk Evaluation Process

A risk evaluation was conducted to determine whether CCR constituents present in groundwater at the Site have the potential to pose adverse health effects to human and ecological receptors. The media evaluated included groundwater, surface water, and sediment. Fish consumption by anglers was evaluated indirectly by comparing surface water concentrations with risk-based water concentrations protective of fish consumption. 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, 2015).

The general risk evaluation approach is summarized in Figure 4.1 and discussed below.

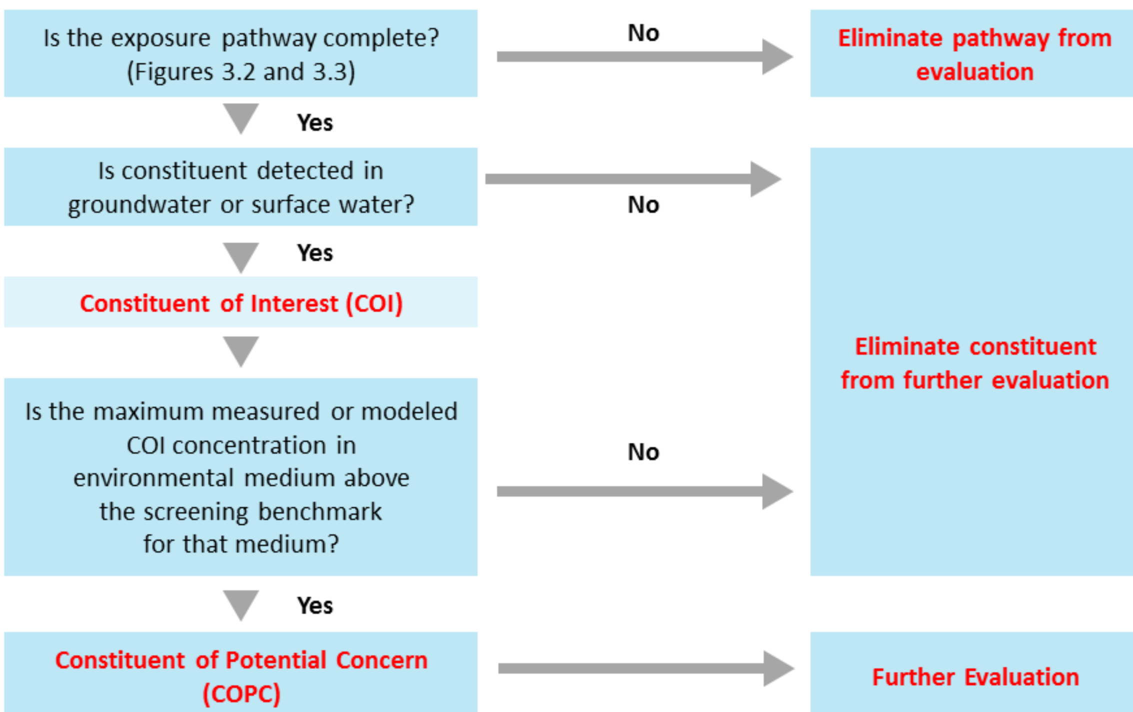


Figure 4.1 Overview of Risk Evaluation Methodology

The first step in the risk evaluation was to develop the CEM and identify complete exposure pathways. All potential receptors and exposure pathways based on the land use, groundwater use, and surface water use in the vicinity of the Site were considered. Exposure pathways that are incomplete were excluded from the evaluation.

Second, measured or modeled COI concentrations in surface water and modeled concentrations in sediment 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 or sediment. Ecological 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 maximum COI concentration exceeding an ecological screening benchmark does not indicate an unacceptable ecological risk, but only that further risk evaluation is warranted. COIs with maximum concentrations exceeding a conservative screening benchmark are identified as constituents of potential concern (COPCs) requiring further evaluation.

As described in more detail below, this evaluation relied on the screening assessment to demonstrate that the potential groundwater CCR constituents do not pose an unacceptable human health or ecological risk to the Vermilion River. That is, after the screening step, no COPCs were identified and an additional assessment was not warranted.

4.2 Human Health Risk Evaluation

The sections below present the results of the human health risk evaluation for recreators (swimmers, boaters, anglers) along the Middle Fork of the Vermilion River adjacent to the Site. For each pathway determined to be complete, risks were assessed for detected or modeled COIs in surface water and sediment.

4.2.1 Recreators Exposed to Surface Water While Swimming or Tubing

Screening Exposures: Recreators could be exposed to surface water *via* incidental ingestion and dermal contact while swimming or tubing. The maximum detected (or modeled) surface water concentration was used as a conservative upper-end estimate of the COI concentration to which a recreator might be exposed (Table 4.1).

Screening Benchmarks: US EPA develops RSLs using generic default assumptions designed to identify constituents that warrant further investigation (US EPA, 2019a). However, because recreational exposure scenarios are site-specific, US EPA has not established recreator RSLs that are protective of recreational exposures to surface water (US EPA, 2019a). Therefore screening benchmarks protective of recreational exposures to surface water were derived using US EPA's RSL guidance (US EPA, 2019a). The recreator benchmarks were calculated using US EPA's recommended assumptions (*i.e.*, dermal permeability coefficient [K_p], body weights, averaging time, target cancer risk, target hazard) and toxicity reference values (*i.e.*, reference dose [RfD] and cancer slope factor [CSF]), along with the following changes. Recreators were assumed to be exposed to surface water as a child for 6 years and as an adult for 20 years.

The entire body was assumed to be submerged while swimming and tubing (recommended surface area of 6,365 cm^2 for a child and 19,652 cm^2 for an adult, based on Stalcup, 2014). Recreators were assumed to incidentally ingest surface water while swimming (0.01 L/day, based on IEPA recommended water ingestion rate while swimming).

US EPA does not recommend a specific exposure frequency for a swimmer. We assumed swimming occurs primarily on days when the water temperature is above 70°F. Based on USGS data for the Vermilion River near Danville, Illinois (five miles east of the site) (USGS, 2019a), in the 2018 water year (October 2017 to September 2018) the mean water temperature was consistently above 70°F between mid-May and the end of September (20 weeks). As a conservative assumption, the recreator is assumed to swim or go tubing in the river two days a week during those 20 weeks, which results in an exposure frequency of 40 days a year. The recreator was assumed to go swimming or tubing for four hours/day. The number of hours spent swimming or tubing is important for quantifying dermal exposure, which requires an estimate of the amount of chemical that can be absorbed through the skin per unit of time. A target hazard quotient of 1 was used based on US EPA's Risk Assessment Guidance for Superfund (RAGS; US EPA, 1989). The target cancer risk was 1×10^{-5} based on the risk target used in US EPA's CCR risk assessment and the guidance US EPA has provided on the evaluation of CCRs in beneficial use assessments (US EPA, 2014a,b).

Surface water data were also compared to the Illinois surface water criteria (IEPA, 2015) known as the Human Threshold Criteria (HTC). The 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 consumption of fish. The comparison to the HTC is discussed in Section 4.2.4.

Table 4.1 presents the recreational RSLs that are protective of recreational exposures to surface water while swimming or tubing. Appendix Table B.1 presents the calculation of RSLs protective of recreational exposures to surface water while swimming or tubing.

Screening Risk Results: The maximum surface water exposure concentrations for all COIs were compared to the conservative benchmarks protective of surface water exposures during swimming and tubing. The maximum detected or modeled concentrations for all COIs were below their respective conservative benchmarks (Table 4.1). Therefore, none of the COIs evaluated in surface water are expected to pose an unacceptable risk to recreators swimming in the Vermilion River adjacent to the Site.

Table 4.1 Risk Evaluation of Recreators Exposed to Surface Water While Swimming

COI	Maximum Detected or Modeled Surface Water Concentration (mg/L)	Recreator Benchmark for Swimming (mg/L)	COPC
Barium	0.040	74	No
Beryllium[a]	0.000016	0.1	No
Boron	0.17	776	No
Cobalt[a]	0.000039	2	No
Fluoride	0.17	155	No
Iron	0.65	2,716	No
Manganese	0.045	5.1	No
Mercury	0.0000013	0.1	No

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern.
(a) Beryllium and cobalt are modeled concentrations. Modeled concentrations for beryllium and cobalt reflect the potential maximum Site-related surface water concentrations from groundwater discharge.

4.2.2 Recreators Exposed to Surface Water While Boating

Screening Exposures: Recreators in the Vermilion River could be exposed to surface water *via* incidental ingestion and dermal contact while boating. The surface water exposure concentrations used for the swimmer were also used for the boater (Table 4.2). Boaters were evaluated separately from swimmers, as boaters are assumed to have a higher exposure frequency, but less skin surface area exposed to water.

Screening Benchmarks: We calculated recreator benchmarks for a boater exposed to surface water. While boaters can potentially be exposed to surface water *via* incidental ingestion, the amount of water incidentally ingested is expected to be *de minimis* because they are not submerged in the water. Therefore, RSLs for the boater were calculated for the protection of dermal exposures only using the same recommended assumptions as the swimmer (*i.e.*, K_p, body weights, averaging time, target cancer risk, target hazard, exposure duration) and toxicity reference values, along with the following changes.

We assumed that boaters are exposed to surface water on their hands, forearms, lower legs, and feet. The age-weighted surface areas of 1,733 cm^2 and 4,824 cm^2 were used for the child and adult, respectively. We assumed boaters could be exposed to surface water four hours a day. We assumed boating activity on the river occurs primarily in the warmer weather. Weather data from the National Oceanic and Atmospheric Administration (NOAA) from Danville, Illinois (five miles east of the site) show that most of the days with a mean air temperature above 60°F occur from April to October, a period of 30 weeks (NOAA, 2008-2018). Based on professional judgment, the recreator is assumed to go boating for two days per week over those 30 weeks, which results in an exposure frequency of 60 days per year.

Table 4.2 presents the recreational RSLs that are protective of recreational exposures to surface water while boating. Appendix Table B.2 presents the calculation of RSLs protective of recreational exposures to surface water while boating.

Screening Risk Results: The maximum surface water exposure concentrations for all COIs were compared to the conservative benchmarks protective of surface water exposures during boating. The maximum detected or modeled concentrations for all analytes were below their respective conservative benchmarks (Table 4.2). Therefore, none of the analytes evaluated in surface water are expected to pose an unacceptable risk to recreators boating in the Vermilion River adjacent to the Site.

Table 4.2 Risk Evaluation of Recreators Exposed to Surface Water While Boating

COI	Maximum Detected or Modeled Surface Water Concentration (mg/L)	Recreator Benchmark for Boating (mg/L)	COPC
Barium	0.040	184	No
Beryllium[a]	0.000016	0.18	No
Boron	0.17	2,632	No
Cobalt[a]	0.000039	9.9	No
Fluoride	0.17	526	No
Iron	0.65	9,213	No
Manganese	0.045	13	No
Mercury	0.0000013	0.28	No

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern.
(a) Beryllium and cobalt are modeled concentrations. Modeled concentrations for beryllium and cobalt reflect the potential maximum Site-related surface water concentrations from groundwater discharge.

4.2.3 Recreators Exposed to Sediment While Swimming or Boating

Recreational exposure to sediment may occur during boating and swimming activity along the river. The Middle Fork of the Vermilion River is shallow enough to walk in during low flow periods, and there are sediment deposition areas along the shoreline adjacent to and near the Site that could be accessible by boat.

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, 2019a). 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, 2019a). These benchmarks were calculated using the recommended assumptions (*i.e.*, oral bioavailability, body weights, averaging time) and toxicity reference values (*i.e.*, RfD and CSF), with the following changes. Recreators were assumed to be exposed to sediment while recreating 60 days a year (or two weekend days per week for 30 weeks a year). The exposure duration was for 6 years as a child and 20 years as an adult, 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, 2011a). Since recreational exposures to sediment are assumed to occur for less than four 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, 2011a). 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, 2019a). As discussed above, screening benchmarks for COIs with carcinogenic endpoints were calculated based on a target risk of 1×10^{-5} and COIs with non-cancer endpoints were calculated based on a target hazard quotient of 1. Appendix Table B.3 presents the calculation of RSLs protective of recreational exposures to sediment.

Screening Risk Evaluation: The calculated RSLs for recreational exposures to sediment are presented in Table 4.3. The modeled sediment concentrations were well below the recreational sediment RSL (Table 4.3). Therefore, exposure to sediment is not expected to pose an unacceptable risk to recreators while swimming or boating.

Table 4.3 Risk Evaluation of Recreators Exposed to Sediment

COI	Modeled Sediment Concentration (mg/kg)	Recreator Benchmark (mg/kg)	COPC
Arsenic	0.033	101	No
Barium	0.11	273,750	No
Beryllium	0.009	2,738	No
Boron	0.65	273,750	No
Cadmium	0.0060	1,219	No
Chromium	0.55	2,053,125	No
Cobalt	0.036	411	No
Copper	0.36	54,750	No
Fluoride	0.35	54,750	No
Iron	0.41	958,125	No
Manganese	71	32,850	No
Nickel	0.94	27,375	No
Selenium	0.00021	6,844	No
Zinc	5.3	410,625	No

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern.
Modeled sediment concentrations reflect the potential maximum Site-related sediment concentrations from groundwater discharge.

4.2.4 Recreators Consuming Fish Caught Near the Site

Screening Exposures: Anglers could consume fish caught in the Middle Fork of the Vermilion River. The maximum detected surface water (or modeled) concentrations were used as conservative upper-end estimates to evaluate potential risks from fish consumption by anglers.
Screening Benchmarks: Illinois provides equations to calculate HTC values, which are surface water quality criteria that account for recreational fish consumption, and incidental ingestion and dermal exposure to surface water (IEPA 2015).

The HTC values were calculated from the following equation (IEPA 2015):

$$HTC = \frac{ADI}{W + (F \times BCF)}$$

where:

HTC = Human health protection criterion in milligrams per liter (mg/L);
ADI = Acceptable daily intake (mg/day)
BCF = Bioconcentration factor (L/kg)
W = Water consumption rate (L/day)
F = Fish consumption rate (kg/day)

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, 2015). US EPA defines the chronic 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, 2011b). Illinois lists methods to derive an ADI from the primary literature (IEPA 2015). As per Illinois guidance, we derived an ADI by multiplying the MCL by the default water ingestion rate of 2 L/day (IEPA, 2015). In the absence of an MCL, we used the RfDs used by US EPA to derive the RSLs (US EPA, 2019b) as a conservative estimate of the ADI. The RfDs are given in mg/kg-day, while the ADI 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.

We used bioconcentration factors (BCFs) from a hierarchy of sources. The primary source of BCFs were those that US EPA used to calculate the National Recommended Water Quality Criteria (NRWQC) Human Health Criteria (US EPA, 2002, 2016). Other sources included BCFs used in the US EPA combustion coal ash risk assessment (US EPA, 2014a), and BCFs reported by Oak Ridge National Laboratory's Risk Assessment Information System (ORNL RAIS).[3]

Illinois recommends a fish consumption rate of 0.020 kg/day (20 g/day) for an adult weighing 70 kg (IEPA 2015). 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 2015). Appendix Table B.4 presents the calculated HTC for fish consumption.

Screening Risk Evaluation: The maximum detected or modeled concentrations in surface water were compared to the calculated Illinois HTC (Table 4.4), and all surface water concentrations were below their

[3] Although recommended by US EPA (2015b), US EPA EpiSuite 4.1 (US EPA, 2019c) was not used as a source of BCFs because inorganic compounds are outside the estimation domain of the program.

respective benchmarks. Thus, none of the COIs evaluated would be expected to pose an unacceptable risk to recreators consuming fish caught in the Vermilion River.

Table 4.4 Risk Evaluation of Recreators Consuming Locally Caught Fish

COI[a]	Maximum Surface Water Concentration (mg/L)	HTC for Fish and Water (mg/L)	HTC for Fish Only (mg/L)	COPC
Barium	0.040	1.5	1.5	No
Beryllium[a]	0.000016	0.021	0.021	No
Boron	0.17	1,400	NA	No
Cobalt[a]	0.000039	0.0035	0.0035	No
Fluoride	0.17	143	174	No
Iron	0.65	126	129	No
Manganese	0.045	93	210	No
Mercury	0.0000013	0.000053	0.000053	No

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; HTC = Human Threshold Criteria; NA = Bioconcentration factor was not available, therefore, an HTC based on fish ingestion alone could not be calculated.
(a) Beryllium and cobalt are modeled concentrations. Modeled concentrations for beryllium and cobalt reflect the potential maximum Site-related surface water concentrations from groundwater discharge.

Tables B.5 to B.10 in Appendix B compare the detection limits for non-detects in surface water (and the modeled sediment concentrations for undetected metals in groundwater) to human and ecological benchmarks. The detection limits do not exceed the benchmarks, except for arsenic, where the detection limit in surface water (0.025 mg/L) is slightly above the human threshold concentration for the angler for consumption of fish (0.023 mg/L).

4.3 Ecological Risk Evaluation

Based on the ecological CEM (Figure 2.5), ecological receptors could be exposed to surface water, sediment, and dietary items (*i.e.*, prey and plants) potentially impacted by Site-related COIs. The following COIs were evaluated: all constituents detected in surface water and all constituents detected in groundwater but not analyzed in surface water (*i.e.*, beryllium and cobalt). Concentrations for these COIs in sediment were modeled based on maximum groundwater concentrations.

4.3.1 Ecological Receptors Exposed to Surface Water

Screening Exposures: The ecological evaluation considered aquatic communities in the Vermilion River potentially impacted by groundwater from the Site. While dissolved concentrations are a better indicator of toxicity for ecological receptors (US EPA, 1993), the maximum of the total and dissolved analyte concentration detected in surface water was conservatively compared to risk-based ecological screening benchmarks. Beryllium and cobalt were not analyzed in surface water but were detected in groundwater. Therefore, these two analytes were modeled in surface water based on their maximum groundwater concentration 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:

- Illinois Surface Water Quality Standards (IL SWQS) (IEPA, 2015). IL SWQS are regulatory standards that are intended to protect aquatic life exposed to surface water on a long-term basis (*i.e.*, chronic exposure). The IL SWQS for several metals are hardness dependent (cadmium, chromium, copper, fluoride, lead, manganese, nickel, zinc). Screening benchmarks for these analytes were calculated using an average hardness of 300 mg/L for the Middle Fork of Vermilion River based on measured data from a monitoring site located above Oakwood, IL (USGS, 2019b)[4];
- National Recommended Water Quality Criteria – Aquatic Life Criteria Table (US EPA, 2019d); and
- US EPA Region IV (2018) Surface Water Ecological Screening Values (ESVs) for Hazardous Waste Sites.

Risk Evaluation: The maximum detected or modeled concentrations in surface water were compared to the above hierarchy of benchmarks protective of aquatic life (Table 4.5). All 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 Middle Fork of the Vermilion River.

The modeled concentrations for all constituents modeled in surface water (including additional constituents not analyzed or not detected in surface water) were below the ecological screening benchmarks (Table C.6 in Appendix C), which supports the results from the measured surface water data.

Table 4.5 Risk Evaluation of Ecological Receptors Exposed to Surface Water

COI	Maximum Surface Water Concentration (mg/L)	Ecological Freshwater Benchmark (mg/L)	Basis	COPC
Barium	0.040	5.0	IEPA (2015)	No
Beryllium[c]	0.000016	0.064	US EPA R4 (2018)	No
Boron	0.17	7.6	IEPA (2015)	No
Cobalt[c]	0.000039	0.019	US EPA R4 (2018)	No
Fluoride[d]	0.17	9.1	IEPA (2015)	No
Iron	0.65	1.0	IEPA (2015)	No
Manganese[d]	0.045	4.0	IEPA (2015)	No
Mercury	0.0000013	0.0011	IEPA (2015)	No

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; IEPA = Illinois Environmental Protection Agency; US EPA R4 = United States Environmental Protection Agency Region IV.
(c) Beryllium and cobalt are modeled concentrations. Modeled concentrations for beryllium and cobalt reflect the potential maximum Site-related surface water concentrations from groundwater discharge.
(d) An average hardness of 300 mg/L was used to calculate hardness-dependent benchmarks (fluoride and manganese).

4.3.2 Ecological Receptors Exposed to Sediment

Screening Exposures: COIs in impacted groundwater discharging into the Middle Fork of the Vermilion 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

[4] Hardness data include 135 samples collected from 1980 to 1997 (USGS, 2019b).

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 ESVs for constituents not reported in MacDonald *et al.* (2000) (*i.e.*, iron and manganese) are the lowest effect levels, or the lowest level that can be tolerated by a majority of sediment-dwelling organisms from Persaud *et al.* (1993). The benchmarks used in this evaluation are listed in Table 4.6.

The above sources did not have sediment benchmarks for beryllium, boron, and fluoride. Therefore, the following additional sources were searched for sediment benchmarks:

- US EPA (2014a)
- US EPA (1999)
- ORNL RAIS (Oak Ridge National Laboratory, 2018)
- Los Alamos National Laboratory (LANL) EcoRisk Database (US DOE, 2017)
- European Chemicals Agency Substance Evaluation (ECHA, 2007)
- NOAA Screening Quick Reference Tables (Buchman, 2008)

Boron did not have a published benchmark in the above sources, thus a no observed effect concentration (NOEC) for boron was used as a conservative benchmark (ECHA, 2019). Sediment benchmarks protective of aquatic receptors were not available for beryllium and fluoride.

Screening Risk Results: The maximum modeled COI sediment concentrations were all below their respective sediment screening benchmarks (Table 4.6). The modeled sediment concentrations attributed to potential contributions from site groundwater for all COIs (with the exception of manganese) were less than 5% 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 Vermilion River adjacent to the Site.

Screening benchmarks were not available for beryllium and fluoride. However, beryllium primarily absorbs to clay and does not readily bioaccumulate from sediment to bottom feeders (WHO, 2001). Similarly, fluoride entering a water body bonds strongly to the sediment particles (ATSDR, 2003). Further, the modeled concentrations for beryllium and fluoride are low in comparison to typical concentrations found in sediment. For example, the maximum modeled beryllium concentration (0.009 mg/kg) is well below beryllium concentrations measured in Illinois lakes (1.4-7.4 mg/kg) (WHO, 2001) and concentrations measured in US rivers (0.1-3.8 mg/kg) (ATSDR, 2002). The maximum modeled fluoride concentration (0.35 mg/kg) is orders of magnitude lower than the concentrations measured in freshwater lakes (450-1,100 mg/kg) (ATSDR, 2003). Therefore, potential Site-related contributions of beryllium and fluoride from groundwater to sediment are deemed *de minimis*.

Table 4.6 Risk Evaluation of Ecological Receptors Exposed to Sediment

COI	Modeled Sediment Concentration (mg/kg)	ESV[a] (mg/kg)	COPC	% of Benchmark
Arsenic	0.033	9.8	No	0.3%
Barium	0.11	20	No	0.5%
Beryllium	0.0090	NC	No[b]	--
Boron	0.65	38[c]	No	2%
Cadmium	0.0060	0.99	No	0.6%
Chromium	0.55	43	No	1%
Cobalt	0.036	50	No	0.07%
Copper	0.36	32	No	1%
Fluoride	0.35	NC	No[b]	--
Iron	0.41	20,000	No	0.002%
Manganese	71	460	No	15%
Nickel	0.94	23	No	4%
Selenium	0.00021	0.8	No	0.03%
Zinc	5.3	121	No	4%

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; ESV = Ecological Screening Value; NC = No criterion available, therefore, not evaluated; NOEC = No Observed Effect Concentration.
(a) ESV from US EPA Region IV (2018).
(b) Maximum modeled concentrations from groundwater contributions are low compared to typical sediment levels and are therefore not expected to meaningfully contribute to ecological exposures and potential risks.
(c) Boron NOEC of 38 mg/kg was used as a conservative benchmark for boron in the absence of an ESV (ECHA, 2019).

4.3.3 Ecological Receptors Exposed to Bioaccumulative COIs

Screening Exposures: COIs with bioaccumulative properties can impact higher trophic-level wildlife exposed to these COI *via* direct exposures (surface water and sediment exposure) and secondary exposures through the consumption of dietary items (*e.g.*, plants, invertebrates, small mammals, fish).

Screening Benchmark: US EPA Region IV guidance (2018) was used to identify analytes with potential bioaccumulative effects.

Risk Evaluation: Of the metals detected in surface water and/or groundwater, US EPA Region IV (2018) identifies only mercury[5] and selenium as having potential bioaccumulative effects. However, the maximum detected mercury concentration in surface water[6] is below the screening benchmark protective of bioaccumulative exposures. Selenium was undetected in surface water and the maximum detection limit was below the screening benchmark protective of bioaccumulative exposures. Using the maximum detected concentration is conservative and not reflective of long term wildlife exposures, especially since mercury and selenium were not detected in all surface water and groundwater samples, respectively. In addition, the modeled selenium sediment concentration[7] was below the sediment benchmark protective of

[5] US EPA Region IV (2018) notes that both mercury and methyl mercury have bioaccumulative properties.
[6] The maximum detected mercury concentration (0.0000013 mg/L) is below the acute benchmark (0.000012 mg/L) protective of wildlife accounting for bioaccumulative exposures (US EPA Region IV, 2018). The maximum modeled selenium concentration in sediment was below the benchmark protective of wildlife accounting for bioaccumulative exposures (US EPA Region IV, 2018).
[7] Mercury was not detected in groundwater, therefore a sediment concentration was not modeled. However, the modeled mercury concentration in sediment based on the maximum detection limit is also below the sediment benchmark protective of bioaccumulative exposures.

bioaccumulative exposures. Therefore, potential groundwater contributions of mercury and selenium to the Middle Fork of the Vermilion River are not expected to pose an unacceptable risk from bioaccumulation exposures.

Although arsenic, cadmium, hexavalent chromium, copper, lead, nickel, silver, and zinc were not identified as bioaccumulative in US EPA Region IV (2018), they were identified as bioaccumulative in US EPA (2000). However, these analytes were undetected in surface water and hexavalent chromium, lead, and silver were undetected in groundwater.

Overall, COIs with potential bioaccumulative effects are not expected to meaningfully contribute to potential Site-related ecological exposures in the Vermilion River and are therefore not considered to pose an ecological risk *via* bioaccumulation.

4.4 Uncertainties and Conservatisms

A number of uncertainties and their potential impact on the risk evaluation are discussed below. Wherever possible, conservative assumptions were used (use of maximum detected concentration and conservative screening benchmarks) in an effort to minimize uncertainties and overestimate rather than underestimate risks.

Exposure Estimates:

- The human health and ecological risk characterizations were based on the maximum COI concentrations, rather than on averages. Thus, the variability in exposure concentrations was not considered. Assuming continuous exposure to the maximum concentration overestimates human and ecological exposures given that receptors are mobile and concentrations change over time. 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 concentration did not exceed risk benchmarks, the use of the maximum is not considered a significant source of uncertainty in the risk evaluation.
- Only analytes detected in surface water and/or groundwater were evaluated. However, multiple analytes were not detected (*i.e.*, below detection limits) in surface water and groundwater. For human health, the maximum detection limits for non-detected analytes in surface water were below surface water benchmarks protective of recreational exposures from swimming/tubing and boating. Arsenic was the only non-detected analyte with a maximum detection limit (0.025 mg/L) that exceeded the HTC (0.022 mg/L for water and fish ingestion and 0.023 mg/L for fish ingestion only). However, a maximum detection limit is an overestimation of exposure for an analyte that is not detected, as it could be present at any concentration below the detection limit. Analytes not detected in groundwater were modeled in sediment using the maximum detection limits. The modeled sediment concentrations for these analytes were all below sediment benchmarks protective of recreational exposures.
- For ecological receptors, the maximum detection limits for analytes not detected in surface water and the modeled sediment concentrations for analytes not detected in groundwater are all below their respective surface water and sediment benchmarks. Therefore, although only constituents detected in surface water and groundwater were evaluated, excluding analytes that were not detected does not change our risk conclusions.

- The COIs identified in this evaluation also occur naturally in the environment. Contributions to exposure from natural or other non-Site-related sources were not considered in the evaluation of modeled concentrations; only exposure contributions potentially attributable to the discharge of groundwater into sediment and surface water were evaluated. While not quantified, exposures from potential Site-related groundwater contributions are likely to present only a small fraction of the overall human and ecological exposure to COIs that also have natural or non-Site-related sources.
- The surface water data set from the Middle Fork of the Vermilion River includes six samples, collected at three locations in February and March 2019. Surface water concentrations resulting from the groundwater discharge were also modeled (Appendix C). The concentrations for all modeled constituents in surface water were below the screening benchmarks for human receptors (swimmer/tuber, boater, and angler) (Table C.6 in Appendix C). The modeled data are consistent with the available surface water data, confirming that the measured and modeled data accurately characterize conditions in the Middle Fork of the Vermilion River.
    - For example, the measured concentration of boron at the upriver sampling location ranged from 41 to 46 µg/L (VR-1; OBG, 2019b) and from 103 to 170 µg/L at the sampling location adjacent to the ash ponds (VR-2; OBG, 2019b), which is an increase in boron concentrations between the two sampling locations of 57 to 129 µg/L. This is comparable to the model predicted contribution of boron to the surface water concentration, as a result of groundwater discharge, of 98 µg/L (Appendix C).
    - Surface water sampling did not detect the presence of several analytes (arsenic, cadmium, copper, lead, nickel, silver, zinc; Hanson Professional Services Inc., 2019). The model-predicted surface water concentrations for these constituents were below their respective analytical detection limits (Appendix C). These results indicate that the model-predicted surface water data are in agreement with the measured data.
    - Fluoride was detected in surface water upgradient, adjacent to, and downgradient of the Site at similar concentrations (Hanson Professional Services Inc., 2019, Table 3). These results indicate that the fluoride in surface water is related to a naturally occurring source and that there are only limited contributions of fluoride in surface water resulting from Site-related groundwater discharges. The model predicts low fluoride concentrations (2 µg/L; Appendix C) in surface water as a result of Site-related groundwater discharges. These results indicate that the model-predicted surface water data are in agreement with the measured data.
    - Similarly, iron was detected in surface water upgradient, adjacent to, and downgradient of the Site. Given the number of natural sources of iron and the high concentrations at which iron is naturally present and the fact that iron is not typically a constituent associated with coal ash, it is likely that iron concentrations in surface water are the result of naturally occurring sources. Further, the dissolved iron concentrations were non-detect in every surface water sample (Hanson Professional Services Inc., 2019, Appendix D), which is consistent with the model-predicted surface water concentrations (Appendix C). Since iron contributed to surface water through groundwater discharge would be soluble, the dissolved data are a more appropriate comparison to model predictions.
    - The model conservatively over-predicts mercury concentrations, but at very low concentrations. The model predicts mercury concentrations of 0.004 µg/L (Appendix C), while measured concentrations were 0.001 µg/L (Hanson Professional Services Inc., 2019, Table 3). A factor of 4, erring on the conservative side, is reasonably good agreement for the complexity of the modeling performed in this assessment.
- Sediment samples have not been collected from the Middle Fork of the Vermilion River. As noted earlier, constituents in sediment collected adjacent to the site would not necessarily reflect impacts

from the site because of sediment dynamics in river systems. COIs in sediment were modeled based on maximum detected groundwater concentrations. These model predictions carry uncertainties due to gaps in scientific knowledge. For instance, the relationship between K_d and sediment/water concentrations may result in different predictions depending on environmental factors (*e.g.*, dissolved oxygen content, particle size, *etc*.) giving rise to model uncertainty. The modeling approach and K_d values, however, are consistent with the US EPA (2014a) CCR risk assessment.

- Exposure estimates for human and ecological receptors to metals in sediment assumed 100% bioavailability.[8] This assumption is known to be invalid for most chemical substances under varying environmental conditions (*e.g.*, pH, organic matter content, aging, temperature, humidity, and chemical form) and likely results in overestimates of exposure and risks. In humans, site-specific bioavailability data can be used to increase the accuracy of the exposure estimate and risk calculation (US EPA, 1989). However, in the absence of data, US EPA recommends assuming a chemical is 100% bioavailable. For ecological receptors, sediment characteristics can impact the bioavailability and subsequent toxicity of various metals to benthic organisms. Consequently, US EPA recommends supplementing the sediment chemistry analysis with additional analyses measuring bioavailability (*e.g.*, acid volatile sulfides, organic carbon, particle size, pH) and/or toxicity studies to address the uncertainties of assuming metals are 100% bioavailable (US EPA, 2005, 2007).
- 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 that "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, 2015c). Thus, most individuals will have lower exposures than those presented in this risk assessment.

Toxicity Benchmarks:

- Screening level ecological benchmarks were compiled from 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, generic sediment benchmarks protective of ecological receptors do not incorporate site-specific bioavailability or organic carbon content. The use of generic screening benchmarks in lieu of more refined site-specific benchmarks is expected to have resulted in more stringent benchmarks and a more conservative estimate of potential risks.
- In general, it is important to appreciate that the toxicity factors used in risk assessment 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 resulted in the effects observed in human or animal studies. This means that a risk exceedance does not necessarily equate to actual harm.

[8] The exception is for recreators exposed to arsenic in sediment, where the screening value is calculated using US EPA's default bioavailability of 0.6 (US EPA, 2012).

5 Summary and Conclusions

A screening-level risk evaluation was performed for Site-related constituents in groundwater at the Vermilion Generating Station in Oakwood, Illinois. The groundwater monitoring data indicate that groundwater beneath the ash ponds may be impacted by Site-related constituents. The CSM developed for the Site indicates that groundwater beneath the former CCR ash ponds flows into the Middle Fork of the Vermilion 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 Vermilion 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 2019, and groundwater data collected from 2011 to 2019, 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 that were not analyzed in surface water, but detected in groundwater, a surface water concentration was 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/tubers) 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, tubing or boating in the Middle Fork of the Vermilion River adjacent to the Site.

For recreators exposed to sediment *via* incidental ingestion and dermal contact, all modeled sediment concentrations were below health protective sediment benchmarks. Therefore, none of the COIs modeled in sediment are expected to pose an unacceptable risk to recreators exposed to sediment in the Middle Fork of the Vermilion River adjacent to the Site.

For anglers consuming locally caught fish, the maximum 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 Middle Fork of the Vermilion River.

Ecological receptors exposed to surface water include aquatic and marsh plants, amphibians, reptiles, and fish. The risk evaluation showed that none of the 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). Based on US EPA Region IV (2018), mercury and selenium were identified as bioaccumulative COIs. However, the maximum detected concentration for mercury and the maximum detection limit for selenium (which was undetected) in surface water were below benchmarks protective of bioaccumulative effects. In addition, modeled sediment concentrations were also below benchmarks protective of bioaccumulative exposures. 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 (95 UCL); 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 "reasonable maximum exposure"; 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 ash ponds have been 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. Moreover, the modeled time horizon to achieving the groundwater protection standards (GWPSs) under the various closure alternatives (OBG, 2018) is immaterial from a risk perspective since there is no unacceptable risk associated with exceedances of the GWPSs. Because of this, other factors, such as the impact to the environment and nearby communities and worker safety should be considered when evaluating closure options.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2002. "Toxicological Profile for Beryllium." 290p., September. Accessed at https://www.atsdr.cdc.gov/ToxProfiles/tp.asp?id=1441&tid=33.

Agency for Toxic Substances and Disease Registry (ATSDR). 2003. "Toxicological Profile for Fluorides, Hydrogen Fluoride, and Fluorine." 404p., September.

American Rivers. 2018. "Middle Fork of the Vermilion River [IL]." Accessed at https://www.americanrivers.org/endangered-rivers/middle-fork-of-the-vermilion-river-il/

Buchman, MF. 2008. "NOAA Screening Quick Reference Tables (SQuiRTS) (NOAA OR&R Report 08-1)." National Oceanic and Atmospheric Administration, Office of Response and Restoration Division (Seattle, WA) 34p. Accessed at http://response.restoration.noaa.gov/cpr/sediment/squirt/squirt.html.

Dynegy Midwest Generation, LLC; Stantec Consulting Services Inc.; OBG. 2019. "Closure and Post-Closure Care Plan for North Ash Pond, Old East Ash Pond, and New East Ash Pond at the Vermilion Site (Draft)." 29p., June 28.

European Chemicals Agency (ECHA). 2007. "Guidance on Dossier and Substance Evaluation." 139p., June. Accessed at http://ecb.jrc.it/documents/REACH/RIP_FINAL_REPORTS/RIP_4.1_4.2_EVALUATION/RIP_4.1_4.2_evaluation_en.pdf.

European Chemicals Agency (ECHA). 2019. "Ecotoxicological information: Sediment toxicity: 001 Weight of evidence." In *Reach dossier for Boron (CAS No. 7740-42-8)*. Accessed at https://echa.europa.eu/registration-dossier/-/registered-dossier/14776/6/3.

Fontes, JC; Garnier, JM. 1979. "Determination of the initial ^{14}C activity of the total dissolved carbon: A review of the existing models and a new approach." *Water Resour. Res*. 15(2):399-413. doi: 10.1029/WR015i002p00399.

Hanson Professional Services Inc. 2019. "Antidegradation Assessment for Management of Waters from Closure and Post-Closure Care of Ash Ponds, Vermilion Site, Dynegy Midwest Generation, LLC, NPDES Permit No. IL0004057." Report to Dynegy Midwest Generation, LLC. 151p., June 1,

Illinois Dept. of Natural Resources. 2018. "Activities at Middle Fork." Accessed at https://www.dnr.illinois.gov/Parks/Activity/Pages/MiddleFork.aspx.

Illinois Environmental Protection Agency (IEPA). 2012. "Draft Reissued NPDES Permit to Discharge into Waters of the State." Submitted to Dynegy Midwest Generation, LLC. NPDES Permit No. IL0004057. 12p.

Illinois Environmental Protection Agency (IEPA). 2013. "Dynegy Midwest Generation, L.L.C., Vermilion Power Station Public Hearing, Tuesday, August 6, 2013 (Notice of Water Discharge Permit Public Hearing)." 2p., July 29.

Illinois Environmental Protection Agency (IEPA). 2015. "Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter 1: Pollution Control Board, Part 302 Water Quality Standards." 193p.

Illinois Environmental Protection Agency (IEPA). 2018. "Illinois Integrated Water Quality Report and Section 303(d) List, 2018 (Draft)." 145p., November 14.

Kelron Environmental. 2003. "Regional and Local Hydrogeology and Geochemistry: Vermilion Power Plant, Illinois. Volumes 1-2 (Draft)." Report to Dynegy Midwest Generation, Inc. 495p., November 30.

Kelron Environmental. 2012a. "Hydrogeology and Groundwater Quality of the North Ash Pond System, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC." Report to Dynegy Operating Co. 226p., March 15.

Kelron Environmental. 2012b. "Hydrogeology and Groundwater Quality of the Old East Ash Pond System, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC." Report to Dynegy Operating Co. 226p., March 15.

Kickapoo Adventures. 2017. "Recreation information [Middle Fork of the Vermilion River at the Kickapoo State Recreation Area]." Accessed at http://kickapooadventures.com/

MacDonald, DD; Ingersoll, CG; Berger, TA. 2000. "Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems." *Arch. Environ. Contam. Toxicol.* 39:20-31. doi: 10.1007/s002440010075.

National Oceanic and Atmospheric Administration (NOAA). 2008-2018. "Global Surface Summary of Day (GSOD) average temperature and precipitation data: Danville, IL." National Centers for Environmental Information (NCEI). Accessed at https://www.ncei.noaa.gov.

Oak Ridge National Laboratory. 2018. "Risk Assessment Information System (RAIS) Toxicity Values and Chemical Parameters: Chemical Toxicity Values." Accessed at https://rais.ornl.gov/cgi-bin/tools/TOX_search?select=chem.

OBG. 2018. "2018 Groundwater Monitoring and Modeling Report and Addendum 1, Vermilion Site North Ash Pond System and Old East Ash Pond System Coal Combustion Residual Units, Vermilion, Illinois (Draft)." Report to Dynegy Midwest Generation, LLC. 602p., October.

OBG. 2019a. "Update to the Hydrogeology and Groundwater Quality of the North Ash Pond and Old East Ash Pond, Vermilion Site North Ash Pond and Old East Ash Pond, Oakwood, Illinois (Draft)." Report to Dynegy Midwest Generation, LLC. 94p., June.

OBG. 2019b. "Update to the Regional and Local Hydrogeology and Geochemistry: New East Ash Pond, Vermilion Site New East Ash Pond, Oakwood, Illinois (Draft)." Report to Dynegy Midwest Generation, LLC. 778p., June.

OBG. 2019c. "Groundwater Monitoring Plan, Vermilion Site, North Ash Pond and Old East Ash Pond, Oakwood, Illinois (Draft)." Report to Dynegy Midwest Generation, LLC (Collinsville, IL). June. 109p.

OBG. 2019d. "Groundwater Monitoring Plan, Vermilion Site, New East Ash Pond, Oakwood, Illinois (Draft)." Report to Dynegy Midwest Generation, LLC (Collinsville, IL). June. 62p.

Persaud, D; Jaagumagi, R; Hayton, A. 1993. "*Guidelines for the protection and management of aquatic sediment quality in Ontario*" Ontario Ministry of the Environment, Toronto, Ontario. 32p., August. Accessed at http://www.ene.gov.on.ca/envision/gp/B1-3.pdf.

Prothro, MG. [US EPA, Office of Water]. 1993. Memorandum to US EPA Directors and Regions re: Office of Water policy and technical guidance on interpretation and implementation of aquatic life metals criteria. EPA-822-F93-009. 49p. October 1.

Schlosser, P; Stute, M; Sonntag, C; Munnich, KP. 1989. "Tritiogenic ^{3}He in shallow groundwater." *Earth Planet. Sci. Lett.* 94(3-4):245-256. doi: 10.1016/0012-821X(89)90144-1.

Stalcup, D. [US EPA, Office of Solid Waste and Emergency Response (OSWER)]. 2014. "Memorandum to Superfund National Policy Managers, Regions 1-10 re: Human Health Evaluation Manual, Supplemental Guidance: Update of standard default exposure factors." OSWER Directive 9200.1-120, 7p., February 6. Accessed at https://www.epa.gov/sites/production/files/2015-11/documents/oswer_directive_9200.1-120_exposurefactors_corrected2.pdf.

US Dept. of Energy (US DOE). 2017. "ECORISK Database (Release 4.1)." Los Alamos National Laboratory. Accessed at https://www.lanl.gov/environment/protection/eco-risk-assessment.php.

US EPA. 1989. "Risk Assessment Guidance for Superfund (RAGS). Volume I: Human Health Evaluation Manual (Part A) (Interim final)." Office of Emergency and Remedial Response, NTIS PB90-155581, EPA-540/1-89-002, 287p., December.

US EPA. 1992. "Risk Assessment Guidance for Superfund: Supplemental Guidance to RAGS: Calculating the Concentration Term." Office of Emergency and Remedial Response, OSWER Directive 9285.7-08I, NTIS PB92-963373, 8p., May.

US EPA. 1998. "Methodology for assessing health risks associated with multiple pathways of exposure to combustor emissions." National Center for Environmental Assessment (NCEA), EPA 600/R-98/137, December. http://www.epa.gov/nceawww1/combust.htm.

US EPA. 1999. "Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. Volumes 1 - 3 (Peer Review Draft)." Solid Waste and Emergency Response, EPA530-D-99-001A, August. Accessed at http://www.epa.gov/waste/hazard/tsd/td/combust/ecorisk.htm.

US EPA. 2000. "Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment: Status and Needs." Bioaccumulation Analysis Workgroup, EPA-823-R-00-001, 136p., February.

US EPA. 2002. "National Recommended Water Quality Criteria: 2002. Human Health Criteria Calculation Matrix." Office of Water, EPA-822-R-02-012, 23p., November.

US EPA. 2004. "Risk Assessment Guidance for Superfund (RAGS). Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (Final)." Office of Superfund Remediation and Technology Innovation, EPA/540/R/99/005, OSWER 9285.7-02EP; PB99-963312, 156p., July. Accessed at http://www.epa.gov/oswer/riskassessment/ragse/pdf/part_e_final_revision_10-03-07.pdf.

US EPA. 2005. "Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Metal Mixtures (Cadmium, Copper, Lead, Nickel, Silver, and Zinc)." Office of Research and Development, National Health and Environmental Effects Research Laboratory, EPA/600/R-02/011, January.

US EPA. 2007. "Framework for Metals Risk Assessment." Office of the Science Advisor, EPA 120/R-07/001, 172p., March. Accessed at http://www.epa.gov/raf/metalsframework/pdfs/metals-risk-assessment-final.pdf.

US EPA. 2011a. "Exposure Factors Handbook: 2011 Edition." Office of Research and Development, US EPA, National Center for Environmental Assessment (NCEA), EPA/600/R-090/052F, 1436p., September. Accessed at http://www.epa.gov/ncea/efh/pdfs/efh-complete.pdf.

US EPA. 2011b. "IRIS Glossary." August 31. Accessed at https://ofmpub.epa.gov/sor_internet/registry/termreg/searchandretrieve/glossariesandkeywordlists/search.do?details=&glossaryName=IRIS%20Glossary#formTop 17p.

US EPA. 2012. "Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil." Office of Solid Waste and Emergency Response, OSWER Directive 9200.1-113, 4p., December.

US EPA. 2014a. "Human and Ecological Risk Assessment of Coal Combustion Residuals (Final)." Office of Solid Waste and Emergency Response (OSWER), Office of Resource Conservation and Recovery, 1237p., December. Accessed at http://www.regulations.gov/#!documentDetail;D=EPA-HQ-RCRA-2009-0640-11993.

US EPA. 2014b. "Coal Combustion Residual Beneficial Use Evaluation: Fly Ash Concrete and FGD Gypsum Wallboard (Final)." Office of Solid Waste and Emergency Response (OSWER), Office of Resource Conservation and Recovery (ORCR), 91p., February.

US EPA. 2015a. "Hazardous and solid waste management system; Disposal of coal combustion residuals from electric utilities (Final rule)." *Fed. Reg.* 80(74):21302-21501, 40 CFR 257, 40 CFR 261, April 17.

US EPA. 2015b. "Human Health Ambient Water Quality Criteria: 2015 Update." Office of Water, EPA 820-F-15-001, 3p., June

US EPA. 2015c. "Conducting a Human Health Risk Assessment." October 14. Accessed at http://www2.epa.gov/risk/conducting-human-health-risk-assessment#tab-4.

US EPA. 2016. "National Recommended Water Quality Criteria - Aquatic Life Criteria Table." April 18. Accessed at https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table.

US EPA. 2019a. "Regional Screening Levels (RSLs) - User's Guide." 143p., May. Accessed at https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide.

US EPA. 2019b. "Regional Screening Level (RSL) Summary Table (TR=1E-06, HQ=0.1)." 12p., April. Accessed at https://semspub.epa.gov/work/HQ/199434.pdf.

US EPA. 2019c. "EPI Suite™ - Estimation Program Interface." March 12. Accessed at https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

US EPA. 2019d. "National Recommended Water Quality Criteria - Aquatic Life Criteria Table." Accessed at https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table.

US EPA Region IV. 2018. "Region 4 Ecological Risk Assessment Supplemental Guidance (March 2018 Update)." Superfund Division, Scientific Support Section, 98p., March.

US Geological Survey (USGS). 2019a. "Water-Year Summary 2018 for Site USGS 03339000 Vermilion River near Danville, IL." Accessed at https://nwis.waterdata.usgs.gov/nwis/wys_rpt?dv_ts_ids=&48117&adr_begin_date=2017-10-01&adr_end_date=2018-09-30&site_no=03339000&agency_cd=USGS.

US Geological Survey (USGS). 2019b. "National Water Information System Water Quality Database: Hardness Data (parameter code 900) for Site No. 03336645, Middle Fork Vermilion River Above Oakwood, IL." Accessed at https://nwis.waterdata.usgs.gov/il/nwis/qwdata/?site_no=03336645&agency_cd=USGS.

World Health Organization (WHO). 2001. "Beryllium and Beryllium Compounds." In *Concise International Chemical Assessment Document 32*. 76p.

Appendix A

Data Summary

Table A.1 Groundwater Data Summary (2011-2019)

Group	Analyte	Detects	Total Samples	Min Detect	Max Detect	Min Date	Max Date	Max DL	Units
Metals Dissolved	Antimony	0	50			2011	2011	0.0050	mg/L
Metals Dissolved	Arsenic	64	122	0.00050	0.073	2011	2018	0.073	mg/L
Metals Dissolved	Barium	122	122	0.0097	0.19	2011	2018	0.19	mg/L
Metals Dissolved	Beryllium	1	50	0.0084	0.0084	2011	2011	0.0084	mg/L
Metals Dissolved	Boron	206	212	0.030	53	2011	2019	53	mg/L
Metals Dissolved	Cadmium	1	50	0.0024	0.0024	2011	2011	0.0024	mg/L
Metals Dissolved	Calcium	13	13	69	390	2011	2011	390	mg/L
Metals Dissolved	Chromium	1	50	0.0066	0.0066	2011	2011	0.0066	mg/L
Metals Dissolved	Chromium, Hexavalent	0	1			2019	2019	0.0050	mg/L
Metals Dissolved	Cobalt	1	50	0.021	0.021	2011	2011	0.021	mg/L
Metals Dissolved	Copper	1	52	0.079	0.079	2011	2019	0.079	mg/L
Metals Dissolved	Fluoride	106	122	0.060	1.2	2011	2018	1.2	mg/L
Metals Dissolved	Iron	101	124	0.010	8.6	2011	2019	8.6	mg/L
Metals Dissolved	Lead	0	50			2011	2011	0.0050	mg/L
Metals Dissolved	Magnesium	13	13	23	150	2011	2011	150	mg/L
Metals Dissolved	Manganese	204	212	0.0052	1.6	2011	2019	1.6	mg/L
Metals Dissolved	Mercury	0	50			2011	2011	0.0020	mg/L
Metals Dissolved	Nickel	2	52	0.0081	0.073	2011	2019	0.073	mg/L
Metals Dissolved	Potassium	13	13	1.1	10	2011	2011	10	mg/L
Metals Dissolved	Selenium	13	122	0.00090	0.026	2011	2018	0.026	mg/L
Metals Dissolved	Silver	0	50			2011	2011	0.0050	mg/L
Metals Dissolved	Sodium	13	13	3.4	75	2011	2011	75	mg/L
Metals Dissolved	Thallium	0	50			2011	2011	0.0020	mg/L
Metals Dissolved	Zinc	4	52	0.0055	0.36	2011	2019	0.36	mg/L
Metals Total	Arsenic	0	2			2019	2019	0.025	mg/L
Metals Total	Barium	2	2	0.11	0.12	2019	2019	0.12	mg/L
Metals Total	Boron	2	2	31	38	2019	2019	38	mg/L
Metals Total	Cadmium	0	2			2019	2019	0.00100	mg/L
Metals Total	Chromium	0	2			2019	2019	0.0050	mg/L
Metals Total	Chromium, Hexavalent	0	1			2019	2019	0.0050	mg/L
Metals Total	Cyanide	0	52			2011	2019	0.0080	mg/L
Metals Total	Fluoride	0	2			2019	2019	0.100	mg/L
Metals Total	Iron	1	2	0.15	0.15	2019	2019	0.15	mg/L
Metals Total	Lead	0	2			2019	2019	0.0150	mg/L
Metals Total	Manganese	2	2	0.033	0.073	2019	2019	0.073	mg/L
Metals Total	Mercury	0	2			2019	2019	0.00000080	mg/L
Metals Total	Nickel	0	2			2019	2019	0.0050	mg/L
Metals Total	Selenium	0	2			2019	2019	0.00100	mg/L
Metals Total	Silver	0	2			2019	2019	0.0030	mg/L
Metals Total	Zinc	0	2			2019	2019	0.0100	mg/L
Field	Dissolved Oxygen	22	72	1.0	7.4	2017	2018	7.4	mg/L
Field	Oxidation reduction potential	72	72	-231	139	2017	2018	139	mV
Field	pH (field)	214	214	5.1	8.8	2011	2019	8.8	SU
Field	Specific conductance at 25C	214	214	364	7680	2011	2019	7680	micromhos/cm

Group	Analyte	Detects	Total Samples	Min Detect	Max Detect	Min Date	Max Date	Max DL	Units
Field	Temperature	190	190	7.3	22	2011	2019	22	deg. C
Field	Temperature	24	24	47	70	2018	2019	70	deg. F
Field	Turbidity	34	72	1.0	126	2017	2018	126	JCU
Inorganic	Alkalinity, total	25	25	74	550	2011	2011	550	mg/L
Inorganic	Chloride, total in water	113	124	2.0	51	2011	2019	51	mg/L
Inorganic	Nitrate nitrogen, total	57	124	0.010	1.7	2011	2019	1.7	mg/L
Inorganic	Nitrite nitrogen, total	2	74	0.050	0.060	2017	2019	0.060	mg/L
Inorganic	Nitrogen, Ammonia, Total	2	2	0.63	0.64	2019	2019	0.64	mg/L
Inorganic	Phosphorus, total	0	2			2019	2019	0.100	mg/L
Inorganic	Residue, total filterable (dried at 180C)	212	212	224	4420	2011	2019	4420	mg/L
Inorganic	Sulfate	184	214	6.4	1940	2011	2019	1940	mg/L
Inorganic	Total dissolved solids	2	2	1400	1400	2019	2019	1400	mg/L
Inorganic	Total Kjeldahl nitrogen	0	2			2019	2019	1.00	mg/L
Inorganic	Total suspended solids	0	2			2019	2019	6.0	mg/L

Notes:

DL = Detection Limit; JCU = Jackson Candle Turbidity Units; SU = Standard Units.

Table A.2 Surface Water Data Summary, Middle Fork of the Vermilion River (2019)

Group	Analyte	Detects	Samples	Min Detect	Max Detect	Max DL	Units
Field	pH (field)	6	6	7.6	8.2	8.2	SU
Field	Specific conductance at 25C	6	6	662	696	696	micromhos/cm
Field	Temperature	3	3	7.4	8.6	8.6	deg. C
Field	Temperature	3	3	37	38	38	deg. F
Inorganic	Chloride, total in water	6	6	19	22	22	mg/L
Inorganic	Nitrate nitrogen, total	6	6	4.3	5.6	5.6	mg/L
Inorganic	Nitrite nitrogen, total	0	6			0.050	mg/L
Inorganic	Nitrogen, Ammonia, Total	0	6			0.10	mg/L
Inorganic	Phosphorus, total	6	6	0.11	0.32	0.32	mg/L
Inorganic	Sulfate	6	6	25	40	40	mg/L
Inorganic	Total Dissolved Solids	6	6	290	370	370	mg/L
Inorganic	Total Kjeldahl Nitrogen	1	6	1.5	1.5	1.5	mg/L
Inorganic	Total Suspended Solids	4	6	6.0	9.0	9.0	mg/L
Metals Dissolved	Chromium, Hexavalent	0	3			0.0050	mg/L
Metals Dissolved	Copper	0	6			0.0050	mg/L
Metals Dissolved	Iron	0	6			0.040	mg/L
Metals Dissolved	Nickel	0	6			0.0050	mg/L
Metals Dissolved	Zinc	0	6			0.010	mg/L
Metals Total	Arsenic	0	6			0.025	mg/L
Metals Total	Barium	6	6	0.036	0.040	0.040	mg/L
Metals Total	Boron	6	6	0.041	0.17	0.17	mg/L
Metals Total	Cadmium	0	6			0.0010	mg/L
Metals Total	Chromium	0	6			0.0050	mg/L
Metals Total	Chromium, Hexavalent	0	3			0.0050	mg/L
Metals Total	Cyanide	0	6			0.0050	mg/L
Metals Total	Fluoride	6	6	0.15	0.17	0.17	mg/L
Metals Total	Iron	6	6	0.34	0.65	0.65	mg/L
Metals Total	Lead	0	6			0.015	mg/L
Metals Total	Manganese	6	6	0.023	0.045	0.045	mg/L
Metals Total	Mercury	3	6	0.0000012	0.0000013	0.0000013	mg/L
Metals Total	Nickel	0	6			0.0050	mg/L
Metals Total	Selenium	0	6			0.0010	mg/L
Metals Total	Silver	0	6			0.0030	mg/L
Metals Total	Zinc	0	6			0.010	mg/L

Notes:

DL = Detection limit.

Appendix B

Screening Benchmarks

Table B.1 Recreator Exposure to Surface Water While Swimming

Detected Chemicals	Dermal Permeability Coefficient Kp (cm/hr)	Cancer TRV CSF $(mg/kg\text{-}d)^{-1}$	Cancer TRV Derm. CSF $(mg/kg\text{-}d)^{-1}$	Cancer Child + Adult Incidental Ingestion SL_{ing} (mg/L)	Cancer Child + Adult Dermal Contact SL_{derm} (mg/L)	Cancer Child + Adult Cancer SL (mg/L)	Non-Cancer TRV RfD (mg/kg-d)	Non-Cancer TRV Derm. RfD (mg/kg-d)	Non-Cancer Child Incidental Ingestion SL_{ing} (mg/L)	Non-Cancer Child Dermal Contact SL_{derm} (mg/L)	Non-Cancer Adult Incidental Ingestion SL_{ing} (mg/L)	Non-Cancer Adult Dermal Contact SL_{derm} (mg/L)	Non-Cancer SL (mg/L) Child	Non-Cancer SL (mg/L) Adult	Swimmer RSL Surface Water (mg/L)	Basis
Barium	0.0010	NC	NC	NC	NC	NC	0.20	0.014	2751	76	14673	131	74	130	74	nc
Beryllium	0.0010	NC	NC	NC	NC	NC	0.0020	0.000014	28	0.076	147	0.13	0.075	0.13	0.075	nc
Boron	0.0010	NC	NC	NC	NC	NC	0.20	0.20	2751	1081	14673	1867	776	1656	776	nc
Cobalt	0.00040	NC	NC	NC	NC	NC	0.00030	0.00030	4.1	4.1	22	7.0	2.0	5.3	2.0	nc
Fluoride	0.0010	NC	NC	NC	NC	NC	0.040	0.040	550	216	2935	373	155	331	155	nc
Iron	0.0010	NC	NC	NC	NC	NC	0.70	0.70	9629	3782	51357	6533	2716	5796	2716	nc
Manganese	0.0010	NC	NC	NC	NC	NC	0.024	0.00096	330	5.2	1761	9.0	5.1	8.9	5.1	nc
Mercury	0.0010	NC	NC	NC	NC	NC	0.00030	0.000021	4.1	0.11	22	0.20	0.11	0.19	0.11	nc
Thallium	0.0010	NC	NC	NC	NC	NC	0.000010	0.000010	0.14	0.054	0.73	0.093	0.039	0.083	0.039	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 presented as c = based on cancer endpoint or nc = based on non-cancer endpoint.

$$\text{Screening Benchmark} = \frac{1}{\frac{1}{SL_{ing}} + \frac{1}{SL_{derm}}}$$

$$\text{Non-cancer } SL_{ing} = \frac{THQ * RfD}{Intake} \qquad \text{Cancer } SL_{ing} = \frac{TR}{Intake * CSF}$$

$$\text{Non-cancer } SL_{derm} = \frac{THQ * RfD}{Intake * Kp} \qquad \text{Cancer } SL_{derm} = \frac{TR}{Intake * Kp * CSF}$$

Target Cancer Risk (TR) = 1E-05

Target Hazard Quotient (THQ) = 1

Surface Water – Ingestion (Chemical)

$$\text{Intake Factor (IF)} = \frac{IR \times EF \times ED}{BW \times AT} =$$

		Non-Cancer Child	Non-Cancer Adult	Cancer Child	Cancer Adult	Basis
	Intake Factor (IF)	7.3E-05	1.4E-05	6.2E-06	3.9E-06	
IR	Ingestion Rate (L/day)	0.01	0.01	0.01	0.01	Recommended water consumption rate while swimming (IEPA, 201X)
EF	Surface Water Exposure Frequency (days/year)	40	40	40	40	2 days/week between mid-May and end of Sept when water temp. > 70°F (Prof. Judgment)
ED	Exposure Duration (years)	6	20	6	20	Default value for Resident (US EPA, 2019)
BW	Body Weight (kg)	15	80	15	80	Default value for Resident (US EPA, 2019)
AT	Averaging Time (d)	2,190	7,300	25,550	25,550	Default value for Resident (US EPA, 2019)

Surface Water – Dermal Contact (Chemical)

$$\text{Intake Factor (IF)} = \frac{SA \times ET \times EF \times ED \times CF}{BW \times AT} =$$

		Non-Cancer Child	Non-Cancer Adult	Cancer Child	Cancer Adult	Basis
	Intake Factor (IF)	1.9E-01	1.1E-01	1.6E-02	3.1E-02	
SA	Surface Area Exposed to Surface Water (cm^2)	6,365	19,652	6,365	19,652	Whole Body Default value for Resident (US EPA, 2019)
ET	Exposure Time (hr/d)	4	4	4	4	Professional Judgment
EF	Surface Water Exposure Frequency (days/year)	40	40	40	40	2 days/week between mid-May and end of Sept when water temp. > 70°F (Prof. Judgment)
ED	Exposure Duration (years)	6	20	6	20	Default value for Resident (US EPA, 2019)
CF	Conversion Factor (L/cm^3)	0.001	0.001	0.001	0.001	
BW	Body Weight (kg)	15	80	15	80	Default value for Resident (US EPA, 2019)
AT	Averaging Time (d)	2,190	7,300	25,550	25,550	Default value for Resident (US EPA, 2019)

Table B.2 Recreator Exposure to Surface Water While Boating

Detected Chemicals	Dermal Permeability Coefficient Kp (cm/hr)	Cancer TRV Derm. CSF $(mg/kg\text{-}d)^{-1}$	Cancer Child + Adult Dermal Contact SL_{derm} (mg/L)	Cancer Child + Adult Cancer SL (mg/L)	Non-Cancer TRV Derm. RfD (mg/kg-d)	Non-Cancer Child Dermal Contact SL_{derm} (mg/L)	Non-Cancer Adult Dermal Contact SL_{derm} (mg/L)	Non-Cancer SL (mg/L) Child	Non-Cancer SL (mg/L) Adult	Boater RSL Surface Water (mg/L)	Basis
Barium	0.0010	NC	NC	NC	0.014	184	353	184	353	184	nc
Beryllium	0.0010	NC	NC	NC	0.000014	0.18	0.35	0.18	0.35	0.18	nc
Boron	0.0010	NC	NC	NC	0.20	2632	5045	2632	5045	2632	nc
Cobalt	0.00040	NC	NC	NC	0.00030	9.9	19	9.9	19	9.9	nc
Fluoride	0.0010	NC	NC	NC	0.040	526	1009	526	1009	526	nc
Iron	0.0010	NC	NC	NC	0.70	9213	17656	9213	17656	9213	nc
Manganese	0.0010	NC	NC	NC	0.00096	13	24	13	24	13	nc
Mercury	0.0010	NC	NC	NC	0.000021	0.28	0.53	0.28	0.53	0.28	nc
Thallium	0.0010	NC	NC	NC	0.000010	0.13	0.25	0.13	0.25	0.13	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 presented as c = based on cancer endpoint or nc = based on non-cancer endpoint.

Screening Benchmark = SL_{derm}

$$\text{Non-cancer } SL_{derm} = \frac{THQ * RfD}{Intake * Kp} \qquad \text{Cancer } SL_{derm} = \frac{TR}{Intake * Kp * CSF}$$

Target Cancer Risk (TR) = 1E-05

Target Hazard Quotient (THQ) = 1

Surface Water – Dermal Contact (Chemical)

$$\text{Intake Factor (IF)} = \frac{SA \times ET \times EF \times ED \times CF}{BW \times AT} =$$

		Non-Cancer Child	Non-Cancer Adult	Cancer Child	Cancer Adult	Basis
IF		7.6E-02	4.0E-02	6.5E-03	1.1E-02	
SA	Surface Area Exposed to Surface Water (cm²)	1,733	4,824	1,733	4,824	Age weighted SA for hands, forearms, lower legs and feet (EPA, 2011a)
ET	Exposure Time (hr/d)	4	4	4	4	Professional Judgment
EF	Surface Water 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, 2019)
CF	Conversion Factor (L/cm³)	0.001	0.001	0.001	0.001	
BW	Body Weight (kg)	15	80	15	80	Default value for Resident (US EPA, 2019)
AT	Averaging Time (d)	2,190	7,300	25,550	25,550	Default value for Resident (US EPA, 2019)

Table B.3 Recreator Exposure to Sediment While Swimming or Boating

Chemical COIs	Relative Bioavailability B (unitless)	Dermal Absorption Fraction ABS (unitless)	Cancer: TRV: CSF $(mg/kg\text{-}d)^{-1}$	Cancer: TRV: Derm. CSF $(mg/kg\text{-}d)^{-1}$	Cancer: Child + Adult: Incidental Ingestion SL_{ing} (mg/kg)	Cancer: Child + Adult: Dermal Contact SL_{derm} (mg/kg)	Cancer SL (mg/kg)	Non-Cancer: TRV: RfD (mg/kg-d)	Non-Cancer: TRV: Derm. RfD (mg/kg-d)	Non-Cancer: Child: Incidental Ingestion SL_{ing} (mg/kg)	Non-Cancer: Child: Dermal Contact SL_{derm} (mg/kg)	Non-Cancer: Adult: Incidental Ingestion SL_{ing} (mg/kg)	Non-Cancer: Adult: Dermal Contact SL_{derm} (mg/kg)	Non-Cancer SL (mg/kg): Child	Non-Cancer SL (mg/kg): Adult	Recreator RSL Sediment (mg/kg)	Basis
Arsenic	0.60	0.030	1.5	1.5	135	405	101	0.00030	0.00030	684	4445	7,300	8,042	593	3,827	101	c
Barium	1.0	NA	NC	NC	NC	NC	NC	0.20	0.014	273,750	NA	2,920,000	NA	273,750	2,920,000	273,750	nc
Beryllium	1.0	NA	NC	NC	NC	NC	NC	0.0020	0.000014	2,738	NA	29,200	NA	2,738	29,200	2,738	nc
Boron	1.0	NA	NC	NC	NC	NC	NC	0.20	0.20	273,750	NA	2,920,000	NA	273,750	2,920,000	273,750	nc
Cadmium	1.0	0.0010	NC	NC	NC	NC	NC	0.0010	0.000025	1,369	11114	14,600	20,105	1,219	8,458	1,219	nc
Chromium	1.0	NA	NC	NC	NC	NC	NC	1.5	0.020	2,053,125	NA	21,900,000	NA	2,053,125	21,900,000	2,053,125	nc
Cobalt	1.0	NA	NC	NC	NC	NC	NC	0.00030	0.00030	411	NA	4,380	NA	411	4,380	411	nc
Copper	1.0	NA	NC	NC	NC	NC	NC	0.040	0.040	54,750	NA	584,000	NA	54,750	584,000	54,750	nc
Fluoride	1.0	NA	NC	NC	NC	NC	NC	0.040	0.040	54,750	NA	584,000	NA	54,750	584,000	54,750	nc
Iron	1.0	NA	NC	NC	NC	NC	NC	0.70	0.70	958,125	NA	10,220,000	NA	958,125	10,220,000	958,125	nc
Manganese	1.0	NA	NC	NC	NC	NC	NC	0.024	0.00096	32,850	NA	350,400	NA	32,850	350,400	32,850	nc
Nickel	1.0	NA	NC	NC	NC	NC	NC	0.020	0.00080	27,375	NA	292,000	NA	27,375	292,000	27,375	nc
Selenium	1.0	NA	NC	NC	NC	NC	NC	0.0050	0.0050	6,844	NA	73,000	NA	6,844	73,000	6,844	nc
Zinc	1.0	NA	NC	NC	NC	NC	NC	0.30	0.30	410,625	NA	4,380,000	NA	410,625	4,380,000	410,625	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 presented as c = based on cancer endpoint or nc = based on non-cancer endpoint; Lead = based on US EPA's residential standard for lead.

$$\text{Screening Benchmark} = \frac{1}{\frac{1}{SL_{ing}} + \frac{1}{SL_{derm}}}$$

$$\text{Non-cancer } SL_{ing} = \frac{THQ * RfD}{Intake} \qquad \text{Cancer } SL_{ing} = \frac{TR}{Intake * CSF}$$

$$\text{Non-cancer } SL_{derm} = \frac{THQ * RfD}{Intake * ABS} \qquad \text{Cancer } SL_{derm} = \frac{TR}{Intake * ABS * CSF}$$

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: Child	Non-Cancer: Adult	Cancer: Child	Cancer: Adult	Basis
IF		7.3E-07	6.8E-08	6.3E-08	2.0E-08	
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, 2019)
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, 2019)
AT	Averaging Time (d)	2,190	7,300	25,550	25,550	Default value for Resident (US EPA, 2019)

Sediment – Dermal Contact (Chemical)

Intake Factor (IF) = $\frac{SA \times AF \times EF \times ED \times CF}{BW \times AT}$ =

		Non-Cancer: Child	Non-Cancer: Adult	Cancer: Child	Cancer: Adult	Basis
IF		2.2E-06	1.2E-06	1.9E-07	3.6E-07	
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 (EPA, 2011a)
AF	Sediment Skin Adherence Factor (mg/cm^2)	0.2	0.2	0.2	0.2	Age weighted AF for children exposed to sediment (EPA, 2011a)
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, 2019)
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, 2019)
AT	Averaging Time (d)	2,190	7,300	25,550	25,550	Default value for Resident (US EPA, 2019)

Table B.4 Calculated Water Quality Standards Protective of 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[c] (mg/day)	Water & Fish (mg/L)	Fish Only (mg/L)
Barium	130	US EPA, 2014	2.0	0.20	4.0	1.5	1.5
Beryllium	19	NRWQC 2002	0.0040	0.0020	0.0080	0.021	0.021
Boron	NA		NC	0.20	14	1400	NA
Cobalt	300	ORNL RAIS	NC	0.00030	0.021	0.0035	0.0035
Fluoride	2.3	US EPA, 2014	4.0	0.040	8.0	143	174
Iron	19	US EPA, 2014	NC	0.70	49	126	129
Manganese	0.4	US EPA, 2014	NC	0.024	1.7	93	210
Mercury	3,760	NRWQC 2002	0.0020	0.00030	0.0040	0.000053	0.000053
Thallium	116	NRWQC 2002	0.0020	0.000010	0.0040	0.0017	0.0017

Notes:

ADI = Average Daily Intake; BCF = Bioconcentration Factor; COI = Constituent of Interest; F = Fish Consumption Rate; HTC = Human Threshold Criteria; MCL = Maximum Contaminant Level; NA = BCF not available, 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, RSC = Relative Source Contribution; THQ = Target Hazard Quotient; W = Water Consumption Rate; WQS = Water Quality Standard; 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 (2014a). Human and Ecological Risk Assessment of Coal Combustion Residuals.

ORNL RAIS (2018). Risk Assessment Information System (RAIS) Toxicity Values and Chemical Parameters.

(b) In the absence of chemical specific RCS, an RCS of 100% was used.

(c) 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 using an RfD as the RfD (mg/kg-d) multiplied by the body weight (70 kg).

(d) WQS based on US EPA's action levels.

Evaluation of Non-detects

Table B.5 Risk Evaluation for Recreators Exposed to Surface Water While Swimming

Undetected Metals in Surface Water	Surface Water Concentration[a] (mg/L)	Recreator Benchmark for Swimming (mg/L)	Exceedance
Arsenic	ND (0.025)	0.12	No
Cadmium	ND (0.001)	0.13	No
Chromium	ND (0.005)	105	No
Chromium, Hexavalent	ND (0.005)	0.0054	No
Copper	ND (0.005)	155	No
Cyanide	ND (0.005)	2.3	No
Lead	ND (0.015)	0.015	No
Nickel	ND (0.005)	20	No
Selenium	ND (0.001)	19	No
Silver	ND (0.003)	1.8	No
Zinc	ND (0.01)	1,633	No

Notes:

COPC = Constituent of Potential Concern; ND = Not Detected, maximum detection limit presented.

(a) Surface water concentration is the maximum detection limit of the total or dissolved metals analyses.

Table B.6 Risk Evaluation for Recreators Exposed to Surface Water While Boating

Undetected Metals in Surface Water	Surface Water Concentration[a] (mg/L)	Recreator Benchmark for Boating (mg/L)	Exceedance
Arsenic	ND (0.025)	0.37	No
Cadmium	ND (0.001)	0.33	No
Chromium	ND (0.005)	257	No
Chromium, Hexavalent	ND (0.005)	0.014	No
Copper	ND (0.005)	526	No
Cyanide	ND (0.005)	7.9	No
Lead	ND (0.015)	0.015	No
Nickel	ND (0.005)	53	No
Selenium	ND (0.001)	66	No
Silver	ND (0.003)	4.4	No
Zinc	ND (0.01)	6,581	No

Notes:

COPC = Constituent of Potential Concern; ND = Not Detected, maximum detection limit presented.

(a) Surface water concentration is the maximum detect limit of the total or dissolved metals analyses.

Table B.7 Risk Evaluation for Recreators Exposed to Sediment

Undetected Metals in Groundwater	Modeled Sediment Concentration[a] (mg/kg)	Recreator Benchmark (mg/kg)	Exceedance
Antimony	ND (0.027)	548	No
Chromium, Hexavalent	ND (0.00057)	243	No
Cyanide	ND[b]	821	No
Lead	ND (0.28)	400	No
Mercury	ND (0.13)	411	No
Silver	ND (0.011)	6,844	No
Thallium	ND (0.000071)	14	No

Notes:

COPC = Constituent of Potential Concern; ND = Not Detected, maximum detection limit presented.

(a) Sediment concentration is modeled using the maximum detect limit of the total or dissolved metals groundwater analyses.

(b) Cyanide concentration in sediment was not modeled, however, the modeled concentration is expected to be lower than the sediment benchmark.

Table B.8 Risk Evaluation for Recreators Consuming Locally Caught Fish

Undetected Metals in Surface Water	Surface Water Concentration[a] (mg/L)	HTC for Fish and Water (mg/L)	HTC for Fish Only (mg/L)	Exceedance
Arsenic	ND (0.025)	0.022	0.023	Yes
Cadmium	ND (0.001)	0.013	1.5	No
Chromium	ND (0.005)	318	328	No
Chromium, Hexavalent	ND (0.005)	0.64	0.66	No
Copper	ND (0.005)	1.3	1.3	No
Cyanide	ND (0.005)	13	20	No
Lead	ND (0.015)	0.015	0.015	No
Nickel	ND (0.005)	1.5	1.5	No
Selenium	ND (0.001)	0.94	1.0	No
Silver	ND (0.003)	18	35	No
Zinc	ND (0.01)	22	22	No

Notes:

COPC = Constituent of Potential Concern; HTC = Human Threshold Criteria; ND = Not Detected, maximum detection limit presented.

(a) Surface water concentration is the maximum detect limit of the total or dissolved metals analyses.

Table B.9 Risk Evaluation for Ecological Receptors Exposed to Surface Water

Undetected Metals in Surface Water	Surface Water Concentration[a] (mg/L)	Ecological Freshwater Benchmark[b] (mg/L)	Exceedance
Arsenic	ND (0.025)	0.19	No
Cadmium	ND (0.001)	0.0021	No
Chromium	ND (0.005)	0.44	No
Chromium, Hexavalent	ND (0.005)	0.011	No
Copper	ND (0.005)	0.029	No
Cyanide	ND (0.005)	0.0052	No
Lead	ND (0.015)	0.051	No
Nickel	ND (0.005)	0.013	No
Selenium	ND (0.001)	1.0	No
Silver	ND (0.003)	0.0050	No
Zinc	ND (0.01)	0.079	No

Notes:

COPC = Constituent of Potential Concern; ND = Not Detected, maximum detection limit presented.

(a) Surface water concentration is the maximum detect limit of the total or dissolved metals analyses.

(b) Surface water benchmarks from Illinois Environmental Protection Agency (IEPA, 2015) Water Quality Standards. An average hardness of 30 mg/L was used to calculated hardness-dependent benchmarks (cadmium, chromium, copper, lead, nickel, and zinc).

Table B.10 Risk Evaluation for Ecological Receptors Exposed to Sediment

Undetected Metals in Groundwater	Modeled Sediment Concentration[a] (mg/kg)	ESV[b] (mg/kg)	Exceedance
Antimony	ND (0.027)	2.0	No
Chromium, Hexavalent	ND (0.00057)	43	No
Cyanide	ND[c]	NC	NC
Lead	ND (0.28)	36	No
Mercury	ND (0.13)	0.17	No
Silver	ND (0.011)	1.0	No
Thallium	ND (0.000071)	NC	NC

Notes:

COPC = Constituent of Potential Concern; ESV = Ecological Screening Value; ND = Not Detected, maximum detection limit presented; US EPA = United States Environmental Protection Agency.

(a) Sediment concentration is modeled using the maximum detect limit of the total or dissolved metals groundwater analyses.

(b) Ecological Screening Value (ESV) from US EPA Region IV (2018).

(c) Cyanide concentration in sediment was not modeled; however, the modeled concentration is expected to be lower than the sediment benchmark.

Appendix C

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) discharged to the 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 Middle Fork of the Vermilion River ("Vermilion 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 Middle Groundwater Unit (MGU) and the Lower Groundwater Unit (LGU), in the direction of the river. For both layers, 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 ash ponds with potential coal combustion residual (CCR)-related impacts and a height equal to each layer's thickness. All the groundwater flowing through these two layers discharges to the river; thus the total flow into the river is the sum of the flows in the two layers. The length of the river adjacent to the ponds was estimated based on the modeled boron plume obtained from the existing groundwater flow model for the Site (OBG, 2018). Using the modeled boron plume length to represent the length of potential CCR-impacted groundwater discharging into surface water is conservative because boron has very low retardation in groundwater; thus boron will be more widely distributed in groundwater than other CCR-related constituents.

The groundwater flow into the river mixes with the surface water in the Middle Fork of the Vermilion River. The COIs entering the river *via* groundwater can dissolve into the water column, sorb to suspended sediments, or sorb to benthic sediments. Using the 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 assumed that the groundwater concentrations were uniformly equal to the maximum detected concentration for each individual COI, in both the MGU and the LGU. For COIs that were not detected in groundwater, but for which the maximum detection limit exceeded the surface water ecological benchmark, we used the maximum detection limit. We ignored absorption by subsurface soil and assumed that all the groundwater flowing through MGU and LGU and intersecting the river bank was discharged 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 or the maximum detection limit if the constituent was not detected (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 C.1. The total mass discharge rate for each COI is the sum of the mass discharge rates in the MGU and the LGU. The calculated mass discharge rates were used as inputs for the surface water and sediment partitioning model.

Surface Water and Sediment Concentration

Groundwater discharged 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, 2014a). 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 (US EPA, 2014a). These coefficients are presented in Table C.2.

To be conservative, we assumed that the constituents were not affected by dissipation or degradation once they entered the waterbody. The total waterbody concentration of the COI was calculated as (Table J-1-9 in US EPA, 2014a):

$$C_{waterbody} = \frac{m_c}{V_f \times f_{water} \times \frac{d_z}{d_w}}$$

where:

$C_{waterbody}$	Total waterbody concentration of the constituent (mg/L)
V_f	Waterbody annual flow (L/year)
d_z	Waterbody depth (m)
d_w	Water column depth (m)
f_{water}	Fraction of COI in the water column (unitless)
m_c	Mass discharge rate of the COI (mg/year)

The fraction of COI in the water column was calculated for each COI using the sediment/water and suspended solids/water partition coefficients (Table J-1-1 in US EPA 2014a). The values of the fraction of COIs in the water column and other calculated parameters are presented in Table C.3. For the Vermilion River annual flow rate, we conservatively used a value reported by OBG as representative of low flow conditions (OBG, 2019b); a flow rate of 17 cfs was calculated as the 90th percentile low of the daily mean discharge rates between 1979 and 2018 at the Oakwood gaging station. Other waterbody parameters are presented in Table C.4.

The equation above calculates the total concentration of constituents in the waterbody. Using the fraction of COIs in the water column, we derived the concentration of COIs in the water column (Table J-1-10 in US EPA, 2014a). From these values, and based on the equilibrium partition coefficients, we computed the fraction of water column sediments that are dissolved in the water column and those that are sorbed to suspended solids in the water column. These were used to calculate the concentration of dissolved COIs in the water column and the concentration of COIs sorbed to suspended solids in the water column (Table J-1-11 in US EPA, 1998, 2014a):

$$C_{sw} = C_{dw} \times K_{dsw}$$

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 waterbody concentration and the fraction of COIs in the benthic sediments, the model derives the total concentration in benthic sediments (Table J-1-12 in US EPA 2014a). This value can be used to calculate dry weight sediment concentration as follows:

$$C_{sed-dw} = \frac{C_{bs-tot}}{bsc}$$

where:

C_{sed-dw}	Dry weight sediment concentration (mg/kg)
C_{bs-tot}	Total sediment concentration (mg/L)
bsc	Bed sediment bulk density (used the default value from US EPA, 2014a : 1 g/m^3)

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:

$$C_{sb} = C_{dbs} \times K_{dbs}$$

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 C.5.

Table C.1 Parameters Used to Estimate Groundwater Discharge to Surface Water

GW Unit	Parameter	Full Name	Value	Unit
MGU	A	Cross-Sectional Area	3,931	m^2
MGU	i	Hydraulic Gradient	0.0093	m/m
MGU	K	Hydraulic Conductivity	2.15E-03	cm/s
LGU	A	Cross-Sectional Area	978	m^2
LGU	i	Hydraulic Gradient	0.0075	m/m
LGU	K	Hydraulic Conductivity	8.47E-04	cm/s

Notes:

GW = Groundwater Unit; LGU = Lower Groundwater Unit; MGU = Middle Groundwater Unit; NEAP = New East Ash Pond.

Mass discharge from the NEAP was not included, because groundwater monitoring results indicate that impacted groundwater from the NEAP is not reaching the Middle Fork (OBG, 2019b).

Source: OBG, 2018.

Table C.2 Partition Coefficients

	Sediment-Water, Mean, Kdbs		Suspended Sediment-Water, Mean, Kdsw	
Constituent	**Value (log_{10}) (mL/g)**	**Value (mL/g)**	**Value (log_{10}) (mL/g)**	**Value (mL/g)**
Antimony	3.6	3.98E+03	4.8	6.31E+04
Arsenic	2.4	2.51E+02	3.9	7.94E+03
Barium	2.5	3.16E+02	4.0	1.00E+04
Beryllium	2.8	6.31E+02	4.2	1.58E+04
Boron	0.8	6.31E+00	3.9	7.94E+03
Cadmium	3.3	2.00E+03	4.9	7.94E+04
Chromium III	4.9	7.94E+04	5.1	1.26E+05
Chromium VI	1.7	5.01E+01	4.2	1.58E+04
Cobalt	3.1	1.26E+03	4.8	6.31E+04
Copper	3.5	3.16E+03	4.7	5.01E+04
Cyanide	-	--	-	--
Fluoride	2.2	1.58E+02	2.2	1.58E+02
Iron	1.4	2.51E+01	1.4	2.51E+01
Lead	4.6	3.98E+04	5.7	5.01E+05
Manganese	4.4	2.80E+04	4.4	2.80E+04
Mercury	4.9	7.94E+04	5.3	2.00E+05
Nickel	3.9	7.94E+03	4.4	2.51E+04
Selenium	0.6	3.98E+00	3.8	6.31E+03
Silver	3.6	3.98E+03	5.2	1.58E+05
Thallium	1.3	2.00E+01	4.1	1.26E+04
Zinc	4.1	1.26E+04	5.0	1.00E+05

Notes:

Cyanide was not modeled because it lacks a Kd value in US EPA, 2014a.

Source: US EPA, 2014a.

Table C.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 $f_{dissolved}$
Antimony	0.0057	0.9943	0.7254
Arsenic	0.0649	0.9351	0.9545
Barium	0.0528	0.9472	0.9434
Beryllium	0.0281	0.9719	0.9132
Boron	0.7165	0.2835	0.9545
Cadmium	0.0122	0.9878	0.6772
Chromium (III)	0.0004	0.9996	0.5697
Chromium (VI)	0.2646	0.7354	0.9132
Cobalt	0.0179	0.9821	0.7254
Copper	0.0068	0.9932	0.7688
Cyanide	--	--	--
Fluoride	0.0949	0.9051	0.9990
Iron	0.3933	0.6067	0.9998
Lead	0.0017	0.9983	0.2496
Manganese	0.0007	0.9993	0.8562
Mercury	0.0005	0.9995	0.4551
Nickel	0.0024	0.9976	0.8690
Selenium (IV)	0.7906	0.2094	0.9635
Silver	0.0081	0.9919	0.5126
Thallium	0.4659	0.5341	0.9298
Zinc	0.0021	0.9979	0.6250

Table C.4 Surface Water Parameters

Parameter	Full Name	Value	Unit
TSS	Total Suspended Solids	6	mg/L
V_{fx}	Surface Water Flow Rate	1.52E+10	L/yr
db	Depth of Upper Benthic Layer (default: 0.03)	0.03	m
dw	Depth of Water Column	0.5	m
dz	Depth of Water Body	0.53	m
bsc	Bed Sediment Bulk Density (default: 1.0)	1	g/cm3
bsp	Bed Sediment Porosity (default: 0.6)	0.6	-
M_{TSS}	TSS Mass per Unit Area	0.003	kg/m2
M_S	Sediment Mass per Unit Area	30	kg/m2

Notes:

Source of default values: US EPA, 2014a.

Table C.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	Total Concentration in Benthic Sediments (Dry Weight) mg/kg.dw
Antimony	5.00E-03	1.33E+05	9.29E-06	2.68E-02	2.68E-02
Arsenic	7.30E-02	1.94E+06	1.36E-04	3.25E-02	3.26E-02
Barium	1.90E-01	5.06E+06	3.53E-04	1.05E-01	1.06E-01
Beryllium	8.40E-03	2.24E+05	1.56E-05	8.99E-03	9.00E-03
Boron	5.28E+01	1.41E+09	9.81E-02	5.91E-01	6.47E-01
Cadmium	2.40E-03	6.39E+04	4.46E-06	6.03E-03	6.03E-03
Chromium (III)	6.60E-03	1.76E+05	1.23E-05	5.55E-01	5.55E-01
Chromium (VI)	6.60E-03	1.76E+05	1.23E-05	5.61E-04	5.68E-04
Cobalt	2.10E-02	5.59E+05	3.90E-05	3.56E-02	3.57E-02
Copper	7.90E-02	2.10E+06	1.47E-04	3.57E-01	3.57E-01
Cyanide	8.00E-03	2.13E+05			
Fluoride	1.20E+00	3.20E+07	2.23E-03	3.53E-01	3.54E-01
Iron	8.60E+00	2.29E+08	1.60E-02	4.01E-01	4.11E-01
Lead	1.50E-02	3.99E+05	2.79E-05	2.77E-01	2.77E-01
Manganese	1.60E+00	4.26E+07	2.97E-03	7.13E+01	7.13E+01
Mercury	2.00E-03	5.33E+04	3.72E-06	1.34E-01	1.34E-01
Nickel	7.30E-02	1.94E+06	1.36E-04	9.36E-01	9.36E-01
Selenium (VI)	2.60E-02	6.92E+05	4.83E-05	1.85E-04	2.13E-04
Silver	3.00E-03	7.99E+04	5.57E-06	1.14E-02	1.14E-02
Thallium	2.00E-03	5.33E+04	3.72E-06	6.89E-05	7.10E-05
Zinc	3.60E-01	9.59E+06	6.69E-04	5.26E+00	5.26E+00

Notes:

Cyanide was not modeled due to lack of Kd value in US EPA, 2014a.

Table C.6 Modeled Surface Water Concentrations Compared to Benchmarks

Status	Constituent	Modeled Surface Water Concentration (mg/L)	Ecological Freshwater Benchmark (mg/L)	Recreator Benchmark for Swimming (mg/L)	Recreator Benchmark for Boating (mg/L)	HTC Water & Fish (mg/L)	Exceedances
NA in SW, ND in GW	Antimony	9.29E-06	0.19	--	--	--	No
ND in SW	Arsenic	1.36E-04	0.19	0.12	0.37	0.022	No
Detected in SW	Barium	3.53E-04	5	74	184	1.5	No
NA in SW	Beryllium	1.56E-05	0.064	0.1	0.18	0.021	No
Detected in SW	Boron	9.81E-02	7.6	776	2,632	1400	No
ND in SW	Cadmium	4.46E-06	0.0021	0.13	0.33	0.013	No
ND in SW	Chromium (III)	1.23E-05	0.44	105	257	318	No
ND in SW	Chromium (VI)	1.23E-05	0.011	0.0054	0.014	0.64	No
NA in SW	Cobalt	3.90E-05	0.019	2	9.9	0.0035	No
ND in SW	Copper	1.47E-04	0.029	155	526	1.3	No
ND in SW	Cyanide	[not modeled]	0.0052	2.3	7.9	13	No
Detected in SW	Fluoride	2.23E-03	9.1	155	526	143	No
Detected in SW	Iron	1.60E-02	1	2,716	9,213	126	No
ND in SW	Lead	2.79E-05	0.051	0.015	0.015	0.015	No
Detected in SW	Manganese	2.97E-03	4	5	13	93	No
Detected in SW	Mercury	3.72E-06	0.0011	0.1	0.28	0.000053	No
ND in SW	Nickel	1.36E-04	0.013	20	53	1.5	No
ND in SW	Selenium (VI)	4.83E-05	1	19	66	0.94	No
ND in SW	Silver	5.57E-06	0.005	1.8	4.4	18	No
NA in SW, ND in GW	Thallium	3.72E-06	0.006	--	--	0.0017	No
ND in SW	Zinc	6.69E-04	0.079	1,633	6581	22	No

Notes:
ND - not detected
NA - not analyzed

Appendix B

2021 Update to 2020 Human Health and Ecological Risk Assessment

Memorandum

To: Dynegy Midwest Generation, LLC **Date:** October 27, 2021

From: Gradient

Subject: Lithium and Molybdenum Risks at Dynegy Midwest Generation, LLC's Vermilion Power Plant, Oakwood, Illinois

1 Introduction

Gradient (2020) conducted a screening-level Human Health and Ecological Risk Assessment for the Dynegy Midwest Generation LLC (DMG) Vermilion Power Plant (VPP) using a tiered approach consistent with United States Environmental Protection Agency (US EPA) guidance (US EPA, 1989). The groundwater monitoring data indicate that groundwater beneath the former coal combustion residue (CCR) ash ponds may be impacted by Site-related constituents. While no one is exposed to this groundwater,[1] the hydrogeology of the area indicates that the groundwater is flowing into the Middle Fork of the Vermilion River adjacent to the Site, potentially impacting surface water and sediment. Recreators (swimmers and boaters) in the Vermilion River who are exposed to surface water and sediment and anglers who consume locally caught fish could potentially be exposed to these Site-specific constituents of interest (COIs). 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. Gradient (2020) concluded that none of the COIs measured in surface water and modeled in surface water and sediment using Site groundwater data pose an unacceptable risk to the identified human (swimmers, boaters, and anglers) or ecological (aquatic life, benthic invertebrates, and wildlife) receptors.

Risks were not evaluated for lithium and molybdenum in the 2020 Risk Assessment because no data were available for these constituents. Additional groundwater and surface water samples were collected in 2021 and analyzed for lithium and molybdenum, in addition to other constituents already evaluated in the 2020 risk assessment. Therefore, this memorandum focuses on potential risks to human health and the environment associated with lithium and molybdenum using the same approach as the original Risk Assessment (Gradient, 2020).

[1] Based on the local hydrogeology, residential exposure to groundwater used for drinking water or irrigation is not a complete pathway and was not evaluated.

One Beacon Street, 17th Floor, Boston, MA 02108 | 617-395-5000 | www.gradientcorp.com

2 Exposure Data and Estimates

Groundwater samples were collected from 41 wells[2] between March and July 2021. Surface water samples[3] were collected from five locations downstream of VPP in June and July 2021. Table 1 presents a summary of the lithium and molybdenum groundwater and surface water results from the recent sampling events.

Table 1 Summary Statistics of 2021 Lithium and Molybdenum Data

Media	Constituent of Interest	Detected	Sampled	Maximum Detection Limit (mg/L)	Minimum Detected (mg/L)	Average (mg/L)	Maximum Detected (mg/L)
Groundwater	Lithium (total)	176	211	0.0050	0.0031	0.10	1.2
	Molybdenum (total)	165	211	0.0017	0.0011	0.049	0.79
Surface Water	Lithium (total)	5	5	–	0.0047	0.0056	0.0070
	Lithium (dissolved)	3	3	–	0.0055	0.0057	0.0059
	Molybdenum (total)	0	5	0.01	ND	ND	ND
	Molybdenum (dissolved)	0	3	0.01	ND	ND	ND

Notes:
– = Not Applicable; ND = Not Detected.

Similar to the risk assessment, potential risks associated with lithium and molybdenum were evaluated for the identified human (boaters, swimmers, and anglers) and ecological (aquatic life, benthic invertebrates, and wildlife) receptors with complete exposure pathways to surface water and sediment. While none of the receptors are exposed to groundwater, surface water and sediment concentrations were modeled based on the maximum detected concentration in groundwater, which may flow into surface water.

Both the total and dissolved fractions of lithium and molybdenum were analyzed in surface water. While total metal concentrations are typically used to quantify human exposures (US EPA, 1989) and dissolved metals are a better indicator of toxicity for ecological receptors (US EPA, 1993), the maximum total lithium concentration was used to quantify exposures for both types of receptors, because it is higher than the dissolved concentration. Total and dissolved molybdenum were not detected in surface water; therefore, using the approach used in the 2020 Risk Assessment (Gradient, 2020), they would not be carried forward in the risk evaluation. However, to supplement the measured surface water data, we modeled the lithium and molybdenum contributions to surface water based on groundwater flow into the river.

Sediment sampling has not been conducted in the Middle Fork of the Vermilion River. In the absence of sediment data, Gradient modeled molybdenum concentrations in river sediments as a result of groundwater flow into the river. Gradient used the same modeling approach presented in the 2020 Risk Assessment

[2] Groundwater samples from the following wells were included: 1, 2, 3R, 4, 5, 7R, 8R, 10, 17, 16A, 18, 20-22, 34, 35D, 36-38, 40-44, 70D, 70S, 71D, 71S, 101-105, 101S-105S, ND3, NED1, and OED1.
[3] Surface water samples from locations SW-1 through SW-5 were included. Two field duplicate samples collected in June 2021 were excluded because the locations of the parent samples were unknown. Excluding these field duplicate samples is not expected to change the conclusions of this risk evaluation, because these field duplicate samples do not contain the maximum concentrations used as the exposure estimate.

(Gradient, 2020, Section 3.3). Equilibrium partitioning coefficients (K_d values) for molybdenum were based on values from US EPA (2014a) (Table 2).

Table 2 Equilibrium Partitioning Coefficients for Molybdenum

Parameter	Value (mL/g)
Suspended Sediment-Water (Kd_{sw})	25,119
Sediment-Water (Kd_{bs})	316

Sediment lithium concentrations were not modeled because lithium is highly soluble and does not readily partition into sediment. US EPA (2014a) used a conservative K_d of zero (no partitioning) to estimate lithium fate and transport, citing the insufficient information on adsorption and known low retardation of this constituent. A K_d of zero indicates that the chemical constituent remains in solution and enters the surface water with no partitioning into the sediment. The Agency acknowledges that a lithium K_d of zero will result in an overestimate of downgradient surface water exposures (US EPA, 2014a). Because lithium does not readily sorb to sediments *via* chemical partitioning, we did not model lithium concentrations in sediment and assumed that the lithium sediment concentration is zero.

Total concentrations were used for both the surface water and sediment modeling, because groundwater samples were only analyzed for total concentrations. This may result in an overestimation of exposure, as the dissolved groundwater concentration is generally lower and represents the mobile portion of a constituent that could likely discharge into surface water and sediment. Table 3 presents the exposure estimates used for all receptors in this risk evaluation.

Table 3 Lithium and Molybdenum Exposure Estimates for Surface Water and Sediment

Exposure Medium	Lithium	Molybdenum
Measured Surface Water Concentration (mg/L)[a]	0.0070	ND (0.01)
Modeled Surface Water Concentration (mg/L)[a]	0.0023[b]	0.0015[c]
Modeled Sediment Concentration (mg/kg)	0[d]	0.40[c]

Notes:
ND = Not Detected (detection limit presented).
(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.
(b) Modeled based on the maximum measured groundwater lithium concentration of 1.2 mg/L.
(c) Modeled based on the maximum measured groundwater molybdenum concentration of 0.79 mg/L.
(d) Sediment concentrations were not modeled because lithium does not readily sorb to sediments *via* chemical partitioning.

3 Human Health Risk Evaluation

Risks to recreators (swimmers and boaters) and anglers were evaluated using the exposure estimates presented in Table 3 and screening benchmarks protective of the various receptors. The screening benchmarks were calculated using the same methodology presented in the 2020 Risk Assessment (Gradient, 2020), as summarized below.

Recreators Exposed to Surface Water

Recreators can be exposed to surface water while swimming, boating, and fishing. Recreators could be exposed to surface water *via* incidental ingestion and dermal contact while swimming or boating.[4] Anglers could consume locally caught fish and incidentally ingest water while fishing.

For calculating Human Threshold Criteria (HTC), which are benchmarks protective of fish consumption or fish and water consumption, a BCF of 4 from US EPA (2014a) was used for molybdenum. A BCF was not available for lithium. Therefore, Gradient assumed a BCF of 1, indicating that the fish concentration is equal to the water concentration. This is a conservative assumption, as lithium is not noted to have bioaccumulative properties (US EPA Region IV, 2018) and does not readily bioaccumulate in the aquatic environment (ECHA, 2020a).

The surface water exposure concentrations were compared to conservative benchmarks protective of surface water exposures during swimming, boating, and fishing, *via* (1) fish consumption and water ingestion, and (2) fish consumption only. The maximum detected and modeled lithium and molybdenum concentrations were orders of magnitude lower than their respective conservative benchmarks for all three exposure scenarios (Table 4). Therefore, lithium and molybdenum in surface water do not result in unacceptable risk to recreators swimming, boating, or fishing in the Middle Fork of the Vermilion River adjacent to the Site.

Table 4 Risk Evaluation of Recreators Exposed to Surface Water

Constituent of Interest	Surface Water Exposure Estimate (mg/L)	Swimmer	Boater	Angler	
		Recreator Benchmark for Swimming (mg/L)	Recreator Benchmark for Boating (mg/L)	HTC for Fish and Water (mg/L)	HTC for Fish Only (mg/L)
Lithium (measured)	0.0070	7.8	26	4.7	7.0
Lithium (modeled)[a]	0.0023	7.8	26	4.7	7.0
Molybdenum (modeled)[b]	0.0015	19	63	3.9	4.4

Notes:
HTC = Human Threshold Criteria.
(a) Although lithium was detected in surface water, the modeled concentration was also compared to surface water benchmarks protective of various human receptors to supplement the measured surface water data. The modeled surface water concentration is based on the maximum groundwater concentration and reflects the potential maximum Site-related surface water concentration from groundwater discharge.
(b) Molybdenum was not detected in surface water, thus only the modeled concentration was used. The modeled concentration reflects the potential maximum Site-related surface water concentration from groundwater discharge.

Recreators Exposed to Sediment

Recreational exposure to sediment may occur during boating and swimming activity along the river. The Middle Fork of the Vermilion River is shallow enough to walk in during low-flow periods, and there are sediment deposition areas along the shoreline adjacent to and near the Site that could be accessible by boat.

Conservative benchmarks protective of sediment exposures during swimming and boating were calculated using the same approach and assumptions noted in the risk assessment. The maximum modeled molybdenum concentration (0.40 mg/kg) was orders of magnitude below the benchmark protective of sediment recreational exposures (6,844 mg/kg). As noted above, lithium does not readily sorb to sediments

[4] Boaters were evaluated separately from swimmers, as boaters are assumed to have a higher exposure frequency, but less skin surface area exposed to water.

via chemical partitioning, eliminating potential sediment exposure and risk (*e.g.*, exposure concentration of 0 mg/kg). Therefore, lithium and molybdenum in sediment do not result in unacceptable risk to recreators swimming or boating in the Middle Fork of the Vermilion River adjacent to the Site.

4 Ecological Risk Evaluation

Ecological receptors could be exposed to surface water, sediment, and dietary items (*i.e.*, prey and plants) potentially impacted by lithium and molybdenum in groundwater. The screening benchmarks were obtained from the same methodology presented in the 2020 Risk Assessment (Gradient, 2020), as summarized below.

Ecological Receptors Exposed to Surface Water

The surface water exposure concentrations were compared to screening benchmarks protective of aquatic life. The maximum detected and modeled lithium and molybdenum concentrations are at least an order of magnitude lower than their respective benchmarks (Table 5). Therefore, lithium and molybdenum in surface water do not result in unacceptable risk to aquatic life in the Middle Fork of the Vermilion River adjacent to the Site.

Table 5 Risk Evaluation of Ecological Receptors Exposed to Surface Water

Constituent of Interest	Surface Water Exposure Estimate (mg/L)	Ecological Freshwater Benchmark[a] (mg/L)
Lithium (measured)	0.0070	0.44
Lithium (modeled)[b]	0.0023	0.44
Molybdenum (modeled)[c]	0.0015	0.80

Notes:
(a) Benchmarks from US EPA Region IV (2018).
(b) Although lithium was detected in surface water, the modeled concentration was also compared to surface water benchmarks protective of various human receptors to supplement the measured surface water data. The modeled surface water concentration is based on the maximum groundwater concentration and reflects the potential maximum Site-related surface water concentration from groundwater discharge.
(c) Because molybdenum was not detected in surface water, the exposure estimate is modeled using the maximum detected groundwater concentration. The modeled concentration reflects the potential maximum Site-related surface water concentration from groundwater discharge.

Ecological Receptors Exposed to Sediment

A hierarchy of sources outlined in the 2020 Risk Assessment (Gradient, 2020) was reviewed for lithium and molybdenum sediment screening benchmarks. US EPA does not have sediment screening benchmarks[5] for lithium or molybdenum (US EPA 2014a,b; US EPA Region IV, 2018). As part of the molybdenum chemical registration under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation, a predicted no effects level (PNEC) of 22,600 mg/kg for sediment was estimated using the equilibrium partitioning method and the PNEC for water of 12.7 mg/L (ECHA, 2020b). No benchmarks were identified for lithium.

[5] US EPA (2014a,b) did not evaluate sediment risks for lithium and molybdenum and acknowledged that not characterizing risks for constituents with benchmarks that are not available (*i.e.*, lithium and molybdenum) is not a significant source of uncertainty.

The maximum modeled molybdenum concentration (0.40 mg/kg) was orders of magnitude lower than the REACH benchmark protective of sediment exposures (22,600 mg/kg). As noted above, lithium does not readily sorb to sediments *via* chemical partitioning, resulting in an exposure concentration of 0 mg/kg. Therefore, the modeled sediment concentrations attributed to potential lithium and molybdenum contributions from Site groundwater are not expected to significantly contribute to ecological exposures in the Vermilion River adjacent to the Site.

Ecological Receptors Exposed to Bioaccumulative COIs

Lithium and molybdenum are not identified as analytes with potential bioaccumulative effects (US EPA Region IV, 2018). Therefore, these COIs are not considered to pose an ecological risk *via* bioaccumulation.

5 Conclusions

Similar to the 2020 Risk Assessment (Gradient, 2020), this risk evaluation for lithium and molybdenum incorporates a number of conservative assumptions that tend to overestimate exposure and risk. However, despite the conservative assumptions, this evaluation demonstrates that the lithium and molybdenum surface water and groundwater concentrations are not expected to pose an unacceptable risk to human (swimmers, boater, and anglers) or ecological (aquatic life, benthic invertebrates, and wildlife) receptors exposed to surface water and sediment in the Middle Fork of the Vermilion River adjacent to the Site. These results are consistent with the overall conclusions of the 2020 Risk Assessment that groundwater from the ash ponds at the VPP and potential groundwater contributions to surface water and sediment concentrations in the Middle Fork of the Vermilion River pose no unacceptable risks to human health or the environment.

References

European Chemicals Agency (ECHA). 2020a. "REACH dossier for lithium (CAS No. 7439-93-2)." Accessed on January 1, 2020 at https://echa.europa.eu/registration-dossier/-/registered-dossier/14178.

European Chemicals Agency (ECHA). 2020b. "REACH dossier for molybdenum (CAS No. 7439-98-7)." Accessed on January 1, 2020 at https://echa.europa.eu/registration-dossier/-/registered-dossier/15524.

Gradient. 2020. "Human Health and Ecological Risk Assessment, Vermilion Generating Station, Oakwood, Illinois (Draft)." Report to Schiff Hardin LLP. 77p., February 27.

US EPA Region IV. 2018. "Region 4 Ecological Risk Assessment Supplemental Guidance (March 2018 Update)." Superfund Division, Scientific Support Section. 98p., March. Accessed at https://www.epa.gov/sites/production/files/2018-03/documents/era_regional_supplemental_guidance_report-march-2018_update.pdf.

US EPA. 1989. "Risk Assessment Guidance for Superfund (RAGS). Volume I: Human Health Evaluation Manual (Part A) (Interim final)." Office of Emergency and Remedial Response. NTIS PB90-155581; EPA-540/1-89-002. 287p., December.

US EPA. 1993. Memorandum from M.G. Prothro (US EPA, Office of Water) to US EPA Directors and Regions re: Office of Water policy and technical guidance on interpretation and implementation of aquatic life metals criteria. EPA-822-F93-009. 49p., October 1.

US EPA. 2014a. "Human and Ecological Risk Assessment of Coal Combustion Residuals (Final)." Office of Solid Waste and Emergency Response (OSWER), Office of Resource Conservation and Recovery. 1237p., December. Accessed at http://www.regulations.gov/#!documentDetail;D=EPA-HQ-RCRA-2009-0640-11993.

US EPA. 2014b. "Coal Combustion Residual Beneficial Use Evaluation: Fly Ash Concrete and FGD Gypsum Wallboard (Final)." Office of Solid Waste and Emergency Response (OSWER), Office of Resource Conservation and Recovery (ORCR). 91p., February.

Appendix C

Supporting Information

Geosyntec Consultants Construction Schedule; Labor, Vehicle, and Equipment Demands; and Cost Estimates for Closure of the North Ash Pond/Old East Ash Pond and the New East Ash Pond, Vermilion Power Station

Worksheet 1 - General Questions

	NAP	OEAP	NEAP	Note
Surface area of CCR layer (sq. ft.):	1,742,400	871,200	914,760	Areas provided by Others in the closure plan and associated cost estimates.
Total ash volume (cubic yards):	1,150,000	992,000	343,000	Volume provided by Others in the closure plan and associated cost estimates.
Dry bulk density of CCR (pcf):	70.9	82.5	80.7	2 density tests were available for the NAP. 11 density tests were available for the OEAP. No density tests were available for the NEAP, all tests were averaged for this entry.

Worksheet 2 -Key Transportation Distances and Questions

Description	Distance (miles)	Notes
Distance between landfill and surface impoundments for closure by removal alternative	15	Republic Services Brickyard Disposal Landfill has been tentatively identified as the landfill.
Distance between soil depot (origin of fill soil) and surface impoundments (to bring in topsoil)	8	A borrow site is assumed to be 8 miles from the project site; however, a borrow site has not been identified.
Distance between origin of raw materials and surface impoundment (bentonite, geomembrance)	1000	Bentonite material may come from ash far away as Wyoming. Geomembrane may come from Huston, Texas.
Distance between origin of raw materials and surface impoundment (for geotextile, etc.)	250	This encompasses Chicago, Indianapolis, Cincinnati, and St. Louis. Most materials would be available within this range. Some specific materials (liner) may come from a much greater distance.
Distance between origin of raw materials and landfill (for geotextile, etc.)	250	This encompasses Chicago, Indianapolis, Cincinnati, and St. Louis. Most materials would be available within this range. Some specific materials (liner) may come from a much greater distance.
Average distance between offsite offices and the site	250	This encompasses Chicago, Indianapolis, Cincinnati, and St. Louis.
Average distance between the workers residence and surface impoundment	15	Assume the workers reside in Danville, IL.
Average distance between the workers residence and landfill	5	Assume the workers reside in Danville, IL.
Average distance for onsite hauling	12	0.75 round trip, assume 16 trips per day.
Average distance of travel for onsite vehicles	5	Daily onsite mileage usage.

Question	Answer (CY)	Notes
Do on-site workers use personal vehicles for daily commute? What are other alternatives and what percentage of workers use each alternative?	Yes. No other alternatives are available.	Public transportation is not present near the site.
Capacity of dump trucks used for CCR transport on-site (within or between SIs)	34	Assume CAT 745
Capacity of dump trucks used for CCR transport off-site (to landfill)	16.5	Tandem dump truck
Capacity of trucks used for transportation of top soil	16.5	Tandem dump truck
Capacity of trucks used for transportation of bulk materials to the site	26	Trailer dump truck

Typical workday	10	Assume 10 hours per day
Bulk material delivery	10	Assume 55 MPH
Bulk material delivery (bentonite, geomembrane)	37	Assume 55 MPH

Worksheet 2 -Key Transportation Distances and Questions

Equipment List	Engine Size (Horsepower)	Notes
support truck (standard pickup truck)	300	standard pickup truck
track hoe excavator (standard)	359	Komatsu PC490LC-11
track hoe excavator (standard with extended boom)	359	Komatsu PC490LC-10SLF
very large track hoe excavator	775	Komatsu PC1250
clamshell excavator	530	Liebherr Clamshell with HS 8100 Duty Cycle Crawler Crane
articulating dump truck	504	CAT 745
tandem dump truck	485	2020 WESTERN STAR 4900SF DUMP TRUCK
dozer	436	CAT D8
front end loader	263	CAT 950M
sheepsfoot roller	405	CAT C15
smooth drum roller	100	CAT CS44B
tractor pulled disc	300	2006 JOHN DEERE 8430 (this is the tractor, not the disc)
skid steer	95	CAT 272D2
4-inch pump	5.5	BE TP-4013HM - 580 GPM (4") Trash Pump w/ Honda GX Engine
6-inch pump	44	Thompson Pump 6HT-DIS-4LE2T
generator	410	Doosan G325 Generator (270kW)
geomembrane welder (wedge welder and extrusion welder)	2.5 5	Pro-Wedge VM20 Pro-X5 Model 600-0105/X5/A
delivery truck (flatbed with 48,000 lbs. capacity or 26 cy load)	475	2020 KENWORTH T880 FLATBED TRUCK, ROLLBACK TOW TRUCK
fuel truck	430	2003 PETERBILT 385 FUEL TRUCK - LUBE TRUCK, WASTE OIL TRUCKS, TANKER TRUCK
water truck	565	2019 INTERNATIONAL HX WATER TRUCK

hydroseeding truck	450	2018 Finn T-170 Hydroseeder and International Truck
drilling rig	115	Diedrich D-50

Worksheet 3.1 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Closure By Removal, Offsite Landfill).

Closure By Removal Closure Plan																												
Alternative Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
2.1 NAP Closure	2.1.1 Project Duration Items	Project duration	-	-	-	0	-	-	0	0	5.1	years	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	Schedule not defined, assume 5.1 years total project duration.
		Owner's representative site visits	-	-	-	1	vehicle per day	support truck (daily mob)	250	10	265	day	1	0	2,650	2,650	132,500	1,325	0	0	0	0	0	0	0	0	Weekly site visits.	
		Contractor Construction & Safety Managers	-	-	-	2	vehicle per day	support truck	15	10	1,326	day	2	1	26,520	39,780	119,340	13,260	500	0	0	0	0	0	0	0	Three full time staff.	
		Office facilities	-	-	-	2	equipment per day	work trailer	0	10	1,326	day	0	0	26,520	0	0	0	0	0	0	0	0	0	0	0	Office Trailer.	
		Electric usage (average per day)	1,326,000	KWH	100	0	KWH per day	electricity	0	10	1,326	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Assume 50 kWh per trailer.	
		Site specific security	-	-	-	1	vehicle per day	support truck	15	10	1,326	day	1	0	13,260	13,260	39,780	6,630	500	0	0	0	0	0	0	0	One full time staff.	
		CQA Officer / Engineer site visit	-	-	-	1	vehicle per day	support truck (daily mob)	250	10	265	day	1	0	2,650	2,650	132,500	1,325	0	0	0	0	0	0	0	0	Weekly site visits.	
		CQA staff	-	-	-	1	vehicle per day	support truck	15	10	1,326	day	1	0	13,260	13,260	39,780	6,630	500	0	0	0	0	0	0	0	One full time staff.	
		Equipment mobilization	-	-	-	61	equipment mob	heavy equipment mob	250	10	1	mob	61	0	610	610	1,830	0	0	15,250	15,250	0	0	0	0	0	Estimated mobilization for heavy equipment. Includes all non vehicles. Vehicles are assumed to travel to the site daily.	
		Equipment fueling	-	-	-	1	vehicle per day	fuel truck	15	2	1,326	day	1	0	2,652	2,652	39,780	6,630	0	0	0	0	0	0	0	0	Daily refueling.	
		Portable restrooms	-	-	-	1	equipment per day	restroom units	0	10	1,326	day	0	0	13,260	0	0	0	0	0	0	0	0	0	0	0	Full time.	
		Portable restroom service	-	-	-	1	vehicle per day	maintenance vehicle	15	2	265	day	1	0	530	530	7,950	1,325	0	0	0	0	0	0	0	0		
		Dust suppression	-	-	-	1	equipment per day	water truck	12	10	1,326	day	1	0	13,260	13,260	39,780	0	0	0	0	15,912	0	0	0	0		
		Groundwater monitoring	-	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Monitoring included in Task 2.4.	-
		NPDES monitoring	-	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	2.1.2 Install EPSC Measures	Silt fence	2,650	LF	1,300	1	vehicle per day	support truck	15	10	3	day	1	1	30	60	180	15	500	0	0	0	0	0	0	0	Assumes silt fence not required along west side.	RSMeans 3125 1416 1000.
		Material deliveries	1	EA	1	1	materials	truck delivery - silt fence	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Assume to be delivered in 1 load.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
	2.1.3 Unwatering NAP and Secondary NAP	Pump NAP to Secondary NAP, pump Secondary NAP to NPDES Outfall 001	14	MG	1	2	equipment per day	6-inch pump	0	10	14	day	1	0	280	140	420	0	0	0	0	0	0	0	0	0	Assume 1 pump from the NAP to the Secondary NAP and 1 pump from the Secondary NAP to Outfall 001. Assume 40 hp pump.	Volumes and pump rates provided in Stantec Unwatering and Dewatering Memo (4/19/19). Assume effort consistent with the closure plan.
			10,360	KWH	74	0	KWH per hour	electricity	0	10	14	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	14	day	0	0	140	0	0	70	500	0	0	0	0	0	0	0		
	2.1.4 Dewatering and Stormwater Management	Excavate dewatering ditches and install dewatering sumps	31,700	CY	540	3	equipment per day	track hoe excavator	0	10	20	day	3	0	600	600	1,800	0	0	0	0	0	0	0	0	0	Assume dewatering to a depth of 10 feet with 15-foot ditches and sumps. Assume 2,000 LF of 15-foot, 1:1 slope ditches, 4-foot base. Assume effort consistent with the closure plan.	RSMeans 3123 1613 0130.
			-	-	-	3	equipment per day	articulating dump truck	12	10	20	day	3	0	600	600	1,800	0	0	0	0	720	0	0	0	0		
			-	-	-	1	equipment per day	dozer	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	smooth drum roller	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	0	10	20	day	1	0	200	200	0	100	500	0	0	0	0	0	0	0		
		Dewater for Excavation	83	MG	0	3	equipment per day	sump pump	0	10	730	day	1	0	21,900	7,300	21,900	0	0	0	0	0	0	0	0	0	Assume 3 sump locations, 7 days per week for 6 months dewatering. Assume stormwater management for 5.1 years. Assume 40 hp pump. Assume a 50% increase of the effort for the closure plan split between the NAP (2/3) and OEAP (1/3) for stormwater management.	Volumes provided in Stantec Unwatering and Dewatering Memo (4/19/19). Assume effort consistent with the closure plan.
			810,300	KWH	111	0	KWH per hour	electricity	0	10	730	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Stormwater Management	381	MG	0	3	equipment per day	sump pump	0	10	1,862	day	1	0	55,860	18,620	55,860	0	0	0	0	0	0	0	0	0		
			2,066,820	KWH	111	0	KWH per hour	electricity	0	10	1,862	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	2,592	day	0	0	25,920	0	0	12,960	500	0	0	0	0	0	0	0		
	2.1.5 Soil Stripping and Stockpiling	Excavation and loading soil	65,300	BCY	3,400	1	equipment per day	track hoe excavator	0	10	14	day	1	0	140	140	420	0	0	0	0	0	0	0	0	0	Soil to be stockpiled onsite and used to regraded excavated areas.	A swell of 10% was included. Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping in stockpile	71,830	LCY	544	10	equipment per day	articulating dump truck	12	10	14	day	10	1	1,400	1,540	4,620	0	0	0	0	1,680	0	0	0	0		
		Place and spread in stockpile	71,830	LCY	3,500	1	equipment per day	dozer	0	10	14	day	1	1	140	280	840	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	14	day	1	0	140	140	420	70	500	0	0	0	0	0	0	0		
	2.1.6 Excavate CCR Material and Haul to Landfill	Excavate and load CCR	1,171,000	BCY	3,400	1	equipment per day	track hoe excavator	0	10	654	day	1	0	6,540	6,540	19,620	0	0	0	0	0	0	0	0	0	Excavation of CCR from the NAP and haul to offsite landfill. Includes 1-ft overexcavation.	A swell of 10% was included. Production rate based on 30 mile around trip with a speed of 35 MPH, wait time of 15 minutes and capacity of 16.5 CYs. Roughly 2,000 CY/DAY.
		Hauling and dumping	1,288,100	LCY	116	17	haul trucks per day	tandem dump truck	15	10	654	day	17	1	111,180	117,720	353,160	0	0	0	0	0	1,171,000	1,171,000	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	654	day	1	1	6,540	13,080	39,240	3,270	500	0	0	0	0	0	0	0		
		Moisture conditioning	1,288,100	LCY	10,000	1	equipment per day	tractor pulled disc	0	10	129	day	1	0	1,290	1,290	3,870	0	0	0	0	0	0	0	0	0	In place MC is ~35% and assume a target of ~30%. The majority of samples were above 30%, assume conditioning of total quantity. 10% of the samples had a MC over 45%.	Assume addition effort from track hoe for above MC 45%.
			128,810	LCY	3,400	1	equipment per day	excavator	0	10	38	day	1	0	380	380	1,140	0	0	0	0	0	0	0	0	0		
	2.1.7 Excavate Coal Yard Material and Haul to Landfill	Excavate and load CCR	50,000	BCY	3,400	1	equipment per day	track hoe excavator	0	10	28	day	1	0	280	280	840	0	0	0	0	0	0	0	0	0	Excavation of coal from the Coal Yard and haul to offsite landfill. Includes 1-ft overexcavation.	Volume provided by the Owner. A swell of 10% was included. Production rate based on 30 mile around trip onsite with a speed of 35 MPH, wait time of 15 minutes and capacity of 16.5 CYs. Roughly 2,000 CY/DAY.
		Hauling and dumping	55,000	LCY	116	17	haul trucks per day	tandem dump truck	15	10	28	day	17	0	4,760	4,760	14,280	0	0	0	0	0	50,000	50,000	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	28	day	1	0	280	280	840	140	500	0	0	0	0	0	0	0		
	2.1.8 Seed and Mulch	Hydroseed and mulch	40	AC	2	1	equipment per day	hydroseeder truck	250	10	20	day	1	1	200	400	1,200	0	0	0	0	5,000	0	0	0	0	Hydromulch assumed.	RSMeans 3292 1913 1100.
			-	-	-	1	vehicle per day	support truck	250	10	20	day	1	0	200	200	10,000	100	500	0	0	0	0	0	0	0		
		Material deliveries	30	TON	24	1	materials	truck delivery - hydroseed/mulch	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	Assume 26 CY truck or 48,000 LB flat bed delivery truck.

Worksheet 3.1 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Closure By Removal, Offsite Landfill).

Closure By Removal Closure Plan

Alternative Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
2.1 NAP Closure	2.1.9 Install monitoring / observation wells	Drilling for monitoring well and observation well installations, drilling for abandonment of monitoring wells	4	EA	1	1	equipment per day	drilling rig	0	10	6	day	1	0	60	60	180	0	0	0	0	0	0	0	0	0	Assumes wells will be powered with onsite power. Includes 2 days for mobilization/demobilization.	Install 4 new monitoring wells.
			-	-	-	1	vehicle per day	support truck (daily mob)	250	10	6	day	1	0	60	60	3,000	30	0	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	skid steer	0	10	6	day	1	0	60	60	180	0	0	0	0	0	0	0	0	0		
		Clearing for monitoring wells	-	-	-	1	equipment per day	track hoe excavator	0	10	5	day	1	0	50	50	150	0	0	0	0	0	0	0	0	0	8 locations are currently vegetated.	
		Material deliveries	1	EA	1	1	materials	truck delivery - flush mount	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Assume to be delivered in 1 load.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
			1	EA	1	1	materials	truck delivery - well steel	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - PVC	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - sand	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - bentonite	250	37	1	load	1	0	37	37	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - cement	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
	2.1.10 General Grading	Excavate and load from stockpile	253,000	BCY	3,400	2	equipment per day	track hoe excavator	0	10	56	day	2	0	1,120	1,120	3,360	0	0	0	0	0	0	0	0	0	To promote positive drainage once the ash is removed. Assumes onsite material from soil stripping and other sources.	A swell of 20% was included. Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping general fill	303,600	LCY	544	10	equipment per day	articulating dump truck	12	10	56	day	10	0	5,600	5,600	16,800	0	0	0	0	6,720	0	0	0	0		
		Place and spread general fill	303,600	LCY	3,500	2	equipment per day	dozer	0	10	56	day	2	0	1,120	1,120	3,360	0	0	0	0	0	0	0	0	0		
		Compact general fill	303,600	LCY	2,400	3	equipment per day	sheepsfoot roller	0	10	56	day	3	0	1,680	1,680	5,040	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	1	day	1	0	10	10	30	5	500	0	0	0	0	0	0	0		
		Riprap Protection for Stormwater Inflow Into the NAP	-	-	-	2	equipment per day	track hoe excavator	0	10	15	day	2	0	300	300	900	0	0	0	0	0	0	0	0	0	Riprap at geotextile fabric to reduce velocity in the NAP.	
			-	-	-	1	equipment per day	articulating dump truck	12	10	15	day	1	0	150	150	450	0	0	0	0	180	0	0	0	0		
			-	-	-	1	equipment per day	dozer	0	10	15	day	1	0	150	150	450	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	15	day	1	0	150	150	450	75	500	0	0	0	0	0	0	0		
			-	-	-	2	vehicle per day	support truck	15	10	15	day	2	1	300	450	1,350	150	500	0	0	0	0	0	0	0		
			11,111	CY	26	1	materials	truck delivery - riprap	250	10	427	load	1	0	4,270	4,270	0	0	0	0	0	0	0	0	106,750	106,750	Assume 100,000 SF of riprap at 18-inches thick.	
			1	EA	1	1	materials	truck delivery - geotextile	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
2.2 OEAP Closure	2.2.1 Preconstruction Tasks	Groundwater Collection Trench	-	-	-	1	equipment per day	one pass trencher	0	10	40	day	1	0	400	400	1,200	0	0	0	0	0	0	0	0	0	Scope not defined. Improvements may not be necessary dependent on results of stability analyses. Work depicted assumed based on current understanding of the project. Includes Construction Manager, laborers, and CQA staff.	2 months, to be refined during design phase.
			-	-	-	2	equipment per day	front end loader	0	10	40	day	2	0	800	800	2,400	0	0	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	dozer	0	10	40	day	1	0	400	400	1,200	0	0	0	0	0	0	0	0	0		
						1	equipment per day	articulating dump truck	12	10	40		1	0	400	400	1,200	0	0	0	0	480	0	0	0	0		
						1	equipment per day	6-inch pump	0	10	40		1	0	400	400	1,200	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	40	day	1	0	400	400	1,200	200	500	0	0	0	0	0	0	0		
			-	-	-	2	vehicle per day	support truck	15	10	40	day	2	0	800	800	2,400	400	500	0	0	0	0	0	0	0		
			1,500	LF	1,500	1	materials	truck delivery - 6-inch piping	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Piping to dewater trench excavation and take to the NEAP.	
			3,000	LF	1,500	1	materials	truck delivery - 4-inch piping	250	10	2	load	1	0	20	20	0	0	0	0	0	0	0	0	500	500		
			1,222	CY	26	1	materials	truck delivery - coarse aggregate	250	10	47	load	1	0	470	470	0	0	0	0	0	0	0	0	11,750	11,750	Assume emergency buttress of 1,100 ft x 30 ft x 2 ft .	
			1	EA	1	1	materials	truck delivery - geotextile	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
		OEAP Riverslope Stabilization Installation	-	-	-	2	equipment per day	track hoe excavator	0	10	30	day	2	0	600	600	1,800	0	0	0	0	0	0	0	0	0	Scope not defined. Improvements may not be necessary dependent on results of stability analyses. Work depicted assumed based on current understanding of the project. Includes Construction Manager, laborers, and CQA staff.	6 weeks, to be refined during design phase.
			-	-	-	1	equipment per day	articulating dump truck	12	10	30	day	1	0	300	300	900	0	0	0	0	360	0	0	0	0		
			-	-	-	1	equipment per day	dozer	0	10	30	day	1	0	300	300	900	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	30	day	1	0	300	300	900	150	500	0	0	0	0	0	0	0		
			-	-	-	2	vehicle per day	support truck	15	10	30	day	2	1	600	900	2,700	300	500	0	0	0	0	0	0	0		
			1,852	CY	26	1	materials	truck delivery - riprap	250	10	71	load	1	0	710	710	0	0	0	0	0	0	0	0	17,750	17,750	Assume emergency buttress of 1,000 ft x 10 ft x 10 ft .	
			1	EA	1	1	materials	truck delivery - geotextile	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
		OEAP Riverslope Stabilization Removal	-	-	-	1	equipment per day	track hoe excavator	0	10	10	day	1	0	100	100	300	0	0	0	0	0	0	0	0	0	Temporary improvement that will be removed in the future.	2 weeks.
			-	-	-	1	equipment per day	articulating dump truck	12	10	10	day	1	0	100	100	300	0	0	0	0	120	0	0	0	0		
			-	-	-	1	equipment per day	dozer	0	10	10	day	1	0	100	100	300	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	10	day	1	0	100	100	300	50	500	0	0	0	0	0	0	0		

Worksheet 3.1 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Closure By Removal, Offsite Landfill).

Closure By Removal Closure Plan																												
Alternative Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
2.2 OEAP Closure	2.2.2 Project Duration Items	Project duration	-	-	-	0	-	-	0	0	2.5	years	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	Schedule not defined, assume 2.5 years total project duration.
		Owner's representative site visits	-	-	-	1	vehicle per day	support truck (daily mob)	250	10	130	day	1	0	1,300	1,300	65,000	650	0	0	0	0	0	0	0	0	Weekly site visits.	
		Contractor Construction & Safety Managers	-	-	-	2	vehicle per day	support truck	15	10	650	day	2	1	13,000	19,500	58,500	6,500	500	0	0	0	0	0	0	0	Three full time staff.	
		Office facilities	-	-	-	2	equipment per day	work trailer	0	10	650	day	0	0	13,000	0	0	0	0	0	0	0	0	0	0	0	Office Trailer.	
		Electric usage (average per day)	650,000	KWH	100	0	KWH per day	electricity	0	10	650	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Assume 50 kWh per trailer.	
		Site specific security	-	-	-	1	vehicle per day	support truck	15	10	650	day	1	0	6,500	6,500	19,500	3,250	500	0	0	0	0	0	0	0	One full time staff.	
		CQA Officer / Engineer site visit	-	-	-	1	vehicle per day	support truck (daily mob)	250	10	130	day	1	0	1,300	1,300	65,000	650	0	0	0	0	0	0	0	0	Weekly site visits.	
		CQA staff	-	-	-	1	vehicle per day	support truck	15	10	650	day	1	0	6,500	6,500	19,500	3,250	500	0	0	0	0	0	0	0	One full time staff.	
		Equipment mobilization	-	-	-	63	equipment mob	heavy equipment mob	250	10	1	mob	63	0	630	630	1,890	0	0	15,750	15,750	0	0	0	0	0	Estimated mobilization for heavy equipment. Includes all non vehicles. Vehicles are assumed to travel to the site daily.	
		Equipment fueling	-	-	-	1	vehicle per day	fuel truck	15	2	650	day	1	0	1,300	1,300	19,500	3,250	0	0	0	0	0	0	0	0	Daily refueling.	
		Portable restrooms	-	-	-	1	equipment per day	restroom units	0	10	650	day	0	0	6,500	0	0	0	0	0	0	0	0	0	0	0	Full time.	
		Portable restroom service	-	-	-	1	vehicle per day	maintenance vehicle	15	2	130	day	1	0	260	260	3,900	650	0	0	0	0	0	0	0	0		
		Dust suppression	-	-	-	1	equipment per day	water truck	0	10	650	day	1	0	6,500	6,500	19,500	0	0	0	0	0	0	0	0	0		
		Groundwater monitoring	-	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Monitoring included in Task 2.4.	-
		NPDES monitoring	-	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	2.2.3 Install EPSC Measures	Silt fence	2,350	LF	1,300	1	vehicle per day	support truck	15	10	2	day	1	1	20	40	120	10	500	0	0	0	0	0	0	0	Assumes silt fence not required along south side.	RSMeans 3125 1416 1000.
		Material deliveries	1	EA	1	1	materials	truck delivery - silt fence	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Assume to be delivered in 1 load.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
	2.2.4 Dewatering and Stormwater Management	Excavate dewatering ditches and install dewatering sumps	15,900	CY	540	3	equipment per day	track hoe excavator	0	10	10	day	3	0	300	300	900	0	0	0	0	0	0	0	0	0	Assume dewatering to a depth of 10 feet with 15-foot ditches and sumps. Assume 1,000 LF of 15-foot, 1:1 slope ditches, 4-foot base. Assume effort consistent with the closure plan.	RSMeans 3123 1613 0130.
			-	-	-	3	equipment per day	articulating dump truck	12	10	10	day	3	0	300	300	900	0	0	0	0	360	0	0	0	0		
			-	-	-	1	equipment per day	dozer	0	10	10	day	1	0	100	100	300	0	0	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	smooth drum roller	0	10	10	day	1	0	100	100	300	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	0	10	10	day	1	0	100	100	0	50	500	0	0	0	0	0	0	0		
		Dewater for Excavation	0	MG	-	3	equipment per day	sump pump	0	10	0	day	1	0	0	0	0	0	0	0	0	0	0	0	0	0	Assume 3 sump locations, 7 days per week for 6 months dewatering. Assume stormwater management for 2.5 years. Assume 40 hp pump. Assume a 50% increase of the effort for the closure plan split between the NAP (2/3) and OEAP (1/3).	Volumes provided in Stantec Unwatering and Dewatering Memo (4/19/19). Assume effort consistent with the closure plan.
			0	KWH	111	0	KWH per hour	electricity	0	10	0	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Stormwater Management	93	MG	0	3	equipment per day	sump pump	0	10	913	day	1	0	27,390	9,130	27,390	0	0	0	0	0	0	0	0	0		
			1,013,430	KWH	111	0	KWH per hour	electricity	0	10	913	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	913	day	0	0	9,130	0	0	4,565	500	0	0	0	0	0	0	0		
	2.2.5 Soil Stripping and Stockpiling	Excavation and loading soil	283,000	BCY	3,400	1	equipment per day	track hoe excavator	0	10	58	day	1	0	580	580	1,740	0	0	0	0	0	0	0	0	0	Soil to be stockpiled onsite and used to regraded excavated areas.	A swell of 20% was included. Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping in stockpile	311,300	LCY	544	10	equipment per day	articulating dump truck	12	10	58	day	10	1	5,800	6,380	19,140	0	0	0	0	6,960	0	0	0	0		
		Place and spread in stockpile	311,300	LCY	3,500	1	equipment per day	dozer	0	10	58	day	1	1	580	1,160	3,480	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	58	day	1	0	580	580	1,740	290	500	0	0	0	0	0	0	0		
	2.2.6 Excavate CCR Material and Haul to Landfill	Excavate and load CCR	992,000	BCY	3,400	1	equipment per day	track hoe excavator	0	10	554	day	1	0	5,540	5,540	16,620	0	0	0	0	0	0	0	0	0	Excavation of CCR from the OEAP and haul to offsite landfill. Includes 1-ft overexcavation.	A swell of 10% was included. Production rate based on 30 mile around trip with a speed of 35 MPH, wait time of 15 minutes and capacity of 16.5 CYs. Roughly 2,000 CY/DAY.
		Hauling and dumping	1,091,200	LCY	116	17	haul trucks per day	tandem dump truck	15	10	554	day	17	1	94,180	99,720	299,160	0	0	0	0	0	992,000	992,000	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	554	day	1	1	5,540	11,080	33,240	2,770	500	0	0	0	0	0	0	0		
		Moisture conditioning	1,091,200	LCY	10,000	1	equipment per day	tractor pulled disc	0	10	110	day	1	0	1,100	1,100	3,300	0	0	0	0	0	0	0	0	0	In place MC is ~39% and assume a target of ~30%. The majority of samples were above 30%, assume conditioning of total quantity. 10% of the samples had a MC over 45%.	Assume addition effort from track hoe for above MC 45%.
			109,120	LCY	3,400	1	equipment per day	excavator	0	10	33	day	1	0	330	330	990	0	0	0	0	0	0	0	0	0		
	2.2.7 Abandon or Removal of OEAP Drainage Pipes	Excavation and backfill	-	-	-	1	equipment per day	track hoe excavator	0	10	1	day	1	0	10	10	30	0	0	0	0	0	0	0	0	0	Two pipes have been located that require removal from the ash ponds.	Assume 1 day to excavated and haul off.
		Compact	-	-	-	1	equipment per day	sheepsfoot roller	0	10	1	day	1	0	10	10	30	0	0	0	0	0	0	0	0	0		
		Haul Off	-	-	-	1	haul trucks per day	tandem dump truck	15	10	1	day	1	0	10	10	30	0	0	0	0	0	15	15	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	1	day	1	1	10	20	60	5	500	0	0	0	0	0	0	0		
	2.2.8 Seed and Mulch	Hydroseed and mulch	20	AC	2	1	equipment per day	hydroseeder truck	250	10	10	day	1	1	100	200	600	0	0	0	0	2,500	0	0	0	0	Hydromulch assumed.	RSMeans 3292 1913 1100.
			-	-	-	1	vehicle per day	support truck	250	10	10	day	1	0	100	100	5,000	50	500	0	0	0	0	0	0	0		
		Material deliveries	15	TON	24	1	materials	truck delivery - hydroseed/mulch	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	Assume 26 CY truck or 48,000 LB flat bed delivery truck.

Worksheet 3.1 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Closure By Removal, Offsite Landfill).

Closure By Removal Closure Plan

Alternative Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
2.2 OEAP Closure	2.2.9 Install monitoring / observation wells	Drilling monitoring well and observation well installations, drilling for abandonment monitoring wells	4	EA	1	1	equipment per day	drilling rig	0	10	6	day	1	0	60	60	180	0	0	0	0	0	0	0	0	0	Includes 2 days for mobilization/demobilization.	Install 4 new monitoring wells.
			-	-	-	1	vehicle per day	support truck (daily mob)	250	10	6	day	1	0	60	60	3,000	30	0	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	skid steer	0	10	6	day	1	0	60	60	180	0	0	0	0	0	0	0	0	0		
		Clearing for monitoring wells	-	-	-	1	equipment per day	track hoe excavator	0	10	5	day	1	0	50	50	150	0	0	0	0	0	0	0	0	0	2 locations are currently vegetated.	
		Material deliveries	1	EA	1	1	materials	truck delivery - flush mount	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Assume to be delivered in 1 load.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
			1	EA	1	1	materials	truck delivery - well steel	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - PVC	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - sand	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - bentonite	0	37	1	load	1	0	37	37	0	0	0	0	0	0	0	0	0	0		
			1	EA	1	1	materials	truck delivery - cement	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
	2.2.10 General Grading	Excavate and load from stockpile	84,000	BCY	3,400	2	equipment per day	track hoe excavator	0	10	19	day	2	0	380	380	1,140	0	0	0	0	0	0	0	0	0	To promote positive drainage once the ash is removed. Assumes onsite material from soil stripping and other sources. OEAP is not assumed to be usable.	A swell of 20% was included. Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping general fill	100,800	LCY	544	10	equipment per day	articulating dump truck	12	10	19	day	10	0	1,900	1,900	5,700	0	0	0	0	2,280	0	0	0	0		
		Place and spread general fill	100,800	LCY	3,500	2	equipment per day	dozer	0	10	19	day	2	0	380	380	1,140	0	0	0	0	0	0	0	0	0		
		Compact general fill	100,800	LCY	2,400	3	equipment per day	sheepsfoot roller	0	10	19	day	3	0	570	570	1,710	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	19	day	1	0	190	190	570	95	500	0	0	0	0	0	0	0		
2.3 NEAP Closure	2.3.1 Project Duration Items	Project Duration	-	-	-	0	-	-	0	0	3.1	years	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	Schedule not defined, assume 3.1 years total project duration.
		Owner's representative site visits	-	-	-	1	vehicle per day	support truck (daily mob)	250	10	161	day	1	0	1,612	1,612	80,600	806	0	0	0	0	0	0	0	0	Weekly site visits.	
		Contractor Construction & Safety Managers	-	-	-	2	vehicle per day	support truck	15	10	806	day	2	1	16,120	24,180	72,540	8,060	500	0	0	0	0	0	0	0	Three full time staff.	
		Office facilities	-	-	-	2	unit per day	work trailer	0	10	806	day	0	0	16,120	0	0	0	0	0	0	0	0	0	0	0	Office Trailer.	
		Electric usage (average per day)	806,000	KWH	100	0	KWH per day	electricity	0	10	806	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Assume 50 kWh per trailer.	
		Site specific security	-	-	-	1	vehicle per day	support truck	15	10	806	day	1	0	8,060	8,060	24,180	4,030	500	0	0	0	0	0	0	0	One full time staff.	
		CQA Officer / Engineer site visit	-	-	-	1	vehicle per day	support truck (daily mob)	250	10	38	day	1	0	380	380	19,000	190	0	0	0	0	0	0	0	0	Monthly site visits.	
		CQA staff	-	-	-	1	vehicle per day	support truck	15	10	806	day	1	0	8,060	8,060	24,180	4,030	500	0	0	0	0	0	0	0	One full time staff.	
		Equipment mobilization	-	-	-	53	equipment mob	heavy equipment mob	250	10	1	mob	53	0	530	530	1,590	0	0	13,250	13,250	0	0	0	0	0	Estimated mobilization for heavy equipment. Includes all non vehicles. Vehicles are assumed to travel to the site daily.	
		Equipment fueling	-	-	-	1	vehicle per day	fuel truck	15	1	806	day	1	0	806	806	24,180	4,030	0	0	0	0	0	0	0	0	Daily refueling.	
		Portable restrooms	-	-	-	1	equipment per day	restroom units	0	10	806	day	0	0	8,060	0	0	0	0	0	0	0	0	0	0	0	Full time.	
		Portable restroom service	-	-	-	1	vehicle per day	maintenance truck	15	2	162	day	1	0	324	324	4,860	810	0	0	0	0	0	0	0	0		
		Dust suppression	-	-	-	1	equipment per day	water truck	0	10	806	day	1	0	8,060	8,060	24,180	0	0	0	0	0	0	0	0	0		
		Groundwater monitoring	-	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Monitoring included in Task 2.4.	-
		NPDES monitoring	-	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	2.3.2 Install EPSC Measures	Silt fence	5,000	LF	1,300	1	vehicle per day	support truck	15	10	4	day	1	1	40	80	240	20	500	0	0	0	0	0	0	0	Assumes silt fence not required along west side.	RSMeans 3125 1416 1000.
		Material deliveries	1	EA	1	1	materials	truck delivery - silt fence	0	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	0	0	Assume to be delivered in 1 load.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
	2.3.3 Unwatering NEAP and Secondary NEAP	Pump NEAP to Secondary NEAP, pump Secondary NEAP to NPDES Outfall 003	3	MG	0	2	equipment per day	6-inch pump	0	10	15	day	2	0	300	300	900	0	0	0	0	0	0	0	0	0	Assume 1 pump from the NEAP to the Sec. NEAP and 1 pump from the Secondary NEAP to Outfall 003. Assume 40 hp pump.	Volumes and pump rates provided in Stantec Unwatering and Dewatering Memo (4/19/19). Assume effort consistent with the closure plan.
			11,100	KWH	74	0	KWH per hour	electricity	0	10	15	day	2	0	0	0	0	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	15	day	2	0	150	300	900	75	500	0	0	0	0	0	0	0		
	2.3.4 Dewatering and Stormwater Management	Excavate dewatering ditches and install dewatering sumps	10,600	CY	540	1	equipment per day	track hoe excavator	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0	Assume dewatering to a depth of 10 feet with 15-foot ditches and sumps. Assume 1,000 LF of 15-foot, 1:1 slope ditches, 4-foot base. Assume effort consistent with the closure plan.	RSMeans 3123 1613 0130.
			-	-	-	1	equipment per day	articulating dump truck	12	10	20	day	1	0	200	200	600	0	0	0	0	240	0	0	0	0		
			-	-	-	1	equipment per day	dozer	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	smooth drum roller	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	0	10	20	day	1	0	200	200	0	100	500	0	0	0	0	0	0	0		
		Dewater for Excavation	17	MG	0	3	equipment per day	sump pump	0	10	730	day	1	0	21,900	7,300	21,900	0	0	0	0	0	0	0	0	0	Assume 3 sump locations, 7 days per week for 6 months dewatering. Assume stormwater management for 3.1 years. Assume 40 hp pump. Assume effort consistent with the closure plan.	Volumes provided in Stantec Unwatering and Dewatering Memo (4/19/19). Assume effort consistent with the closure plan.
			810,300	KWH	111	0	KWH per hour	electricity	0	10	730	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Stormwater Management	103	MG	0	3	equipment per day	sump pump	0	10	1,132	day	1	0	33,960	11,320	33,960	0	0	0	0	0	0	0	0	0		
			1,256,520	KWH	111	0	KWH per hour	electricity	0	10	1,132	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	1,862	day	0	0	18,620	0	0	9,310	500	0	0	0	0	0	0	0		
	2.3.5 Soil Stripping and Stockpiling	Excavation and loading soil	119,500	BCY	3,400	1	equipment per day	track hoe excavator	0	10	25	day	1	0	250	250	750	0	0	0	0	0	0	0	0	0	Soil to be stockpiled onsite and used to regraded excavated areas.	A swell of 20% was included. Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping in stockpile	131,450	LCY	544	10	equipment per day	articulating dump truck	12	10	25	day	10	1	2,500	2,750	8,250	0	0	0	0	3,000	0	0	0	0		
		Place and spread in stockpile	131,450	LCY	3,500	1	equipment per day	dozer	0	10	25	day	1	1	250	500	1,500	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	25	day	1	0	250	250	750	125	500	0	0	0	0	0	0	0		

Worksheet 3.1 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Closure By Removal, Offsite Landfill).

Closure By Removal Closure Plan																												
Alternative Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
2.3 NEAP Closure	2.3.6 Excavate CCR Material and Haul to Landfill	Excavate and load CCR	376,000	BCY	3,400	2	equipment per day	track hoe excavator	0	10	210	day	2	0	4,200	4,200	12,600	0	0	0	0	0	0	0	0	0	Excavation of CCR from the NEAP and hauling to onsite landfill. Includes 1-ft overexcavation.	A swell of 10% was included. Production rate based on 1.5 mile around trip onsite with a speed of 10 MPH, wait time of 15 minutes and capacity of 34 CYs. Roughly 1,900 CY/DAY.
		Hauling and dumping	413,600	LCY	116	17	haul trucks per day	tandem dump truck	15	10	210	day	17	1	35,700	37,800	113,400	0	0	0	0	0	376,000	376,000	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	210	day	1	1	2,100	4,200	12,600	1,050	500	0	0	0	0	0	0	0		
		Moisture conditioning	413,600	LCY	10,000	1	equipment per day	tractor pulled disc	0	10	42	day	1	0	420	420	1,260	0	0	0	0	0	0	0	0	0	In place MC is ~59% and assume a target of ~30%. All samples were above 30%, assume conditioning of total quantity. All samples had a MC over 45%.	Assume addition effort from track hoe for above MC 45%.
			413,600	LCY	3,400	1	equipment per day	excavator	0	10	122	day	1	0	1,220	1,220	3,660	0	0	0	0	0	0	0	0	0		
	2.3.7 Seed and Mulch	Hydroseed and mulch	21	AC	2	1	equipment per day	hydroseeder truck	250	10	11	day	1	1	110	220	660	0	0	0	0	2,750	0	0	0	0	Hydromulch assumed.	RSMeans 3292 1913 1100.
			-	-	-	1	vehicle per day	support truck	250	10	11	day	1	0	110	110	5,500	55	500	0	0	0	0	0	0	0		
		Material deliveries	0	TON	24	1	materials	truck delivery - hydroseed/mulch	250	10	0	load	1	0	0	0	0	0	0	0	0	0	0	0	0	0	-	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
	2.3.8 Constructing run off ditches and stormwater outfalls	construction details (earth work volume, materials used)?	4,000	CY	540	1	equipment per day	track hoe excavator	0	10	7	day	1	0	70	70	210	0	0	0	0	0	0	0	0	0	Ditch quantity based on closure plan drawings. Assume effort consistent with the closure plan.	RSMeans 3123 1613 0130.
			-	-	-	1	equipment per day	articulating dump truck	12	10	7	day	1	0	70	70	210	0	0	0	0	84	0	0	0	0		
		Turf reinforcement mat	5,100	SY	2,400	1	vehicle per day	support truck	15	10	2	day	1	1	20	40	120	10	500	0	0	0	0	0	0	0		RSMeans 3125 1416 0020.
		Material deliveries	1	EA	1	1	materials	truck delivery - turf reinforcement mat	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Assume to be delivered in 1 load.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
			42	EA	26	1	materials	truck delivery - riprap	250	10	2	load	1	0	20	20	0	0	0	0	0	0	0	0	500	500	Assume 3 aprons at 150 SF.	
			0	EA	0	0	materials	truck delivery - pipe material	250	10	0	load	1	0	0	0	0	0	0	0	0	0	0	0	0	0	Piping not currently included in design.	
			0	EA	0	0	materials	truck delivery - discharge pipe(s)	250	10	0	load	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	2.3.9 Install monitoring / observation wells	Drilling for monitoring well installations and abandonments	4	EA	1	1	equipment per day	drilling rig	0	10	6	day	1	0	60	60	180	0	0	0	0	0	0	0	0	0	Installed to a depth of 30-40 feet. Includes 2 days for mobilization/demobilization.	Install 4 new monitoring wells.
			-	-	-	1	vehicle per day	support truck	15	10	6	day	1	0	60	60	180	30	500	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	skid steer	0	10	6	day	1	0	60	60	180	0	0	0	0	0	0	0	0	0		
		Clearing for monitoring wells	-	-	-	1	equipment per day	track hoe excavator	0	10	1	day	1	0	10	10	30	0	0	0	0	0	0	0	0	0	2 locations are currently vegetated.	
		Material deliveries	1	EA	1	1	materials	truck delivery - flush mount	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Assume to be delivered in 1 load.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
			1	EA	1	1	materials	truck delivery - well steel	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - PVC	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - sand	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - bentonite	1,000	37	1	load	1	0	37	37	0	0	0	0	0	0	0	0	1,000	1,000		
			1	EA	1	1	materials	truck delivery - cement	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
	2.3.10 General Grading	Excavate and load from stockpile	7,800	BCY	3,400	2	equipment per day	track hoe excavator	0	10	2	day	2	0	40	40	120	0	0	0	0	0	0	0	0	0	To promote positive drainage ash is removed. Assumes onsite material from soil stripping and other sources.	A swell of 20% was included. Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping general fill	9,360	LCY	544	10	equipment per day	articulating dump truck	12	10	2	day	10	0	200	200	600	0	0	0	0	240	0	0	0	0		
		Place and spread general fill	9,360	LCY	3,500	2	equipment per day	dozer	0	10	2	day	2	0	40	40	120	0	0	0	0	0	0	0	0	0		
		Compact general fill	9,360	LCY	2,400	3	equipment per day	sheepsfoot roller	0	10	2	day	3	0	60	60	180	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	2	day	1	0	20	20	60	10	500	0	0	0	0	0	0	0		

Worksheet 3.1 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Closure By Removal, Offsite Landfill).

Closure By Removal Closure Plan																												
Alternative Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
2.4 Long Term Operations and Maintenance	2.4.1 Groundwater Monitoring	Years During construction (quarterly sampling)	21	TRIP	1	1	vehicle per day	support truck (daily mob)	250	28	21	day	1	1	588	1,176	21,000	105	0	0	0	0	0	0	0	0	Assumes 8 hours round trip travel (STL to Site) and 20 hours on site. Assume 2 person crew for safety.	Sampling intervals noted in closure plan by Others. NAP: 16 monitoring wells will be sampled and 15 observations wells will be read each trip. NEAP: 8 monitoring wells will be sampled per trip. Based on Geosyntec experience. Added sampling for 5.1 years of construction based on Owner comments.
		Years 1-5 (quarterly sampling)	20	TRIP	1	1	vehicle per day	support truck (daily mob)	250	28	20	day	1	1	560	1,120	20,000	100	0	0	0	0	0	0	0	0		
		Years 6-10 (semiannual sampling)	10	TRIP	1	1	vehicle per day	support truck (daily mob)	250	28	10	day	1	1	280	560	10,000	50	0	0	0	0	0	0	0	0		
		Years 11-30 (annual sampling)	20	TRIP	1	1	vehicle per day	support truck (daily mob)	250	28	20	day	1	1	560	1,120	20,000	100	0	0	0	0	0	0	0	0		
		Field Equipment	71	TRIP	1	1	field equipment	water level meter	0	28	71	day	0	0	1,988	0	0	0	0	0	0	0	0	0	0	0		
			71	TRIP	1	1	field equipment	ground water sampler	0	28	71	day	0	0	1,988	0	0	0	0	0	0	0	0	0	0	0		
			71	TRIP	1	8	field equipment	sample containers	0	28	71	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			71	TRIP	1	1	field equipment	pH meter	0	28	71	day	0	0	1,988	0	0	0	0	0	0	0	0	0	0	0		
			71	TRIP	1	1	field equipment	thermometer	0	28	71	day	0	0	1,988	0	0	0	0	0	0	0	0	0	0	0		
			71	TRIP	1	1	field equipment	specific conductance meter	0	28	71	day	0	0	1,988	0	0	0	0	0	0	0	0	0	0	0		
		Lab Testing	71	EA	22	1	lab test	boron test	0	1	1,562	test	0	1	1,562	1,562	46,860	0	0	0	0	0	0	0	0	0	Each trip.	
			71	EA	22	1	lab test	manganese test	0	1	1,562	test	0	1	1,562	1,562	46,860	0	0	0	0	0	0	0	0	0	Each trip.	
			8	EA	22	1	lab test	silver test	0	1	176	test	0	1	176	176	5,280	0	0	0	0	0	0	0	0	0	1st 8 quarterly trips.	
			71	EA	22	1	lab test	total dissolved solids test	0	1	1,562	test	0	1	1,562	1,562	46,860	0	0	0	0	0	0	0	0	0	Each trip.	
			71	EA	22	1	lab test	total sulfate	0	1	1,562	test	0	1	1,562	1,562	46,860	0	0	0	0	0	0	0	0	0	Each trip.	
			8	EA	22	1	lab test	radium 226	0	1	176	test	0	1	176	176	5,280	0	0	0	0	0	0	0	0	0	1st 8 quarterly trips.	
			8	EA	22	1	lab test	radium 228	0	1	176	test	0	1	176	176	5,280	0	0	0	0	0	0	0	0	0	1st 8 quarterly trips.	
	2.4.2 Surface Water Monitoring	Years During construction (weekly sampling)	266	TRIP	1	1	vehicle per day	support truck (daily mob)	250	16	266	day	1	1	4,256	8,512	266,000	1,330	0	0	0	0	0	0	0	0	Assumes 8 hours round trip travel (STL to Site) and 8 hours on site. Assume 2 person crew for safety.	Sampling intervals are weekly for Outfalls 001 (NAP) and 003 (NEAP) as noted in permit. Based on Geosyntec experience. Added sampling for 5.1 years of construction based on Owner comments.
		Years 1-30 (weekly sampling)	1,560	TRIP	1	1	vehicle per day	support truck (daily mob)	250	16	1,560	day	1	1	24,960	49,920	1,560,000	7,800	0	0	0	0	0	0	0	0		
		Lab Testing	1,826	TRIP	2	1	lab test	total suspended solids	0	1	3,652	test	0	1	3,652	3,652	109,560	0	0	0	0	0	0	0	0	0	Each trip. 24 hour composite sample.	
			457	TRIP	2	1	lab test	oil and grease	0	1	913	test	0	1	913	913	27,390	0	0	0	0	0	0	0	0	0	Monthly. Grab sample.	
			1,826	TRIP	2	1	lab test	total dissolved solids	0	1	3,652	test	0	1	3,652	3,652	109,560	0	0	0	0	0	0	0	0	0	Each trip. 24 hour composite sample.	
			1,826	TRIP	2	1	lab test	sulfates	0	1	3,652	test	0	1	3,652	3,652	109,560	0	0	0	0	0	0	0	0	0	Each trip. 24 hour composite sample.	
			1,826	TRIP	2	1	lab test	boron	0	1	3,652	test	0	1	3,652	3,652	109,560	0	0	0	0	0	0	0	0	0	Each trip. 24 hour composite sample.	
			457	TRIP	2	1	lab test	iron	0	1	913	test	0	1	913	913	27,390	0	0	0	0	0	0	0	0	0	Monthly. 24 hour composite sample.	

	Equipment and Vehicle Total Hours	**Labor Total Hours**	**Daily Labor Mobilization Miles**	**Vehicles Miles Onsite**	**Vehicle Mob/Demob Mileage**	**Equipment Mobilization Miles - Unloaded**	**Equipment Mobilization Miles - Loaded**	**Daily Equipment Miles Onsite**	**Daily Haul Truck Miles - Unloaded**	**Daily Haul Truck Miles - Loaded**	**Material Delivery Miles - Unloaded**	**Material Delivery Miles - Loaded**
Selected Closure Plan Totals	**845,959**	**681,723**	**4,934,950**	**123,501**	**21,500**	**44,250**	**44,250**	**49,586**	**2,589,015**	**2,589,015**	**144,500**	**144,500**

Worksheet 3.2 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Closure By Removal, Onsite Landfill).

Closure By Removal Closure Plan																												
Alternative Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
2.1 NAP Closure	2.1.1 Project Duration Items	Project duration	-	-	-	0	-	-	0	0	4.8	years	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	Schedule not defined, assume 4.8 years total project duration.
		Owner's representative site visits	-	-	-	1	vehicle per day	support truck (daily mob)	250	10	250	day	1	0	2,500	2,500	125,000	1,250	0	0	0	0	0	0	0	0	Weekly site visits.	
		Contractor Construction & Safety Managers	-	-	-	2	vehicle per day	support truck	15	10	1,248	day	2	1	24,960	37,440	112,320	12,480	500	0	0	0	0	0	0	0	Three full time staff.	
		Office facilities	-	-	-	2	equipment per day	work trailer	0	10	1,248	day	0	0	24,960	0	0	0	0	0	0	0	0	0	0	0	Office Trailer.	
		Electric usage (average per day)	1,248,000	KWH	100	0	KWH per day	electricity	0	10	1,248	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Assume 50 kWh per trailer.	
		Site specific security	-	-	-	1	vehicle per day	support truck	15	10	1,248	day	1	0	12,480	12,480	37,440	6,240	500	0	0	0	0	0	0	0	One full time staff.	
		CQA Officer / Engineer site visit	-	-	-	1	vehicle per day	support truck (daily mob)	250	10	250	day	1	0	2,500	2,500	125,000	1,250	0	0	0	0	0	0	0	0	Weekly site visits.	
		CQA staff	-	-	-	1	vehicle per day	support truck	15	10	1,248	day	1	0	12,480	12,480	37,440	6,240	500	0	0	0	0	0	0	0	One full time staff.	
		Equipment mobilization	-	-	-	61	equipment mob	heavy equipment mob	250	10	1	mob	61	0	610	610	1,830	0	0	15,250	15,250	0	0	0	0	0	Estimated mobilization for heavy equipment. Includes all non vehicles. Vehicles are assumed to travel to the site daily.	
		Equipment fueling	-	-	-	1	vehicle per day	fuel truck	15	2	1,248	day	1	0	2,496	2,496	37,440	6,240	0	0	0	0	0	0	0	0	Daily refueling.	
		Portable restrooms	-	-	-	1	equipment per day	restroom units	0	10	1,248	day	0	0	12,480	0	0	0	0	0	0	0	0	0	0	0	Full time.	
		Portable restroom service	-	-	-	1	vehicle per day	maintenance vehicle	15	2	250	day	1	0	500	500	7,500	1,250	0	0	0	0	0	0	0	0		
		Dust suppression	-	-	-	1	equipment per day	water truck	12	10	1,248	day	1	0	12,480	12,480	37,440	0	0	0	0	14,976	0	0	0	0		
		Groundwater monitoring	-	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Monitoring included in Task 2.4.	-
		NPDES monitoring	-	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	2.1.2 Install EPSC Measures	Silt fence	2,650	LF	1,300	1	vehicle per day	support truck	15	10	3	day	1	1	30	60	180	15	500	0	0	0	0	0	0	0	Assumes silt fence not required along west side.	RSMeans 3125 1416 1000.
		Material deliveries	1	EA	1	1	materials	truck delivery - silt fence	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Assume to be delivered in 1 load.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
	2.1.3 Unwatering NAP and Secondary NAP	Pump NAP to Secondary NAP, pump Secondary NAP to NPDES Outfall 001	14	MG	1	2	equipment per day	6-inch pump	0	10	14	day	1	0	280	140	420	0	0	0	0	0	0	0	0	0	Assume 1 pump from the NAP to the Secondary NAP and 1 pump from the Secondary NAP to Outfall 001. Assume 40 hp pump.	Volumes and pump rates provided in Stantec Unwatering and Dewatering Memo (4/19/19). Assume effort consistent with the closure plan.
			10,360	KWH	74	0	KWH per hour	electricity	0	10	14	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	14	day	1	0	140	0	0	70	500	0	0	0	0	0	0	0		
	2.1.4 Dewatering and Stormwater Management	Excavate dewatering ditches and install dewatering sumps	31,700	CY	540	3	equipment per day	track hoe excavator	0	10	20	day	3	0	600	600	1,800	0	0	0	0	0	0	0	0	0	Assume dewatering to a depth of 10 feet with 15-foot ditches and sumps. Assume 2,000 LF of 15-foot, 1:1 slope ditches, 4-foot base. Assume effort consistent with the closure plan.	RSMeans 3123 1613 0130.
			-	-	-	3	equipment per day	articulating dump truck	12	10	20	day	3	0	600	600	1,800	0	0	0	0	720	0	0	0	0		
			-	-	-	1	equipment per day	dozer	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	smooth drum roller	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	0	10	20	day	1	0	200	200	0	100	500	0	0	0	0	0	0	0		
		Dewater for Excavation	80	MG	0	3	equipment per day	sump pump	0	10	730	day	1	0	21,900	7,300	21,900	0	0	0	0	0	0	0	0	0	Assume 3 sump locations, 7 days per week for 6 months dewatering. Assume stormwater management for 4.8 years. Assume 40 hp pump. Assume a 50% increase of the effort for the closure plan split between the NAP (2/3) and OEAP (1/3) for stormwater management.	Volumes provided in Stantec Unwatering and Dewatering Memo (4/19/19). Assume effort consistent with the closure plan.
			810,300	KWH	111	0	KWH per hour	electricity	0	10	730	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Stormwater Management	358	MG	0	3	equipment per day	sump pump	0	10	913	day	1	0	27,390	9,130	27,390	0	0	0	0	0	0	0	0	0		
			1,013,430	KWH	111	0	KWH per hour	electricity	0	10	913	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	1,643	day	0	0	16,430	0	0	8,215	500	0	0	0	0	0	0	0		
	2.1.5 Soil Stripping and Stockpiling	Excavation and loading soil	65,300	BCY	3,400	1	equipment per day	track hoe excavator	0	10	14	day	1	0	140	140	420	0	0	0	0	0	0	0	0	0	Soil to be stockpiled onsite and used to regraded excavated areas.	A swell of 10% was included. Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping in stockpile	71,830	LCY	544	10	equipment per day	articulating dump truck	12	10	14	day	10	1	1,400	1,540	4,620	0	0	0	0	1,680	0	0	0	0		
		Place and spread in stockpile	71,830	LCY	3,500	1	equipment per day	dozer	0	10	14	day	1	1	140	280	840	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	14	day	1	0	140	140	420	70	500	0	0	0	0	0	0	0		
	2.1.6 Excavate CCR Material and Haul to Landfill	Excavate and load CCR	1,171,000	BCY	3,400	1	equipment per day	track hoe excavator	0	10	588	day	1	0	5,880	5,880	17,640	0	0	0	0	0	0	0	0	0	Excavation of CCR from the NAP and haul to onsite landfill. Includes 1-ft overexcavation.	A swell of 10% was included. Production rate based on 30 mile around trip with a speed of 35 MPH, wait time of 15 minutes and capacity of 16.5 CYs. Roughly 2,000 CY/DAY.
		Hauling and dumping	1,288,100	LCY	510	4	haul trucks per day	articulating dump truck	12	10	588	day	4	1	25,284	31,164	93,492	0	0	0	0	0	30,341	30,341	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	588	day	1	1	5,880	11,760	35,280	2,940	500	0	0	0	0	0	0	0		
		Moisture conditioning	1,288,100	LCY	10,000	1	equipment per day	tractor pulled disc	0	10	129	day	1	0	1,290	1,290	3,870	0	0	0	0	0	0	0	0	0	In place MC is ~35% and assume a target of ~30%. The majority of samples were above 30%, assume conditioning of total quantity. 10% of the samples had a MC over 45%.	Assume addition effort from track hoe for above MC 45%.
			128,810	LCY	3,400	1	equipment per day	excavator	0	10	38	day	1	0	380	380	1,140	0	0	0	0	0	0	0	0	0		
	2.1.7 Excavate Coal Yard Material and Haul to Landfill	Excavate and load CCR	50,000	BCY	3,400	1	equipment per day	track hoe excavator	0	10	26	day	1	0	260	260	780	0	0	0	0	0	0	0	0	0	Excavation of coal from the Coal Yard and haul to offsite landfill. Includes 1-ft overexcavation.	Volume provided by the Owner. A swell of 10% was included. Production rate based on 1 mile around trip onsite with a speed of 10 MPH, wait time of 15 minutes and capacity of 34 CYs. Roughly 2,200 CY/DAY.
		Hauling and dumping	55,000	LCY	510	4	haul trucks per day	articulating dump truck	12	10	26	day	4	0	1,118	1,118	3,354	0	0	0	0	0	1,342	1,342	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	26	day	1	0	260	260	780	130	500	0	0	0	0	0	0	0		
	2.1.8 Seed and Mulch	Hydroseed and mulch	40	AC	2	1	equipment per day	hydroseeder truck	250	10	20	day	1	1	200	400	1,200	0	0	0	0	5,000	0	0	0	0	Hydromulch assumed.	RSMeans 3292 1913 1100.
			-	-	-	1	vehicle per day	support truck	250	10	20	day	1	0	200	200	10,000	100	500	0	0	0	0	0	0	0		
		Material deliveries	30	TON	24	1	materials	truck delivery - hydroseed/mulch	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	Assume 26 CY truck or 48,000 LB flat bed delivery truck.

Worksheet 3.2 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Closure By Removal, Onsite Landfill).

Closure By Removal Closure Plan

Alternative Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
2.1 NAP Closure	2.1.9 Install monitoring / observation wells	Drilling for monitoring well and observation well installations, drilling for abandonment of monitoring wells	4	EA	1	1	equipment per day	drilling rig	0	10	6	day	1	0	60	60	180	0	0	0	0	0	0	0	0	0	Assumes wells will be powered with onsite power. Includes 2 days for mobilization/demobilization.	Install 4 new monitoring wells.
			-	-	-	1	vehicle per day	support truck (daily mob)	250	10	6	day	1	0	60	60	3,000	30	0	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	skid steer	0	10	6	day	1	0	60	60	180	0	0	0	0	0	0	0	0	0		
		Clearing for monitoring wells	-	-	-	1	equipment per day	track hoe excavator	0	10	5	day	1	0	50	50	150	0	0	0	0	0	0	0	0	0	8 locations are currently vegetated.	
		Material deliveries	1	EA	1	1	materials	truck delivery - flush mount	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Assume to be delivered in 1 load.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
			1	EA	1	1	materials	truck delivery - well steel	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - PVC	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - sand	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - bentonite	250	37	1	load	1	0	37	37	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - cement	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
	2.1.10 General Grading	Excavate and load from stockpile	253,000	BCY	3,400	2	equipment per day	track hoe excavator	0	10	56	day	2	0	1,120	1,120	3,360	0	0	0	0	0	0	0	0	0	To promote positive drainage once the ash is removed. Assumes onsite material from soil stripping and other sources.	A swell of 20% was included. Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping general fill	303,600	LCY	544	10	equipment per day	articulating dump truck	12	10	56	day	10	0	5,600	5,600	16,800	0	0	0	0	6,720	0	0	0	0		
		Place and spread general fill	303,600	LCY	3,500	2	equipment per day	dozer	0	10	56	day	2	0	1,120	1,120	3,360	0	0	0	0	0	0	0	0	0		
		Compact general fill	303,600	LCY	2,400	3	equipment per day	sheepsfoot roller	0	10	56	day	3	0	1,680	1,680	5,040	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	1	day	1	0	10	10	30	5	500	0	0	0	0	0	0	0		
		Riprap Protection for Stormwater Inflow Into the NAP	-	-	-	2	equipment per day	track hoe excavator	0	10	15	day	2	0	300	300	900	0	0	0	0	0	0	0	0	0	Riprap at geotextile fabric to reduce velocity in the NAP.	
			-	-	-	1	equipment per day	articulating dump truck	12	10	15	day	1	0	150	150	450	0	0	0	0	180	0	0	0	0		
			-	-	-	1	equipment per day	dozer	0	10	15	day	1	0	150	150	450	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	15	day	1	0	150	150	450	75	500	0	0	0	0	0	0	0		
			-	-	-	2	vehicle per day	support truck	15	10	15	day	2	1	300	450	1,350	150	500	0	0	0	0	0	0	0		
			11,111	CY	26	1	materials	truck delivery - riprap	250	10	427	load	1	0	4,270	4,270	0	0	0	0	0	0	0	0	106,750	106,750	Assume 100,000 SF of riprap at 18-inches thick.	
			1	EA	1	1	materials	truck delivery - geotextile	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
2.2 OEAP Closure	2.2.1 Preconstruction Tasks	Groundwater Collection Trench	-	-	-	1	equipment per day	one pass trencher	0	10	40	day	1	0	400	400	1,200	0	0	0	0	0	0	0	0	0	Scope not defined. Improvements may not be necessary dependent on results of stability analyses. Work depicted assumed based on current understanding of the project. Includes Construction Manager, laborers, and CQA staff.	2 months, to be refined during design phase.
			-	-	-	2	equipment per day	front end loader	0	10	40	day	2	0	800	800	2,400	0	0	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	dozer	0	10	40	day	1	0	400	400	1,200	0	0	0	0	0	0	0	0	0		
						1	equipment per day	articulating dump truck	12	10	40		1	0	400	400	1,200	0	0	0	0	480	0	0	0	0		
						1	equipment per day	6-inch pump	0	10	40		1	0	400	400	1,200	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	40	day	1	0	400	400	1,200	200	500	0	0	0	0	0	0	0		
			-	-	-	2	vehicle per day	support truck	15	10	40	day	2	0	800	800	2,400	400	500	0	0	0	0	0	0	0		
			1,500	LF	1,500	1	materials	truck delivery - 6-inch piping	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Piping to dewater trench excavation and take to the NEAP.	
			3,000	LF	1,500	1	materials	truck delivery - 4-inch piping	250	10	2	load	1	0	20	20	0	0	0	0	0	0	0	0	500	500		
			1,222	CY	26	1	materials	truck delivery - coarse aggregate	250	10	47	load	1	0	470	470	0	0	0	0	0	0	0	0	11,750	11,750	Assume emergency buttress of 1,100 ft x 30 ft x 2 ft .	
			1	EA	1	1	materials	truck delivery - geotextile	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
		OEAP Riverslope Stabilization Installation	-	-	-	2	equipment per day	track hoe excavator	0	10	30	day	2	0	600	600	1,800	0	0	0	0	0	0	0	0	0	Scope not defined. Improvements may not be necessary dependent on results of stability analyses. Work depicted assumed based on current understanding of the project. Includes Construction Manager, laborers, and CQA staff.	6 weeks, to be refined during design phase.
			-	-	-	1	equipment per day	articulating dump truck	12	10	30	day	1	0	300	300	900	0	0	0	0	360	0	0	0	0		
			-	-	-	1	equipment per day	dozer	0	10	30	day	1	0	300	300	900	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	30	day	1	0	300	300	900	150	500	0	0	0	0	0	0	0		
			-	-	-	2	vehicle per day	support truck	15	10	30	day	2	1	600	900	2,700	300	500	0	0	0	0	0	0	0		
			1,852	CY	26	1	materials	truck delivery - riprap	250	10	71	load	1	0	710	710	0	0	0	0	0	0	0	0	17,750	17,750	Assume emergency buttress of 1,000 ft x 10 ft x 10 ft .	
			1	EA	1	1	materials	truck delivery - geotextile	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
		OEAP Riverslope Stabilization Removal	-	-	-	1	equipment per day	track hoe excavator	0	10	10	day	1	0	100	100	300	0	0	0	0	0	0	0	0	0	Temporary improvement that will be removed in the future.	2 weeks.
			-	-	-	1	equipment per day	articulating dump truck	12	10	10	day	1	0	100	100	300	0	0	0	0	120	0	0	0	0		
			-	-	-	1	equipment per day	dozer	0	10	10	day	1	0	100	100	300	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	10	day	1	0	100	100	300	50	500	0	0	0	0	0	0	0		

Worksheet 3.2 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Closure By Removal, Onsite Landfill).

Closure By Removal Closure Plan																												
Alternative Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
2.2 OEAP Closure	2.2.2 Project Duration Items	Project duration	-	-	-	0	-	-	0	0	2.3	years	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	Schedule not defined, assume 2.5 years total project duration.
		Owner's representative site visits	-	-	-	1	vehicle per day	support truck (daily mob)	250	10	120	day	1	0	1,200	1,200	60,000	600	0	0	0	0	0	0	0	0	Weekly site visits.	
		Contractor Construction & Safety Managers	-	-	-	2	vehicle per day	support truck	15	10	598	day	2	1	11,960	17,940	53,820	5,980	500	0	0	0	0	0	0	0	Three full time staff.	
		Office facilities	-	-	-	2	equipment per day	work trailer	0	10	598	day	0	0	11,960	0	0	0	0	0	0	0	0	0	0	0	Office Trailer.	
		Electric usage (average per day)	598,000	KWH	100	0	KWH per day	electricity	0	10	598	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Assume 50 kWh per trailer.	
		Site specific security	-	-	-	1	vehicle per day	support truck	15	10	598	day	1	0	5,980	5,980	17,940	2,990	500	0	0	0	0	0	0	0	One full time staff.	
		CQA Officer / Engineer site visit	-	-	-	1	vehicle per day	support truck (daily mob)	250	10	120	day	1	0	1,200	1,200	60,000	600	0	0	0	0	0	0	0	0	Weekly site visits.	
		CQA staff	-	-	-	1	vehicle per day	support truck	15	10	598	day	1	0	5,980	5,980	17,940	2,990	500	0	0	0	0	0	0	0	One full time staff.	
		Equipment mobilization	-	-	-	63	equipment mob	heavy equipment mob	250	10	1	mob	63	0	630	630	1,890	0	0	15,750	15,750	0	0	0	0	0	Estimated mobilization for heavy equipment. Includes all non vehicles. Vehicles are assumed to travel to the site daily.	
		Equipment fueling	-	-	-	1	vehicle per day	fuel truck	15	2	598	day	1	0	1,196	1,196	17,940	2,990	0	0	0	0	0	0	0	0	Daily refueling.	
		Portable restrooms	-	-	-	1	equipment per day	restroom units	0	10	598	day	0	0	5,980	0	0	0	0	0	0	0	0	0	0	0	Full time.	
		Portable restroom service	-	-	-	1	vehicle per day	maintenance vehicle	15	2	120	day	1	0	240	240	3,600	600	0	0	0	0	0	0	0	0		
		Dust suppression	-	-	-	1	equipment per day	water truck	0	10	598	day	1	0	5,980	5,980	17,940	0	0	0	0	0	0	0	0	0		
		Groundwater monitoring	-	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Monitoring included in Task 2.4.	-
		NPDES monitoring	-	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	2.2.3 Install EPSC Measures	Silt fence	2,350	LF	1,300	1	vehicle per day	support truck	15	10	2	day	1	1	20	40	120	10	500	0	0	0	0	0	0	0	Assumes silt fence not required along south side.	RSMeans 3125 1416 1000.
		Material deliveries	1	EA	1	1	materials	truck delivery - silt fence	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Assume to be delivered in 1 load.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
	2.2.4 Dewatering and Stormwater Management	Excavate dewatering ditches and install dewatering sumps	15,900	CY	540	3	equipment per day	track hoe excavator	0	10	10	day	3	0	300	300	900	0	0	0	0	0	0	0	0	0	Assume dewatering to a depth of 10 feet with 15-foot ditches and sumps. Assume 1,000 LF of 15-foot, 1:1 slope ditches, 4-foot base. Assume effort consistent with the closure plan.	RSMeans 3123 1613 0130.
			-	-	-	3	equipment per day	articulating dump truck	12	10	10	day	3	0	300	300	900	0	0	0	0	360	0	0	0	0		
			-	-	-	1	equipment per day	dozer	0	10	10	day	1	0	100	100	300	0	0	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	smooth drum roller	0	10	10	day	1	0	100	100	300	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	0	10	10	day	1	0	100	100	0	50	500	0	0	0	0	0	0	0		
		Dewater for Excavation	0	MG	-	3	equipment per day	sump pump	0	10	0	day	1	0	0	0	0	0	0	0	0	0	0	0	0	0	Assume 3 sump locations, 7 days per week for 6 months dewatering. Assume stormwater management for 2.3 years. Assume 40 hp pump. Assume a 50% increase of the effort for the closure plan split between the NAP (2/3) and OEAP (1/3).	Volumes provided in Stantec Unwatering and Dewatering Memo (4/19/19). Assume effort consistent with the closure plan.
			0	KWH	111	0	KWH per hour	electricity	0	10	0	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Stormwater Management	86	MG	0	3	equipment per day	sump pump	0	10	840	day	1	0	25,200	8,400	25,200	0	0	0	0	0	0	0	0	0		
			932,400	KWH	111	0	KWH per hour	electricity	0	10	840	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	840	day	0	0	8,400	0	0	4,200	500	0	0	0	0	0	0	0		
	2.2.5 Soil Stripping and Stockpiling	Excavation and loading soil	283,000	BCY	3,400	1	equipment per day	track hoe excavator	0	10	58	day	1	0	580	580	1,740	0	0	0	0	0	0	0	0	0	Soil to be stockpiled onsite and used to regraded excavated areas.	A swell of 20% was included. Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping in stockpile	311,300	LCY	544	10	equipment per day	articulating dump truck	12	10	58	day	10	1	5,800	6,380	19,140	0	0	0	0	6,960	0	0	0	0		
		Place and spread in stockpile	311,300	LCY	3,500	1	equipment per day	dozer	0	10	58	day	1	1	580	1,160	3,480	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	58	day	1	0	580	580	1,740	290	500	0	0	0	0	0	0	0		
	2.2.6 Excavate CCR Material and Haul to Landfill	Excavate and load CCR	992,000	BCY	3,400	1	equipment per day	track hoe excavator	0	10	498	day	1	0	4,980	4,980	14,940	0	0	0	0	0	0	0	0	0	Excavation of CCR from the OEAP and haul to offsite landfill. Includes 1-ft overexcavation.	A swell of 10% was included. Production rate based on 1 mile around trip onsite with a speed of 10 MPH, wait time of 15 minutes and capacity of 34 CYs. Roughly 2,200 CY/DAY.
		Hauling and dumping	1,091,200	LCY	510	4	haul trucks per day	articulating dump truck	12	10	498	day	4	1	21,414	26,394	79,182	0	0	0	0	0	25,697	25,697	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	498	day	1	1	4,980	9,960	29,880	2,490	500	0	0	0	0	0	0	0		
		Moisture conditioning	1,091,200	LCY	10,000	1	equipment per day	tractor pulled disc	0	10	110	day	1	0	1,100	1,100	3,300	0	0	0	0	0	0	0	0	0	In place MC is ~39% and assume a target of ~30%. The majority of samples were above 30%, assume conditioning of total quantity. 10% of the samples had a MC over 45%.	Assume addition effort from track hoe for above MC 45%.
			109,120	LCY	3,400	1	equipment per day	excavator	0	10	33	day	1	0	330	330	990	0	0	0	0	0	0	0	0	0		
	2.2.7 Abandon or Removal of OEAP Drainage Pipes	Excavation and backfill	-	-	-	1	equipment per day	track hoe excavator	0	10	1	day	1	0	10	10	30	0	0	0	0	0	0	0	0	0	Two pipes have been located that require removal from the ash ponds.	Assume 1 day to excavated and haul off.
		Compact	-	-	-	1	equipment per day	sheepsfoot roller	0	10	1	day	1	0	10	10	30	0	0	0	0	0	0	0	0	0		
		Haul Off	-	-	-	1	haul trucks per day	tandem dump truck	15	10	1	day	1	0	10	10	30	0	0	0	0	0	15	15	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	1	day	1	1	10	20	60	5	500	0	0	0	0	0	0	0		
	2.2.8 Seed and Mulch	Hydroseed and mulch	20	AC	2	1	equipment per day	hydroseeder truck	250	10	10	day	1	1	100	200	600	0	0	0	0	2,500	0	0	0	0	Hydromulch assumed.	RSMeans 3292 1913 1100.
			-	-	-	1	vehicle per day	support truck	250	10	10	day	1	0	100	100	5,000	50	500	0	0	0	0	0	0	0		
		Material deliveries	15	TON	24	1	materials	truck delivery - hydroseed/mulch	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	Assume 26 CY truck or 48,000 LB flat bed delivery truck.

Worksheet 3.2 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Closure By Removal, Onsite Landfill).

Closure By Removal Closure Plan																												
Alternative Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
2.2 OEAP Closure	2.2.9 Install monitoring / observation wells	Drilling monitoring well and observation well installations, drilling for abandonment monitoring wells	4	EA	1	1	equipment per day	drilling rig	0	10	6	day	1	0	60	60	180	0	0	0	0	0	0	0	0	0	Includes 2 days for mobilization/demobilization.	Install 4 new monitoring wells.
			-	-	-	1	vehicle per day	support truck (daily mob)	250	10	6	day	1	0	60	60	3,000	30	0	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	skid steer	0	10	6	day	1	0	60	60	180	0	0	0	0	0	0	0	0	0		
		Clearing for monitoring wells	-	-	-	1	equipment per day	track hoe excavator	0	10	5	day	1	0	50	50	150	0	0	0	0	0	0	0	0	0	2 locations are currently vegetated.	
		Material deliveries	1	EA	1	1	materials	truck delivery - flush mount	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Assume to be delivered in 1 load.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
			1	EA	1	1	materials	truck delivery - well steel	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - PVC	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - sand	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - bentonite	0	37	1	load	1	0	37	37	0	0	0	0	0	0	0	0	0	0		
			1	EA	1	1	materials	truck delivery - cement	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
	2.2.10 General Grading	Excavate and load from stockpile	84,000	BCY	3,400	2	equipment per day	track hoe excavator	0	10	19	day	2	0	380	380	1,140	0	0	0	0	0	0	0	0	0	To promote positive drainage once the ash is removed. Assumes onsite material from soil stripping and other sources. OEAP is not assumed to be usable.	A swell of 20% was included. Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping general fill	100,800	LCY	544	10	equipment per day	articulating dump truck	12	10	19	day	10	0	1,900	1,900	5,700	0	0	0	0	2,280	0	0	0	0		
		Place and spread general fill	100,800	LCY	3,500	2	equipment per day	dozer	0	10	19	day	2	0	380	380	1,140	0	0	0	0	0	0	0	0	0		
		Compact general fill	100,800	LCY	2,400	3	equipment per day	sheepsfoot roller	0	10	19	day	3	0	570	570	1,710	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	19	day	1	0	190	190	570	95	500	0	0	0	0	0	0	0		
2.3 NEAP Closure	2.3.1 Project Duration Items	Project Duration	-	-	-	0	-	-	0	0	3.0	years	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	Schedule not defined, assume 3.1 years total project duration.
		Owner's representative site visits	-	-	-	1	vehicle per day	support truck (daily mob)	250	10	156	day	1	0	1,560	1,560	78,000	780	0	0	0	0	0	0	0	0	Weekly site visits.	
		Contractor Construction & Safety Managers	-	-	-	2	vehicle per day	support truck	15	10	780	day	2	1	15,600	23,400	70,200	7,800	500	0	0	0	0	0	0	0	Three full time staff.	
		Office facilities	-	-	-	2	unit per day	work trailer	0	10	780	day	0	0	15,600	0	0	0	0	0	0	0	0	0	0	0	Office Trailer.	
		Electric usage (average per day)	780,000	KWH	100	0	KWH per day	electricity	0	10	780	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Assume 50 kWh per trailer.	
		Site specific security	-	-	-	1	vehicle per day	support truck	15	10	780	day	1	0	7,800	7,800	23,400	3,900	500	0	0	0	0	0	0	0	One full time staff.	
		CQA Officer / Engineer site visit	-	-	-	1	vehicle per day	support truck (daily mob)	250	10	36	day	1	0	360	360	18,000	180	0	0	0	0	0	0	0	0	Monthly site visits.	
		CQA staff	-	-	-	1	vehicle per day	support truck	15	10	780	day	1	0	7,800	7,800	23,400	3,900	500	0	0	0	0	0	0	0	One full time staff.	
		Equipment mobilization	-	-	-	53	equipment mob	heavy equipment mob	250	10	1	mob	53	0	530	530	1,590	0	0	13,250	13,250	0	0	0	0	0	Estimated mobilization for heavy equipment. Includes all non vehicles. Vehicles are assumed to travel to the site daily.	
		Equipment fueling	-	-	-	1	vehicle per day	fuel truck	15	1	780	day	1	0	780	780	23,400	3,900	0	0	0	0	0	0	0	0	Daily refueling.	
		Portable restrooms	-	-	-	1	equipment per day	restroom units	0	10	780	day	0	0	7,800	0	0	0	0	0	0	0	0	0	0	0	Full time.	
		Portable restroom service	-	-	-	1	vehicle per day	maintenance truck	15	2	156	day	1	0	312	312	4,680	780	0	0	0	0	0	0	0	0		
		Dust suppression	-	-	-	1	equipment per day	water truck	0	10	780	day	1	0	7,800	7,800	23,400	0	0	0	0	0	0	0	0	0		
		Groundwater monitoring	-	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Monitoring included in Task 2.4.	-
		NPDES monitoring	-	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	2.3.2 Install EPSC Measures	Silt fence	5,000	LF	1,300	1	vehicle per day	support truck	15	10	4	day	1	1	40	80	240	20	500	0	0	0	0	0	0	0	Assumes silt fence not required along west side.	RSMeans 3125 1416 1000.
		Material deliveries	1	EA	1	1	materials	truck delivery - silt fence	0	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	0	0	Assume to be delivered in 1 load.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
	2.3.3 Unwatering NEAP and Secondary NEAP	Pump NEAP to Secondary NEAP, pump Secondary NEAP to NPDES Outfall 003	3	MG	0	2	equipment per day	6-inch pump	0	10	15	day	2	0	300	300	900	0	0	0	0	0	0	0	0	0	Assume 1 pump from the NEAP to the Sec. NEAP and 1 pump from the Secondary NEAP to Outfall 003. Assume 40 hp pump.	Volumes and pump rates provided in Stantec Unwatering and Dewatering Memo (4/19/19). Assume effort consistent with the closure plan.
			11,100	KWH	74	0	KWH per hour	electricity	0	10	15	day	2	0	0	0	0	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	15	day	2	0	150	300	900	75	500	0	0	0	0	0	0	0		
	2.3.4 Dewatering and Stormwater Management	Excavate dewatering ditches and install dewatering sumps	10,600	CY	540	1	equipment per day	track hoe excavator	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0	Assume dewatering to a depth of 10 feet with 15-foot ditches and sumps. Assume 1,000 LF of 15-foot, 1:1 slope ditches, 4-foot base. Assume effort consistent with the closure plan.	RSMeans 3123 1613 0130.
			-	-	-	1	equipment per day	articulating dump truck	12	10	20	day	1	0	200	200	600	0	0	0	0	240	0	0	0	0		
			-	-	-	1	equipment per day	dozer	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	smooth drum roller	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	0	10	20	day	1	0	200	200	0	100	500	0	0	0	0	0	0	0		
		Dewater for Excavation	17	MG	0	3	equipment per day	sump pump	0	10	730	day	1	0	21,900	7,300	21,900	0	0	0	0	0	0	0	0	0	Assume 3 sump locations, 7 days per week for 6 months dewatering. Assume stormwater management for 3 years. Assume 40 hp pump. Assume effort consistent with the closure plan.	Volumes provided in Stantec Unwatering and Dewatering Memo (4/19/19). Assume effort consistent with the closure plan.
			810,300	KWH	111	0	KWH per hour	electricity	0	10	730	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Stormwater Management	99	MG	0	3	equipment per day	sump pump	0	10	1,095	day	1	0	32,850	10,950	32,850	0	0	0	0	0	0	0	0	0		
			1,215,450	KWH	111	0	KWH per hour	electricity	0	10	1,095	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			-	-	-	1	vehicle per day	support truck	15	10	1,825	day	0	0	18,250	0	0	9,125	500	0	0	0	0	0	0	0		
	2.3.5 Soil Stripping and Stockpiling	Excavation and loading soil	119,500	BCY	3,400	1	equipment per day	track hoe excavator	0	10	25	day	1	0	250	250	750	0	0	0	0	0	0	0	0	0	Soil to be stockpiled onsite and used to regraded excavated areas.	A swell of 20% was included. Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping in stockpile	131,450	LCY	544	10	equipment per day	articulating dump truck	12	10	25	day	10	1	2,500	2,750	8,250	0	0	0	0	3,000	0	0	0	0		
		Place and spread in stockpile	131,450	LCY	3,500	1	equipment per day	dozer	0	10	25	day	1	1	250	500	1,500	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	25	day	1	0	250	250	750	125	500	0	0	0	0	0	0	0		

Worksheet 3.2 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Closure By Removal, Onsite Landfill).

Closure By Removal Closure Plan

Alternative Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
2.3 NEAP Closure	2.3.6 Excavate CCR Material and Haul to Landfill	Excavate and load CCR	376,000	BCY	3,400	2	equipment per day	track hoe excavator	0	10	185	day	2	0	3,700	3,700	11,100	0	0	0	0	0	0	0	0	0	Excavation of CCR from the NEAP and hauling to onsite landfill. Includes 1-ft overexcavation.	A swell of 10% was included. Production rate based on 1 mile around trip onsite with a speed of 10 MPH, wait time of 15 minutes and capacity of 34 CYs. Roughly 2,200 CY/DAY.
		Hauling and dumping	413,600	LCY	476	5	haul trucks per day	articulating dump truck	12	10	185	day	5	1	8,695	10,545	31,635	0	0	0	0	0	10,434	10,434	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	185	day	1	1	1,850	3,700	11,100	925	500	0	0	0	0	0	0	0		
		Moisture conditioning	413,600	LCY	10,000	1	equipment per day	tractor pulled disc	0	10	42	day	1	0	420	420	1,260	0	0	0	0	0	0	0	0	0	In place MC is ~59% and assume a target of ~30%. All samples were above 30%, assume conditioning of total quantity. All samples had a MC over 45%.	Assume addition effort from track hoe for above MC 45%.
			413,600	LCY	3,400	1	equipment per day	excavator	0	10	122	day	1	0	1,220	1,220	3,660	0	0	0	0	0	0	0	0	0		
	2.3.7 Seed and Mulch	Hydroseed and mulch	21	AC	2	1	equipment per day	hydroseeder truck	250	10	11	day	1	1	110	220	660	0	0	0	0	2,750	0	0	0	0	Hydromulch assumed.	RSMeans 3292 1913 1100.
			-	-	-	1	vehicle per day	support truck	250	10	11	day	1	0	110	110	5,500	55	500	0	0	0	0	0	0	0		
		Material deliveries	0	TON	24	1	materials	truck delivery - hydroseed/mulch	250	10	0	load	1	0	0	0	0	0	0	0	0	0	0	0	0	0	-	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
	2.3.8 Constructing run off ditches and stormwater outfalls	construction details (earth work volume, materials used)?	4,000	CY	540	1	equipment per day	track hoe excavator	0	10	7	day	1	0	70	70	210	0	0	0	0	0	0	0	0	0	Ditch quantity based on closure plan drawings. Assume effort consistent with the closure plan.	RSMeans 3123 1613 0130.
			-	-	-	1	equipment per day	articulating dump truck	12	10	7	day	1	0	70	70	210	0	0	0	0	84	0	0	0	0		
		Turf reinforcement mat	5,100	SY	2,400	1	vehicle per day	support truck	15	10	2	day	1	1	20	40	120	10	500	0	0	0	0	0	0	0		RSMeans 3125 1416 0020.
		Material deliveries	1	EA	1	1	materials	truck delivery - turf reinforcement mat	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Assume to be delivered in 1 load.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
			42	EA	26	1	materials	truck delivery - riprap	250	10	2	load	1	0	20	20	0	0	0	0	0	0	0	0	500	500	Assume 3 aprons at 150 SF.	
			0	EA	0	0	materials	truck delivery - pipe material	250	10	0	load	1	0	0	0	0	0	0	0	0	0	0	0	0	0	Piping not currently included in design.	
			0	EA	0	0	materials	truck delivery - discharge pipe(s)	250	10	0	load	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	2.3.9 Install monitoring / observation wells	Drilling for monitoring well installations and abandonments	4	EA	1	1	equipment per day	drilling rig	0	10	6	day	1	0	60	60	180	0	0	0	0	0	0	0	0	0	Installed to a depth of 30-40 feet. Includes 2 days for mobilization/demobilization.	Install 4 new monitoring wells.
			-	-	-	1	vehicle per day	support truck	15	10	6	day	1	0	60	60	180	30	500	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	skid steer	0	10	6	day	1	0	60	60	180	0	0	0	0	0	0	0	0	0		
		Clearing for monitoring wells	-	-	-	1	equipment per day	track hoe excavator	0	10	1	day	1	0	10	10	30	0	0	0	0	0	0	0	0	0	2 locations are currently vegetated.	
		Material deliveries	1	EA	1	1	materials	truck delivery - flush mount	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Assume to be delivered in 1 load.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
			1	EA	1	1	materials	truck delivery - well steel	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - PVC	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - sand	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - bentonite	1,000	37	1	load	1	0	37	37	0	0	0	0	0	0	0	0	1,000	1,000		
			1	EA	1	1	materials	truck delivery - cement	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
	2.3.10 General Grading	Excavate and load from stockpile	7,800	BCY	3,400	2	equipment per day	track hoe excavator	0	10	2	day	2	0	40	40	120	0	0	0	0	0	0	0	0	0	To promote positive drainage ash is removed. Assumes onsite material from soil stripping and other sources.	A swell of 20% was included. Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping general fill	9,360	LCY	544	10	equipment per day	articulating dump truck	12	10	2	day	10	0	200	200	600	0	0	0	0	240	0	0	0	0		
		Place and spread general fill	9,360	LCY	3,500	2	equipment per day	dozer	0	10	2	day	2	0	40	40	120	0	0	0	0	0	0	0	0	0		
		Compact general fill	9,360	LCY	2,400	3	equipment per day	sheepsfoot roller	0	10	2	day	3	0	60	60	180	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	2	day	1	0	20	20	60	10	500	0	0	0	0	0	0	0		

Worksheet 3.2 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Closure By Removal, Onsite Landfill).

Closure By Removal Closure Plan

Alternative Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
2.4 Long Term Operations and Maintenance	2.4.1 Groundwater Monitoring	Years During construction (quarterly sampling)	20	TRIP	1	1	vehicle per day	support truck (daily mob)	250	28	20	day	1	1	560	1,120	20,000	100	0	0	0	0	0	0	0	0	Assumes 8 hours round trip travel (STL to Site) and 20 hours on site. Assume 2 person crew for safety.	Sampling intervals noted in closure plan by Others. NAP: 16 monitoring wells will be sampled and 15 observations wells will be read each trip. NEAP: 8 monitoring wells will be sampled per trip. Based on Geosyntec experience. Added sampling for 4.8 years of construction based on Owner comments.
		Years 1-5 (quarterly sampling)	20	TRIP	1	1	vehicle per day	support truck (daily mob)	250	28	20	day	1	1	560	1,120	20,000	100	0	0	0	0	0	0	0	0		
		Years 6-10 (semiannual sampling)	10	TRIP	1	1	vehicle per day	support truck (daily mob)	250	28	10	day	1	1	280	560	10,000	50	0	0	0	0	0	0	0	0		
		Years 11-30 (annual sampling)	20	TRIP	1	1	vehicle per day	support truck (daily mob)	250	28	20	day	1	1	560	1,120	20,000	100	0	0	0	0	0	0	0	0		
		Field Equipment	70	TRIP	1	1	field equipment	water level meter	0	28	70	day	0	0	1,960	0	0	0	0	0	0	0	0	0	0	0		
			70	TRIP	1	1	field equipment	ground water sampler	0	28	70	day	0	0	1,960	0	0	0	0	0	0	0	0	0	0	0		
			70	TRIP	1	8	field equipment	sample containers	0	28	70	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			70	TRIP	1	1	field equipment	pH meter	0	28	70	day	0	0	1,960	0	0	0	0	0	0	0	0	0	0	0		
			70	TRIP	1	1	field equipment	thermometer	0	28	70	day	0	0	1,960	0	0	0	0	0	0	0	0	0	0	0		
			70	TRIP	1	1	field equipment	specific conductance meter	0	28	70	day	0	0	1,960	0	0	0	0	0	0	0	0	0	0	0		
		Lab Testing	70	EA	22	1	lab test	boron test	0	1	1,540	test	0	1	1,540	1,540	46,200	0	0	0	0	0	0	0	0	0	Each trip.	
			70	EA	22	1	lab test	manganese test	0	1	1,540	test	0	1	1,540	1,540	46,200	0	0	0	0	0	0	0	0	0	Each trip.	
			8	EA	22	1	lab test	silver test	0	1	176	test	0	1	176	176	5,280	0	0	0	0	0	0	0	0	0	1st 8 quarterly trips.	
			70	EA	22	1	lab test	total dissolved solids test	0	1	1,540	test	0	1	1,540	1,540	46,200	0	0	0	0	0	0	0	0	0	Each trip.	
			70	EA	22	1	lab test	total sulfate	0	1	1,540	test	0	1	1,540	1,540	46,200	0	0	0	0	0	0	0	0	0	Each trip.	
			8	EA	22	1	lab test	radium 226	0	1	176	test	0	1	176	176	5,280	0	0	0	0	0	0	0	0	0	1st 8 quarterly trips.	
			8	EA	22	1	lab test	radium 228	0	1	176	test	0	1	176	176	5,280	0	0	0	0	0	0	0	0	0	1st 8 quarterly trips.	
	2.4.2 Surface Water Monitoring	Years During construction (weekly sampling)	250	TRIP	1	1	vehicle per day	support truck (daily mob)	250	16	250	day	1	1	4,000	8,000	250,000	1,250	0	0	0	0	0	0	0	0	Assumes 8 hours round trip travel (STL to Site) and 8 hours on site. Assume 2 person crew for safety.	Sampling intervals are weekly for Outfalls 001 (NAP) and 003 (NEAP) as noted in permit. Based on Geosyntec experience. Added sampling for 4.8 years of construction based on Owner comments.
		Years 1-30 (weekly sampling)	1,560	TRIP	1	1	vehicle per day	support truck (daily mob)	250	16	1,560	day	1	1	24,960	49,920	1,560,000	7,800	0	0	0	0	0	0	0	0		
		Lab Testing	1,810	TRIP	2	1	lab test	total suspended solids	0	1	3,620	test	0	1	3,620	3,620	108,600	0	0	0	0	0	0	0	0	0	Each trip. 24 hour composite sample.	
			453	TRIP	2	1	lab test	oil and grease	0	1	905	test	0	1	905	905	27,150	0	0	0	0	0	0	0	0	0	Monthly. Grab sample.	
			1,810	TRIP	2	1	lab test	total dissolved solids	0	1	3,620	test	0	1	3,620	3,620	108,600	0	0	0	0	0	0	0	0	0	Each trip. 24 hour composite sample.	
			1,810	TRIP	2	1	lab test	sulfates	0	1	3,620	test	0	1	3,620	3,620	108,600	0	0	0	0	0	0	0	0	0	Each trip. 24 hour composite sample.	
			1,810	TRIP	2	1	lab test	boron	0	1	3,620	test	0	1	3,620	3,620	108,600	0	0	0	0	0	0	0	0	0	Each trip. 24 hour composite sample.	
			453	TRIP	2	1	lab test	iron	0	1	905	test	0	1	905	905	27,150	0	0	0	0	0	0	0	0	0	Monthly. 24 hour composite sample.	

	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded
Selected Closure Plan Totals	**597,004**	**464,574**	**4,230,493**	**113,035**	**21,500**	**44,250**	**44,250**	**48,650**	**67,828**	**67,828**	**144,500**	**144,500**

Worksheet 3.3 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Onsite Landfill).

Onsite Landfill																												
Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
3.1 Onsite Landfill	3.1.1 Preconstruction Tasks	Conduct landfill design exploration and laboratory testing program	-	-	-	1	equipment per day	drilling rig	0	10	20	day	1	1	200	400	1,200	0	0	0	0	0	0	0	0	0	Scope not defined. Work depicted assumed based on current understanding of the project. Drilling crew consists of three workers (engineer, driller, helper). Materials brought to the site by the drilling crew.	4 weeks, to be refined during design or gap analysis phase.
			-	-	-	2	vehicle per day	support truck	15	10	20	day	1	0	400	200	600	200	500	0	0	0	0	0	0	0		
			-	-	-	1	equipment per day	skid steer	0	10	20	day	0	0	200	0	0	0	0	0	0	0	0	0	0	0		
			4,000	LB	-	0	materials	truck delivery - bentonite	250	10	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			15,040	LB	-	0	materials	truck delivery - cement	250	10	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Lab testing	-	-	-	1	vehicle per day	ship samples	250	10	1	day	1	0	10	10	500	5	0	0	0	0	0	0	0	0	Lab testing assumed based on experience with similar projects.	
			50	EA	-	0	lab test	moisture content	0	0	50	test	0	1	0	13	1,500	0	0	0	0	0	0	0	0	0		
			10	EA	-	0	lab test	classification testing	0	3	10	test	0	1	0	30	300	0	0	0	0	0	0	0	0	0		
			6	EA	-	0	lab test	Proctor testing	0	4	6	test	0	1	0	24	180	0	0	0	0	0	0	0	0	0		
			5	EA	-	0	lab test	liner destructive testing	0	4	5	test	0	1	0	20	150	0	0	0	0	0	0	0	0	0		
			5	EA	-	0	lab test	liner interface testing	0	4	5	test	0	1	0	20	150	0	0	0	0	0	0	0	0	0		
			52	EA	-	0	lab test	Sieve Analysis	0	4	52	test	0	1	0	207	1,551	0	0	0	0	0	0	0	0	0		
			46	EA	-	0	lab test	Standard Proctor Density	0	4	46	test	0	1	0	185	1,386	0	0	0	0	0	0	0	0	0		
			216	EA	-	0	lab test	Hydraulic Conductivity	0	4	216	test	0	1	0	863	6,469	0	0	0	0	0	0	0	0	0		
			6	EA	-	0	lab test	remolded permeability test	0	4	6	test	0	1	0	24	180	0	0	0	0	0	0	0	0	0		
	3.1.2 Project Duration Items	Project duration	-	-	-	0	-	-	0	0	2.4	years	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	Schedule not defined, assume 2.4 years total project duration.
		Owner's representative site visits	-	-	-	1	vehicle per day	support truck (daily mob)	250	10	125	day	1	0	1,250	1,250	62,500	625	0	0	0	0	0	0	0	0	Weekly site visits.	
		Contractor Construction & Safety Managers	-	-	-	2	vehicle per day	support truck	15	10	624	day	2	1	12,480	18,720	56,160	6,240	500	0	0	0	0	0	0	0	Three full time staff.	
		Office facilities	-	-	-	2	equipment per day	work trailer	0	10	624	day	0	0	12,480	0	0	0	0	0	0	0	0	0	0	0	Office Trailer.	
		Electric usage (average per day)	624,000	KWH	100	0	KWH per day	electricity	0	10	624	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Assume 50 kWh per trailer.	
		Site specific security	-	-	-	1	vehicle per day	support truck	15	10	624	day	1	0	6,240	6,240	18,720	3,120	500	0	0	0	0	0	0	0	One full time staff.	
		CQA Officer / Engineer site visit	-	-	-	1	vehicle per day	support truck (daily mob)	250	10	125	day	1	0	1,250	1,250	62,500	625	0	0	0	0	0	0	0	0	Weekly site visits.	
		CQA staff	-	-	-	1	vehicle per day	support truck	15	10	624	day	1	0	6,240	6,240	18,720	3,120	500	0	0	0	0	0	0	0	One full time staff.	
		Equipment mobilization	-	-	-	139	equipment mob	heavy equipment mob	250	10	1	mob	139	0	1,390	1,390	4,260	0	0	34,750	34,750	0	0	0	0	0	Estimated mobilization for heavy equipment. Includes all non vehicles. Vehicles are assumed to travel to the site daily.	
		Equipment fueling	-	-	-	1	vehicle per day	fuel truck	15	2	624	day	1	0	1,248	1,248	18,720	3,120	0	0	0	0	0	0	0	0	Daily refueling.	
		Portable restrooms	-	-	-	1	equipment per day	restroom units	0	10	624	day	0	0	6,240	0	0	0	0	0	0	0	0	0	0	0	Full time.	
		Portable restroom service	-	-	-	1	vehicle per day	maintenance vehicle	15	2	125	day	1	0	250	250	3,750	625	0	0	0	0	0	0	0	0		
		Dust suppression	-	-	-	1	equipment per day	water truck	12	10	624	day	1	0	6,240	6,240	18,720	0	0	0	0	7,488	0	0	0	0		
		Groundwater monitoring	-	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Monitoring included in Task 3.2.	-
		NPDES monitoring	-	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	3.1.3 Install EPSC Measures	Silt fence	5,000	LF	1,300	1	vehicle per day	support truck	15	10	4	day	1	1	40	80	240	20	500	0	0	0	0	0	0	0	Assumed for entire perimeter	RSMeans 3125 1416 1000.
		Riprap & rock check dams	-	-	-	1	equipment per day	track hoe	0	10	1	day	1	0	10	10	30	0	0	0	0	0	0	0	0	0	Installation and removal.	-
			-	-	-	1	vehicle per day	support truck	15	10	1	day	1	1	10	20	60	5	500	0	0	0	0	0	0	0		-
		Waddles	-	-	-	1	vehicle per day	support truck	15	10	1	day	1	1	10	20	60	5	500	0	0	0	0	0	0	0	-	-
		Material deliveries	100	CY	26	1	materials	truck delivery - riprap	250	10	4	load	1	0	40	40	0	0	0	0	0	0	0	0	1,000	1,000	Assumed 100 cubic yards.	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
			1	EA	1	1	materials	truck delivery - waddles	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
			1	EA	1	1	materials	truck delivery - silt fence	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		
	3.1.4 Stripping, Landfill Area, Excavating and Stockpiling	Excavation and loading soil	1,325,000	BCY	3,400	1	equipment per day	track hoe excavator	0	10	347	day	1	0	3,470	3,470	9,630	0	0	0	0	0	0	0	0	0	Soil to be stockpiled onsite and used to regraded excavated areas.	Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping in stockpile	1,766,666	LCY	510	10	equipment per day	articulating dump truck	12	10	347	day	10	1	34,700	38,170	105,930	0	0	0	0	41,640	0	0	0	0		
		Place and spread in stockpile	1,766,666	LCY	3,500	1	equipment per day	dozer	0	10	347	day	1	1	3,470	6,940	19,260	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	347	day	1	0	3,470	3,470	9,630	1,605	500	0	0	0	0	0	0	0		

Worksheet 3.3 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Onsite Landfill).

Onsite Landfill																												
Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
3.1 Onsite Landfill	3.1.5 Composite Bottom Liner System	Excavation and loading of low permeability layer from Stockpile	144,444	BCY	3,400	1	equipment per day	track hoe excavator	0	10	34	day	1	0	340	340	1,020	0	0	0	0	0	0	0	0	0	Bottom liner to be excavated at least 30 feet over 26 acres.	Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping of low permeability layer from Stockpile	173,333	LCY	510	10	equipment per day	articulating dump truck	12	10	34	day	10	0	3,400	3,400	10,200	0	0	0	0	4,080	0	0	0	0		
		Place and spread low permeability layer	173,333	LCY	3,500	1	equipment per day	dozer	0	10	34	day	1	0	340	340	1,020	0	0	0	0	0	0	0	0	0		
		Compact low permeability layer	173,333	LCY	2,400	1	equipment per day	sheepsfoot roller	0	10	34	day	1	0	340	340	1,020	0	0	0	0	0	0	0	0	0		
		Compact - fine finish	173,333	LCY	4,100	1	equipment per day	smooth drum roller	0	10	34	day	1	0	340	340	1,020	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	34	day	1	0	340	340	1,020	170	500	0	0	0	0	0	0	0		
		Construct a test pad	1	EA	1	1	equipment per day	track hoe excavator	0	10	1	day	1	0	10	10	30	0	0	0	0	0	0	0	0	0	-	Assume to be completed in 1 day.
			-	-	-	1	equipment per day	articulating dump truck	12	10	1	day	1	0	10	10	30	0	0	0	0	12	0	0	0	0	-	
			-	-	-	1	equipment per day	dozer	0	10	1	day	1	0	10	10	30	0	0	0	0	0	0	0	0	0	-	
			-	-	-	1	equipment per day	smooth drum roller	0	10	1	day	1	1	10	20	60	0	0	0	0	0	0	0	0	0	-	
		Slope Liner (60 MIL HDPE Geomembrane)	130,680	SY	9,000	2	equipment per day	front end loader (with roller bar)	0	10	16	day	2	0	320	320	960	0	0	0	0	0	0	0	0	0	Geomembrane.	Area noted in closure plan and associated cost estimates by Others. Based on Geosyntec experience. Includes two days for demobilization.
			130,680	SY	-	2	equipment per day	welder	0	10	16	day	2	0	320	320	960	0	0	0	0	0	0	0	0	0		
			130,680	SY	-	2	vehicle per day	support truck	15	10	16	day	2	10	320	1,920	5,760	160	500	0	0	0	0	0	0	0		
		Material deliveries	107	ROLLS	20	1	vehicle per day	truck delivery - geomembrane	1,000	37	6	load	1	0	222	222	12,000	30	0	0	0	0	0	0	0	0		Assumes 48,000 LB flat bed trailer.
		Geotextile - 8 oz/sy cushion	130,680	SY	18,000	2	equipment per day	front end loader (with roller bar)	0	10	10	day	2	0	200	200	600	0	0	0	0	0	0	0	0	0	-	-
			130,680	SY	-	2	vehicle per day	support truck	15	10	10	day	2	8	200	1,000	3,000	100	500	0	0	0	0	0	0	0	-	-
		Material deliveries	330	ROLLS	27	1	materials	truck delivery - geotextile	250	37	14	load	1	0	518	518	0	0	0	0	0	0	0	0	3,500	3,500	-	-
	3.1.6 Landfill Leachate Collection and Transmission System	Place and spread 1-foot thick sand layer and gravel for V-trench	45,465	LCY	3,500	1	equipment per day	dozer	0	10	9	day	1	0	90	90	270	0	0	0	0	0	0	0	0	0	Drainage layer.	-
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	9	day	1	0	90	90	270	45	500	0	0	0	0	0	0	0	-	-
		Material deliveries	1	EA	1	1	materials	truck delivery - sand	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	-
			4	EA	1	1	materials	truck delivery - collection pipe material	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	-
			4	EA	1	1	materials	truck delivery - pumps	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	-
			1	EA	1	1	materials	truck delivery - Gravel	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	-
			1	EA	1	1	materials	truck delivery - Tank	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	-
			4	EA	1	1	materials	truck delivery - riser pipe material	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	-
			4	EA	1	1	materials	truck delivery - forcemain pipe material	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	-
			4	EA	1	1	materials	truck delivery - electric control panel	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	-
			4	EA	1	1	materials	truck delivery - sump pumps	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	-
			1	EA	1	1	materials	truck delivery - leachate storage tanks	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	-
			1	EA	1	1	materials	truck delivery load-out facility	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	-
		Geotextile - 4 oz/sy cushion	130,680	SY	18,000	2	equipment per day	front end loader (with roller bar)	0	10	10	day	2	0	200	200	600	0	0	0	0	0	0	0	0	0	-	-
			130,680	SY	-	2	vehicle per day	support truck	15	10	10	day	2	8	200	1,000	3,000	100	500	0	0	0	0	0	0	0	-	-
		Material deliveries	330	ROLLS	27	1	materials	truck delivery - geotextile	250	37	14	load	1	0	518	518	0	0	0	0	0	0	0	0	3,500	3,500	-	-
	3.1.7 Access Road at Borrow Area and Landfill	Hauling and dumping coarse aggre	2,366	LCY	0	2	equipment per day	articulating dump truck	12	10	3	day	2	0	60	60	180	0	0	0	0	72	0	0	0	0	Assumed 6-inches of base coarse aggregate, 20-ft wide	-
		Place and spread coarse aggregate	2,366	LCY	3,500	3	equipment per day	dozer	0	10	3	day	3	0	90	90	270	0	0	0	0	0	0	0	0	0		-
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	3	day	1	0	30	30	90	15	500	0	0	0	0	0	0	0		-
		Material deliveries	1	EA	1	1	materials	truck delivery - coarse aggregatre	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250		-
			56	ROLLS	27	1	materials	truck delivery - geotextile	250	37	4	load	1	0	148	148	0	0	0	0	0	0	0	0	1,000	1,000		-
	3.1.8 Landfill Daily Operations	Place and spread CCR material	2,847,900	LCY	3,500	4	equipment per day	dozer	0	10	1,446	day	4	0	57,840	57,840	173,520	0	0	0	0	0	0	0	0	0	-	-
		Compact CCR material	2,847,900	LCY	4,100	4	equipment per day	smooth drum roller	0	10	1,446	day	4	0	57,840	57,840	173,520	0	0	0	0	0	0	0	0	0	-	-
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	1,446	day	1	1	14,460	28,920	86,760	7,230	500	0	0	0	0	0	0	0	-	-
		Excavate and load daily cover	21,758	BCY	3,400	1	equipment per day	track hoe excavator	0	10	5	day	1	0	50	50	150	0	0	0	0	0	0	0	0	0	To promote positive drainage once the ash is removed from the OEAP and Secondary NAP. Assumes onsite material from soil stripping and other sources. OEAP is not assumed to be usable.	Volume noted in closure plan and associated cost estimates by Others. Volume provided is 105,000 CYs for all 3 ash ponds. Assume 95,000 CYs for NEAP, consistent with volume provided for Options 2 and 4 as noted in the cost estimates. A shrink/swell of 10/20% was included. Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
		Hauling and dumping daily cover	21,758	LCY	510	10	equipment per day	articulating dump truck	12	10	5	day	10	0	500	500	1,500	0	0	0	0	600	0	0	0	0		
		Place and spread daily cover	21,758	LCY	3,500	1	equipment per day	dozer	0	10	5	day	1	0	50	50	150	0	0	0	0	0	0	0	0	0		
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	5	day	1	0	50	50	150	25	500	0	0	0	0	0	0	0		
		Excavate and load intermediate cover	43,516	BCY	3,400	1	equipment per day	track hoe excavator	0	10	9	day	1	0	90	90	270	0	0	0	0	0	0	0	0	0	To promote positive drainage once the ash is removed from the OEAP and Secondary NAP. Assumes onsite material from soil stripping	Volume noted in closure plan and associated cost estimates by Others. Volume provided is 105,000 CYs for all 3 ash ponds. Assume 95,000 CYs for NEAP, consistent with volume provided for Options 2 and 4 as noted in the cost
		Hauling and dumping intermediate	43,516	LCY	510	10	equipment per day	articulating dump truck	12	10	9	day	10	0	900	900	2,700	0	0	0	0	1,080	0	0	0	0		
		Place and spread intermediate cove	43,516	LCY	3,500	1	equipment per day	dozer	0	10	9	day	1	0	90	90	270	0	0	0	0	0	0	0	0	0		

Worksheet 3.3 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Onsite Landfill).

Onsite Landfill																												
Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	9	day	1	0	90	90	270	45	500	0	0	0	0	0	0	0	and other sources. OEAP is not assumed to be usable.	estimates. A shrink/swell of 10/20% was included. Production rate based on 0.75 mile around trip onsite with a speed of 10 MPH, wait time of 25 minutes and capacity of 34 CYs.
3.1 Onsite Landfill	3.1.9 Landfill Composite Final Cover System	Excavation and loading of low permeability layer	48,111	BCY	3,400	1	equipment per day	track hoe excavator	0	10	12	day	1	0	120	120	360	0	0	0	0	0	0	0	0	0	-	-
		Hauling and dumping of low permeability layer	57,733	LCY	510	10	equipment per day	articulating dump truck	12	10	12	day	10	0	1,200	1,200	3,600	0	0	0	0	1,440	0	0	0	0	-	-
		Place and spread low permeability layer	57,733	LCY	3,500	1	equipment per day	dozer	0	10	12	day	1	0	120	120	360	0	0	0	0	0	0	0	0	0	-	-
		Compact low permeability layer	57,733	LCY	2,400	1	equipment per day	sheepsfoot roller	0	10	12	day	1	0	120	120	360	0	0	0	0	0	0	0	0	0	-	-
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	12	day	1	0	120	120	360	60	500	0	0	0	0	0	0	0	-	-
		Double Sided Geocomposite Drainage Layer	130,680	SY	18,000	2	equipment per day	front end loader (with roller bar)	0	10	10	day	2	0	200	200	600	0	0	0	0	0	0	0	0	0	-	-
			130,680	SY	-	2	vehicle per day	support truck	15	10	10	day	2	8	200	1,000	3,000	100	500	0	0	0	0	0	0	0	-	-
		Material deliveries	330	ROLLS	27	1	materials	truck delivery - geocomposite	1,000	37	14	load	1	0	518	518	0	0	0	0	0	0	0	0	14,000	14,000	-	-
		40 MIL LLDPE Geomembrane	130,680	SY	9,000	2	equipment per day	front end loader (with roller bar)	0	10	15	day	2	0	300	300	900	0	0	0	0	0	0	0	0	0	Geomembrane.	Area noted in closure plan and based on conceptual design. Based on Geosyntec experience. Includes two days for demobilization.
			130,680	SY		3	equipment per day	welder	0	10	15	day	3	0	450	450	1,350	0	0	0	0	0	0	0	0	0		
			130,680	SY	-	2	vehicle per day	support truck	15	10	15	day	2	10	300	1,800	5,400	150	500	0	0	0	0	0	0	0		
		Material deliveries	107	ROLLS	20	1	materials	truck delivery - geomembrane	1,000	37	6	load	1	0	222	222	0	0	0	0	0	0	0	0	6,000	6,000		Assumes 48,000 LB flat bed trailer.
		Excavation and loading of protective cover soil	130,000	BCY	3,400	1	equipment per day	track hoe excavator	0	10	29	day	1	0	290	290	840	0	0	0	0	0	0	0	0	0	-	-
		Hauling and dumping of protective cover soil	143,000	LCY	510	10	equipment per day	articulating dump truck	12	10	29	day	10	0	2,900	2,900	8,400	0	0	0	0	3,480	0	0	0	0	-	-
		Place and spread protective cover soil	143,000	LCY	3,500	1	equipment per day	dozer	0	10	29	day	1	0	290	290	840	0	0	0	0	0	0	0	0	0	-	-
		Laborer Support	-	-	-	1	vehicle per day	support truck	15	10	29	day	1	0	290	290	840	140	500	0	0	0	0	0	0	0	-	-
	3.1.10 Seed and Mulch Final Cover	Hydroseed and mulch	27	AC	2	1	equipment per day	hydroseeder truck	250	10	14	day	1	1	140	280	780	0	0	0	0	3,500	0	0	0	0	Hydromulch assumed.	Area based on conceptual design. RSMeans 3292 1913 1100.
			-	-	-	1	vehicle per day	support truck	250	10	14	day	1	0	140	140	6,500	65	500	0	0	0	0	0	0	0		
		Material deliveries	20	TON	24	1	materials	truck delivery - hydroseed/mulch	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	-	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
	3.1.11 Stormwater Management	Excavate Detention Basin	20,000	CY	540	3	equipment per day	track hoe excavator	0	10	12	day	3	0	360	360	1,080	0	0	0	0	0	0	0	0	0	Area is estiamted. Basin is not currently designed	RSMeans 3123 1613 0130.
			-	-	-	3	equipment per day	articulating dump truck	12	10	12	day	3	0	360	360	1,080	0	0	0	0	432	0	0	0	0	-	
			-	-	-	1	equipment per day	dozer	0	10	12	day	1	0	120	120	360	0	0	0	0	0	0	0	0	0	-	
			-	-	-	1	equipment per day	smooth drum roller	0	10	12	day	1	0	120	120	360	0	0	0	0	0	0	0	0	0	-	
			-	-	-	1	vehicle per day	support truck	15	10	12	day	1	0	120	120	360	60	500	0	0	0	0	0	0	0	-	
		Hydroseed and mulch for basin	5	AC	2	1	equipment per day	hydroseeder truck	250	10	3	day	1	1	30	60	180	0	0	0	0	750	0	0	0	0	Hydromulch assumed. Basin is not designed so values are estimated.	RSMeans 3292 1913 1100.
			-	-	-	1	vehicle per day	support truck	250	10	3	day	1	0	30	30	1,500	15	500	0	0	0	0	0	0	0		
		Material deliveries	4	TON	24	1	materials	truck delivery - hydroseed/mulch	250	10	0	load	1	0	0	0	0	0	0	0	0	0	0	0	0	0	-	Assume 26 CY truck or 48,000 LB flat bed delivery truck.
			0	EA	0	0	materials	truck delivery - discharge pipe(s), culverts, outlet structure	250	10	0	load	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
		Excavate perimeter stormwater ditches and install outfalls	10,600	CY	540	1	equipment per day	track hoe excavator	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0	-	-
			-	-	-	1	equipment per day	articulating dump truck	12	10	20	day	1	0	200	200	600	0	0	0	0	240	0	0	0	0	-	-
			-	-	-	1	equipment per day	dozer	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0	-	-
			-	-	-	1	equipment per day	smooth drum roller	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0	-	-
			-	-	-	1	vehicle per day	support truck	15	10	20	day	1	0	200	200	600	100	500	0	0	0	0	0	0	0	-	-
		Material deliveries	0	EA	0	0	materials	truck delivery - discharge pipe(s)	250	10	0	load	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
		Terrace berm construction	15,556	CY	540	1	equipment per day	track hoe excavator	0	10	29	day	1	0	290	290	870	0	0	0	0	0	0	0	0	0	Values are estimated.	-
			-	-	-	1	equipment per day	articulating dump truck	12	10	29	day	1	0	290	290	870	0	0	0	0	348	0	0	0	0	-	-
			-	-	-	1	equipment per day	dozer	0	10	29	day	1	0	290	290	870	0	0	0	0	0	0	0	0	0	-	-
			-	-	-	1	equipment per day	smooth drum roller	0	10	29	day	1	0	290	290	870	0	0	0	0	0	0	0	0	0	-	-
			-	-	-	1	vehicle per day	support truck	15	10	29	day	1	0	290	290	870	145	500	0	0	0	0	0	0	0	-	-
		Drainage Downchutes	2,400	CY	540	1	equipment per day	track hoe excavator	0	10	4	day	1	0	40	40	120	0	0	0	0	0	0	0	0	0	Values are estimated.	-
			-	-	-	1	equipment per day	articulating dump truck	12	10	4	day	1	0	40	40	120	0	0	0	0	48	0	0	0	0	-	-
			-	-	-	1	equipment per day	dozer	0	10	4	day	1	0	40	40	120	0	0	0	0	0	0	0	0	0	-	-
			-	-	-	1	equipment per day	smooth drum roller	0	10	4	day	1	0	40	40	120	0	0	0	0	0	0	0	0	0	-	-
			-	-	-	1	vehicle per day	support truck	15	10	4	day	1	0	40	40	120	20	500	0	0	0	0	0	0	0	-	-
		Material deliveries	100	CY	26	1	materials	truck delivery - riprap	250	10	4	load	1	0	40	40	0	0	0	0	0	0	0	0	1,000	1,000	Value is estimated	-

Worksheet 3.3 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Onsite Landfill).

Onsite Landfill																												
Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
3.2 Onsite Landfill Post-Closure Care and Long Term Monitoring	3.2.1 Landfill Cap Inspection and Maintenance	Mowing	-	-	-	1	equipment per day	mower (local)	15	10	120	day	1	0	1,200	1,200	3,600	0	0	0	0	1,800	0	0	0	0	Quarterly mowing for 30 years. Local equipment.	-
			-	-	-	1	vehicle per day	support truck	15	10	120	day	1	0	1,200	1,200	3,600	600	500	0	0	0	0	0	0	0		
		Maintenance	-	-	-	1	equipment per day	track hoe (local)	0	10	120	day	1	0	1,200	1,200	3,600	0	0	0	0	0	0	0	0	0	Quarterly maintenance for 30 years. Local equipment.	-
			-	-	-	1	vehicle per day	support truck (local)	15	10	120	day	1	0	1,200	1,200	3,600	600	0	0	0	0	0	0	0	0		
		Inspections	-	-	-	1	vehicle per day	support truck (local)	15	10	120	day	1	1	1,200	2,400	7,200	600	0	0	0	0	0	0	0	0	Quarterly inspections for 30 years.	-
	3.2.2 Groundwater Monitoring	Years During construction (quarterly sampling)	10	TRIP	1	1	vehicle per day	support truck (daily mob)	250	28	10	day	1	1	280	560	10,000	50	0	0	0	0	0	0	0	0	Assumes 8 hours round trip travel (STL to Site) and 20 hours on site. Assume 2 person crew for safety.	Sampling intervals noted in closure plan. NAP: 16 monitoring wells will be sampled and 15 observations wells will be read each trip. NEAP: 8 monitoring wells will be sampled per trip. Based on Geosyntec experience. Added sampling for 2.4 years of construction based on Owner comments.
		Years 1-5 (quarterly sampling)	20	TRIP	1	1	vehicle per day	support truck (daily mob)	250	28	20	day	1	1	560	1,120	20,000	100	0	0	0	0	0	0	0	0		
		Years 6-10 (semiannual sampling)	10	TRIP	1	1	vehicle per day	support truck (daily mob)	250	28	10	day	1	1	280	560	10,000	50	0	0	0	0	0	0	0	0		
		Years 11-30 (annual sampling)	20	TRIP	1	1	vehicle per day	support truck (daily mob)	250	28	20	day	1	1	560	1,120	20,000	100	0	0	0	0	0	0	0	0		
		Field Equipment	60	TRIP	1	1	field equipment	water level meter	0	28	60	day	0	0	1,680	0	0	0	0	0	0	0	0	0	0	0		
			60	TRIP	1	1	field equipment	ground water sampler	0	28	60	day	0	0	1,680	0	0	0	0	0	0	0	0	0	0	0		
			60	TRIP	1	8	field equipment	sample containers	0	28	60	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			60	TRIP	1	1	field equipment	pH meter	0	28	60	day	0	0	1,680	0	0	0	0	0	0	0	0	0	0	0		
			60	TRIP	1	1	field equipment	thermometer	0	28	60	day	0	0	1,680	0	0	0	0	0	0	0	0	0	0	0		
			60	TRIP	1	1	field equipment	specific conductance meter	0	28	60	day	0	0	1,680	0	0	0	0	0	0	0	0	0	0	0		
		Lab Testing	60	EA	22	1	lab test	boron test	0	1	1,320	test	0	1	1,320	1,320	39,600	0	0	0	0	0	0	0	0	0	Each trip.	
			60	EA	22	1	lab test	manganese test	0	1	1,320	test	0	1	1,320	1,320	39,600	0	0	0	0	0	0	0	0	0	Each trip.	
			8	EA	22	1	lab test	silver test	0	1	176	test	0	1	176	176	5,280	0	0	0	0	0	0	0	0	0	1st 8 quarterly trips.	
			60	EA	22	1	lab test	total dissolved solids test	0	1	1,320	test	0	1	1,320	1,320	39,600	0	0	0	0	0	0	0	0	0	Each trip.	
			60	EA	22	1	lab test	total sulfate	0	1	1,320	test	0	1	1,320	1,320	39,600	0	0	0	0	0	0	0	0	0	Each trip.	
			8	EA	22	1	lab test	radium 226	0	1	176	test	0	1	176	176	5,280	0	0	0	0	0	0	0	0	0	1st 8 quarterly trips.	
			8	EA	22	1	lab test	radium 228	0	1	176	test	0	1	176	176	5,280	0	0	0	0	0	0	0	0	0	1st 8 quarterly trips.	
	3.2.3 Leachate Removal and Maintenance	Leachate removal and jetting	296	TRIP	-	1	vehicle per day	5,000 gal. tanker truck	250	10	1	load	1	0	10	10	500	5	0	0	0	0	0	0	0	0	Assumed 5 gallons per acre per day for leachate generation over 30 years, and removal by a 5,000-gallon tanker truck and disposal at the nearest POTW.	-
		Replacement of leachate pumps	40	EA	1	1	materials	truck delivery - pumps	250	10	1	load	1	0	10	10	0	0	0	0	0	0	0	0	250	250	Replacement of 4 pumps every 3 years for 30 years	-
	3.2.4 Surface Water Monitoring	Years During construction (weekly sampling)	125	TRIP	1	1	vehicle per day	support truck (daily mob)	250	16	125	day	1	1	2,000	4,000	125,000	625	0	0	0	0	0	0	0	0	Assumes 8 hours round trip travel (STL to Site) and 8 hours on site. Assume 2 person crew for safety.	Sampling intervals are weekly for Outfalls 001 (NAP) and 003 (NEAP) as noted in permit. Based on Geosyntec experience. Added sampling for 2.4 years of construction based on Owner comments.
		Years 1-30 (weekly sampling)	1,560	TRIP	1	1	vehicle per day	support truck (daily mob)	250	16	1,560	day	1	1	24,960	49,920	1,560,000	7,800	0	0	0	0	0	0	0	0		
		Lab Testing	1,685	TRIP	2	1	lab test	total suspended solids	0	1	3,370	test	0	1	3,370	3,370	101,100	0	0	0	0	0	0	0	0	0	Each trip. 24 hour composite sample.	
			421	TRIP	2	1	lab test	oil and grease	0	1	843	test	0	1	843	843	25,275	0	0	0	0	0	0	0	0	0	Monthly. Grab sample.	
			1,685	TRIP	2	1	lab test	total dissolved solids	0	1	3,370	test	0	1	3,370	3,370	101,100	0	0	0	0	0	0	0	0	0	Each trip. 24 hour composite sample.	
			1,685	TRIP	2	1	lab test	sulfates	0	1	3,370	test	0	1	3,370	3,370	101,100	0	0	0	0	0	0	0	0	0	Each trip. 24 hour composite sample.	
			1,685	TRIP	2	1	lab test	boron	0	1	3,370	test	0	1	3,370	3,370	101,100	0	0	0	0	0	0	0	0	0	Each trip. 24 hour composite sample.	
			421	TRIP	2	1	lab test	iron	0	1	843	test	0	1	843	843	25,275	0	0	0	0	0	0	0	0	0	Monthly. 24 hour composite sample.	

	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded
Totals	**317,897**	**355,182**	**3,349,377**	**38,620**	**14,000**	**34,750**	**34,750**	**67,010**	**0**	**0**	**34,000**	**34,000**

Worksheet 3.4 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Power Station Demolition).

Power Station Demolition																												
Alternative Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
3.4 Demolition	3.4.1 Preconstruction Tasks	Supplemental Pre-Demolition Assessment (update of asbestos and other regulated materials survey) (2 asbestos inspectors)	10	DAY	-	2	vehicle per day	support truck	15	10	10	day	2	0	200	200	600	100	500	0	0	0	0	0	0	0	-	-
		Lab Testing	-	-	-	2	vehicle per day	ship samples	250	10	1	day	2	0	20	20	1,000	10	0	0	0	0	0	0	0	0	-	-
			600	EA		0	lab test	asbestos	0	0	600	test	0	1	0	150	18,000	0	0	0	0	0	0	0	0	0	-	-
			100	EA		0	lab test	lead	0	0	100	test	0	1	0	25	3,000	0	0	0	0	0	0	0	0	0	-	-
			100	EA		0	lab test	PCBs	0	0	100	test	0	1	0	25	3,000	0	0	0	0	0	0	0	0	0	-	-
	3.4.2 Project Duration Items	Project duration	-	-	-	0	-	-	0	0	1.0	years	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
		Equipment Mob	-	-	-	118	equipment mob	heavy equipment mob	250	10	2	mob	118	0	2,360	2,360	7,080	0	0	59,000	59,000	0	0	0	0	0	-	-
		Equipment fueling (daily)	-	-	-	1	vehicle per day	fuel truck	15	2	260	day	1	0	520	520	7,800	1,300	0	0	0	0	0	0	0	0	-	-
		Work Trailers	-	-	-	5	equipment per day	work trailer	0	10	260	day	0	0	13,000	0	0	0	0	0	0	0	0	0	0	0	-	-
		Work Trailers Electric Usage (average per day)	650,000	KWH	250	0	KWH per day	electricity	0	10	260	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
		Portable Restrooms	-	-	-	2	equipment per day	restroom units	0	10	260	day	0	0	5,200	0	0	0	0	0	0	0	0	0	0	0	-	-
		Portable restroom service	-	-	-	1	vehicle per day	maintenance vehicle	15	2	52	day	1	0	104	104	1,560	260	0	0	0	0	0	0	0	0	-	-
		Air Monitoring Stations	-	-	-	4	equipment per day	monitoring stations	12	10	260	day	2	0	10,400	5,200	15,600	0	0	0	0	12,480	0	0	0	0	-	-
		Air Monitoring Stations Electric Usage (average per day)	104,000	KWH	40	0	KWH per day	electricity	0	10	260	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
		Jobsite Dust Suppression	-	-	-	1	equipment per day	water truck	12	10	260	day	1	0	2,600	2,600	7,800	0	0	0	0	3,120	0	0	0	0	-	-
		Owner's Representative Site Visits	-	-	-	2	vehicle per day	support truck	250	10	52	day	2	0	1,040	1,040	52,000	520	500	0	0	0	0	0	0	0	-	-
		Constractor Construction and Safety Managers	-	-	-	3	vehicle per day	support truck	15	10	260	day	3	0	7,800	7,800	23,400	3,900	500	0	0	0	0	0	0	0	-	-
		Site Security	-	-	-	1	vehicle per day	support truck	15	10	260	day	1	0	2,600	2,600	7,800	1,300	500	0	0	0	0	0	0	0	-	-
		Engineer Oversight and Air Monitoring	-	-	-	3	vehicle per day	support truck	15	10	260	day	3	0	7,800	7,800	23,400	3,900	500	0	0	0	0	0	0	0	-	-
		Engineer Safety Officer	-	-	-	1	vehicle per day	support truck	250	2	52	day	1	0	104	104	26,000	260	500	0	0	0	0	0	0	0	-	-
	3.4.3 Install Temporary Controls	Construction Fence	1	EA	1	2	materials	truck delivery - construction fence	250	10	2	load	2	0	40	40	0	0	0	0	0	0	0	0	1,000	1,000	-	-
			5,500	LF	800	1	haul trucks per day	flatbed truck	12	10	7	day	1	0	70	70	210	0	0	0	0	0	84	84	0	0	-	-
			5,500	LF	800	2	equipment per day	skid steer	0	10	7	day	2	0	140	140	420	0	0	0	0	0	0	0	0	0	-	-
		Laborers	5,500	LF	800	4	vehicle per day	support truck	15	10	7	day	4	0	280	280	840	140	500	0	0	0	0	0	0	0	-	-
		Silt Fence	1	EA	1	2	materials	truck delivery - silt fence	250	10	2	load	2	0	40	40	0	0	0	0	0	0	0	0	1,000	1,000	-	-
			5,500	LF	1,300	2	equipment per day	skid steer	0	10	5	day	2	0	100	100	300	0	0	0	0	0	0	0	0	0	-	-
		Laborers	5,500	LF	1,300	4	vehicle per day	support truck	15	10	5	day	4	0	200	200	600	100	500	0	0	0	0	0	0	0	-	-
	3.4.4 Asbestos Containing Materials (ACM) Abatement	Abatement Equipment	90	DAY	-	2	equipment per day	chip hammers	0	10	90	day	2	0	1,800	1,800	5,400	0	0	0	0	0	0	0	0	0	estimate based on table titled "Summary of Asbestos-Containing Materials (ACMs)" provided in October 19, 2012 "Asbestos Survey Activities" report for Vermillion Power Station	-
			90	DAY	-	1	equipment per day	truck-mounted wet/dry vac	0	10	90	day	1	0	900	900	2,700	0	0	0	0	0	0	0	0	0		-
			90	DAY	-	1	equipment per day	scissor lift	0	10	90	day	1	0	900	900	2,700	0	0	0	0	0	0	0	0	0		-
			90	DAY	-	1	equipment per day	telescoping boom lift	0	10	90	day	1	0	900	900	2,700	0	0	0	0	0	0	0	0	0		-
			90	DAY	-	2	equipment per day	skid steer	0	10	90	day	2	0	1,800	1,800	5,400	0	0	0	0	0	0	0	0	0		-
			90	DAY	-	4	equipment per day	blowers (negative pressure enclosures)	0	10	90	day	4	0	3,600	3,600	10,800	0	0	0	0	0	0	0	0	0		-
		Blowers (negative pressure enclosures) Electric Usage	360,000	KWH	400	0	KWH per day	electricity	0	10	90	day	0	0	0	0	0	0	0	0	0	0	0	0	0	0		-
		Transport to Off-Site Disposal Facility	5	DAY	-	5	haul trucks per day	tractor trailer	15	10	5	day	5	0	250	250	750	0	0	0	0	0	375	375	0	0		-
		Asbestos Foreman (3), Asbestos Workers (21)	90	DAY	-	24	vehicle per day	support truck	15	10	90	day	24	0	21,600	21,600	64,800	10,800	500	0	0	0	0	0	0	0		-
		Laborer Foreman, Laborers (2)	90	DAY	-	3	vehicle per day	support truck	15	10	90	day	3	0	2,700	2,700	8,100	1,350	500	0	0	0	0	0	0	0		-
		Clearance Inspector/Sampler	90	DAY	-	1	vehicle per day	support truck	15	10	90	day	1	0	900	900	2,700	450	500	0	0	0	0	0	0	0		-
	3.4.5 Other Regulated Materials Removal, Piping and Tank Decommissioning	Removal Equipment	40	DAY	-	1	equipment per day	telescoping boom lift	0	10	40	day	1	0	400	400	1,200	0	0	0	0	0	0	0	0	0	types and quantities unknown; assume the following materials to be removed/addressed: Universal waste, oil-containing equipment, electrical cabling with oil-impregnated insulation, storage tank and aboveground piping decommissioning, removal of accumulations of lead-based paint, removal of coal and ash residuals from structures, cleaning of slabs with oily accumulations	-
			40	DAY	-	1	equipment per day	scissor lift	0	10	40	day	1	0	400	400	1,200	0	0	0	0	0	0	0	0	0		-
			40	DAY	-	2	equipment per day	off-road dump truck	12	10	40	day	2	0	800	800	2,400	0	0	0	0	960	0	0	0	0		-
			40	DAY	-	2	equipment per day	skid steer	0	10	40	day	2	0	800	800	2,400	0	0	0	0	0	0	0	0	0		-
			40	DAY	-	1	equipment per day	truck-mounted wet/dry vac	0	10	40	day	1	0	400	400	1,200	0	0	0	0	0	0	0	0	0		-
			40	DAY	-	1	equipment per day	truck-mounted pressure washer	0	10	40	day	1	0	400	400	1,200	0	0	0	0	0	0	0	0	0		-
			10	DAY	-	1	equipment per day	vac truck	0	10	10	day	1	0	100	100	300	0	0	0	0	0	0	0	0	0		-
			40	DAY	-	1	equipment per day	backhoe loader	0	10	40	day	1	0	400	400	1,200	0	0	0	0	0	0	0	0	0		-
		Transport to Off-Site Disposal Facility	10	DAY	-	10	haul trucks per day	flatbed truck	250	10	10	day	10	0	1,000	1,000	3,000	0	0	0	0	0	25,000	25,000	0	0		-
			10	DAY	-	10	haul trucks per day	tractor trailer dump truck	250	10	10	day	10	0	1,000	1,000	3,000	0	0	0	0	0	25,000	25,000	0	0		-
			10	DAY	-	10	haul trucks per day	tanker truck	250	10	10	day	10	0	1,000	1,000	3,000	0	0	0	0	0	25,000	25,000	0	0		-
		Disposal On-Site (coal and ash residuals)	40	DAY	-	1	equipment per day	dozer	0	10	10	day	1	0	100	100	300	0	0	0	0	0	0	0	0	0		-
		Skilled Foreman (2), Skilled Workers (14)	40	DAY	-	16	vehicle per day	support truck	15	10	40	day	16	0	6,400	6,400	19,200	3,200	500	0	0	0	0	0	0	0		-
		Foreman, Laborers (7)	40	DAY	-	8	vehicle per day	support truck	15	10	40	day	8	0	3,200	3,200	9,600	1,600	500	0	0	0	0	0	0	0		-
	3.4.6 Pre-Demo Surface Cleaning	Cleaning Equipment	25	DAY		3	equipment per day	truck-mounted wet/dry vac	0	10	25	day	3	0	750	750	2,250	0	0	0	0	0	0	0	0	0	cleaning and removal of accumulations from surfaces, such as walls, floors, structural framing, shallow trenches, mezzanines, stairwells, ductwork, piping, and other horizontal surfaces	-
			25	DAY	-	3	equipment per day	skid steer	0	10	25	day	3	0	750	750	2,250	0	0	0	0	0	0	0	0	0		-
			25	DAY		1	equipment per day	scissor lift	0	10	25	day	1	0	250	250	750	0	0	0	0	0	0	0	0	0		-
		Transport to Off-Site Disposal Facility	2	DAY	-	2	haul trucks per day	haul truck	250	10	2	day	2	0	40	40	120	0	0	0	0	0	1,000	1,000	0	0		-
		Foreman, Laborers (6)	25	DAY	-	7	vehicle per day	support truck	15	10	25	day	7	0	1,750	1,750	5,250	875	500	0	0	0	0	0	0	0		-
	3.4.7 Other Pre-Demo Activities (utility disconnect, misc.)	Equipment	10	DAY	-	1	equipment per day	excavator	0	10	10	day	1	0	100	100	300	0	0	0	0	0	0	0	0	0	-	-
			10	DAY	-	1	equipment per day	vac truck (minor dewatering)	0	10	10	day	1	0	100	100	300	0	0	0	0	0	0	0	0	0	-	-
		Transport to Off-Site Disposal Facility (removed water)	2	DAY	-	2	haul trucks per day	tanker truck	250	10	2	day	2	0	40	40	120	0	0	0	0	0	1,000	1,000	0	0	-	-
		Skilled Trades (Electrician, Plumber)	10	DAY	-	4	vehicle per day	support truck	15	10	10	day	4	0	400	400	1,200	200	500	0	0	0	0	0	0	0	-	-
		Foreman, Laborers (2)	10	DAY	-	3	vehicle per day	support truck	15	10	10	day	3	0	300	300	900	150	500	0	0	0	0	0	0	0	-	-

Worksheet 3.4 - Work Element Details, Equipment, Hours, Labor and Materials Detail (Power Station Demolition).

Power Station Demolition																												
Alternative Component	Work Element	Details/Questions for Each Work Element	Project Quantity	Project Unit	Production Rate (Unit/Time)	Equipment Amount	Equipment Units	Equipment/ Material	One way travel per day (miles) for vehicles	hrs	total time	unit	# Drivers	# Additional Workers per day	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded	Notes	Production Rate / Duration Reference
3.4 Demolition	3.4.8.1 Structural Razing - Large Structures (metal, concrete, masonry structures)	Demolition Equipment	120	DAY	-	3	equipment per day	crane	0	10	120	day	3	0	3,600	3,600	10,800	0	0	0	0	0	0	0	0	0	estimate based on 2011/2012 survey map depicting structure footprint dimensions and heights; concrete and masonry demolition debris to be disposed in on-site landfill	-
			120	DAY	-	3	equipment per day	demolition excavator (extended boom)	0	10	120	day	3	0	3,600	3,600	10,800	0	0	0	0	0	0	0	0	0		-
			120	DAY	-	6	equipment per day	loader	0	10	120	day	6	0	7,200	7,200	21,600	0	0	0	0	0	0	0	0	0		-
			120	DAY	-	3	equipment per day	off-road dump truck	12	10	120	day	3	0	3,600	3,600	10,800	0	0	0	0	4,320	0	0	0	0		-
			120	DAY	-	6	equipment per day	skid steer	0	10	120	day	6	0	7,200	7,200	21,600	0	0	0	0	0	0	0	0	0		-
			120	DAY	-	6	equipment per day	dust misting cannon w/diesel gen	0	10	120	day	6	0	7,200	7,200	21,600	0	0	0	0	0	0	0	0	0		-
		Disposal On-Site (concrete, masonry)	120	DAY	-	1	equipment per day	excavator w/ hammer	0	10	120	day	1	0	1,200	1,200	3,600	0	0	0	0	0	0	0	0	0		-
			120	DAY	-	1	equipment per day	dozer	0	10	120	day	1	0	1,200	1,200	3,600	0	0	0	0	0	0	0	0	0		-
		Foreman, Laborers (8)	120	DAY	-	9	vehicle per day	support truck	15	10	120	day	9	0	10,800	10,800	32,400	5,400	500	0	0	0	0	0	0	0		-
	3.4.8.2 Structural Razing - Small Structures (primarily metal structures)	Demolition Equipment	40	DAY	-	1	equipment per day	demolition excavator (extended boom)	0	10	40	day	1	0	400	400	1,200	0	0	0	0	0	0	0	0	0	estimate based on 2011/2012 survey map depicting structure footprint dimensions and heights; primarily metal buildings	-
			40	DAY	-	1	equipment per day	loader	0	10	40	day	1	0	400	400	1,200	0	0	0	0	0	0	0	0	0		-
			40	DAY	-	1	equipment per day	off-road dump truck	12	10	40	day	1	0	400	400	1,200	0	0	0	0	480	0	0	0	0		-
			40	DAY	-	2	equipment per day	skid steer	12	10	40	day	2	0	800	800	2,400	0	0	0	0	960	0	0	0	0		-
			40	DAY	-	2	equipment per day	dust misting cannon w/diesel gen	0	10	40	day	2	0	800	800	2,400	0	0	0	0	0	0	0	0	0		-
		Foreman, Laborers (3)	40	DAY	-	4	vehicle per day	support truck	15	10	40	day	4	0	1,600	1,600	4,800	800	500	0	0	0	0	0	0	0		-
	3.4.8.3 Structural Razing - Stack (assume primarily concrete, masonry, non-ACM)	Demolition Equipment	15	DAY	-	1	equipment per day	demolition excavator	0	10	15	day	1	0	150	150	450	0	0	0	0	0	0	0	0	0	assume stack will be razed by explosive demolition; demolition debris to be disposed in on-site landfill	-
			15	DAY	-	1	equipment per day	loader	0	10	15	day	1	0	150	150	450	0	0	0	0	0	0	0	0	0		-
			15	DAY	-	1	equipment per day	off-road dump truck	12	10	15	day	1	0	150	150	450	0	0	0	0	180	0	0	0	0		-
			15	DAY	-	1	equipment per day	dust misting cannon w/diesel gen	0	10	15	day	1	0	150	150	450	0	0	0	0	0	0	0	0	0		-
		Disposal On-Site (concrete, masonry)	15	DAY	-	1	equipment per day	excavator w/ hammer	0	10	15	day	1	0	150	150	450	0	0	0	0	0	0	0	0	0		-
			15	DAY	-	1	equipment per day	dozer	0	10	15	day	1	0	150	150	450	0	0	0	0	0	0	0	0	0		-
		Foreman, Powderman, Laborers (4)	15	DAY	-	6	vehicle per day	support truck	15	10	15	day	6	0	900	900	2,700	450	500	0	0	0	0	0	0	0		-
	3.4.9 Slab Removals (and on-Site Landfill placement)	Demolition Equipment	30	DAY	-	2	equipment per day	excavator w/ hammer	0	10	30	day	2	0	600	600	1,800	0	0	0	0	0	0	0	0	0	estimate based on 2011/2012 survey map depicting structure footprint and exterior concrete slab dimensions	-
			30	DAY	-	2	equipment per day	loader	0	10	30	day	2	0	600	600	1,800	0	0	0	0	0	0	0	0	0		-
			30	DAY	-	2	equipment per day	off-road dump truck	12	10	30	day	2	0	600	600	1,800	0	0	0	0	720	0	0	0	0		-
		Disposal On-Site	30	DAY	-	1	equipment per day	dozer	0	10	30	day	1	0	300	300	900	0	0	0	0	0	0	0	0	0		-
		Foreman, Laborers (3)	30	DAY	-	4	vehicle per day	support truck	15	10	30	day	4	0	1,200	1,200	3,600	600	500	0	0	0	0	0	0	0		-
	3.4.10 Sub-Surface Demolition	Demolition Equipment	30	DAY	-	1	equipment per day	excavator w/ hammer	0	10	30	day	1	0	300	300	900	0	0	0	0	0	0	0	0	0	break floors (or remove) below-ground structures; pits, basements, trenches, hoppers, shafts, vaults, sumps; quantities unknown (duration based on type and number of site structures)	-
			30	DAY	-	1	equipment per day	excavator	0	10	30	day	1	0	300	300	900	0	0	0	0	0	0	0	0	0		-
			30	DAY	-	1	equipment per day	loader	0	10	30	day	1	0	300	300	900	0	0	0	0	0	0	0	0	0		-
			30	DAY	-	1	equipment per day	off-road dump truck	12	10	30	day	1	0	300	300	900	0	0	0	0	360	0	0	0	0		-
			30	DAY	-	1	equipment per day	vac truck	0	10	10	day	1	0	100	100	300	0	0	0	0	0	0	0	0	0		-
		Disposal On-Site	30	DAY	-	1	equipment per day	dozer	0	10	30	day	1	0	300	300	900	0	0	0	0	0	0	0	0	0		-
		Transport to Off-Site Disposal Facility (removed residual liquids)	5	DAY	-	5	haul trucks per day	tanker truck	250	10	5	day	5	0	250	250	750	0	0	0	0	0	6,250	6,250	0	0		-
		Foreman, Laborers (7)	30	DAY	-	8	vehicle per day	support truck	15	10	30	day	8	0	2,400	2,400	7,200	1,200	500	0	0	0	0	0	0	0		-
	3.4.11 Demolition Debris Management (Off-Site Disposal)	Supplemental Processing (size reduction, etc.)	120	DAY	-	2	equipment per day	excavator w/ shear	0	10	120	day	2	0	2,400	2,400	7,200	0	0	0	0	0	0	0	0	0	demolition debris not placed in on-site landfill (non-concrete and masonry); assume demolition debris transport and disposal conducted currently with demolition	-
		Loading	120	DAY	-	2	equipment per day	loader	0	10	120	day	2	0	2,400	2,400	7,200	0	0	0	0	0	0	0	0	0		-
		Transport to Disposal or Scrap Facility	20	DAY	-	60	haul trucks per day	haul truck	15	10	20	day	60	0	12,000	12,000	36,000	0	0	0	0	0	18,000	18,000	0	0		-
		Foreman, Laborers (3)	120	DAY	-	4	vehicle per day	support truck	15	10	120	day	4	0	4,800	4,800	14,400	2,400	500	0	0	0	0	0	0	0		-
	3.4.12 Piping Abandonment (Filling)	Equipment	20	DAY	-	1	equipment per day	loader/excavator	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0	filling intake/discharge, water circulation piping and other larger underground piping systems; quantities unknown (piping drawings not available)	-
		Materials (grout, flowable fill and/or concrete)	1	EA	1	100	materials	truck delivery - materials	250	10	4	load	100	0	4,000	4,000	0	0	0	0	0	0	0	0	100,000	100,000		-
		Pipe Abandonment	20	DAY	-	2	equipment per day	grout pump	0	10	20	day	2	0	400	400	1,200	0	0	0	0	0	0	0	0	0		-
			20	DAY	-	2	equipment per day	air compressor	0	10	20	day	2	0	400	400	1,200	0	0	0	0	0	0	0	0	0		-
			20	DAY	-	2	equipment per day	diesel generator	0	10	20	day	2	0	400	400	1,200	0	0	0	0	0	0	0	0	0		-
		Foreman, Laborers (5)	20	DAY	-	6	vehicle per day	support truck	15	10	20	day	6	0	1,200	1,200	3,600	600	500	0	0	0	0	0	0	0		-
	3.4.13 Backfilling Below-Ground Voids (with on-site soil) and Interim Surface Stabilization (gravel)	Excavate and Load from stockpile	20	DAY	-	1	equipment per day	loader/excavator	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0	-	-
		Hauling from stockpile	20	DAY	-	1	equipment per day	off-road dump truck	12	10	20	day	1	0	200	200	600	0	0	0	0	240	0	0	0	0	backfilling of all below-ground structures; pits, basements, trenches, hoppers, shafts, vaults, sumps, and other depressions; placing interim gravel surface (3 inches) over disturbed areas (assumed approximately 4 acres)	-
		Placement	20	DAY	-	1	equipment per day	loader	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0		-
		Compaction	20	DAY	-	1	equipment per day	excavator w/ tamper	0	10	20	day	1	0	200	200	600	0	0	0	0	0	0	0	0	0		-
		Foreman, Laborers (5)	20	DAY	-	6	vehicle per day	support truck	15	10	20	day	6	0	1,200	1,200	3,600	600	500	0	0	0	0	0	0	0		-
		Gravel Borrow Delivery	1	EA	1	100	materials	truck delivery - materials	250	10	2	load	100	0	2,000	2,000	0	0	0	0	0	0	0	0	50,000	50,000		-
		Gravel Spreading	2,000	CY	600	1	equipment per day	dozer	12	10	4	day	1	0	40	40	120	0	0	0	0	48	0	0	0	0		-
		Laborers (2)	2,000	CY	600	2	vehicle per day	support truck	15	10	4	day	2	0	80	80	240	40	500	0	0	0	0	0	0	0		-

	Equipment and Vehicle Total Hours	Labor Total Hours	Daily Labor Mobilization Miles	Vehicles Miles Onsite	Vehicle Mob/Demob Mileage	Equipment Mobilization Miles - Unloaded	Equipment Mobilization Miles - Loaded	Daily Equipment Miles Onsite	Daily Haul Truck Miles - Unloaded	Daily Haul Truck Miles - Loaded	Material Delivery Miles - Unloaded	Material Delivery Miles - Loaded
Totals	202,518	179,318	626,110	42,505	12,500	59,000	59,000	23,868	101,709	101,709	152,000	152,000

Worksheet 3.5 - Cost Estimates

Impoundment		Alternative[1] New Onsite Landfill	Alternative[1] Offsite Existing Landfill[2]
NAP & OEAP Closure By Removal		**$63,600,000**	**$208,400,000**
	Preconstruction / Engineering Tasks	$8,790,600	$9,805,900
	Engineering and Mobilization / Demobilization	$2,108,600	$7,638,800
	Operational Pool Lowering4,5	$7,810,400	$8,356,400
	Soil Excavation and Stockpiling	$3,039,400	$3,039,400
	Excavate Ash and Dispose in Landfill	$35,144,200	$172,807,700
	General Fill Placement (On-Site Soil)	$4,401,800	$4,401,800
	Stormwater Outfalls	$865,800	$865,800
	Seed and Mulch	$952,900	$952,900
	Erosion and Sediment Controls	$413,400	$425,100
	Instrumentation6,7,8	$0	$0
	Demolition	$97,500	$97,500
NEAP Closure By Removal		**$14,300,000**	**$36,800,000**
	Preconstruction / Engineering Tasks	$3,153,800	$3,213,600
	Mobilization / Demobilization	$429,000	$1,292,200
	Operational Pool Lowering4,5	$1,752,400	$1,797,900
	Soil Excavation and Stockpiling	$1,049,100	$1,049,100
	Consolidate NEAP Ash and Dispose in Landfill	$7,140,900	$28,692,300
	General Fill Placement (On-Site Soil)	$101,400	$101,400
	Stormwater Outfalls	$39,000	$39,000
	Seed and Mulch	$341,900	$341,900
	Erosion and Sediment Controls	$197,600	$198,900
	Instrumentation6,7	$0	$0
	Demolition	$97,500	$97,500
New Onsite Landfill Construction (less Post-Closure Care)		**$40,000,000**	**$0**
	Engineering Support and other Report Requirements	$3,185,000	$0
	Mobilization / Demobilization	$860,811	$0
	Erosion and Sediment Controls	$89,700	$0
	Monitoring & Instrumentation	$221,000	$0
	Site Clearing	$197,600	$0
	Earthwork	$25,668,500	$0
	Landfill Geosynthetics Components	$8,977,800	$0
	Turf and Grasses for Final Cover System	$526,500	$0
	Landfill Stormwater Management Features	$317,200	$0
	Post-Closure Cost Estimate (30-year)	$3,455,400	$0
Drainage Cutoff Trench		**$3,800,000**	**$3,800,000**
	Engineering and construction	$2,500,000	$2,500,000
	10 yr operations	$1,300,000	$1,300,000
TOTAL (less New LF PCC)		**$121,700,000**	**$249,000,000**

Notes:

[1]Includes a 30 percent contengency

[2]Includes tipping fees

Completed By:	T. Ward
Checked By:	M. Martz
Approved By:	J. Varsho

Letter from Geosyntec Consultants to Dynegy Midwest Generation Re: Summary of Old East Ash Pond Area Slope Stability Reliability Assessment, Vermillion Power Plant, November 2021

Geosyntec consultants

134 N. La Salle Street, Suite 300
Chicago, Illinois 60602
PH 312.658.0500
FAX 312.658.0576
www.geosyntec.com

4 November 2021

Mr. Victor Modeer, P.E., D.G.E.
Senior Project Engineer
Vistra Energy
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Subject: Summary of Old East Ash Pond Area Slope Stability Reliability Assessment
Vermillion Power Plant
Dynegy Midwest Generation, LLC

Dear Mr. Modeer:

Geosyntec has completed the slope stability reliability assessment for the Old East Ash Pond area (OEAP) at the Vermillion Power Plant (VPP) at the request of Dynegy Midwest Generation, LLC (Dynegy). The assessment was conducted as part of the potential need for temporary riverbank stabilization measures along the Middle Fork of the Vermilion River (River). This summary provides a synopsis of the calculations prepared by Geosyntec that documents the details of the reliability assessment.

CLOSURE REQUIREMENTS

The Final Closure Plan for the OEAP is undergoing the Construction Permit Application and approval process. The Agreed Interim Order (Illinois Attorney General, June 2021) ("Interim Order") includes the requirement for closure by removal (CBR) of the OEAP, North Ash Pond area (NAP), and New East Ash Pond (NEAP).

Until the Closure Plan is implemented, continued riverbank erosion along the OEAP creates a concern for the destabilization of the perimeter embankment caused by the loss of riverbank soils.

PUROSE OF RELIABILITY ASSESSMENT

The purpose of the reliability assessment was to have information to reach an informed decision of when to implement the temporary riverbank stabilization measures, if necessary, prior to closure of the OEAP. Once the OEAP is closed, the coal combustion residuals (CCR) and most of the embankment would be removed and the temporary riverbank stabilization measures will not be necessary.

APPROACH

The reliability assessment was conducted based on the "best practice" document series prepared by the United States Bureau of Reclamation (USBR) and the United States Army Corps of Engineers (USACE) for "Probabilistic Stability Analysis (Reliability Analysis)" updated most recently as of July 2018. The reliability assessment is a probabilistic analysis that accounts for the inherent variability of key soil properties that affect the stability of the slope. Unlike deterministic slope stability analyses that yield a factor of safety based on a single estimate of the soil properties, the reliability assessment estimates the probability of slope failure based on the variability of soil and groundwater conditions.

An erosion assessment was conducted to assess the time to when erosion would be at the stage that could require initiation of design and permitting of the temporary riverbank stabilization measures and when they would need to be installed. The assessment was completed using historical aerials and spatial data.

Using this approach, the reliability of existing and future conditions resulting from progressing riverbank erosion were evaluated.

RELIABILITY ASSESSMENT

The reliability assessment approach relies on the calculation of the reliability index, β, of the slope, which is related to the probability of failure—the larger the reliability index, the farther the slope is from failure. The reliability index value that defines the condition when the temporary riverbank stabilization measures could be implemented, $\beta_{trigger}$, was set at 3.0, which is a common target for critical designs with little redundancy based on available sources.

When the $\beta_{trigger}$ is reached, it should not be conflated with a condition that could lead to imminent movement of the slope. It is the condition where action should be taken with sufficient time to conduct design, permitting and construction, to restore the condition to a higher degree of reliability.

Geosyntec conducted the reliability assessment in the following general order:

1) Review existing geotechnical data and establish subsurface stratigraphy and engineering parameters, including statistical parameters describing the expected variability of engineering parameters.
2) Select the slope stability analysis cross-sections for the OEAP that are deemed as the most critical, based on OEAP geometry, subsurface material layering, and the depth of the river channel.
3) Identify whether undrained or drained shear strength parameters are to be used in the reliability analysis and explained the basis of the selection.
4) Estimate the rate of erosion and the approximate time that it would take for riverbank erosion to initiate the implementation of temporary mitigation measures.
5) Conduct reliability analyses on cross-sections deemed as critical as part of item 2 using SLOPE/W software, as part of the GeoStudio software package (2019) [1].
6) Compare the β value for the existing slope configuration from the analysis to $\beta_{trigger}$. If the β value is greater than $\beta_{trigger}$, the cross-section was modified based on the expected erosion progression until the β value is equal to or below $\beta_{trigger}$.

This iterative process identified the geometric conditions and time frame based on estimated riverbank erosion rates when temporary riverbank stabilization measures, initiating with design and permitting, would be required.

Geosyntec examined six potentially critical cross sections and performed analyses at three cross-sections (A, D and F) along the OEAP. The plan view depicting the sections are shown on Figure 1 and the sections are shown on Figures 2 and 3.

EROSION ASSESSMENT

The erosion rate was evaluated to estimate when the edge of the River, which is also the toe of the slope for the OEAP containment embankment, reaches a position where the reliability index reaches the $\beta_{trigger}$ criterion.

Geosyntec reviewed several sources to the estimate erosion rate for the riverbank along the OEAP. Sources that were utilized included aerial imagery after 2000 and spatial data from Vermilion County [2].

Imagery and spatial data provided by Vermilion County provided the clearest demarcation of the edge of water. The edge of water for the Vermilion River was digitized using the 2004 and 2018 aerial images. The two lines depicting the edge of water were overlaid on the aerial images using GIS, and the two lines from the two different times were compared to estimate the rate of erosion.

Appendix A provides a comparison of the edge of water from 2004 and 2018 aerial images. The difference between the two lines depicting the edge of water ranges from an approximate distance of few feet to 10 feet. In general, a distance of 7 to 10 feet between the two lines is consistently visible. Based on this assessment, which utilizes the best information available to us, the average riverbank erosion along the OEAP is 10 feet over the course of 14 years resulting in a range of 0.5 to 0.7 ft/year. For purposes of this evaluation, an overall rate of 1 ft/year may be used representing an upper range.

RESULTS

The critical slope stability analyses are presented in **Appendix B** and **Table 1**. In summary, Geosyntec obtained the following results:

- The reliability index, β is greater than 3.0 for the existing conditions.
- The estimated lateral riverbank erosion rate is 1 ft/year.
- Stability analyses containing the eroded riverbank condition were not modeled for Section A because the ash pond is approximately 250 ft from the river channel; therefore, riverbank erosion is not expected to impact stability of the ash pond for many years relative to Sections D and F.
- The $\beta_{trigger}$ value is reached after 10 ft of riverbank erosion for cross-section D and 15 ft of riverbank erosion for cross-section F for varying groundwater conditions.
- The $\beta_{trigger}$ value is reached after 16 ft of riverbank erosion for cross-section D and 20 ft of riverbank erosion for cross-section F for fixed groundwater conditions.

Table 1 – Summary of Reliability Indices

<table>
<tr><th rowspan="2">Section</th><th rowspan="2">Groundwater Condition</th><th colspan="2">Reliability Index, β</th><th rowspan="2">Riverbank Erosion (ft)</th></tr>
<tr><th>Existing Condition</th><th>Eroded Condition</th></tr>
<tr><td rowspan="2">Section A</td><td>Varied</td><td>3.6</td><td colspan="2" rowspan="2">Not Modeled</td></tr>
<tr><td>Fixed</td><td>4.3</td></tr>
<tr><td rowspan="2">Section D</td><td>Varied</td><td>4.0</td><td>2.9</td><td>10</td></tr>
<tr><td>Fixed</td><td>4.8</td><td>3.2</td><td>15</td></tr>
<tr><td rowspan="2">Section F</td><td>Varied</td><td>6.2</td><td>2.9</td><td>15</td></tr>
<tr><td>Fixed</td><td>7.3</td><td>3.1</td><td>20</td></tr>
</table>

CONCLUSIONS

The following is concluded:

- Based on the approximated erosion rate of 1 ft/year, it may take 10 years to reach $\beta_{trigger}$ value of 3.0 at the critical cross-section assuming *varying* groundwater condition.
- Based on the approximate erosion rate of 1 ft/year, it may take 16 years to reach $\beta_{trigger}$ value of 3.0 at the critical cross-section assuming a *fixed* groundwater condition.

Please call John Seymour at (312) 416-3919 or Omer Bozok at (312) 416-3924 if you have any questions.

Omer Bozok, P.E.
Senior Engineer

John Seymour, P.E.
Senior Principal

cc: David Mitchell
Phil Morris

REFERENCES

[1] GeoStudio, "Slope/W, Version 10.0.2.18035," GeoStudio, 2019.

[2] "Vermilion County GIS," 2019. [Online]. Available: http://vermilion.il.bhamaps.com/.

FIGURES

LEGEND

- EXISTING MAJOR CONTOUR (5- FT INTERVAL)
- EXISTING MINOR CONTOUR (1- FT INTERVAL)
- SEPTEMBER 2019 SURVEY POINT (NOTE 4)
- ST-07 BORING LOCATION
- APPROXIMATE LIMITS OF EXISTING ASH
- APPROXIMATE ORDINARY HIGH WATER MARK (OHWM)
- GRAVEL ACCESS ROAD
- OHE OVERHEAD ELECTRIC LINE
- DRAFT PROFILE ALONG THE CENTERLINE OF NAP RIVERBANK STABILIZATION TRENCH

NOTES:

1. BASE MAP IS AN AMALGAM OF PUBLICLY AVAILABLE LIDAR DATA AND SURVEY CONDUCTED BY INGENAE ON MARCH 2018.
2. COORDINATE SYSTEM IS NORTH AMERICAN DATUM OF 1983 (NAD 83) ILLINOIS STATE PLANE EAST, AND VERTICAL DATUM IS IN NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
3. THE DATE OF AERIAL IMAGE IS APRIL 20, 2019 OBTAINED FROM GOOGLE EARTH PRO.
4. ADDITIONAL TOPOGRAPHIC SURVEY WAS COMPLETED BY INGENAE ON SEPTEMBER 19, 2019.

0 50 100
SCALE IN FEET

FOR REVIEW PURPOSES ONLY
DRAFT CONCEPTUAL DRAWING - NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1 MCBRIDE AND SON CENTER DRIVE, SUITE 202
CHESTERFIELD MO 63005 USA
TELEPHONE: 636.812.0800

DYNEGY MIDWEST GENERATION
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: OLD EAST ASH POND RIVERBANK PLAN VIEW

PROJECT: VERMILION RIVERBANK STABILIZATION

SITE: VERMILION COUNTY, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

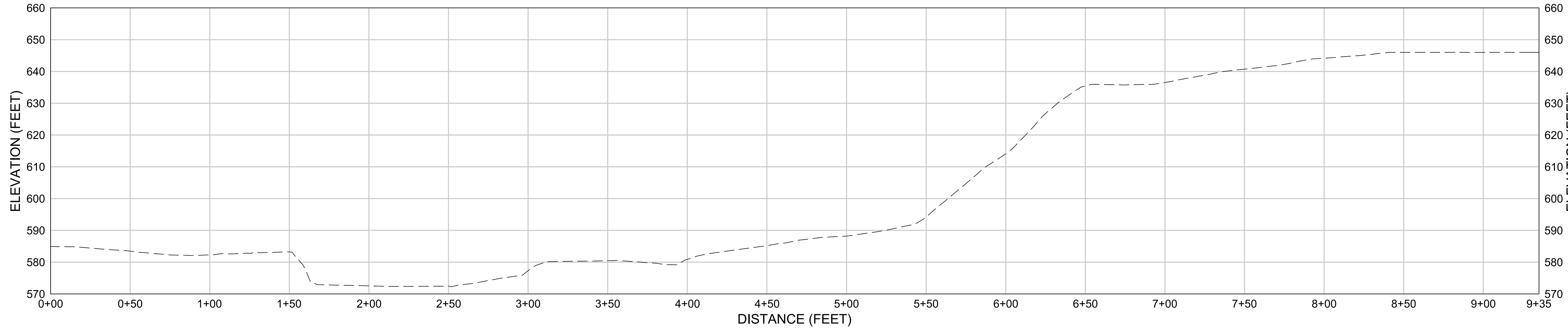
DATE

DRAFT

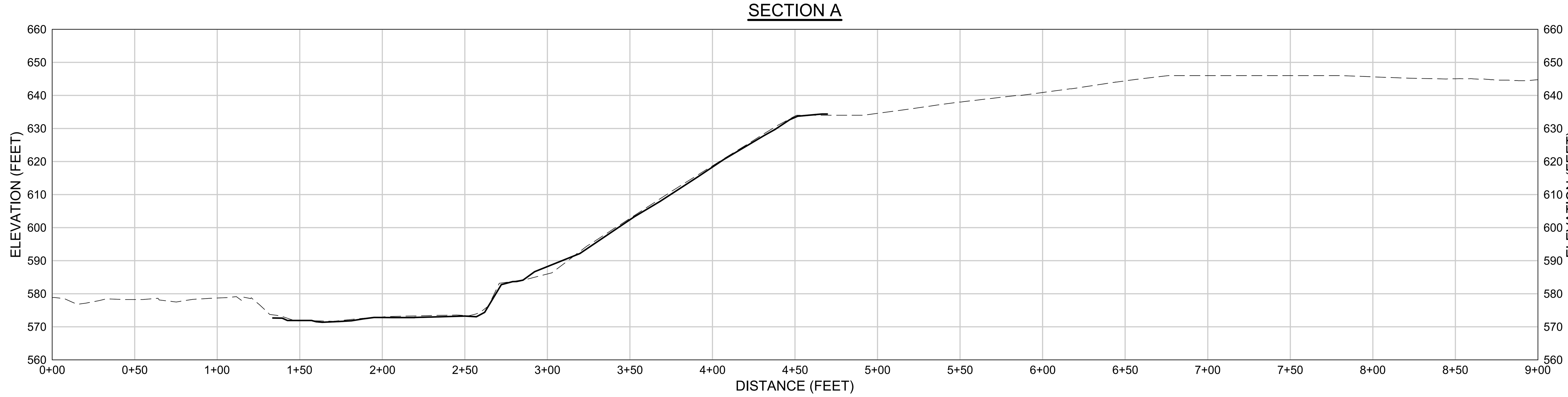
DESIGN BY:
DRAWN BY:
CHECKED BY:
REVIEWED BY:
APPROVED BY:

FIGURE 1

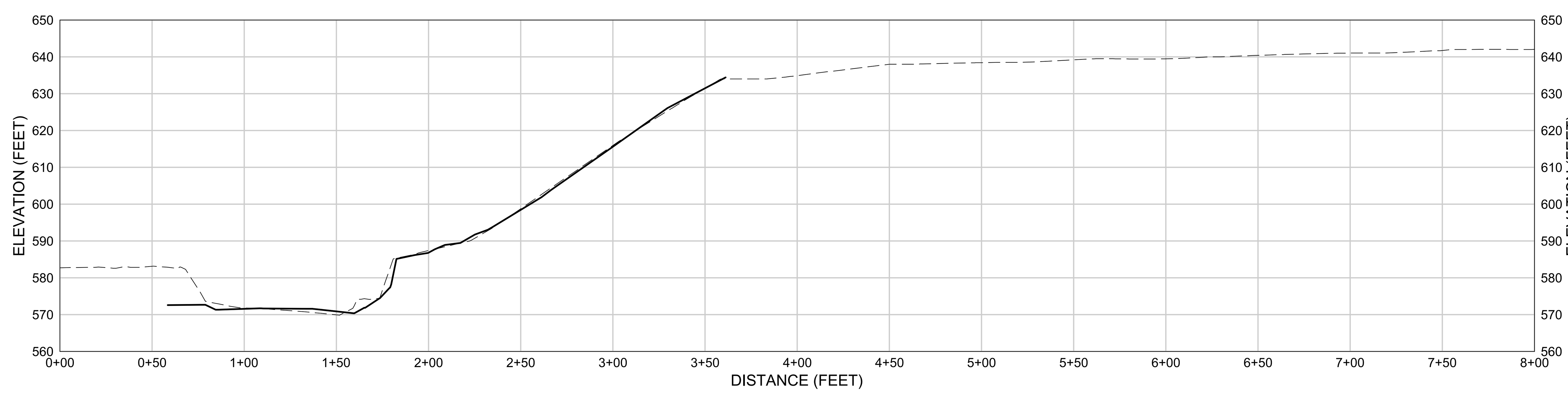
FIGURE 2 - OLD EAST ASH POND RIVERBANK PLAN VIEW



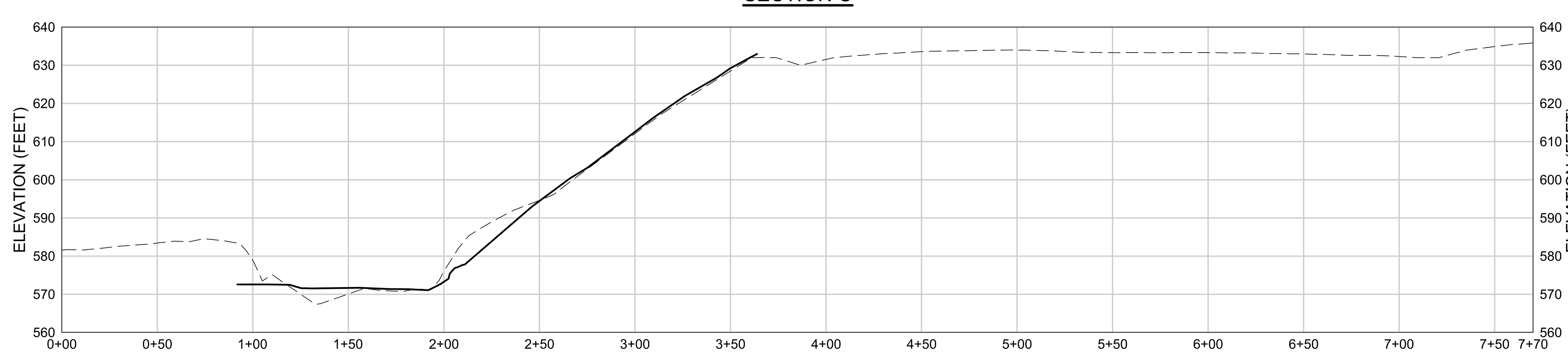
SECTION A



SECTION B



SECTION C



SECTION D

LEGEND

- - - - - BASE MAP GRADE (NOTE 1)

———— SEPTEMBER 2019 TOPOGRAPHY (NOTE 3)

NOTES:

1. BASE MAP IS AN AMALGAM OF PUBLICLY AVAILABLE LIDAR DATA AND SURVEY CONDUCTED BY INGENAE ON MARCH 2018.
2. VERTICAL DATUM IS IN NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
3. SEPTEMBER 2019 TOPOGRAPHY IS BASED ON A SURFACE ESTABLISHED USING GROUND SURVEY POINTS.

0 50' 100'
HORIZONTAL SCALE IN FEET

0 25' 50'
VERTICAL SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1 MCBRIDE AND SON CENTER DRIVE, SUITE 202
CHESTERFIELD MO 63005 USA
TELEPHONE: 636.812.0800

DYNEGY MIDWEST GENERATION
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: OLD EAST ASH POND RIVERBANK SECTIONS I

PROJECT: VERMILION RIVERBANK STABILIZATION

SITE: VERMILION COUNTY, ILLINOIS

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SIGNATURE

DATE

DRAFT

DESIGN BY:
DRAWN BY:
CHECKED BY:
REVIEWED BY:
APPROVED BY:

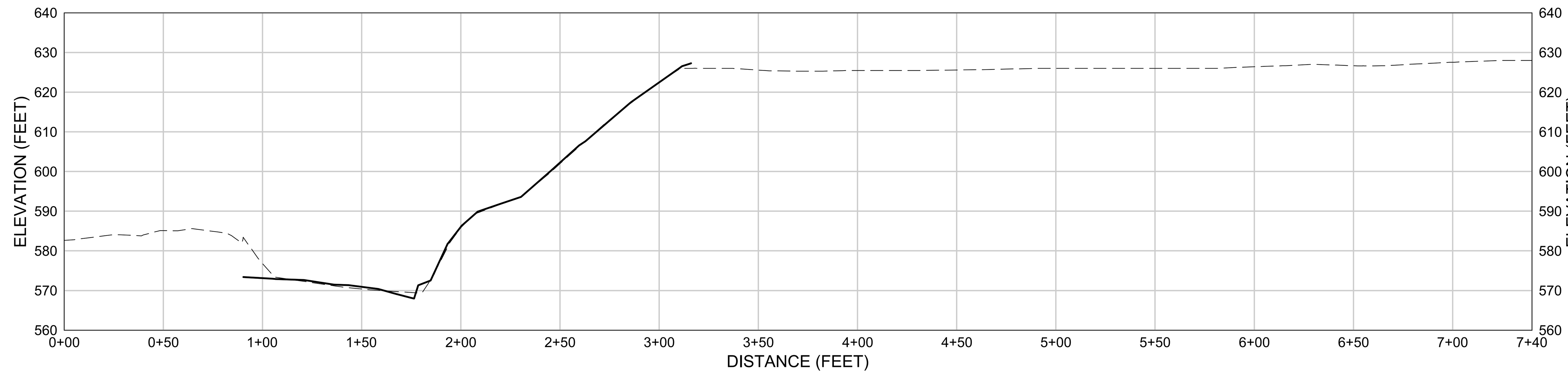
DATE: NOVEMBER 2019
PROJECT NO.: CHE8404
FILE:

FIGURE 2

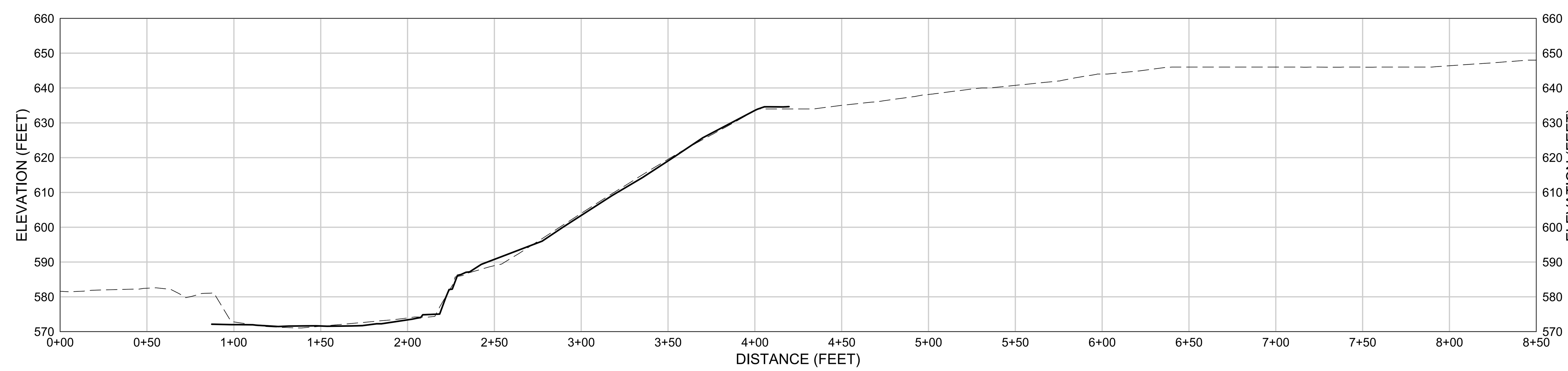
FOR REVIEW PURPOSES ONLY
DRAFT CONCEPTUAL DRAWING - NOT FOR CONSTRUCTION

P:\DWG\V\CHE8404 VPS CLOSURE\DRAWINGS\CHE8404-006-008 OEAP PLAN VIEW&SECTIONS.DWG Last Edited by: MKateleva on 11/14/19

FIGURE 3 - OLD EAST ASH POND RIVERBANK SECTIONS I



SECTION E



SECTION F

LEGEND

BASE MAP GRADE (NOTE 1)

SEPTEMBER 2019 TOPOGRAPHY (NOTE 3)

NOTES:

1. BASE MAP IS AN AMALGAM OF PUBLICLY AVAILABLE LIDAR DATA AND SURVEY CONDUCTED BY INGENAE ON MARCH 2018.
2. VERTICAL DATUM IS IN NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
3. SEPTEMBER 2019 TOPOGRAPHY IS BASED ON A SURFACE ESTABLISHED USING GROUND SURVEY POINTS.

0 50' 100'
HORIZONTAL SCALE IN FEET

0 25' 50'
VERTICAL SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1 MCBRIDE AND SON CENTER DRIVE, SUITE 202
CHESTERFIELD MO 63005 USA
TELEPHONE: 636.812.0800

DYNEGY MIDWEST GENERATION
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: OLD EAST ASH POND RIVERBANK SECTIONS II

PROJECT: VERMILION RIVERBANK STABILIZATION

SITE: VERMILION COUNTY, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DRAFT

DESIGN BY:		DATE:	NOVEMBER 2019
DRAWN BY:		PROJECT NO.:	CHE8404
CHECKED BY:		FILE:	
REVIEWED BY:			
APPROVED BY:			

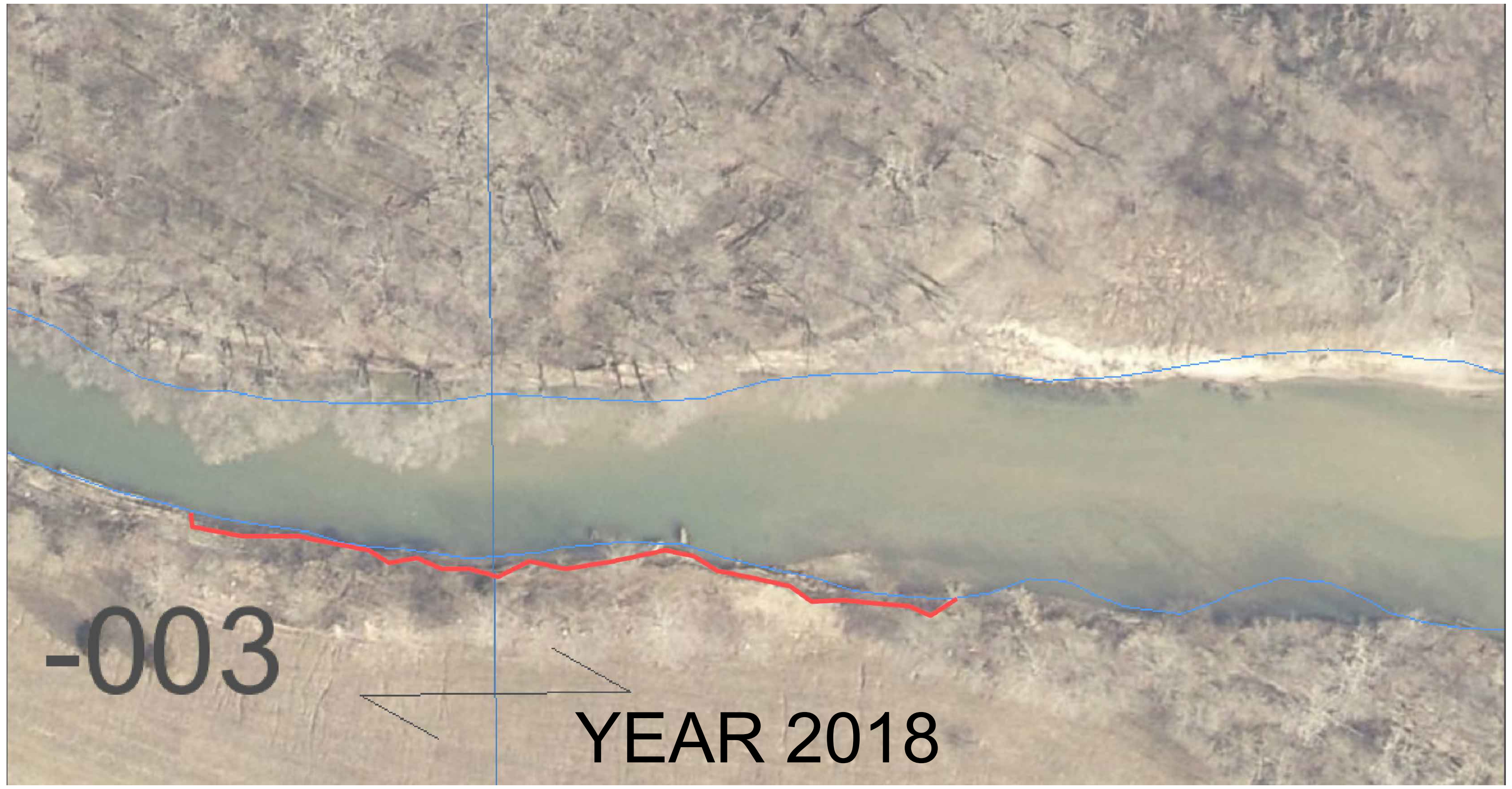
FIGURE 3

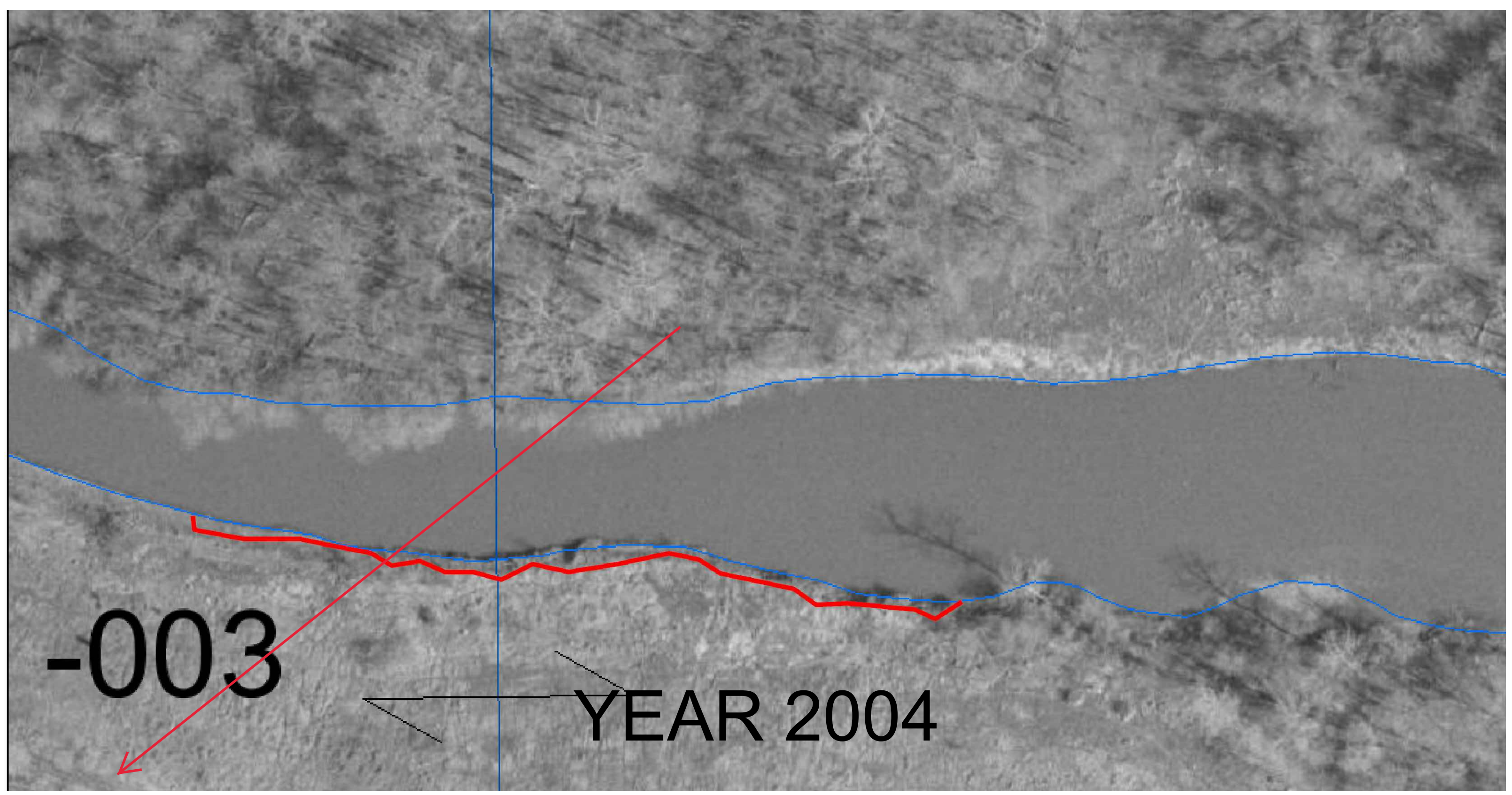
FOR REVIEW PURPOSES ONLY
DRAFT CONCEPTUAL DRAWING - NOT FOR CONSTRUCTION

P:\DWG\CHE8404 VPS CLOSURE\DRAWINGS\CHE8404-006-008 OEAP PLAN VIEW&SECTIONS.DWG Last Edited by: MKateleva on 11/14/19

FIGURE 4 - OLD EAST ASH POND RIVERBANK SECTIONS II

APPENDIX A





NOTE:

OEAP EMBANKMENT EROSION:

THE BLUE LINE REPRESENTS THE EDGE OF WATER DIGITIZED FROM THE SURFACE IN THE RED LINE DRAWN FROM TOP OF BANK IN 2018 SHOWS THE DEPARTURE.

N

0 100'
SCALE IN FEET

DISCLAIMER:

IMAGERY AND VECTOR DATA SHOWN ARE THE PROPERTY OF VERMILLION COUNTY, IL.

OEAP EMBANKMENT EROSION
VERMILION RIVERBANK STABILIZATION

VERMILION COUNTY, ILLINOIS

Geosyntec consultants

PROJECT NO: CHE8404	DECEMBER 2019	FIGURE 1

APPENDIX B

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	01_Fill	Mohr-Coulomb	131	0	40	1
	02_Coal Ash	Mohr-Coulomb	107	0	37	1
	03_Clay Alluvium	Mohr-Coulomb	112	0	34	1
	06_Glacial Till	Mohr-Coulomb	129	0	37	1
	07_Bedrock	Mohr-Coulomb	140	0	45	1

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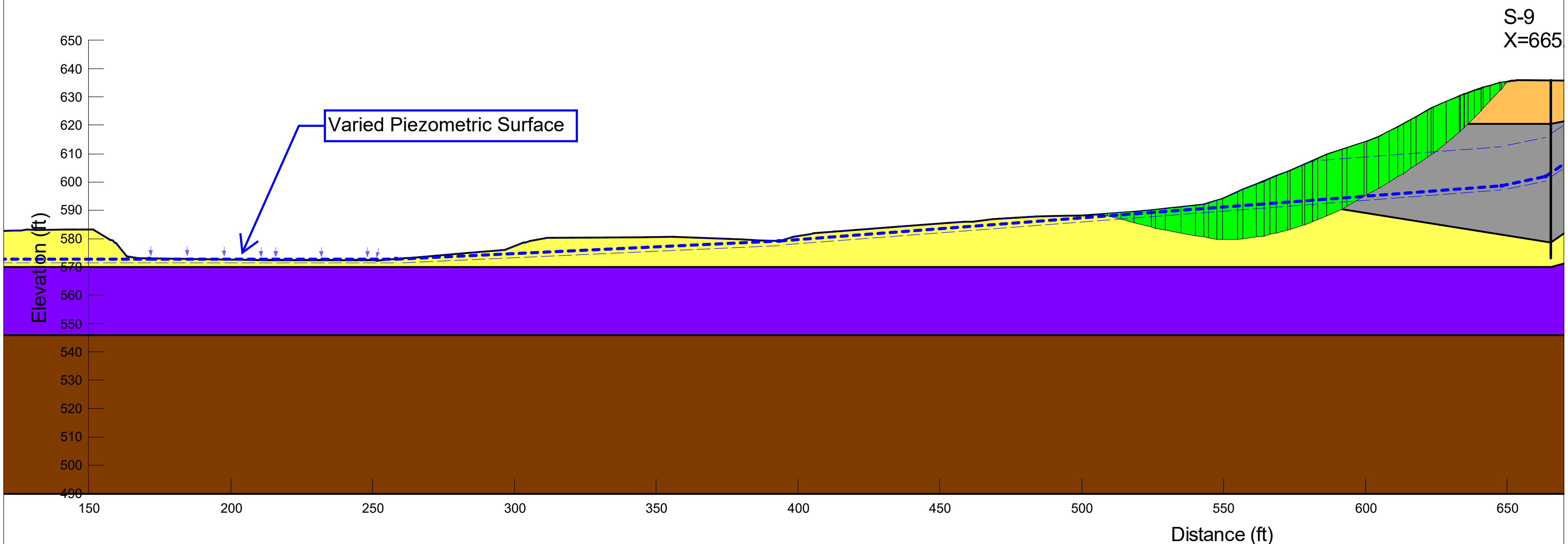
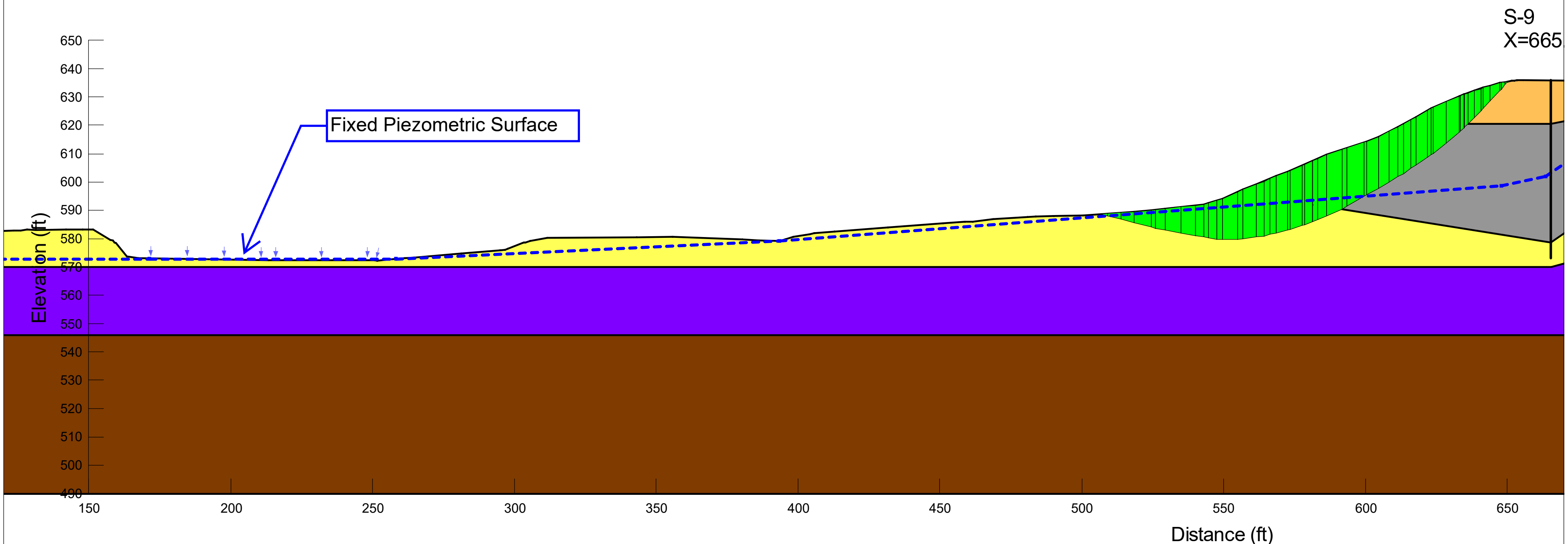
Std. Dev. F of S: 0.20150183
Reliability Index: 3.5520608



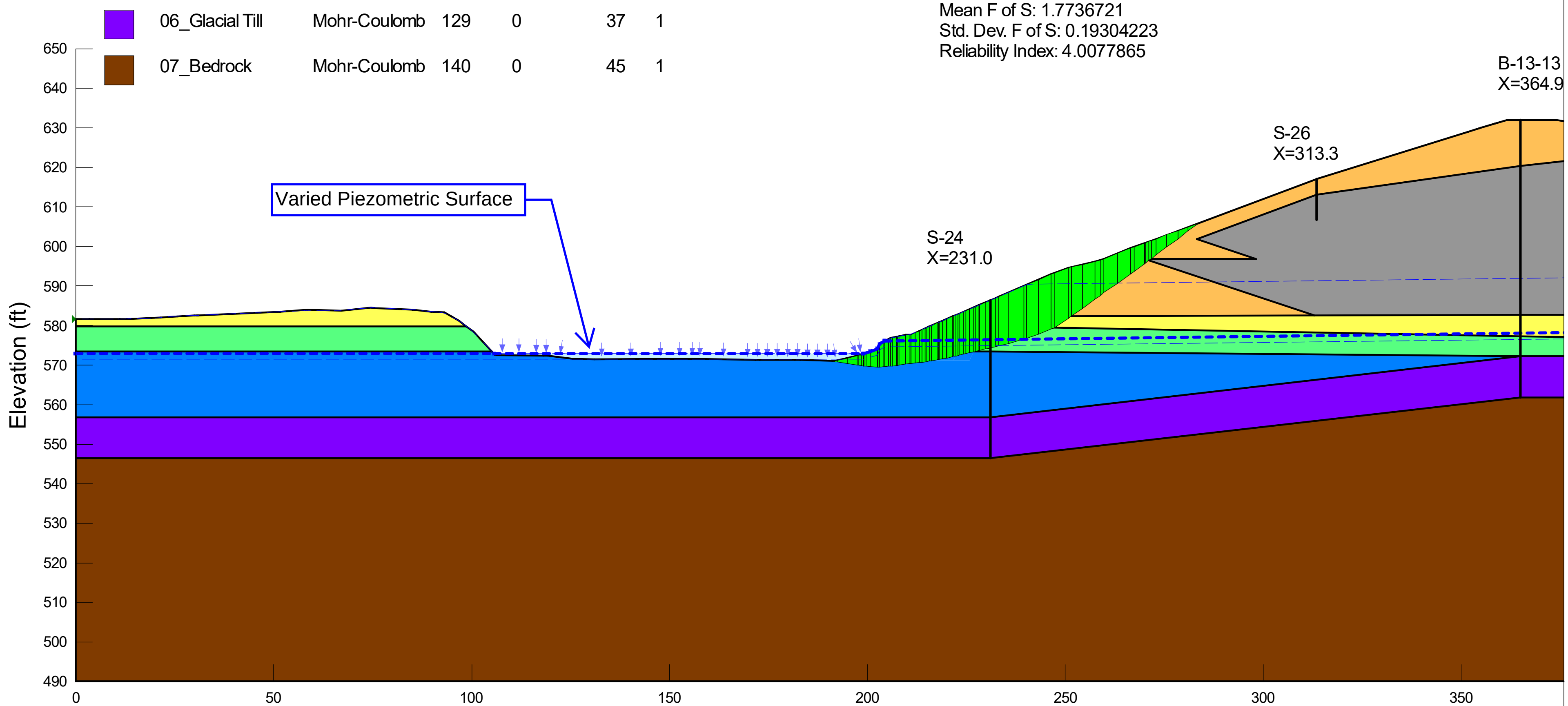
Geosyntec consultants engineers | scientists | innovators	Vermillion OEAP Stability and Reliability Analysis				Existing Condition
	SectionA - Probabilistic FS				
	Created By: Zachary Fallert	Date:12/2/2019	Checked By: Alex Stern	Date:12/3/2019	

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	01_Fill	Mohr-Coulomb	131	0	40	1
	02_Coal Ash	Mohr-Coulomb	107	0	37	1
	03_Clay Alluvium	Mohr-Coulomb	112	0	34	1
	06_Glacial Till	Mohr-Coulomb	129	0	37	1
	07_Bedrock	Mohr-Coulomb	140	0	45	1

Mean F of S: 1.7802087
Std. Dev. F of S: 0.18164199
Reliability Index: 4.29531



Geosyntec consultants engineers | scientists | innovators	Vermillion OEAP Stability and Reliability Analysis				Existing Condition
	SectionA - Probabilistic FS				
	Created By: Zachary Fallert	Date:12/2/2019	Checked By: Alex Stern	Date:12/3/2019	



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	01_Fill	Mohr-Coulomb	131	0	40	1
	02_Coal Ash	Mohr-Coulomb	107	0	37	1
	03_Clay Alluvium	Mohr-Coulomb	112	0	34	1
	04_Sand Alluvium	Mohr-Coulomb	122	0	37	1
	05_Reworked Till	Mohr-Coulomb	141	0	35	1
	06_Glacial Till	Mohr-Coulomb	129	0	37	1
	07_Bedrock	Mohr-Coulomb	140	0	45	1

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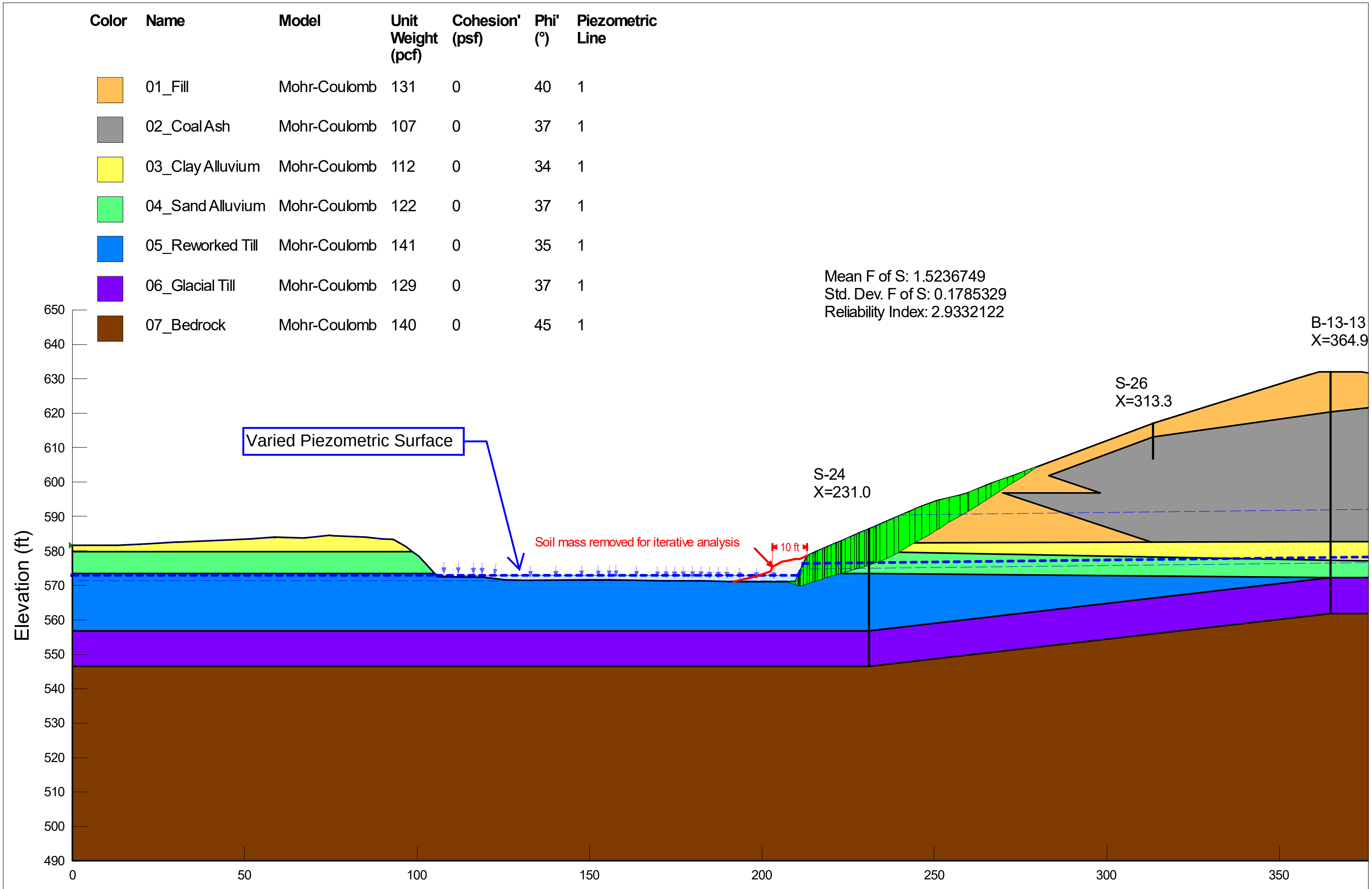
Vermillion OEAP Stability and Reliability Analysis

01_Section D - Probabilistic FS

Created By: Zachary Fallert | Date:12/2/2019 | Checked By: Alex Stern | Date:12/3/2019

Stage 01



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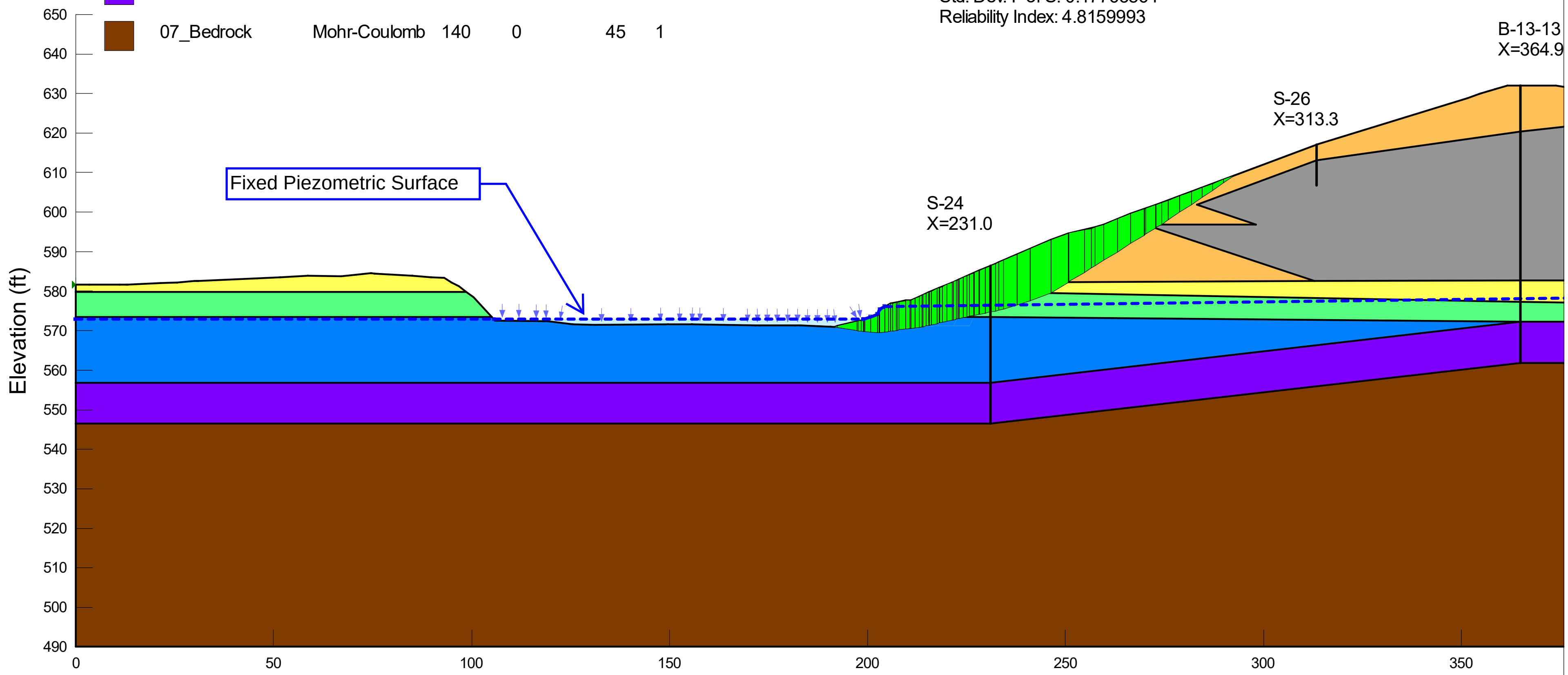
Vermillion OEAP Stability and Reliability Analysis			
03_Section D - Probabilistic FS			
Created By: Zachary Fallert	Date:12/2/2019	Checked By: Alex Stern	Date:12/3/2019

Stage 03

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	01_Fill	Mohr-Coulomb	131	0	40	1
	02_Coal Ash	Mohr-Coulomb	107	0	37	1
	03_Clay Alluvium	Mohr-Coulomb	112	0	34	1
	04_Sand Alluvium	Mohr-Coulomb	122	0	37	1
	05_Reworked Till	Mohr-Coulomb	141	0	35	1
	06_Glacial Till	Mohr-Coulomb	129	0	37	1
	07_Bedrock	Mohr-Coulomb	140	0	45	1

Mean F of S: 1.8555076
Std. Dev. F of S: 0.17763864
Reliability Index: 4.8159993



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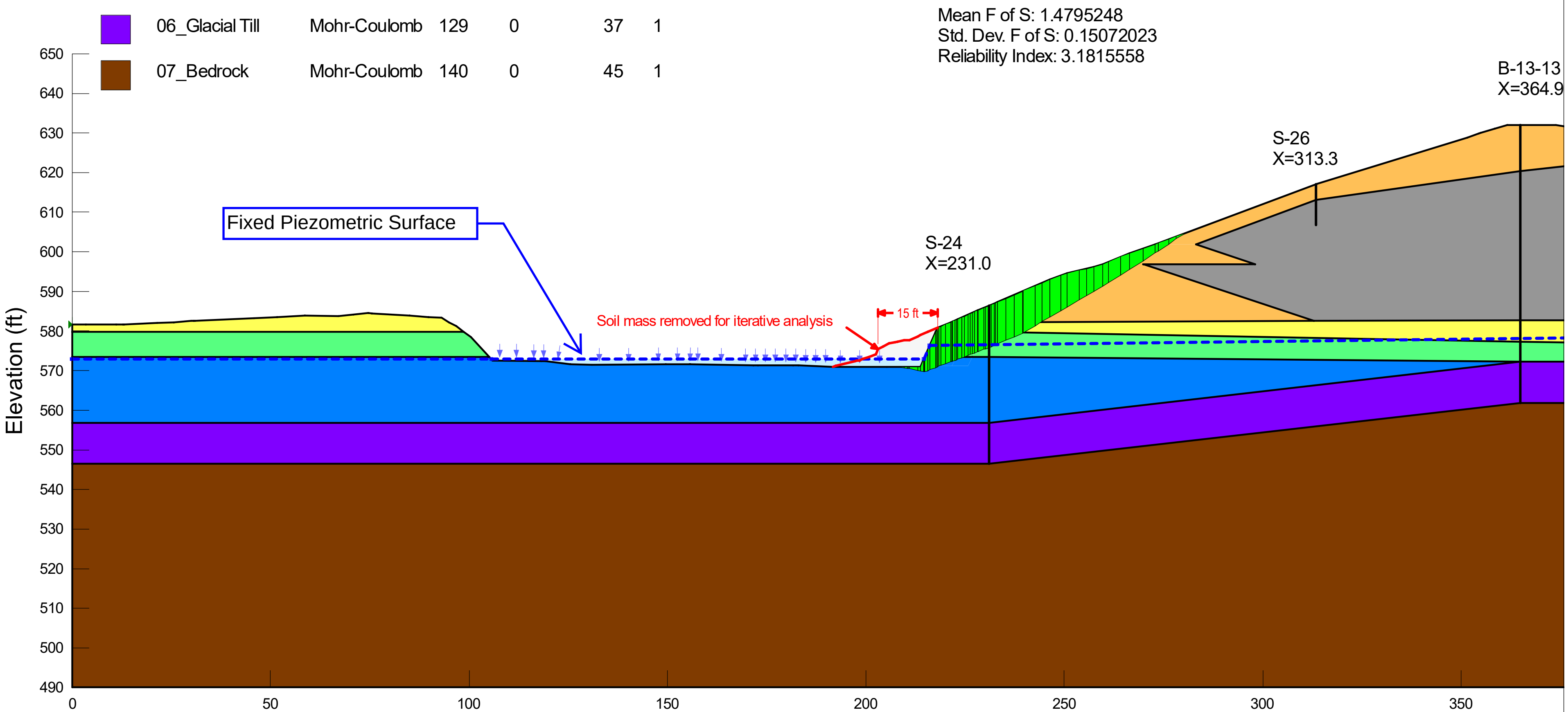
Vermillion OEAP Stability and Reliability Analysis

01_Section D - Probabilistic FS

Created By: Zachary Fallert | Date:12/2/2019 | Checked By: Alex Stern | Date:12/3/2019

Stage 01

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	01_Fill	Mohr-Coulomb	131	0	40	1
	02_Coal Ash	Mohr-Coulomb	107	0	37	1
	03_Clay Alluvium	Mohr-Coulomb	112	0	34	1
	04_Sand Alluvium	Mohr-Coulomb	122	0	37	1
	05_Reworked Till	Mohr-Coulomb	141	0	35	1
	06_Glacial Till	Mohr-Coulomb	129	0	37	1
	07_Bedrock	Mohr-Coulomb	140	0	45	1



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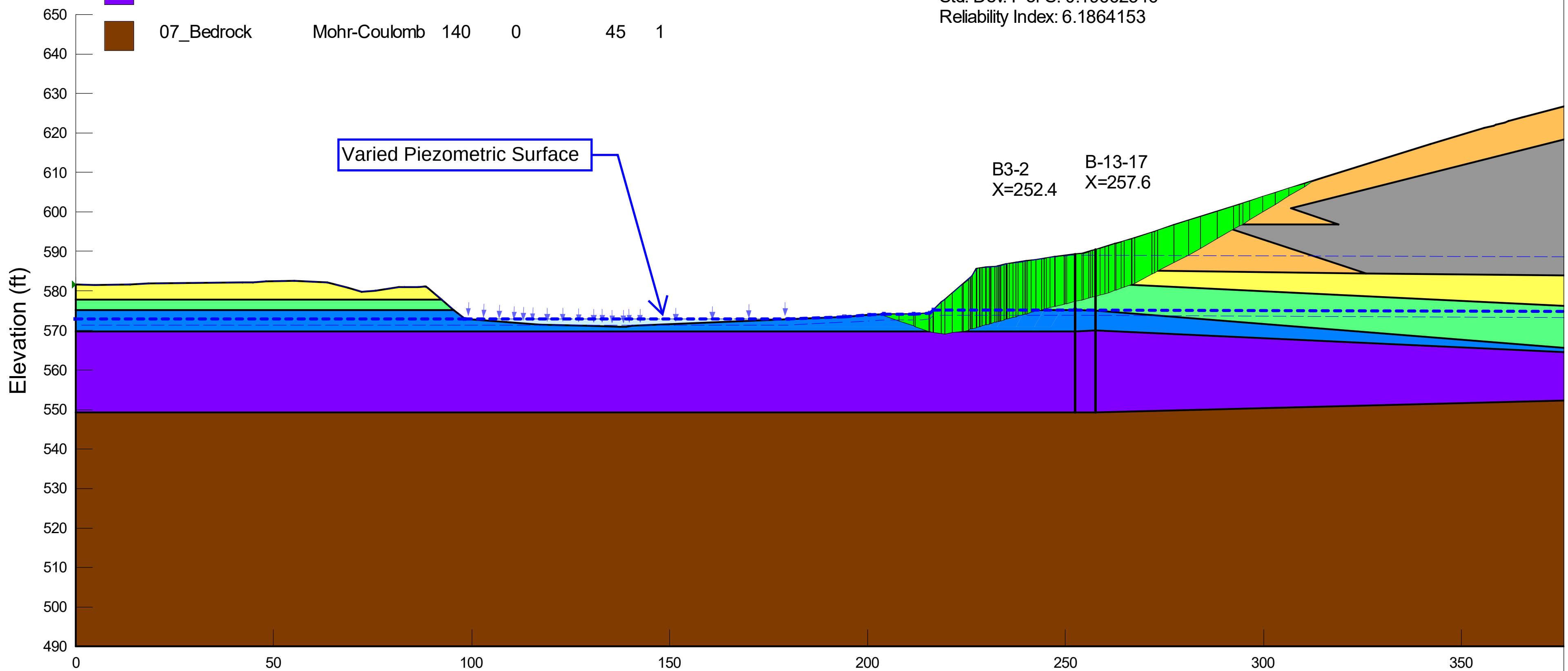
Vermillion OEAP Stability and Reliability Analysis			
04_Section D - Probabilistic FS			
Created By: Zachary Fallert	Date:12/2/2019	Checked By: Alex Stern	Date:12/3/2019

Stage 04

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	01_Fill	Mohr-Coulomb	131	0	40	1
	02_Coal Ash	Mohr-Coulomb	107	0	37	1
	03_Clay Alluvium	Mohr-Coulomb	112	0	34	1
	04_Sand Alluvium	Mohr-Coulomb	122	0	37	1
	05_Reworked Till	Mohr-Coulomb	141	0	35	1
	06_Glacial Till	Mohr-Coulomb	129	0	37	1
	07_Bedrock	Mohr-Coulomb	140	0	45	1

Mean F of S: 2.2163944
Std. Dev. F of S: 0.19662346
Reliability Index: 6.1864153



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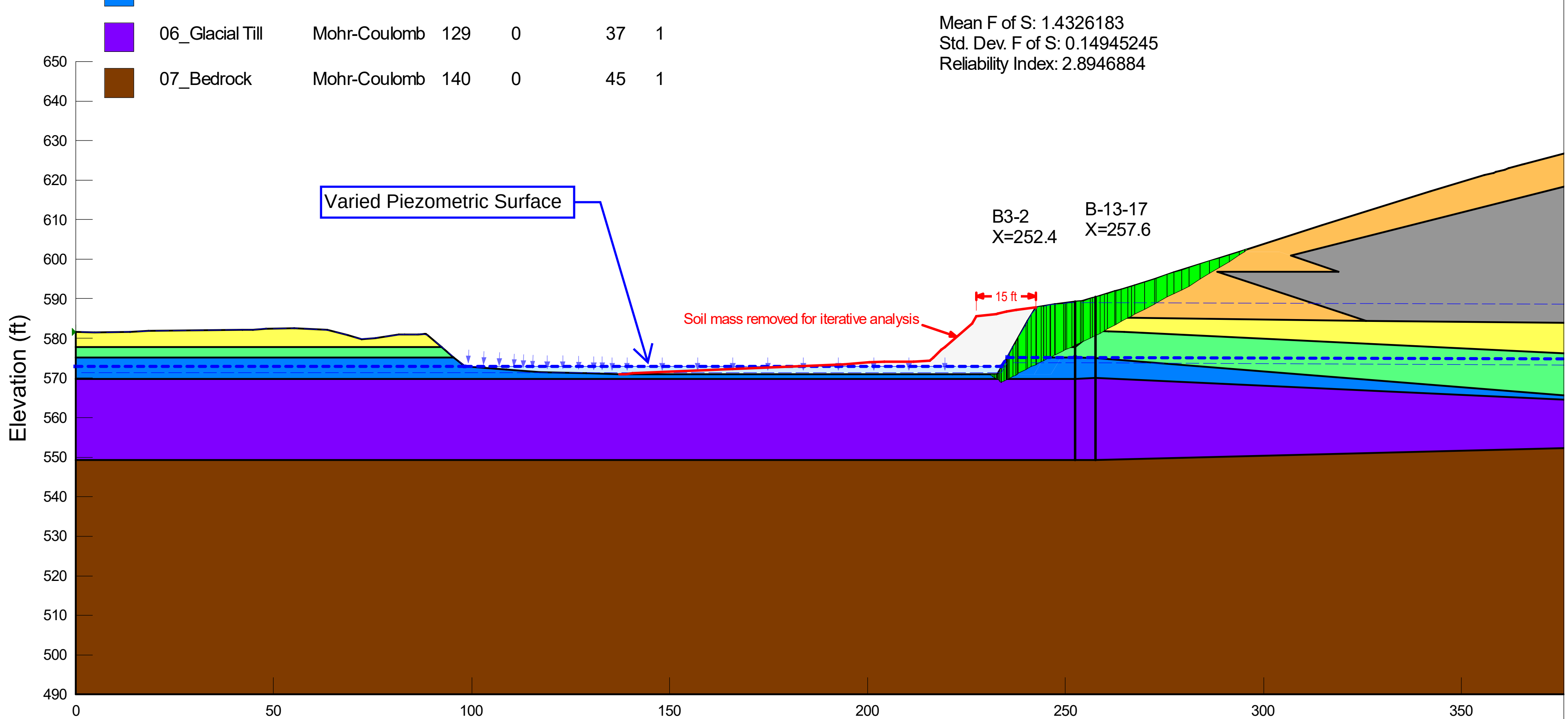
Vermillion OEAP Stability and Reliability Analysis

01_Section F - Probabilistic FS

Created By: Zachary Fallert	Date:12/2/2019	Checked By: Alex Stern	Date:12/3/2019

Stage 01

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	01_Fill	Mohr-Coulomb	131	0	40	1
	02_Coal Ash	Mohr-Coulomb	107	0	37	1
	03_Clay Alluvium	Mohr-Coulomb	112	0	34	1
	04_Sand Alluvium	Mohr-Coulomb	122	0	37	1
	05_Reworked Till	Mohr-Coulomb	141	0	35	1
	06_Glacial Till	Mohr-Coulomb	129	0	37	1
	07_Bedrock	Mohr-Coulomb	140	0	45	1



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Vermillion OEAP Stability and Reliability Analysis

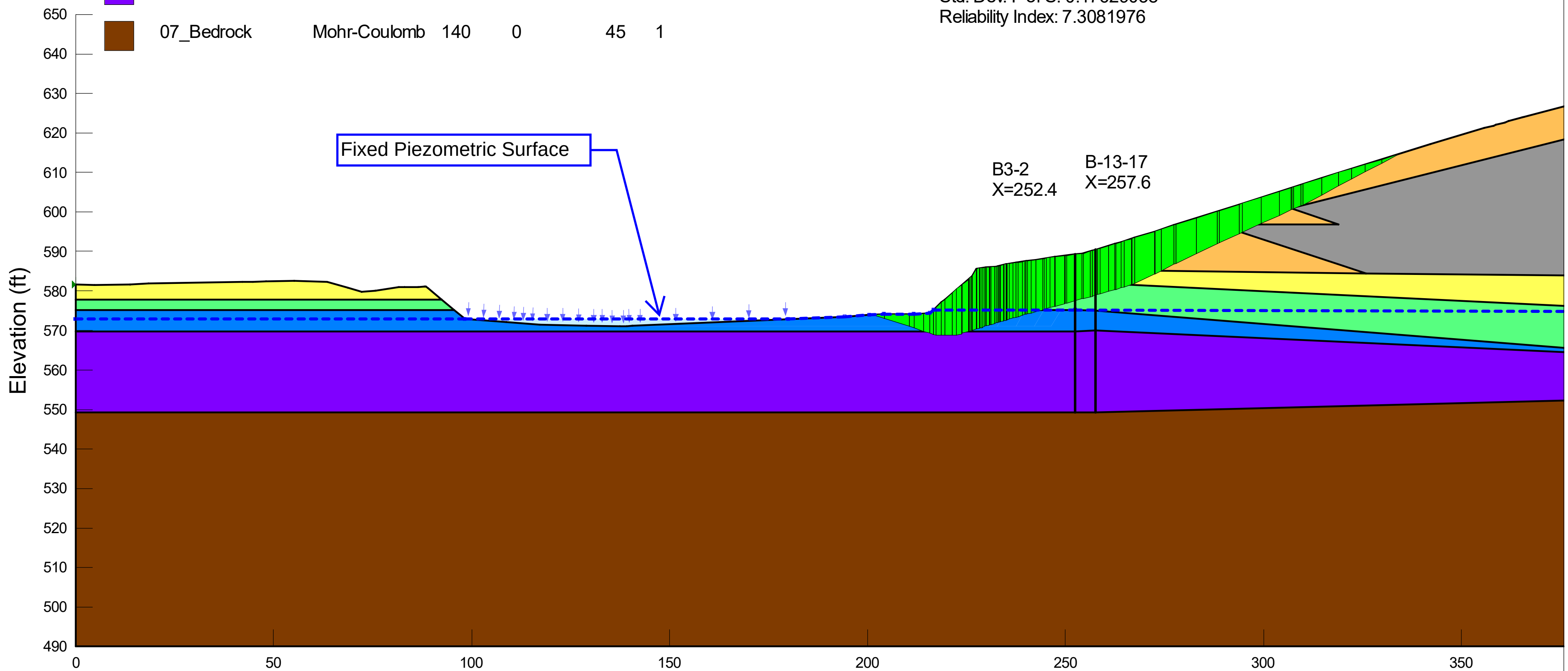
05_Section F - Probabilistic FS

Created By: Zachary Fallert | Date:12/2/2019 | Checked By: Alex Stern | Date:12/3/2019

Stage 05

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	01_Fill	Mohr-Coulomb	131	0	40	1
	02_Coal Ash	Mohr-Coulomb	107	0	37	1
	03_Clay Alluvium	Mohr-Coulomb	112	0	34	1
	04_Sand Alluvium	Mohr-Coulomb	122	0	37	1
	05_Reworked Till	Mohr-Coulomb	141	0	35	1
	06_Glacial Till	Mohr-Coulomb	129	0	37	1
	07_Bedrock	Mohr-Coulomb	140	0	45	1

Mean F of S: 2.2883649
Std. Dev. F of S: 0.17629038
Reliability Index: 7.3081976



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Vermillion OEAP Stability and Reliability Analysis

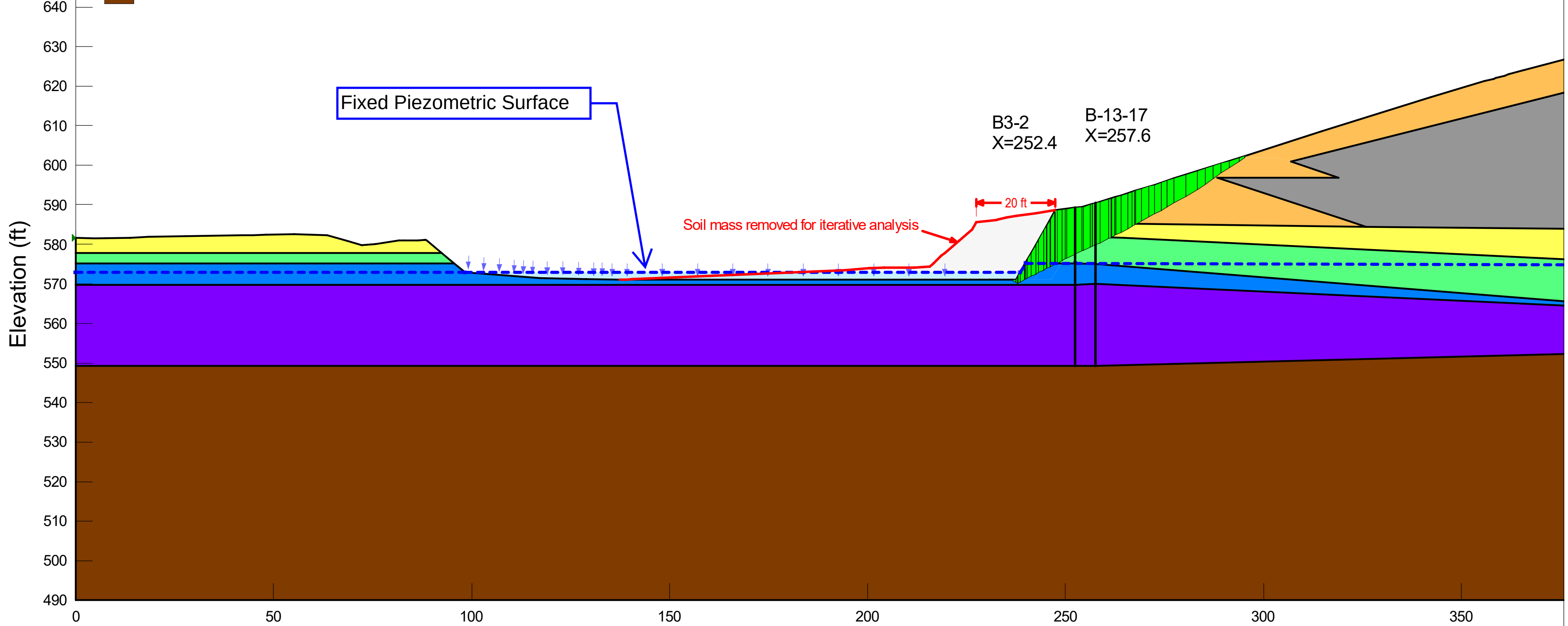
01_Section F - Probabilistic FS

Stage 01

Created By: Zachary Fallert	Date:12/2/2019	Checked By: Alex Stern	Date:12/3/2019

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
	01_Fill	Mohr-Coulomb	131	0	40	1
	02_Coal Ash	Mohr-Coulomb	107	0	37	1
	03_Clay Alluvium	Mohr-Coulomb	112	0	34	1
	04_Sand Alluvium	Mohr-Coulomb	122	0	37	1
	05_Reworked Till	Mohr-Coulomb	141	0	35	1
	06_Glacial Till	Mohr-Coulomb	129	0	37	1
	07_Bedrock	Mohr-Coulomb	140	0	45	1

Mean F of S: 1.411626
Std. Dev. F of S: 0.13369335
Reliability Index: 3.078882



Geosyntec consultants	Vermillion OEAP Stability and Reliability Analysis		Stage 06
	06_Section F - Probabilistic FS		
	Created By: Zachary Fallert	Date:12/2/2019	
	Checked By: Alex Stern	Date:12/3/2019	

ATTACHMENT O

Monitoring Natural Attenuation (MNA) Evaluation

Prepared for

Dynegy Midwest Generation
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Monitored Natural Attenuation Evaluation

Vermilion Power Plant

North Ash Pond (CCR Unit #910) and Old East Ash Pond (CCR Unit #911) Areas

Prepared by

Geosyntec consultants

engineers | scientists | innovators

134 N. Lasalle Street, Suite 300
Chicago, Illinois 60602

CHE8404B

January 2022

TABLE OF CONTENTS

1. Executive Summary 1

2. Site Background 2
   2.1. Site Overview 2
   2.2. Groundwater Monitoring 3

3. MNA Evaluation 4
   3.1. Tier I Analysis - Initial Considerations and Source Control 4
      3.1.1. Tier I Analysis – Initial Considerations 4
      3.1.2. Tier I and Tier II Analysis – Constituent Attenuation Mechanisms 5
      3.1.3. Batch Attenuation Testing 10
   3.2. Tier II Analysis – Rate of Attenuation Assessment 15
   3.3. Tier III – System Capacity and Attenuation Stability Assessment 15
      3.3.1. System Capacity 16
      3.3.2. Batch Desorption Tests 17
   3.4. Geochemical Conceptual Site Model 19
   3.5. Tier IV Analysis – Long-Term Monitoring and Remedy Evaluation 20

4. Summary 22

5. References 23

TABLE OF CONTENTS (Continued)

LIST OF TABLES

Table 1	Surface Water Analytical Results
Table 2	Tier I Geochemical Model Inputs
Table 3	Solid Phase Total Constituent Concentrations
Table 4	X-Ray Diffraction Results
Table 5	Sequential Extraction Procedure Results
Table 6	Batch Attenuation Test Design
Table 7	Batch Attenuation Test Aqueous Phase Analytical Results
Table 8	Site-Specific Partition Coefficient Values
Table 9	Chemical Attenuation Capacity Calculations
Table 10	Batch Desorption Test Design and Results

LIST OF FIGURES

Figure 1	Monitoring Well and Surface Water Sampling Location Map
Figure 2	Piper Diagram – Downgradient Groundwater Conditions
Figure 3	Batch Attenuation Testing – Linear Sorption Results
Figure 4	Batch Attenuation Testing – Freundlich Sorption Results
Figure 5	Batch Desorption Testing – Remaining Mass Adsorbed

LIST OF APPENDICES

Appendix A	Soil Boring Logs
Appendix B	Tier I Geochemical Modeling Outputs

TABLE OF CONTENTS (Continued)

LIST OF ACRONYMS

AVS	acid volatile sulfides
CA	Corrective Action
CAA	Closure Alternatives Analysis
CAAA	Corrective Action Alternatives Analysis
CBR	Closure-by-Removal
CCR	Coal Combustion Residual
CIP	Closure-in-Place
CMA	Corrective Measures Assessment
COCs	Constituents of Concern
CSM	Conceptual Site Model
DMG	Dynegy Midwest Generation, LLC
EPRI	Electric Power Research Institute
GWPS	Groundwater Protection Standards
HCR	Hydrogeologic Site Characterization Report
I.A.C	Illinois Administrative Code
IAEA	International Atomic Energy Agency
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
ITRC	Interstate Technology Regulatory Council
LGU	Lower Groundwater Unit
LTM	long-term monitoring
MGU	Middle Groundwater Unit
mg/kg	milligrams per kilogram
MNA	Monitored Natural Attenuation
N	normal
NAP	North Ash Pond
OEAP	Old East Ash Pond
OEPA	Ohio Environmental Protection Agency
ORP	Oxidation-Reduction Potential
PMP	Potential Migration Pathway
PRB	permeable reactive barriers
RCRA	Resources Conservation and Recovery Act
SEP	Sequential Extraction Procedure

TABLE OF CONTENTS (Continued)

SIs	Saturation Indices
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
UCU	Upper Confining Unit
USEPA	United States Environmental Protection Agency
VPP	Vermillion Power Plant

1. EXECUTIVE SUMMARY

A monitored natural attenuation (MNA) evaluation was completed to provide input to the corrective measures assessment (CMA) and corrective action alternatives analysis (CAAA) for boron, lithium molybdenum, sulfate, and TDS in groundwater downgradient of the retired North Ash Pond/Old East Ash Pond (NAP/OEAP) impoundment system (the Site) located on Dynegy Midwest Generation, LLC's Vermilion Power Plant property near Oakwood Illinois. Multiple lines of evidence were considered as part of the MNA evaluation to provide information that can be used in the CMA/CAAA to assess whether selection of MNA (together with source control), as either a stand-alone remedial alternative for groundwater or groundwater remedy component.

Characterization of the aquifer solids and geochemical modeling were completed to identify likely chemical attenuation mechanisms for each constituent of concern (COC). Batch attenuation testing was completed to calculate Site-specific partition coefficients for each COC that were used in evaluations of attenuation rate and capacity. Batch desorption testing was also completed to assess the stability of the chemical attenuation mechanisms.

The MNA evaluation found that for all COCs some chemical attenuation is expected based on the results of site characterization and batch attenuation testing, but with greater chemical attenuation for lithium and molybdenum relative to boron and sulfate. The test results on these samples indicate that there is likely insufficient capacity in the downgradient aquifer system through chemical attenuation alone to attenuate groundwater concentrations of boron to below the groundwater protection standards (GWPS). Therefore, attenuation via both physical and chemical attenuation mechanisms would be required to achieve the GWPS and successfully demonstrate MNA of the COCs at the Site.

2. SITE BACKGROUND

2.1. Site Overview

This monitored natural attenuation (MNA) evaluation was completed to provide input to the corrective measures assessment (CMA) and corrective action alternatives analysis (CAAA) for potential groundwater exceedances downgradient of the North Ash Pond area (NAP; Illinois Environmental Protection Agency [IEPA] identification [ID] number [No.] W1838000002-01)/Old East Ash Pond area (OEAP; IEPA ID No. W1838000002-03) coal combustion residual (CCR) unit at the Vermilion Power Plant (VPP), which is owned by Dynegy Midwest Generation, LLC (DMG). The 37-acre NAP and 21-acre OEAP are inactive, unlined surface impoundments which overlap and have a separator berm constructed of ash for prior operational purposes. Thus, the NAP and OEAP areas have been treated as one CCR unit for the purposes of this report.

The NAP and OEAP impoundments, which are the subject of this evaluation, are located adjacent to each other in the northern portion of the VPP. The NAP is bordered to the north by fallow fields owned by the Illinois Department of Natural Resources (IDNR), to the east by the Middle Fork of the Vermilion River, to the south by the OEAP, and to the west by steep bluffs that include the Illinois Department of Conservation-designated Orchid Hill Natural Heritage Landmark. The Orchid Hill National Heritage Landmark is partially within the VPP property boundary but is administered by IDNR. The OEAP is bordered to the north and northeast by the Middle Fork, to the southeast, south, and west by steep bluffs, and to the northwest by the NAP. The NAP and OEAP are both located on terraces adjacent to the Middle Fork, which is bordered to the east and west by steep bluffs. The combined area including the NAP and OEAP will herein after be referred to as the Site.

A Hydrogeologic Site Characterization Report (HCR) detailing the Site and regional geology and hydrogeology was included in the Operating Permit submittal for the NAP/OEAP (Ramboll, 2021a). The Middle Groundwater Unit (MGU), which is continuous below the NAP/OEAP, was designated as the uppermost aquifer (UA). The Lower Groundwater Unit (LGU), which is separated from the MGU by a low-permeability confining unit, was identified as a Potential Migration Pathway (PMP).

2.2. Groundwater Monitoring

A groundwater monitoring network was proposed in accordance with Illinois Administrative Code (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 NAP/OEAP. The proposed groundwater monitoring network is described in the Groundwater Monitoring Plan (Ramboll, 2021b) and shown on Figure 1.

35 I.A.C § Part 845 parameters were monitored in the MGU (*i.e.,* uppermost aquifer) and LGU (*i.e.,* PMP) monitoring wells at the NAP and OEAP areas as part of the groundwater quality investigations performed between 1988 and 2018. A preliminary review of groundwater quality at wells in the groundwater monitoring network was completed using the methodology proposed in the Statistical Analysis Plan (Appendix A to the Groundwater Monitoring Plan, Ramboll 2021b), which has not been reviewed or approved by IEPA at the time of this report. The following potential exceedances above the groundwater protection standard (GWPS) were identified (Ramboll, 2021c):

- Boron;
- Lithium;
- Molybdenum;
- pH;
- Sulfate; and,
- Total dissolved solids (TDS).

The potential pH exceedance of the lower limit was not attributable to the NAP or OEAP (Ramboll, 2021d). Thus, boron, lithium, molybdenum, sulfate, and TDS were identified as constituents of concern (COCs) for the NAP/OEAP areas.

3. MNA EVALUATION

The NAP/OEAP MNA evaluation was completed following the tiered guidance established by the USEPA (USEPA, 2015) and ITRC (ITRC, 2010). In a tiered MNA evalution, multiple lines of evidence are considered to evaluate whether selection of MNA as a stand-alone groundwater remedial alternative, or a groundwater remedy component, will adequately protect human health and potential ecological receptors by reducing groundwater concentrations to below the GWPS in an appropriate time frame. The results of the tiered evaluation are summarized below.

3.1. Tier I Analysis - Initial Considerations and Source Control

Three objectives were identified for Tier I of the MNA evaluation. The first objective is to identify whether MNA should be eliminated from consideration as a groundwater remedial alternative based on the conceptual site model (CSM), as discussed in Section 3.1.1. The second objective of the Tier I analysis is to evaluate if attenuation of the COCs is likely to occur under Site conditions, as discussed in Sections 3.1.2 and 3.1.3.

The third objective of the Tier I analysis is to evaluate if the plume is stable or receding. Because source control measures have not yet been completed, the plume stability analysis could not be completed at this time. However, groundwater fate and transport modeling was completed to predict the effect of source control measures on downgradient groundwater concentrations. The fate and transport model indicates that the concentrations of COCs are expected to decline following removal of source materials (Ramboll, 2022). The plume stability analysis would be completed as part of the long-term monitoring program following completion of source control measures (Section 3.5).

3.1.1. Tier I Analysis – Initial Considerations

The first aspect of the Tier I analysis is to develop an understanding of the CSM to evaluate whether MNA should be eliminated from further consideration.

A review of previously collected groundwater data identified potential exceedances of the site COCs. As discussed in Section 2.2, those COCs include boron, lithium, molybdenum, sulfate, and TDS. Additional wells were installed in March 2021 to delineate the extent of the groundwater COCs to the extent feasible. The location of groundwater monitoring wells which are proposed as part of the Site groundwater monitoring network are provided in Figure 1. Key well (and soil boring) locations used in the MNA evaluation include:

- Well 03R, which is downgradient of the NAP and screened in the LGU;
- Well 07R, which is downgradient of the OEAP and is screened in the MGU;
- Well 08R, which is downgradient of the NAP and screened in the MGU:
- Well 36, which is downgradient of both the OEAP and NAP and is screened in the MGU; and,
- Well 43, which is a background monitoring location.

All source control activities being considered will largely eliminate future loading of COC mass to groundwater when completed. However, groundwater impacts from prior releases might remain following source control activities. Given that there were not any complete exposure pathways with unacceptable risk identified in Gradient (2022) and the groundwater model output (Ramboll, 2022) predicts future concentrations are expected to be lower following source control than those currently detected, further evaluation of MNA as a potential groundwater corrective action for these impacts was deemed warranted.

3.1.2. Tier I and Tier II Analysis – Constituent Attenuation Mechanisms

For the second objective of the Tier I analysis, an initial characterization was completed to identify if attenuation might occur for each COC. Where attenuation might occur, the Tier II analysis was initiated, with the objective of characterizing the predominant attenuation mechanisms.

To support the Tier I analysis, geochemical modeling using groundwater concentration data at downgradient wells 03R, 07R, 08R, and 36 and an approximation of aquifer solids was completed to evaluate the potential for adsorption and precipitation attenuation mechanisms. Well 03R is screened in the LGU; the other three wells of interest are screened within the Middle Groundwater Unit MGU, which is also the designated UA. The average of the first six background monitoring events at wells 03R, 08R and 36 (completed March – July 2021) and the first four background monitoring events at well

07R (completed May – July 2021) were used for the groundwater composition inputs (Table 2).

The groundwater modeling to support the Tier I analysis was completed using the commercial software package Geochemist's Workbench (v12.0.4). Thermodynamic database r.8 (Lawrence Livermore) and the FeOH+ surface complexation database were used. The r.8 thermodynamic database was modified to incorporate the thermodynamic data for powellite ($CaMoO_4$) precipitation, which was available in the Visual MINTEQ database. The model calculates the percentage of each basis species adsorbed via surface complexation reactions with iron oxyhydroxides. It was conservatively assumed that 0.1 weight percent hydrous ferric oxide grain coatings were present in the aquifer solids. The model input for the available iron is lower than the total iron concentrations detected in the solid phase (Table 3). The remaining aquifer solids were conservatively assumed to be inert for this initial modeling. Therefore, additional potential attenuation mechanisms, including adsorption to clay minerals, organic matter, aluminium and magnesium oxides, were not evaluated in the model. Adsorption complexes for molybdenum and lithium were unavailable or not considered representative of site conditions (Gustafsson, 2003; Brinza et al., 2019); thus, adsorption modeling results are only available for boron and sulfate. Reaction kinetics were not included in the preliminary geochemical models. The model outputs are provided in Appendix A and discussed in Sections 3.1.2.1 through 3.1.2.4.

Following the Tier I evaluation, field investigations were completed in April 2021 to collect additional site materials for use in the Tier II MNA evaluation. These materials were analyzed to evaluate if they indicated active removal of the COCs from groundwater via chemical attenuation processes. Soil borings were advanced adjacent to the 03R/08R and 02/07R well pairs (Figure 1) to collect aquifer solids from locations downgradient of the NAP and OEAP, respectively. An additional soil boring was advanced adjacent to the 43/44 well pair to collect aquifer solids from a background location. The soil borings were logged for geologic description; the soil boring logs are provided in Appendix B. Groundwater samples were collected from existing wells 07R, 08R, and 43 for use in the MNA evaluation.

Soil samples from the interval co-located with the well screen elevation at each location were placed in double sealed bags and air was removed to the maximum extent feasible. The soil was shipped to SiREM Laboratories (Guelph, ON) for sample storage at 4˚C. A portion of each sample was submitted to SGS Analytical (Guelph, ON) for initial characterization. The analyses included:

- Total metals via USEPA Method 200.8. Results are provided in Table 3.
- Total organic carbon (TOC) via SM 5310C. Results are provided in Table 3.
- Acid volatile sulfides (AVS) via analysis of generated hydrogen sulfide following extraction of the soil with 1 normal (N) hydrochloric acid (HCl). AVS analysis was completed by PRIMA Environmental of El Dorado Hills, CA. Results are provided in Table 3.
- X-Ray diffraction (XRD) via Rietvelt refinement. Results are provided in Table 4.

An additional sample of composited material from each boring location was submitted to Eurofins TestAmerica (Knoxville, TN) for sequential extraction procedure (SEP). SEP testing can provide insight into the attenuation mechanism, capacity, and reversibility under specific conditions. Results of the SEP analysis are provided in Table 5.

The results of the initial characterization found that the elemental composition (Table 3) and mineral composition (Table 4) was generally consistent at both locations sampled in the MGU. Further, the mineral composition of the MGU was generally comparable to the composition of the LGU. One notable difference was the detection of pyrite (FeS_2) within the LGU sample (Table 4). The preliminary assessment regarding attenuation mechanism for each COC based on the characterization data are provided below.

3.1.2.1. Boron

The total boron concentrations in the downgradient MGU aquifer solids (samples "SB-21-02/07R-12-14'" and "SB-21-03R/08R-13-15'") were both higher (12 and 17 mg/kg, respectively) than the total boron concentration detected in the background sample collected from adjacent to well 43 (6 mg/kg; Table 3). The higher total boron concentrations at the downgradient locations indicate some attenuation may be occurring. The boron concentrations in the downgradient LGU aquifer solids were comparable to background (Table 3).

The SEP results for boron were all below the detection limit for the first six extraction steps[1], precluding any insights into attenuation mechanism from this test (Table 5). Geochemical modeling predicts that boron will largely be present as the neutral $B(OH)_3$ species. Geochemical modeling also predicts that 3.8-4.5% of the boron in the groundwater system would be attenuated via surface complexation reactions with iron oxyhydroxides (Appendix A). Additionally, boron is known to be slightly attenuated via interactions with clay minerals and calcite (Goldberg, 1997); the XRD results identified the presence of a number of clay minerals and calcite at all downgradient locations (Table 4).

Thus, chemical attenuation of boron is possible at locations downgradient of the OEAP and NAP, and batch attenuation tests using Site-specific materials were completed as described in Section 3.1.3 to calculate a Site-specific boron partition coefficient.

3.1.2.2. Lithium

The total lithium concentrations in all upgradient and downgradient aquifer solids samples were similar (Table 3), indicating that lithium is not readily attenuated to a detectable degree at the site. These results are further supported by the similarity between the upgradient and downgradient SEP results, in which greater lithium concentrations were not associated with any of the exchangeable fractions (Table 5). While slightly higher lithium concentrations were associated with the sulfide fraction in the SEP results (Table 5), lithium does not readily form sulfide minerals.

The aqueous speciation results found that more than 99% of the lithium present in solution is predicted to be present as Li^+ (Appendix A). Thus, any lithium attenuation is likely to occur via interaction with cation exchange sites in the organic or clay fraction (Eckstein et. al, 1970). As noted in Section 3.2.1.1, clays were identified within the aquifer solids downgradient of the OEAP and NAP within both the MGU and LGU (Table 4). Thus, batch attenuation tests using Site-specific materials were completed as described in Section 3.1.3 to calculate a Site-specific partition coefficient for lithium.

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[1] Boron is not reported for the residual fraction of the SEP analysis, as boric acid is one of the solutions used in the leaching mixture.

3.1.2.3. Molybdenum

The MGU aquifer solids sample collected downgradient of the OEAP had a total molybdenum concentration of 16 mg/kg, which is higher than the total molybdenum detected in the sample at the background location (5 mg/kg; Table 3). A similar increase was not detected in the samples collected downgradient of the NAP (SB-21-03R/08R) nor any of the samples in the LGU. These findings are reflected in the SEP results, where an order of magnitude higher amount of molybdenum was associated with both the amorphous and crystalline iron and manganese oxide phases downgradient of the OEAP when compared to the background location (Table 5).

According to the geochemical model, the molybdate oxyanion (MoO_4^-) is the predominant aqueous molybdenum species downgradient of the OEAP and NAP (Appendix A). Adsorption of the molybdate oxyanion to iron and manganese oxides, including amorphous iron oxides, is well understood and documented in literature (Smedley and Kinniburgh, 2017; Goldberg et al, 1996a). The geochemical model also predicts precipitation of iron oxides under current conditions downgradient of the OEAP and NAP; these oxides could serve as sorbing surfaces. Unfortunately, reliable modeling databases for molybdenum adsorption to iron oxides are not widely available (Gustafsson, 2003; Brinza et al., 2019) and data could not be generated to predict the precent of molybdenum attenuated via adsorption.

In addition to saturation of iron oxides, the mineral powellite ($CaMoO_4$) is predicted to precipitate at well 07R (saturation index [SI][2] = 0.19), which is downgradient of the OEAP (Appendix A). Powellite is predicted to be marginally undersaturated, and there is not predicted to precipitate as a new mineral, at the other monitoring locations of interest (SIs between -0.45 and -0.72), likely due to the slightly lower aqueous molybdenum and calcium concentrations at those locations (Table 2). Precipitation of the mineral powelllite provides an additional mechanism for attenuation of molybdenum at the site.

The geochemical conditions at the four downgradient wells selected for the evaluation are reducing. Under these conditions, interactions between molybdenum and sulfur-

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[2] The calculated saturation index is the log of the ratio of the ion activity product (IAP) and solubility product constant (K_{sp}). The K_{sp} is a value which represents idealized conditions for mineral equilibrium, whereas the IAP is calculated using observed concentrations in groundwater. Saturation indices greater than -0.2 indicate potential equilibrium or supersaturation (precipitation) with respect to the mineral.

containing species, including the generation of thiomolybdates is possible (Fruend et al., 2016). Both molybdates and thiomolybdates can be adsorbed to oxides and clays. Additionally, molybdates or thiomolybdates may be adsorbed to pyrite or substituted into amorphous Fe-Mo-S structures under reducing conditions. The presence of detectable pyrite within the LGU (Table 4) indicates that either sorption onto or inclusion within pyritic minerals is a potential additional route for molybdenum attenuation at the site, even at locations where pyrite may be below the XRD detection limit (i.e., the MGU).

Thus, chemical attenuation of molybdenum via interactions with oxide minerals and various sulfur-containing species is feasible. Additional attenuation may occur via precipitation of powellite depending on aqueous molybdenum and calcium concentrations. Batch attenuation tests using Site-specific materials were completed as described in Section 3.1.3 to calculate a Site-specific molybdenum partition coefficient.

3.1.2.4. Sulfate and TDS

As illustrated in the Piper diagram provided in Figure 2, the anion composition of select wells downgradient of the OEAP and NAP is dominated by presence of sulfate. Thus, TDS concentrations are likely to be predominantly influenced by the contribution of sulfate and a reduction in sulfate concentrations will result in lower TDS concentrations as well.

The geochemical model predicts between 13.1 and 31.7% of the sulfate present in groundwater would be attenuated via surface complexation reactions with iron oxyhydroxides (Appendix A). Additional attenuation might occur via precipitation of sulfides. Samples collected from the LGU had detectable concentrations of aqueous sulfide (Table 3) and pyrite (FeS_2), a reduced iron sulfide mineral, was detected via XRD (Table 4). Similar conditions may be present but undetected in the limited samples from the MGU. Thus, batch attenuation tests using Site-specific materials were completed as described in Section 3.1.3 to calculate a Site-specific partition coefficient for sulfate.

3.1.3. Batch Attenuation Testing

Batch attenuation testing was performed to further evaluate the Tier I/II findings that each COC undergoes chemical attenuation, as predicted by the geochemical modeling and Site characterization data analysis discussed in Section 3.1.2. As part of the batch attenuation testing, Site-specific partition coefficients were developed for each COC. The Site-specific partition coefficients represent the relative propensity for the COC to be associated with the solid versus the aqueous phase.

Four separate tests were conducted, as outlined in Table 6, to calculate the Site-specific partition coefficient for each COC under varying conditions. Each test used well 08R groundwater, which was selected to represent CCR-impacted groundwater downgradient of the NAP at the Site, and homogenized aquifer solids from background location well 43, which represent unimpacted material with the maximum amount of potential attenuation capacity. The average concentration of key constituents in groundwater at 08R over the first six background monitoring events is provided in Table 5. Given the similarities in the aquifer solids in the MGU and LGU (Table 3 and Table 4), it was assumed that the experimental design was reflective of conditions in both the MGU and LGU across the Site.

The 08R groundwater was spiked in each test to achieve the starting target concentrations on Day 0 listed in Table 6. No amendments were spiked during the fourth test to evaluate how boron and lithium, which were predicted to be poorly attenuated, interacted with the aquifer solids without interference from other amended constituents. The spiked 08R groundwater was then mixed with the aquifer solids at five different solid-to-liquid ratios provided in Table 6. Approximately 100 mL of groundwater was added to each batch reactor with the mass of aquifer solids adjusted to achieve the target ratios.

All batch attenuation tests were conducted for seven days. During that time, the microcosms were agitated once daily at room temperature (~22 °C) so the soil and groundwater remained well mixed. After 7 days of contact time, an aliquot of the free liquid was collected and filtered through a 0.45 µm filter prior to analysis for dissolved concentrations of COCs and iron. Additionally, the pH and ORP were measured at Day 0 and Day 7 for each batch reactor.

An initial sample of the stock solution for each experimental design was collected on Day 0, and a control sample (only 08R groundwater with no aquifer solids) was collected on Day 7 after tumbling in polypropylene bottleware to evaluate any loss to interactions with the bottleware or ambient conditions. Duplicates were constructed for each microcosm, including the control samples.

The pH values remained relatively constant for each amendment tested at varying soil:water ratios (Table 7). Although the attenuation isotherms were prepared under anaerobic conditions, the ORP values were variable, with lower ORP values consistently detected in the microsms with greater soil:water ratios. These trends are attributed primarily to higher organic matter content in microcosms containing more soil, which would drive microbial reactions and shift the geochemical environment to more anaerobic conditions. The lower ORP may have affected the stability of iron oxides in the system through reductive dissolution, as greater concentrations of aqueous iron were detected at the higher soil:water ratios.

Data obtained from the tests were used to construct 5-point attenuation isotherms for the constituents of interest. Mathematical fitting was used to calculate the attenuation distribution coefficients (K_d), assuming linear adsorption. The linear adsorption equation was used:

$$q_e = K_d \times C_e \qquad \text{Eq. 1}$$

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. Linear graphs for the adsorption isotherms are provided in Figure 3. Some of the data showed a deviation from a linear trend, and so were also fitted using a non-linear isotherm. A common non-linear Freundlich equation was used:

$$q_e = K_F(C_e)^{1/n} \qquad \text{Eq. 2}$$

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:

$$log(q_e) = \log(K_F) + (1/n)\log(C_e) \qquad \text{Eq. 3}$$

The log-transformed Freundlich plots are provided in Figure 4. The calculated linear and Freundlich adsorption distribution coefficients (K_d and K_{dF}, respectively) and $1/n$ values are shown in Table 8. The selected coefficient for each parameter is bolded and shaded blue.

A comparison of the Site-specific partition coefficient to literature values is discussed for each COC in Sections 3.1.3.1 through 3.1.3.4.

3.1.3.1. Boron

The K_{dF} value of 0.43 L/kg for boron derived from the sulfate-amended batch attenuation test was selected as most representative of Site conditions. The Freundlich transformation paired with the sulfate amended dataset resulted in the highest correlation coefficient (R^2=0.85), indicating a good fit to the model data. Previous studies found that boron adsorption often exhibits non-linear behavior (EPRI, 2005), further supporting the selection of the Freundlich transformation. The Freundlich coefficient (1/n) derived from the sulfate amended dataset (4.15) indicates highly non-linear behavior. A K_d or K_{dF} value was not generated for boron using the results of the unamended dataset because a slightly negative correlation was calculated, indicating no relationship between boron concentration and adsorption under those conditions.

The selected K_{dF} value is comparable to those observed at other sites with a sand, loamy sand, or sandy loam composition, which had a mean K_{dF} value of 1.149 ± 0.692 L/kg (EPRI, 2005). Additionally, the calculated K_{dF} value, which is indicative of high mobility in the groundwater system, is consistent with the geochemical modeling which predicted limited boron adsorption to iron oxide surfaces (Appendix B).

3.1.3.2. Lithium

The K_d value of 8.53 L/kg for lithium derived from the sulfate-amended batch attenuation test was selected as the most representative of Site conditions. The linear transformation paired with the sulfate-amended dataset resulted in the highest correlation coefficient (R^2=0.81), indicating a good fit to the experimental data. The selection of a linear partition coefficient is appropriate because lithium was not amended in any of the experimental designs, indicating that adsorption sites are likely not satuated at even the lowest soil:water ratio. The sulfate amended batch results were selected as the K_d value given the higher correlation coefficient and selection of the same dataset for boron.

Literature K_d values for lithium are highly variable, ranging from 0.02-0.25 L/kg in a sandy aquifer (EPRI, 2006) to 190-370 L/kg in organic rich sediments and clays (Sheppard et al, 2009). The XRD analysis of the MGU soils 03R/08R identified 68% sand, with contributions of clays and carbonates (Table 4). Thus, the selected K_d value is at the lower end of this range, as would be expected for a sandier aquifer with detectable concentrations of clays. As discussed in Section 3.1.3.2, lithium is likely associated with the clay fraction of the solid phase via cation exchange processes.

3.1.3.3. Molybdenum

The K_{dF} value of 109 L/kg for molybdenum derived from the molybdenum and sulfate-amended batch attenuation test was selected as the most representative of Site conditions. Both the linear and Freundlich transformation of the molybdenum and sulfate-amended batch attenuation test had correlation coefficients (R^2) of 0.97, indicating a good fit to the experimental data. However, the Freundlich transformation was selected given that it was more representative of reported partition coefficients for lithologies with relatively low amounts of organics, such as sands or lower-organic fraction clays (Sheppard et al, 2009; IAEA, 2004).

The higher correlation coefficients for the molybdenum and sulfate-amended dataset compared to molybdenum alone indicates a relationship between the two constituents. Freundlich behavior has been detected for molybdenum and sulfate solutions in the past, with high concentrations of sulfate reducing molybdate adsorption (Wu et al., 2002).

3.1.3.4. Sulfate

The K_d value of 9.97 L/kg for sulfate derived from the sulfate-amended batch attenuation test was selected as the most representative of Site conditions. The linear transformation paired with the molybdenum and sulfate-amended dataset resulted in the highest correlation coefficient (R^2=0.74), indicating a good fit to the experimental data. This was the same set of data selected for the molybdenum Site-specific partition coefficient, further indicating a relationship between sulfate and molybdenum attenuation behavior. The Site-specific partition coefficients were not calculated for the other three experimental designs (molybdenum amendment, sulfate amendment, no amendment) because slightly negative slopes were calculated, indicating no relationship between sulfate concentration and attenuation under those conditions.

The calculated sulfate K_d value is much lower than the K_{dF} calculated for molybdenum, which is consistent with literature that says molybdate is much more readily adsorbed to aluminum oxides than sulfate (Wu et. al, 2002). Sulfate is more readily adsorbed at lower pH values, with a detected maximum around pH 4.0 (Courchesne and Hendershot, 1988). The pH values recorded in the test microcosm were slightly acidic (pH 6.6 – 6.8) but below the observed pH values in the field, indicating the potential for diminished sulfate chemical attenuation capacity under Site conditions.

3.2. Tier II Analysis – Rate of Attenuation Assessment

Two objectives were identified for Tier II of the MNA analysis. The first objective, presented in Section 3.1.2, is to identify potential chemical attenuation mechanisms for each COC based on Site conditions. The second objective for Tier II of the MNA evaluation is to establish whether the rates for the identified attenuation mechanisms are sufficient for attaining the GWPS.

Because source control measures have not yet been completed, calculation of attenuation rates using declining groundwater concentrations could not be completed at this time. Instead, a fate and transport model was generated by Ramboll (2022) to predict how groundwater concentrations will decline following completion of source control measures. The fate and transport modeling report prepared by Ramboll (2022) was included in the Construction Permit application to which this MNA report is attached.

In addition to the groundwater fate and transport modeling completed by Ramboll (2022), which predicts declines in aqueous concentrations due to physical attenuation mechanisms, the results of the batch attenuation testing described in Section 3.1.3. were used to understand short-term rates of the chemical attenuation mechanisms. USEPA guidance (2007) indicates that adsorption reaction kinetics are fast relative to typical advective groundwater flow velocities. These results were confirmed by the batch tests site-specific materials because partitioning to aquifer solids was detected during the relatively short timeframe of the test (one week).

3.3. Tier III – System Capacity and Attenuation Stability Assessment

Two objectives were identified for Tier III of the MNA analysis. The first objective is to investigate the Site-specific attenuation capacity for the COCs, as discussed in Section 3.3.1. The second objective of the Tier III analysis is evaluate the stability of the predominant attenuation mechanisms under future geochemical conditions that should return to background conditions. The batch desorption testing completed to support the attenuation stability assessment is discussed in Section 3.3.2. While variable redox conditions were evaluated, the pH conditions of the microcosms were not adjusted, as the pH at background locations is comparable to current downgradient pH conditions.

3.3.1. System Capacity

A review of the system chemical attenuation capacity was completed to understand if sufficient capacity is available in the downgradient aquifer to attenuate the constituents of concern via chemical attenuation processes (i.e., adsorption and precipitation). The Site-specific partition coefficients calculated from the batch attenuation tests (Section 3.1.3) were used to estimate the chemical attenuation capacity of the aquifer downgradient of the Site.

Based on the linearity of the batch attenuation isotherm results, the maximum chemical attenuation capacity (q_{max}) for each COC was not identified. However, because the batch attenuation tests were performed at COC concentrations which are comparable to or exceed the groundwater COC concentrations at the Site, a conservative estimate of the chemical attenuation capacity of the aquifer was calculated using the maximum COC concentrations used during the tests. The selected groundwater concentrations and calculated chemical attenuation capacity of the MGU associated with each respective groundwater concentration are provided in Table 9.

The estimated chemical attenuation capacity was compared to the estimated mass flux of each COC to evaluate whether sufficient capacity is available to reduce groundwater concentrations to below the GWPS. The potential total mass flux for boron was calculated using the estimated mass of boron migrating toward the Vermilion River predicted by the groundwater fate and transport model prepared by Ramboll (2022). The total estimated discharged mass includes both historical and future post-closure periods, assuming a 40-year timeframe since the beginning of groundwater impacts and selection of Closure Scenario #1 (removal with on-site disposal and 10 years of operation of a groundwater collection trench) as described in the groundwater modeling report (Ramboll, 2022). Closure Scenario #1 was selected as the most conservative approach for these calculations based on the modeled mass flux. The modeled mass flux included boron in both the MGU, upper confining unit (UCU), and LGU; thus, comparison to the capacity into the MGU alone further resulted in a conservative approach.

Modeled mass flux data was only available for boron, so the mass flux of the other COCs was based on the correlation of each COC to the concentration and flux of boron. The historical mass flux of each COC from the CCR unit to groundwater was estimated using the respective ratios of the average concentrations of lithium, molybdenum, or sulfate in leachate wells ND3 and OED1 to the average concentration of boron in those same wells.

The estimated chemical attenuation capacity is greater than the predicted total mass flux for lithium, sulfate, and molybdenum (Table 9), suggesting that sufficient capacity is available to reduce groundwater concentrations for these COCs. Further decreases in the concentration of these COCs are predicted due to physical attenuation, as described in the groundwater fate and transport model (Ramboll, 2022). This physical attenuation is of particular importance for boron, which is not readily attenuated and where the calculated chemical attenuation capacity appears to be exhausted (Table 9).

Thus, the attenuation capacity testing and groundwater fate and transport modeling calculations found that there is sufficient combined chemical and physical attenuation capacity in the downgradient aquifer to attenuate the concentration of COCs to below the GWPS.

3.3.2. Batch Desorption Tests

Batch desorption testing was completed to evaluate the stability of the chemical attenuation mechanisms under variable redox conditions. Aquifer solids collected from background well 43 were used to construct the microcosms, which were considered representative of both the MGU and LGU. Based on the results of the attenuation tests, varying soil:water ratios and groundwater from well 08R were used to construct the reactors for each constituent. Amendments were added to produce attenuated COCs on the background aquifer solids. For the boron and sulfate tests, the groundwater was amended with sulfate only. For lithium and molybdenum, the groundwater was amended with both molybdenum and sulfate, as that experimental design provided the best correlation in the batch attenuation tests.

A summary of the experimental design is provided in Table 10. The batch reactors were allowed to tumble for seven days following construction to provide time for COC attenuation, after which the aqueous phase was decanted and replaced with unamended groundwater from location 43, which is representative of unimpacted background groundwater that will return beneath and downgradient of the CCR units in the future. While the aquifer solids were loaded with COC mass for seven days, COCs are more likely to be attenuated under site conditions where the reaction time is even longer and the material can become more tightly associated with the aquifer solids.

Following the addition of unimpacted groundwater, the batch reactors were exposed to three different redox conditions to constrain how future geochemical changes may affect attenuation reversibility following closure activities. Strongly reducing (hydrogen sparged) and strongly oxidizing (oxygen sparged) conditions were generated by respectively amending the reactors with 5 mL of hydrogen gas and 5 mL of oxygen (O_2) gas daily. A set of unamended microcosms was also run to represent ambient conditions.

All batch desorption tests were conducted for seven days. During that time, the microcosms were agitated once daily at room temperature (~22 °C) to ensure the soil and groundwater remained well mixed. After 7 days of contact time, an aliquot of the free liquid was collected and filtered through a 0.45 µm filter prior to analysis for dissolved concentrations of COCs and iron. Additionally, the pH and ORP in each batch reactor were measured on Day 0 and Day 7.

The results of the batch desorption tests are summarized in Table 10 and Figure 5. A summary of the results and the implications for attenuation stability is discussed for each COC in Sections 3.3.2.1 through 3.3.2.4.

3.3.2.1. Boron

Of the total boron mass which sorbed to the sediments during the initial phase of the desorption tests, approximately 70% was subsequently released under all three redox conditions. These results indicate that, even if redox conditions change following closure activities at the OEAP and NAP areas, the extent of boron adsorption will remain relatively consistent but is not stable. The lack of correlation between boron desorption and dissolved iron concentrations (Table 10) indicates that boron is more likely attenuated via interaction with the clay, calcite, or organic fractions than iron oxides. Regardless of attenuation mechanism, physical attenuation is expected to contribute more to declining boron groundwater concentrations than chemical interactions.

3.3.2.2. Lithium

The mass of lithium desorbed varied between 25% and 32% for all three treatments, indicating that desorption is only slightly affected by variations in redox conditions (Table 10). This coincides with the prediction that the primary mechanism of lithium attenuation is via cation exchange with clays or the organic fraction in soils. These results indicate that, even if redox conditions change following closure activities at the OEAP and NAP areas, the desorption of lithium will be relatively limited. Instead, displacement of lithium from cation exchange sites following significant changes in the pH or ionic strength of recharge water may be a more significant driver of lithium desorption.

However, pH and ionic strength are expected to be generally stable, thus desorption is not anticipated and attenuation of lithium is more stable than boron.

3.3.2.3. Molybdenum

The extent of molybdenum desorption averaged 8.1% across the three redox treatments, with the greatest desorption under ambient conditions (8.7%) and the lowest under reducing conditions (7.7%). Molybdenum was the least readily desorbed of the constituents of concern (Table 10; Figure 5). The relatively low extent of desorption indicate high sorption affinity between molybdenum and the soil matrix, which is consistent with the relatively high Site-specific partition coefficient that was calculated for molybdenum compared to the other COCs. Further, the consistently low desorption indicate that molybdenum associated with the soil solids at the Site will remain largely immobilized, indicating that chemical attenuation represents a significant mechanism for natural molybdenum attenuation. The lack of correlation between molybdenum desorption and dissolved iron concentrations (Table 10) indicates that adsorption to iron oxides is not a primary attenuation mechanism for molybdenum. Thus, chemical attenuation via interaction with sulfur species or as precipitation of powellite is expected to be the more significant molybdenum attenuation mechanism.

3.3.2.4. Sulfate

Sulfate was readily desorbed across all three redox conditions, with the greatest desorption occurring under oxidizing conditions (94.6%; Table 10). These results indicate that the irreversible sulfate retention capacity of the soils is low regardless of redox conditions. Thus, physical attenuation is expected to contribute more to declining sulfate groundwater concentrations than chemical attenuation.

3.4. Geochemical Conceptual Site Model

The results of the Tiers I through III analyses were combined to develop a geochemical CSM for attenuation of each constituent at the site, as summarized below:

- Under Site conditions, boron is expected to be present as the neutral $B(OH)_3$ species. Because the majority of boron in groundwater is neutral, boron is only slightly attenuated via chemical interaction with the aquifer solids. This attenuation likely occurs through interactions with the clay minerals, calcite or organic materials; however, some interaction with iron oxides is also predicted.

Boron attenuation at the Site is highly reversible and while chemical attenuation will likely result in some decline in groundwater concentrations, physical attenuation is more likely to contribute to concentration reductions.

- Under Site conditions, lithium is expected to be present as the monovalent cation Li^+ species. Thus, any lithium attenuation is likely to occur via interaction with cation exchange sites in the organic or clay fraction. This attenuation is moderately reversible and likely to be dependent on pH. While chemical attenuation will likely result in some decline in groundwater concentrations, physical attenuation will also contribute to concentration reductions.

- Under Site conditions, molybdenum is expected to be more strongly attenuated via interaction with aquifer solid compared to boron and lithium. While SEP results indicate that molybdenum is attenuated via interaction with iron or manganese oxides, testing found that the dissolution of iron oxides did not result in greater desorption rates of molybdenum. Desorption tests resulted in very limited reversal of attenuation. Thus, molybdenum is likely well-attenuated via interaction with sulfur species or as precipitation of powellite. Molybendum concentrations in groundwater will decline from both physical and chemical attenuation mechanisms.

- Under Site conditions, sulfate is only slightly attenuated via chemical interaction with aquifer solids. Some sulfate may be attenuated via precipitation of sulfides, which were identified in the LGU. Additional sulfate attenuation may occur through interaction with iron oxides or clay minerals. Sulfate chemical attenuation is highly reversible; thus, physical attenuation is more likely to contribute to reductions in groundwater concentrations.

3.5. Tier IV Analysis – Long-Term Monitoring and Remedy Evaluation

If MNA is selected as a component of the groundwater corrective action, then a long-term monitoring (LTM) plan and contingency plan will be developed as part of Tier IV of the MNA evaluation. The LTM plan is required to provide data to evaluate the performance of the MNA remedy and the progress of the natural attenuation processes at the Site, particularly following completion of Site closure activities.

Tier IV of the MNA evaluation also calls for a consideration of the contingency plan if the observed declines in groundwater concentrations of COCs are not consistent with the groundwater fate and transport model predictions. Alternatively, the contingency plan may need to be considered if Site conditions which are identified as key for MNA performance are no longer present. The contingency plan may specify a technology that is different from MNA or it may call for modifications to the selected MNA remedy depending on observed changes in Site conditions or performance.

4. SUMMARY

A tiered MNA evaluation was completed to assess if Site conditions are favorable for the implementation of MNA as a groundwater corrective measure in combination with aggressive source control measures. The evaluation found that for all COCs, some chemical attenuation is expected based on the results of site characterization and batch attenuation testing efforts. Significantly greater chemical attenuation is predicted for lithium and molybdenum relative to boron and sulfate based on the results of the desorption testing efforts. There is insufficient capacity in the aquifer system through chemical attenuation alone to attenuate the predicted future contaminant mass flux of boron, so MNA of the COCs will be achieved through a combination of both physical and chemical mechanisms. If MNA is selected as a component of the groundwater corrective action, then a LTM plan and contingency plan will be developed.

5. REFERENCES

Brinza, L., Vu, H.P., Neamtu, M., Benning, L.G. 2019. *Experimental and simulation results of the adsorption of Mo and V onto ferrihydrite.* Sci. Rep. **9**, 1365.

Eckstein, Y., Yaalon, D. H., Yariv, S. 1970. *The effect of lithium on the cation exchange behaviour of crystalline and amorphous clays.*

EPRI, 2005. *Chemical constituents in coal combustion product leachate: boron. Final Report 1005258.*

Freund, C.A., Wishard, A., Brenner, R., Sobel, M., Mizelle, J., Kim, A., Meyer, D. A., Morford, J. L. 2016. *The effect of a thiol-containing organic molecule on molybdenum adsorption onto pyrite*. Geochem. Cosmochim. Acta. **174**, 222-235.

Goldberg, S. Forster, H.S., Godfrey, C. L. 1996a. *Molybdenum adsorption on oxides, clay minerals, and soils*. Soil Sci. Soc. Am. J., **60**, 425-432.

Goldberg, S., Forster, H.S., Lesch, S.M., Heick, E.L. 1996b. *Influence of anion competition on boron adsorption by clays and soils*. Soil Science, **161**, 99-103.

Goldberg, S. 1997. *Reactions of boron with soils*. Plant and Soil, **193**, 35-48.

Gradient. 2022. *Closure Alternatives Analysis and Corrective Measures Assessment/Preliminary Corrective Action Alternatives Analysis for the Vermilion Power Plant*. Oakwood, Illinois. October.

Gustafsson, J.P. 2003. *Modelling molybdate and tungstate adsorption to ferrihydrite*. Chemical Geology. **200**, 105-115.

International Atomic Energy Agency (IAEA). 1994. *Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments*. Technical Report Series No. 364. Vienna.

Interstate Technology and Regulatory Council (ITRC). 2010. *A Decision Framework for Applying Monitored Natural Attenuation Processes to Metals and Radionuclides in Groundwater*. APMR-1. Washington, D.C.: ITRC, Attenuation Processes for Metals and Radionuclides Team. December.

Kelron Environmental. 2003. *Regional and Local Hydrogeology and Geochemistry: Vermilion Power Plant, Illinois. Volumes 1-2 (Draft).* Report to Dynegy Midwest Generation, Inc., November.

Kelron Environmental. 2012. *Hydrogeology and Groundwater Quality of the North Ash Pond System, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC.* Report to Dynegy Operating Co., March.

Natural Resource Technology, Inc. 2014. *Corrective Action Plan – Old East Ash Pond, Vermilion Power Station, Oakwood, Illinois, Dynegy Midwest Generation, LLC.* Report to Dynegy Operating Co., April.

Ramboll. 2021a. *Hydrogeologic Site Characterization Report – Vermilion North Ash Pond and Old East Ash Pond, Vermilion Power Plant, Oakwood, Illinois.* Report to Dynegy Midwest Generation, LLC., August.

Ramboll. 2021b. *Groundwater Monitoring Plan – Vermilion North Ash Pond and Old East Ash Pond.* October.

Ramboll. 2021c. *History of Potential Exceedances – Vermilion North Ash Pond and Old East Ash Pond.* October.

Ramboll, 2022. *Groundwater Modeling Report – Vermilion North Ash Pond and Old East Ash Pond.* November.

Sheppard, S., Long, J. Sanipelli, B., Sohlenius, G. 2009. *Solid/liquid partition coefficients (Kd) for selected soils and sediments at Frosmark and Laxemar-Simpevarp. SKB (Svensk Karnbranslehantering AB). Stockholm, Sweden. R-09.27.*

Smedley, P. L., Kinniburgh, D. G. 2017. *Molybdenum in natural waters: A review of occurrence, distributions and controls.* Appl. Geochem., **84**, 387-432.

United States Environmental Protection Agency (USEPA). 1999. *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites.* Office of Solid Waste and Emergency Response, Directive 9200.4-17P. April.

USEPA. 2007. *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water. Volume 1: Technical Basis for Assessment.* Office of Research and Development. EPA/600/R-07/139. October.

USEPA. 2015. *Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites*. Office of Solid Waste and Emergency Response, Directive 9283.1-36. August.

Wu, C.H., Kuo, C.Y., Lin, C.F., Lo, S.L. 2002. *Modeling competitive adsorption of molybdate, sulfate, selenite, and selenite using a Freundlich-type multi-component isotherm.* Chemosphere, **47**, 283-292.

TABLES

Table 1: Surface Water Analytical Results
Vermilion Power Plant

Analyte	SW-1-20210607	DUP-SW-1-20210607	SW-2-20210607	SW-3-20210709	SW-4-20210709	SW-5-20210709
Description	**Upstream**	**Upstream**	**Site-Adjacent**	**Site-Adjacent**	**Site-Adjacent**	**Downstream**
Boron	0.053	0.054	0.055	0.055	0.058	0.069
Calcium	76	80	76	72	71	72
Iron	0.14	0.12	0.20	0.49	0.51	0.5
Lithium	0.0047	0.0050	0.0050	0.007	0.0056	0.0056
Magnesium	34	35	34	30	30	30
Manganese	0.0098	0.0098	0.0094	0.022	0.022	0.021
Molybdenum	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Potassium	1.2	1.3	1.2	2.4	2.3	2.3
Sodium	8.1	8.7	8.0	7.6	7.3	7.6
Chloride	25	26	26	18	18	19
Sulfate	38	39	29	25	26	26
Dissolved Organic Carbon	2.7	2.7	2.6	3.7	3.1	3.2
Alkalinity	230	220	230	240	230	240
Total Dissolved Solids	380	280	350	340	420	270
Phosphorus as PO_4	0.36	0.20	0.19	0.4	0.43	0.4
Sulfide	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Notes:
All results shown in milligrams per liter (mg/L)
< - compound not detected, the associated value is the detection limit
DUP = duplicate sample

Table 2: Tier I Geochemical Model Inputs
Vermilion Power Plant

Parameter	Units	03R	07R	08R	36
Description		Downgradient LGU	Downgradient MGU	Downgradient MGU	Downgradient MGU
Alkalinity (as bicarbonate)	mg/L	312	70.3	222	198
Boron	mg/L	19.3	36.3	27.2	13.9
Calcium	mg/L	166	930	234	350
Chloride	mg/L	29.8	6.25	5.67	24.33
Iron	mg/L	4.99	1.59	0.16	5.09
Lithium	mg/L	0.0033	0.57	0.26	0.19
Magnesium	mg/L	79.2	90.3	33.8	72.1
Manganese	mg/L	0.0829	4.14	0.25	1.77
Molybdenum	mg/L	0.33	0.53	0.25	0.14
Potassium	mg/L	2.7	60.2	13.6	14.4
Sodium	mg/L	83.3	51.6	36.8	47.4
Sulfate	mg/L	498	1945	520	1003
pH	SU	7.28	7.32	7.19	7.13
ORP	mV	-138	-103	-50	-96
Eh	V	0.062	0.10	0.15	0.10
Temp	°C	12.6	13.1	11.8	11.9

Notes:

While aqueuos iron concentrations are shown, iron was input in the Spec8 system via the Fe(OH)3 sorbing surface.

Eh values were calculated by converting field ORP measurements from mV to V and adding 0.2 V to account for the difference between an Ag/AgCl electrode used in the field and the standard hydrogen electrode.

Porosity was set to 0.33

Bulk Volume was set to 1000 cm^3

Inert Volume was set to 669 cm^3

°C - degrees Celsius

mg/L - milligrams per liter

mV - millivolts

SU - standard units

V - volts

MGU - middle groundwater unit

LGU - lower groundwater uit

Table 3: Solid Phase Total Constituent Concentrations
Vermilion Power Plant

Boring ID		SB-21-02R/07R	SB-21-02R/07R	SB-21-03R/08R	SB-21-03R/08R	SB-21-43
Sample Depth (ft bgs)		12-14'	30-31'	13-15'	31-32'	62.75-63'
Description	Unit	Downgradient MGU	Downgradient LGU	Downgradient MGU	Downgradient LGU	Background
Arsenic	mg/kg	5.4	5.1	3.2	9.7	2.5
Boron	mg/kg	12	5	17	5	6
Lithium	mg/kg	5	7	4	6	8
Molybdenum	mg/kg	16	0.5	0.6	0.8	0.5
Sulfide	wt %	< 0.04	0.13	< 0.04	0.25	0.04
Sulfate	mg/kg	2063	305	111	244	93
Sulfur	wt %	0.26	0.19	0.016	0.32	0.055
AVS	mg/kg	<0.18	1.5	<0.19	0.69	2.4
Iron	mg/kg	13000	11000	5900	11000	10000
TOC	wt %	0.538	0.541	0.272	0.574	0.711

Notes:

Values represent total metals in the solid phase.

mg/kg - milligrams per kilogram

wt% - weight percent

< - compound not detected, the associated value is the detection limit

TOC - total organic carbon

AVS - acid volatile sulfide

ft bgs - feet below ground surface

MGU - middle groundwater unit

LGU - lower groundwater unit

Table 4: X-Ray Diffraction Results
Vermilion Power Plant

Site Material		SB-21-02R/07R	SB-21-02R/07R	SB-21-03R/08R	SB-21-03R/08R	SB-21-43
Sample Depth (ft bgs)		**12-14'**	**30-31'**	**13-15'**	**31-32'**	**62.75-63'**
Mineral	**Mineral Composition**	**Downgradient MGU**	**Downgradient LGU**	**Downgradient MGU**	**Downgradient LGU**	**Background**
Quartz	SiO_2	51.1	56	68.1	49.9	58.4
Calcite	$CaCO_3$	0.4	3.6	2.2	5.2	3
Albite	$NaAlSi_3O_8$	8.6	7.7	8.7	10.9	9.8
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$	3.1	6.2	2.5	1.9	7.6
Dolomite	$CaMg(CO_3)_2$	15.4	10.7	3.8	14.8	6.1
Microcline	$KAlSi_3O_8$	5.5	6.8	8.4	5.9	7.3
Ankerite	$CaFe(CO_3)_2$	5.1	4.9	1.1	4.4	2.4
Biotite	$K(Mg,Fe)_3(AlSi_3O_{10})(OH)_2$	2	1.9	1.6	1.9	1.7
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$	1.1	0.9	0.7	1	1.1
Diopside	$CaMgSi_2O_6$	1.5	1.2	1.5	1.9	1.2
Actinolite	$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$	1.5	-	1.4	2	1.2
Gypsum	$CaSO_4 \cdot 2H2O$	4.7	-	-	-	-
Pyrite	FeS_2	-	0.1	-	0.2	0

Notes:

All samples represented as weight percent normalized to a sum of 100%. A quantity of amorphous material has not been determined.

Zero values indicate that the mineral was included in the refinement, but the calculated concentration is below a measureable value.

-- - not detected

XRD - X-ray diffraction

Table 5: Sequential Extraction Procedure Results
Vermilion Power Plant

Analyte	SEP Fraction	SB-21-43	SB-21-08R	SB-21-07R
		Background	Downgradient NAP	Downgradient OEAP
Boron	Exchangeable	< 48	< 47	< 47
	Carbonate	< 36	< 35	< 35
	Amorphous Fe/Mn Oxides	< 12	< 12	< 12
	Crystalline Fe/Mn Oxides	< 12	< 12	< 12
	Organic-Bound	< 180	< 180	< 180
	Sulfides	< 12	< 12	< 12
Lithium	Exchangeable	< 12	< 12	< 12
	Carbonate	< 8.9	< 8.8	< 8.9
	Amorphous Fe/Mn Oxides	0.18	0.23	0.20
	Crystalline Fe/Mn Oxides	2.00	1.20	1.30
	Organic-Bound	14.00	9.90	13.00
	Sulfides	3.20	3.70	5.20
	Residual	5.30	3.20	7.70
Molybdenum	Exchangeable	< 9.5	< 9.4	0.68
	Carbonate	< 7.1	< 7.0	< 7.1
	Amorphous Fe/Mn Oxides	0.12	0.16	1.70
	Crystalline Fe/Mn Oxides	< 2.4	0.13	2.00
	Organic-Bound	< 36	< 35	< 35
	Sulfides	< 2.4	0.18	0.43
	Residual	< 2.4	< 2.3	0.26

Notes:

All results are reported in mg of constituent/kg of total sample mass

< - compound not detected, the associated value is the detection limit

SEP = sequential extraction procedure

Sulfate data is unavailable using SEP analysis.

Boron data is unavailable for the 'residual' fraction of the SEP analysis because it is the extraction reagent.

Composited sample for both the MGU and LGU at each downgradient location was analyzed.

Table 6: Batch Attenuation Test Design
Vermilion Power Plant

Isotherm	Amendment	Target Concentration (mg/L)	Soil:Water Ratio (grams soil:grams water)				
			Test #1	Test #2	Test #3	Test #4	Test #5
Mo	$Na_2MoO_4 \cdot 2H_2O$	Mo = 0.9	1:0.75	1:1.3	1:6.0	1:11.8	1:29.2
Mo + SO_4	$Na_2MoO_4 \cdot 2H_2O$ + Na_2SO_4	Mo = 0.9; SO_4^{2-} = 1200	1:0.75	1:1.3	1:5.9	1:12.0	1:28.8
SO_4	Na_2SO_4	SO_4^{2-} = 1200	1:0.75	1:1.3	1:6.0	1:11.4	1:29.6
Unamended	--	--	1:0.75	1:1.4	1:6.0	1:11.8	1:28.9

Notes:

The 'unamended' dataset was prepared using groundwater from well 08R only.

The soil:water ratio was calculated assuming the groundwater had a specific gravity of 1.0.

Table 7: Batch Attenuation Test Aqueous Phase Analytical Results

Vermilion Power Plant

Amendment	Soil:Water Ratio	Molybdenum	Boron	Lithium	Iron	Sulfate	pH	ORP
		mg/L	mg/L	mg/L	mg/L	mg/L	SU	mV
Molybdenum	GW Only	0.80	39.53	0.35	0.02	847	6.76	148.0
	1:0.5	0.08	24.70	0.04	2.01	649	6.88	22.5
	1:1	0.12	31.30	0.10	2.30	728	6.83	-6.0
	1.5:1	0.41	36.95	0.24	1.21	704	6.84	56.5
	1:10	0.69	33.05	0.22	0.44	573	6.83	88.5
	1:20	0.77	33.40	0.28	0.09	576	6.87	136.0
Molybdenum and Sulfate	GW Only	0.82	41.35	0.35	0.03	1,271	6.77	127.0
	1:0.5	0.09	26.20	0.05	2.21	915	6.87	18.0
	1:1	0.16	31.00	0.09	2.00	1,099	6.76	116.5
	1.5:1	0.43	36.75	0.19	0.01	1,097	6.80	118.5
	1:10	0.55	38.30	0.27	0.01	1,193	6.76	90.0
	1:20	0.67	38.30	0.26	0.01	1,261	6.74	123.5
Sulfate	GW Only	0.46	41.20	0.34	0.02	1,023	6.62	140.5
	1:0.5	0.06	27.10	0.06	3.10	919	6.86	34.5
	1:1	0.10	31.05	0.09	2.32	1,033	6.78	63.5
	1.5:1	0.27	37.00	0.22	0.07	1,056	6.74	142.0
	1:10	0.35	38.95	0.25	0.02	955	6.70	120.5
	1:20	0.36	39.75	0.29	0.01	966	6.65	159.5
Unamended	GW Only	0.47	45.48	0.26	0.04	705	6.62	140.5
	1:0.5	0.09	42.95	0.08	1.23	624	6.83	26.5
	1:1	0.05	34.90	0.03	1.80	630	6.73	34.5
	1.5:1	0.27	49.15	0.19	1.01	692	6.70	95.5
	1:10	0.33	49.95	0.23	0.32	655	6.69	126.0
	1:20	0.38	49.20	0.24	0.21	706	6.73	159.5

Notes:

The average values of two replicates are provided.

Mo, B, Li, Fe, SO4 are filtered analytical results.

'GW Only' represents the control samples.

mg/L - milligrams per liter

SU - standard units

mV - millivolts

Table 8: Site-Specific Partition Coefficient Values

Vermilion Power Plant

Analyte	Values		Mo	Mo + SO_4	SO_4	None
Molybdenum	Linear	R^2	0.51	0.97	0.70	0.8
		K_d (L/kg)	1.89	6.73	8.44	13.0
	Freundlich	R^2	0.79	0.97	0.83	0.75
		1/n	0.377	0.750	0.748	0.754
		K_{dF} (L/kg)	81.7	**109**	109	126
Boron	Linear	R^2	0.09	0.48	0.65	--
		K_d (L/kg)	6.78	4.46	5.90	--
	Freundlich	R^2	0.22	0.69	0.85	--
		1/n	3.542	3.504	4.150	--
		K_{dF} (L/kg)	1.37	1.11	**0.43**	--
Lithium	Linear	R^2	0.71	0.62	0.81	0.67
		K_d (L/kg)	10.9	9.39	**8.53**	17.3
	Freundlich	R^2	0.60	0.60	0.74	0.57
		1/n	0.129	0.127	0.123	0.167
		K_{dF} (L/kg)	147	145	144	156
Sulfate	Linear	R^2	--	0.74	--	--
		K_d (L/kg)	--	**9.97**	--	--
	Freundlich	R^2	--	0.70	--	--
		1/n	--	6.780	--	--
		K_{dF} (L/kg)	--	1.24E-06	--	--

Notes:

1/n - slope of linearized Freundlich isotherm

K_d - linear adsorption distribution coefficient

K_{dF} - Freundlich adsorption distribution coefficient

L/kg - liters per kilogram

R^2 - linear correlation coefficient

Linearized Freundlich isotherm did not fit unamended Boron data

Sulfate K_d and K_{dF} values were not calculated for the Mo, SO_4, and unamended tests because negative trends were observed.

Blue-shaded and bolded results were selected as most representative for each constituent of concern and were used in further analyses as appropriate.

Table 9: Chemical Attenuation Capacity Calculations
Vermilion Power Plant

MGU Aquifer Parameter Assumptions	Value
Length of Aquifer [m]	30.5
Width of Aquifer [m]	756
Thickness of MGU [m]	2.99
Porosity [-]	0.27
Sediment Bulk Density [kg/m^3]	1656

	Constituent	Boron:COC Ratio	Site-Specific Partition Coefficient	Aqueous Concentration	Estimated Chemical Attenuation Capacity	Estimated Mass Release	% of Estimated Capacity
			L/kg	mg/L	kg	kg	%
Historical	Boron	1:1	0.43	44	1,576	1,527	96.9%
Post-Closure						919	58.3%
Total						**2,446**	**155.2%**
Historical	Lithium	1:0.018	8.53	0.38	270	27.5	10.2%
Post-Closure						16.6	6.1%
Total						**44.1**	**16.3%**
Historical	Molybdenum	1:0.007	109	0.9	8,170	10.1	0.12%
Post-Closure						6.1	0.07%
Total						**16.1**	**0.20%**
Historical	Sulfate	1:39.1	9.97	1200	996,382	59,726	6.0%
Post-Closure						35,931	3.6%
Total						**95,657**	**9.6%**

Assumptions:

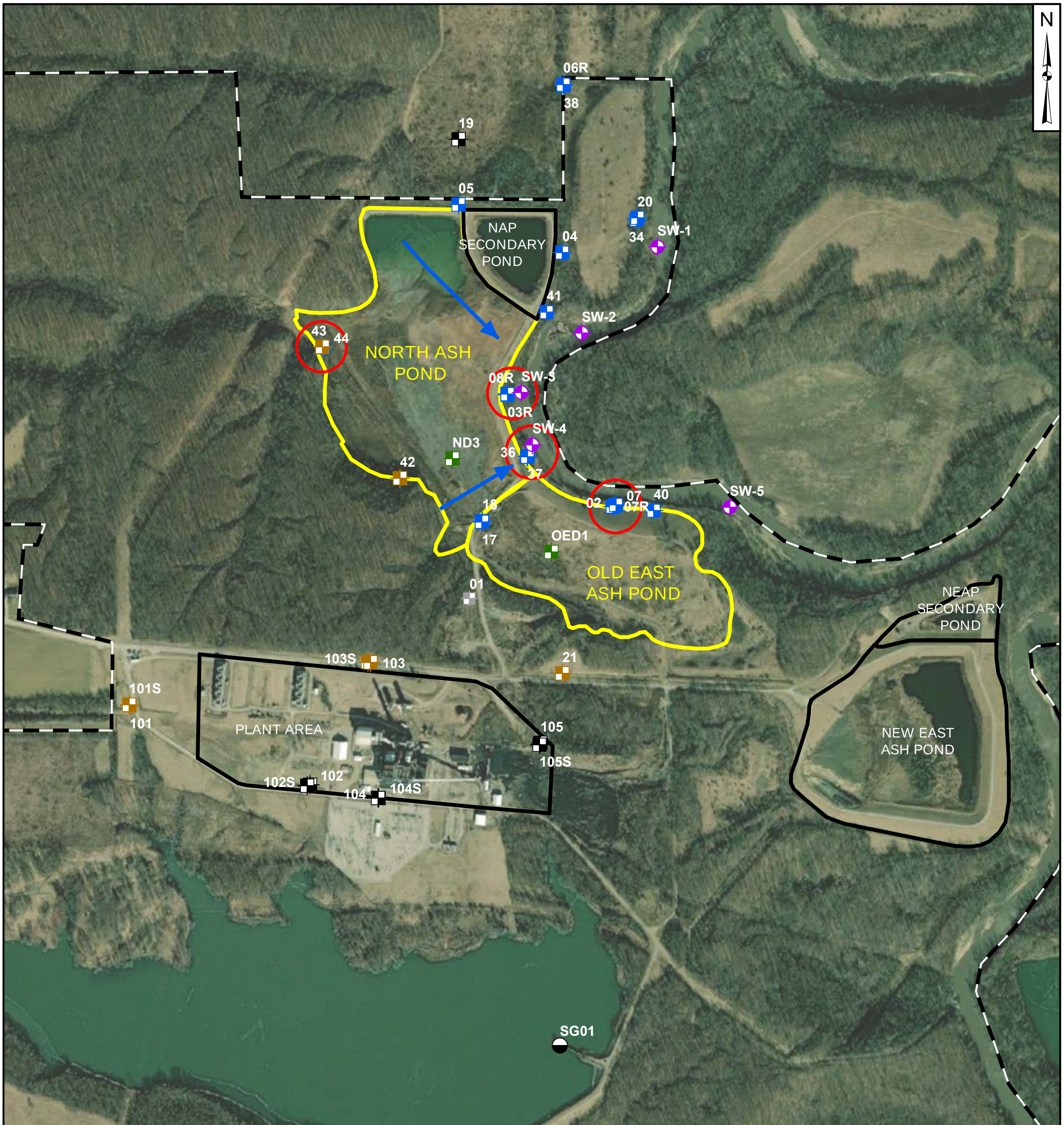
- The aqueous concentration represents the value used in the batch attenuation testing experimental design for the selected Site-specific partition coefficient (Table 8) and was used in the calculation of the estimated chemical attenuation capacity.
- Mass released for boron was generated from the groundwater fate and transport model (Ramboll, 2021d) and was corrected for the other COCs using the ratio of B:COCs in leachate wells ND3 and OED1
- Aquifer length was selected based on the 2020 *Human Health and Ecological Risk Assessment* (Gradient).
- Sediment bulk density and aquifer thickness were generated from the 2021 *Hydrogeologic Site Characterization Report* (Ramboll).
- Porosity and aquifer length were generated from the groundwater fate and transport model (Ramboll, 2021d).

Table 10: Batch Desorption Test Design and Results
Vermilion Power Plant

COC	Amendment	Target Concentration (mg/L)	Soil:Water Ratio	Redox Conditions	Initial Mass Adsorbed (mg)	Remaining Mass Adsorbed (mg)	% Mass Desorbed (%)	Dissolved Iron (mg/L)	pH (SU)	ORP (mV)
B	Na_2SO_4	SO_4^{2-} = 1200	1:6	Reducing	0.67	0.2	69.6	4.6	7.00	-60
				Ambient		0.21	68.2	3.5	7.00	-79
				Oxidizing		0.18	73.6	<0.007	7.50	183
Li	Na_2SO_4	Mo = 0.9; SO_4^{2-} = 1200	1:6	Reducing	0.016	0.011	30.6	4.6	7.00	-60
				Ambient		0.012	25.1	3.5	7.00	-79
				Oxidizing		0.011	31.9	<0.007	7.50	183
Mo	$Na_2MoO_4 \cdot 2H_2O + Na_2SO_4$	Mo = 0.9; SO_4^{2-} = 1200	1:1.3	Reducing	0.077	0.071	8.7	3.4	7.01	-55
				Ambient		0.071	8.0	4.4	7.01	-71
				Oxidizing		0.071	7.7	0.004	7.64	156
SO_4	$Na_2MoO_4 \cdot 2H_2O + Na_2SO_4$	SO_4^{2-} = 1200	1:1.3	Reducing	34.35	2.26	93.4	3.4	7.01	-55
				Ambient		1.87	94.6	4.4	7.01	-71
				Oxidizing		3.48	89.9	0.004	7.64	156

Notes:
< - compound not detected, the associated value is the detection limit
Dissolved iron concentrations reported following completion of the desorption step.
The average results for two duplicate trials are shown.
COC - Constituent of concern
mg/L - milligrams per liter
SU - standard units
mV - millivolts

FIGURES



Legend

- Compliance Well
- Background Well
- Source Sample Location
- Monitoring Well
- Monitoring Well to be Abandoned
- Staff Gauge
- Surface Water Sample Locations
- MNA Sampling Locations
- Groundwater Flow Direction
- Part 845 Regulated Unit (Subject Unit)
- Site Feature
- Property Boundary

Notes
- Figure originally from "Groundwater Monitoring Plan - North Ash Pond and Old East Ash Pond, Vermilion Power Plant." (Ramboll, 2021).
- Locations of interest for the MNA evaluation are circled in red.
- Surface water sampling locations are approximate.

1,000 500 0 1,000 Feet

Monitoring Well and Surface Water Sampling Location Map

Vermilion Power Plant
Oakwood, Illinois

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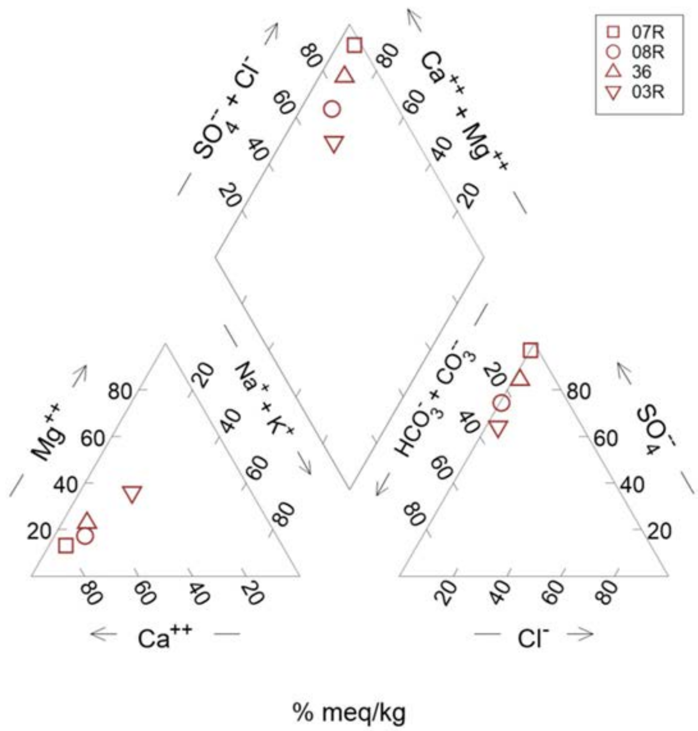
Ann Arbor, Michigan | 2021/10/27

Figure 1

Y:\Company\Projects_post_2014\CHE8404_VPS_Closure_RIA_Sprt\500 - Technical\572 - MNA and GSI Evaluation\GIS\MXDs\20211026_MW and SW Sampling Location Map.mxd. ASoltero. 10/27/2021. CHE8404B.



Notes: Results are shown in relative percentage of milliequivalents per kilogram (% meq/kg). Average results for the first six background monitoring events at wells 03R, 08R, and 36 and the first four background monitoring events at 07R were used for groundwater composition.

Piper Diagram – Downgradient Groundwater Conditions

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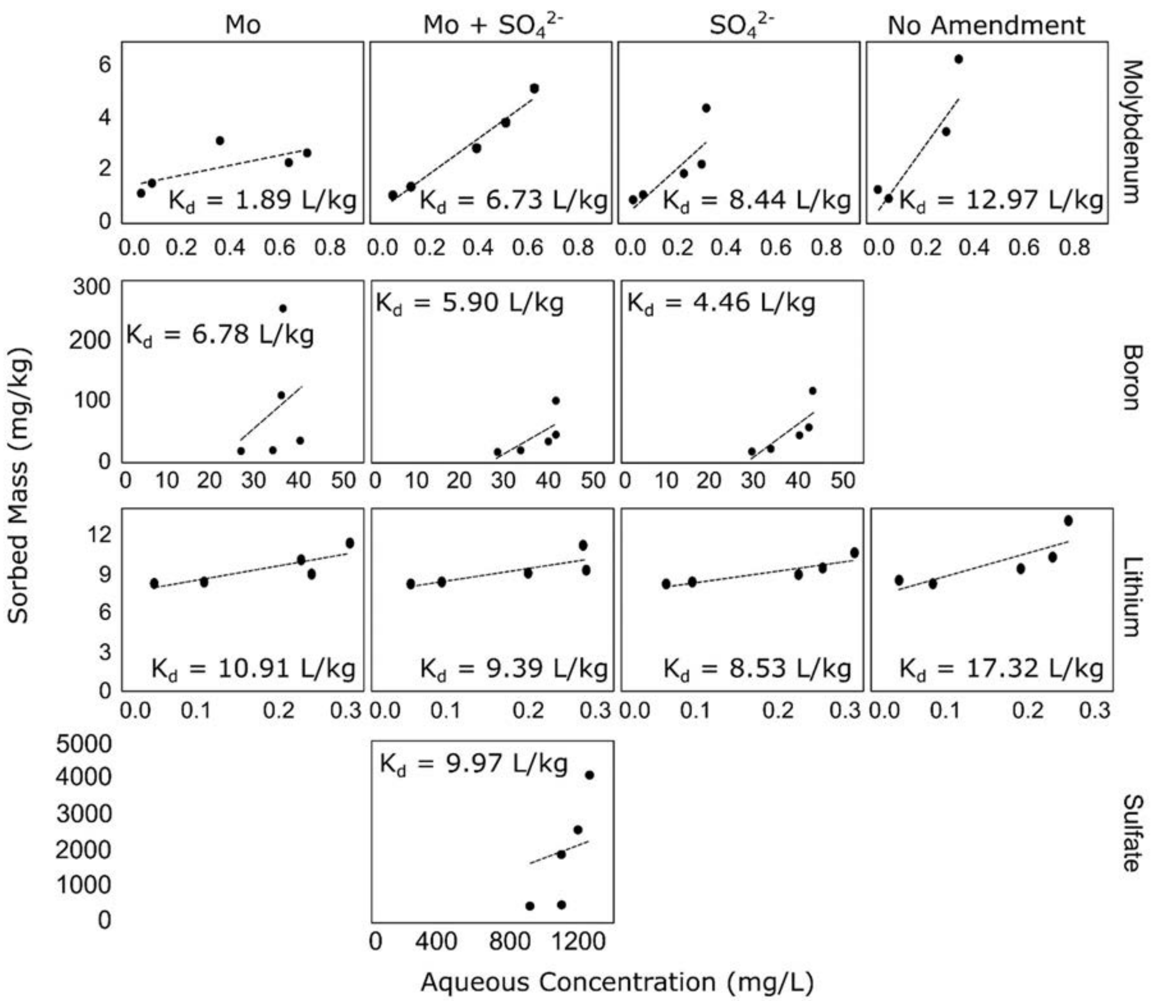
Columbus, OH | 8-Sept-2021

Figure **2**



Notes: K_d values were not generated for boron in the unamended dataset or sulfate in the Mo, SO_4, or unamended datasets because negative slopes were observed. 'No Amendment' was prepared using groundwater from well 08R.

Batch Attenuation Testing – Linear Sorption Results

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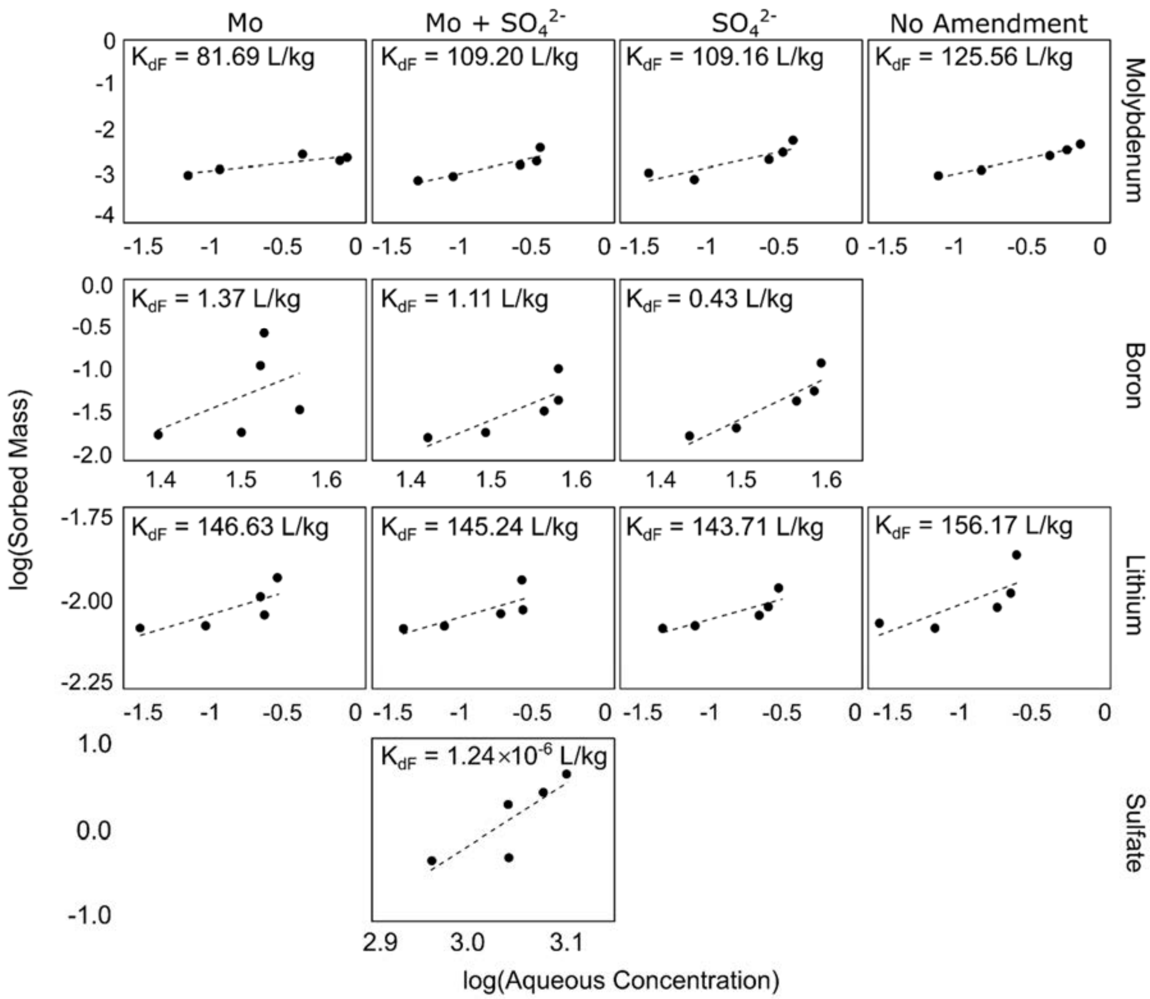
Figure 3



Notes: K_{dF} values were not generated for boron in the unamended dataset or sulfate in the Mo, SO_4, or unamended datasets because negative slopes were observed. 'No Amendment' represents groundwater from well 08R.

Batch Attenuation Testing – Freundlich Sorption Results

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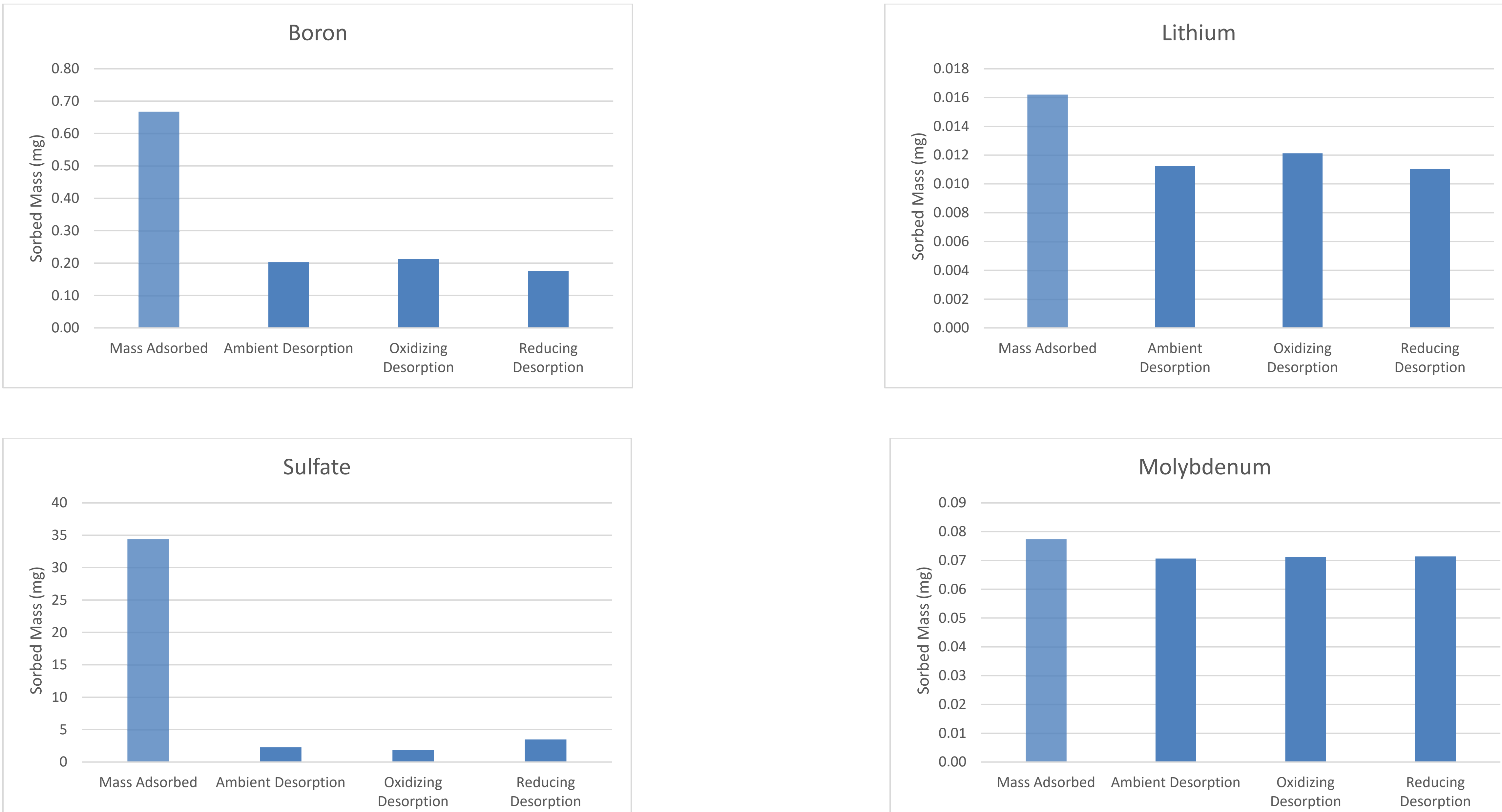
Figure 4



Notes:
-Mass adsorbed represents mass on the soil phase following one week of exposure to the amendment solution.
-Ambient/Oxidizing/Reducing desorption results represent the mass of the constituent adsorbed following one week of treatment under the listed experimental condition.

Desorption Testing – Remaining Mass Adsorbed

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Figure **5**

Columbus, Ohio | 13-Oct-2021

APPENDIX A
Soil Boring Logs

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Client: Dynegy		**WELL LOG**
Project: CHE8404B, Vermilion MNA		**Well No.** MW-07R
Address: 9878 E 2150 North Rd, Danville, IL		**Page:** 1 of 3

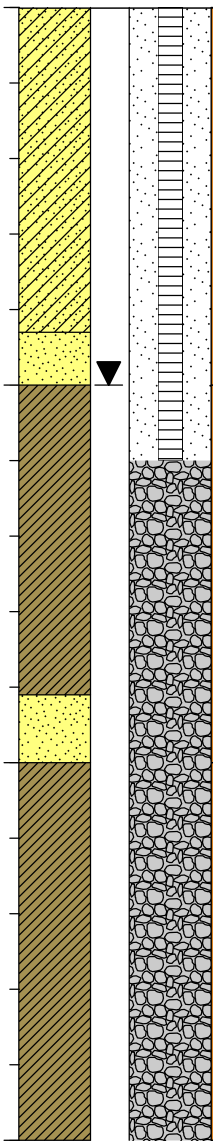
Drilling Start Date:	**04/27/2021**	Boring Depth (ft): **40**		Well Depth (ft):	**21**
Drilling End Date:	**04/27/2021**	Boring Diameter (in):		Well Diameter (in):	**1**
Drilling Company:	**Cascade Drilling**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Sonic**	DTW After Drilling (ft): **20**		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**Geoprobe 8140 DT**	Top of Casing Elev. (ft)		Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Russ Gordon**	Ground Elev. (ft):		Seal Material(s):	**NA**
Logged By:	**Amanda Toye**	Northing, Easting (NAD83):		Filter Pack:	**Sand**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
0				DP	44/60			(0') No Recovery.		0
								(1.33') GRAVELLY SAND (SP); light gray, dry, fine to coarse grained.		
								(3') CLAYEY SILT (ML); burnt orange with gray and black mottling, ash throughout, trace gravel, moist.		
5				DP	19/60			(5') No Recovery.		5
								(8.4') CLAYEY SILT (ML); brown, trace gravel and sand, higher clay content at toe, moist.		
10				DP				(10') No Recovery.		10
								(11') CLAYEY SAND (SC); brown, damp.	SB-21-07R-(12-14)	
								(13') SAND WITH GRAVEL (SP); reddish brown to light gray, moist, fine to coarse grained.		
15										15

NOTES:

Client: Dynegy		**WELL LOG**
Project: CHE8404B, Vermilion MNA		**Well No.** MW-07R
Address: 9878 E 2150 North Rd, Danville, IL		**Page:** 2 of 3

Drilling Start Date:	**04/27/2021**	Boring Depth (ft):	**40**	Well Depth (ft):	**21**
Drilling End Date:	**04/27/2021**	Boring Diameter (in):		Well Diameter (in):	**1**
Drilling Company:	**Cascade Drilling**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Sonic**	DTW After Drilling (ft):	**20**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**Geoprobe 8140 DT**	Top of Casing Elev. (ft)		Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Russ Gordon**	Ground Elev. (ft):		Seal Material(s):	**NA**
Logged By:	**Amanda Toye**	Northing, Easting (NAD83):		Filter Pack:	**Sand**



DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
15				DP	60/60			(15') CLAYEY SAND (SC); gray, wood at 19", moist, fine grained.		15
								(19.3') SAND (SP); gray, saturated, fine grained.		
20				DP	60/60			(20') CLAY WITH SAND (CL); gray, trace fine gravel, saturated, medium plasticity.		20
								(24.1') SAND (SP); gray, saturated, fine grained.		
25				DP	60/60			(25') SILTY CLAY WITH SAND (CL); gray, sand seams present, trace gravel, moist.		25
30										30

NOTES:

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Client: Dynegy		**WELL LOG**
Project: CHE8404B, Vermilion MNA		**Well No.** MW-07R
Address: 9878 E 2150 North Rd, Danville, IL		**Page:** 3 of 3

Drilling Start Date:	**04/27/2021**	Boring Depth (ft):	**40**	Well Depth (ft):	**21**
Drilling End Date:	**04/27/2021**	Boring Diameter (in):		Well Diameter (in):	**1**
Drilling Company:	**Cascade Drilling**	DTW During Drilling (ft):		Screen Slot (in):	**0.010**
Drilling Method:	**Sonic**	DTW After Drilling (ft):	**20**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**Geoprobe 8140 DT**	Top of Casing Elev. (ft)		Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Russ Gordon**	Ground Elev. (ft):		Seal Material(s):	**NA**
Logged By:	**Amanda Toye**	Northing, Easting (NAD83):		Filter Pack:	**Sand**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
30				DP	60/60			(30') SAND WITH CLAY (SP); gray, moist, fine grained.	SB-21-07R-(30-31)	30
								(31') SILTY CLAY WITH SAND (CL); gray, trace fine to coarse gravel, moist.		
35				DP	60/60			(35') As above: higher sand content.		35
								(39.3') SAND (SP); gray, some clay, saturated, fine grained.		
40								(40') End of Boring.		40
45										45

NOTES:

Geosyntec consultants engineers | scientists | innovators	**Client:** Dynegy **Project:** CHE8404B, Vermilion MNA **Address:** 9878 E 2150 North Rd, Danville, IL	**BORING LOG** **Boring No.** SB-21-03/08R **Page:** 1 of 3

Drilling Start Date:	**04/26/2021**	Boring Depth (ft):	**40**
Drilling End Date:	**04/26/2021**	Boring Diameter (in):	
Drilling Company:	**Cascade Drilling**	Sampling Method(s):	**Direct Push**
Drilling Method:	**Sonic**	DTW During Drilling (ft):	
Drilling Equipment:	**Geoprobe 8140 DT**	DTW After Drilling (ft):	
Driller:	**Russ Gordon**	Ground Surface Elev. (ft):	
Logged By:	**Amanda Toye**	Northing, Easting (NAD83):	

DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
0				DP	60/60			(0') GRAVELLY CLAY (CL); light brown, dry.		0
								(3') LEAN CLAY (CL); gray and brown mottling, dry.		
								(4') SANDY CLAY (CL); gray to brown mottling, trace gravel, dry.		
5				DP	60/60			(5') As above.		5
								(6.5') SILTY SAND (SM); gray, moist.		
								(8') SILTY CLAY (CL); gray, moist.		
10				DP	60/60			(10') SAND WITH SILT (SP); brown, moist, fine grained.		10
								(12') SAND (SP); brownish gray, moist, fine grained.	SB-21-08R-(13-15)	
15										15

NOTES:

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Client: Dynegy		**BORING LOG**
Project: CHE8404B, Vermilion MNA		**Boring No.** SB-21-03/08R
Address: 9878 E 2150 North Rd, Danville, IL		

Drilling Start Date:	**04/26/2021**	Boring Depth (ft):	**40**
Drilling End Date:	**04/26/2021**	Boring Diameter (in):	
Drilling Company:	**Cascade Drilling**	Sampling Method(s):	**Direct Push**
Drilling Method:	**Sonic**	DTW During Drilling (ft):	
Drilling Equipment:	**Geoprobe 8140 DT**	DTW After Drilling (ft):	
Driller:	**Russ Gordon**	Ground Surface Elev. (ft):	
Logged By:	**Amanda Toye**	Northing, Easting (NAD83):	

DEPTH (ft)	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
15	DP	48/60			(15') As above.		15
					(16') SAND WITH GRAVEL (SP); gray, moist, fine to coarse grained.		
					(17.3') LEAN CLAY (CL); gray, moist, medium plasticity, till (slough).		
					(19') No Recovery.		
20	DP	60/60			(20') LEAN CLAY (CL); gray, trace gravel, moist.		20
25	DP	54/60			(25') As above.		25
					(26.5') SAND WITH CLAY AND GRAVEL (SP); gray, moist, fine to coarse grained.		
					(27.2') LEAN CLAY (CL); gray, moist, medium plasticity.		
					(28.8') SANDY SILT (ML); gray, saturated.		
					(29.5') No Recovery.		
30							30

NOTES:

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Client: Dynegy
Project: CHE8404B, Vermilion MNA
Address: 9878 E 2150 North Rd, Danville, IL

BORING LOG

Boring No. SB-21-03/08R

Drilling Start Date:	**04/26/2021**	Boring Depth (ft):	**40**
Drilling End Date:	**04/26/2021**	Boring Diameter (in):	
Drilling Company:	**Cascade Drilling**	Sampling Method(s):	**Direct Push**
Drilling Method:	**Sonic**	DTW During Drilling (ft):	
Drilling Equipment:	**Geoprobe 8140 DT**	DTW After Drilling (ft):	
Driller:	**Russ Gordon**	Ground Surface Elev. (ft):	
Logged By:	**Amanda Toye**	Northing, Easting (NAD83):	

DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
30				DP	48/60			(30') SAND WITH GRAVEL AND CLAY (SP); gray, saturated.		30
								(31') SAND (SP); gray, some clay, trace gravel, moist.	SB-21-08R-(31-32)	
								(32.3') SAND, gray, some gravel, moist.		
								(33.6') No Recovery.		
35				DP	60/60			(35') SAND (SP); gray, some gravel, moist.		35
								(37.4') SAND (SP); gray, moist, fine to coarse grained.		
40								(40') End of Boring.		40
45										45

NOTES:

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Client:	Dynegy
Project:	CHE8404B, Vermilion MNA
Address:	9878 E 2150 North Rd, Danville, IL

BORING LOG

Boring No. SB-21-43

Drilling Start Date:	04/29/2021	Boring Depth (ft):	65
Drilling End Date:	04/29/2021	Boring Diameter (in):	
Drilling Company:	Cascade Drilling	Sampling Method(s):	Direct Push
Drilling Method:	Sonic	DTW During Drilling (ft):	
Drilling Equipment:	Geoprobe 8140 DT	DTW After Drilling (ft):	
Driller:	Russ Gordon	Ground Surface Elev. (ft):	
Logged By:	Amanda Toye	Northing, Easting (NAD83):	

DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
0				DP	60/60			(0') CLAY (CL); grayish brown, some gray mottling, trace gravel, stiff, dry.		0
5				DP	60/60			(5') SANDY CLAY (CL); grayish brown, some orange mottling, trace gravel, dry, low plasticity.		5
10				DP	55/60			(10') As above: slightly higher clay content, dry.		10
								(14.6') No Recovery.		
15										15

NOTES:

Client: Dynegy		**BORING LOG**
Project: CHE8404B, Vermilion MNA		**Boring No.** SB-21-43
Address: 9878 E 2150 North Rd, Danville, IL		**Page:** 2 of 5

Drilling Start Date:	**04/29/2021**	Boring Depth (ft):	**65**
Drilling End Date:	**04/29/2021**	Boring Diameter (in):	
Drilling Company:	**Cascade Drilling**	Sampling Method(s):	**Direct Push**
Drilling Method:	**Sonic**	DTW During Drilling (ft):	
Drilling Equipment:	**Geoprobe 8140 DT**	DTW After Drilling (ft):	
Driller:	**Russ Gordon**	Ground Surface Elev. (ft):	
Logged By:	**Amanda Toye**	Northing, Easting (NAD83):	

DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
15				DP	60/60			(15') CLAY WITH SAND (CL); dark gray, trace gravel, moist, medium plasticity.		15
20				DP	60/60			(20') As above: sand lense at 15".		20
25				DP	60/60			(25') As above: some black mottling.		25
30										30

NOTES:

Geosyntec consultants
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Client: Dynegy		**BORING LOG**
Project: CHE8404B, Vermilion MNA		**Boring No.** SB-21-43
Address: 9878 E 2150 North Rd, Danville, IL		

Drilling Start Date:	**04/29/2021**	Boring Depth (ft):	**65**
Drilling End Date:	**04/29/2021**	Boring Diameter (in):	
Drilling Company:	**Cascade Drilling**	Sampling Method(s):	**Direct Push**
Drilling Method:	**Sonic**	DTW During Drilling (ft):	
Drilling Equipment:	**Geoprobe 8140 DT**	DTW After Drilling (ft):	
Driller:	**Russ Gordon**	Ground Surface Elev. (ft):	
Logged By:	**Amanda Toye**	Northing, Easting (NAD83):	

DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
30				DP	60/60			(30') CLAY WITH SAND (CL); dark gray, trace silt, moist, low plasticity.		30
								(34.3') As above: moist, medium plasticity.		
35				DP	60/60			(35') SILTY CLAY (CL); gray, few sand, trace gravel, moist, soft, medium plasticity.		35
40				DP	60/60			(40') As above.		40
45										45

NOTES:

Drilling Start Date:	**04/29/2021**	Boring Depth (ft):	**65**
Drilling End Date:	**04/29/2021**	Boring Diameter (in):	
Drilling Company:	**Cascade Drilling**	Sampling Method(s):	**Direct Push**
Drilling Method:	**Sonic**	DTW During Drilling (ft):	
Drilling Equipment:	**Geoprobe 8140 DT**	DTW After Drilling (ft):	
Driller:	**Russ Gordon**	Ground Surface Elev. (ft):	
Logged By:	**Amanda Toye**	Northing, Easting (NAD83):	

DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
45				DP	60/60			(45') As above.		45
50				DP	60/60			(50') As above.		50
54									SB-21-43-(54-55)	
55				DP	60/60			(55') CLAYEY SAND (SC); dark gray, saturated.	SB-21-43-(55-56)	55
55.3								(55.3') SILTY CLAY (CL); dark gray, moist, soft, medium plasticity.		
59.5								(59.5') SAND (SP); gray, saturated, fine grained.		
60										60

NOTES:

Geosyntec consultants	Client: Dynegy Project: CHE8404B, Vermilion MNA Address: 9878 E 2150 North Rd, Danville, IL	**BORING LOG** Boring No. SB-21-43 Page: 5 of 5

Drilling Start Date:	**04/29/2021**	Boring Depth (ft):	**65**
Drilling End Date:	**04/29/2021**	Boring Diameter (in):	
Drilling Company:	**Cascade Drilling**	Sampling Method(s):	**Direct Push**
Drilling Method:	**Sonic**	DTW During Drilling (ft):	
Drilling Equipment:	**Geoprobe 8140 DT**	DTW After Drilling (ft):	
Driller:	**Russ Gordon**	Ground Surface Elev. (ft):	
Logged By:	**Amanda Toye**	Northing, Easting (NAD83):	

DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT: Sample Type	COLLECT: Recovery (in)	COLLECT: Blow Counts	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: Lab Sample	DEPTH (ft)
60				DP	60/60			(60') As above.	SB-21-43-(60-61)	60
								(61') SILTY CLAY (CL); dark gray, moist, soft, medium plasticity.		
								(62') SAND (SP); gray, saturated, fine grained.	SB-21-43-(62-62.2)	
								(62.2') SILTY CLAY (CL); dark gray, moist, soft, medium plasticity.		
								(62.75') SAND (SP); gray, saturated, fine grained.	SB-21-43-(62.75-63)	
								(63.25') SILTY CLAY (CL); dark gray, moist, medium plasticity, soft.		
								(63.75') SAND (SP); gray, saturated, fine grained.		
								(64') SILTY CLAY (CL); dark gray, moist, soft, medium plasticity.	SB-21-43-(64-65)	
65								(65') End of Boring.		65
70										70

NOTES:

APPENDIX B
Tier 1 Geochemical Modeling Outputs

MW-03R Spec8 Output

```
Temperature =  12.6 C     Pressure =  1.013 bars
pH =  7.275               log fO2 =  -53.403
Eh =   0.0620 volts       pe =   1.0943
Ionic strength      =    0.025571 molal
Charge imbalance    =    0.003952 eq/kg (13.19% error)
Activity of water   =    0.999971
Solvent mass        =     0.33679 kg
Solution mass       =     0.33723 kg
Mineral mass        =      1.7760 kg
Solution density    =    1.022    g/cm3
Solution viscosity  =    0.012    poise
Chlorinity          =    0.000825 molal
Dissolved solids    =        1287 mg/kg sol'n
Elect. conductivity =     1448.54 uS/cm (or umho/cm)
Hardness            =      725.44 mg/kg sol'n as CaCO3
  carbonate         =      222.14 mg/kg sol'n as CaCO3
  non-carbonate     =      503.30 mg/kg sol'n as CaCO3
Carbonate alkalinity=      222.14 mg/kg sol'n as CaCO3
Water type          =    Ca-SO4
Bulk volume         =    1.00e+03 cm3
Fluid volume        =        330. cm3
Mineral volume      =        1.15 cm3
Inert volume        =        669. cm3
Porosity            =        33.0 %
Permeability        =    8.80e-09 cm2
HFO sorbing surface:
  Surface charge    =        1.33 uC/cm2
  Surface potential =        33.9 mV
  Surface area      =    2.15e+07 cm2
```

Minerals in system	moles	log moles	grams	volume (cm3)
Fe(OH)3	0.03351	-1.475	3.581	1.151
(total)			3.581	670.0

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
HCO3-	0.004260	259.6	0.8605	-2.4359
SO4--	0.003956	379.5	0.5444	-2.6669
Na+	0.003530	81.06	0.8605	-2.5175
Ca++	0.003446	137.9	0.5715	-2.7057
Mg++	0.002510	60.92	0.5956	-2.8254
B(OH)3(aq)	0.001735	107.1	1.0000	-2.7607
Cl-	0.0008227	29.13	0.8545	-3.1530
Fe++	0.0006503	36.27	0.5715	-3.4299
MgSO4(aq)	0.0006060	72.85	1.0000	-3.2175
CO2(aq)	0.0005423	23.84	1.0000	-3.2658
CaSO4(aq)	0.0005163	70.20	1.0000	-3.2871

CaHCO3+	9.638e-05	9.731	0.8605	-4.0813
MgHCO3+	7.106e-05	6.055	0.8605	-4.2136
K+	6.659e-05	2.600	0.8545	-4.2448
NaHCO3(aq)	2.027e-05	1.701	1.0000	-4.6932
BO2-	1.574e-05	0.6730	0.8605	-4.8683
CaCO3(aq)	7.836e-06	0.7833	1.0000	-5.1059
CO3--	4.328e-06	0.2594	0.5514	-5.6222
MgCO3(aq)	3.018e-06	0.2542	1.0000	-5.5202
MoO4--	2.019e-06	0.3224	0.5514	-5.9534
Mn++	1.186e-06	0.06510	0.5715	-6.1688
KSO4-	1.071e-06	0.1446	0.8605	-6.0355
MgCl+	9.612e-07	0.05737	0.8605	-6.0824
Li+	4.658e-07	0.003229	0.8710	-6.3918
NaCl(aq)	3.341e-07	0.01950	1.0000	-6.4761
CaCl+	3.262e-07	0.02460	0.8605	-6.5518
MnSO4(aq)	2.913e-07	0.04393	1.0000	-6.5357
FeCl+	2.079e-07	0.01896	0.8605	-6.7473
OH-	8.012e-08	0.001361	0.8576	-7.1630
H+	6.005e-08	6.044e-05	0.8841	-7.2750
NaCO3-	3.901e-08	0.003234	0.8605	-7.4740
HSO4-	9.333e-09	0.0009048	0.8605	-8.0952
KCl(aq)	1.005e-09	7.486e-05	1.0000	-8.9976
MnCl+	8.448e-10	7.626e-05	0.8605	-9.1385
CaCl2(aq)	2.638e-10	2.924e-05	1.0000	-9.5787
NaOH(aq)	3.608e-11	1.441e-06	1.0000	-10.4428
FeCO3+	1.454e-11	1.683e-06	0.8605	-10.9026
LiCl(aq)	8.294e-12	3.512e-07	1.0000	-11.0812
HCl(aq)	7.866e-12	2.864e-07	1.0000	-11.1042
FeCl2(aq)	6.210e-13	7.861e-08	1.0000	-12.2069
KHSO4(aq)	2.716e-14	3.694e-09	1.0000	-13.5661
Fe+++	9.064e-16	5.056e-11	0.3240	-15.5321
FeSO4+	4.196e-17	6.365e-12	0.8605	-16.4425
FeCl4--	1.712e-18	3.379e-13	0.5444	-18.0306
Formate	8.976e-20	4.036e-15	0.8576	-19.1136
FeCl++	3.216e-20	2.933e-15	0.5514	-19.7511
H2(aq)	7.977e-21	1.606e-17	1.0000	-20.0982
Ca(For)+	5.188e-21	4.409e-16	0.8605	-20.3503
Mg(For)+	4.630e-21	3.206e-16	0.8605	-20.3996
Fe(For)+	2.824e-21	2.845e-16	0.8605	-20.6144
Na(For)(aq)	2.753e-22	1.870e-17	1.0000	-21.5602
Formic_acid(aq)	2.388e-23	1.098e-18	1.0000	-22.6219
SO3--	1.057e-23	8.450e-19	0.5514	-23.2345
HSO3-	5.194e-24	4.205e-19	0.8605	-23.3498
K(For)(aq)	4.544e-24	3.818e-19	1.0000	-23.3425
Mn(For)+	3.549e-24	3.543e-19	0.8605	-23.5151
CO(aq)	4.108e-26	1.149e-21	1.0000	-25.3863
Oxalate	1.028e-26	9.038e-22	0.5444	-26.2521
SO2(aq)	1.340e-29	8.571e-25	1.0000	-28.8730
H-Oxalate	5.771e-30	5.132e-25	0.8605	-29.3040
Mn+++	3.157e-31	1.732e-26	0.2687	-31.0715

Oxalic_acid(aq)	4.795e-36	4.312e-31	1.0000	-35.3192
Fe(For)2(aq)	3.879e-39	5.651e-34	1.0000	-38.4113
Mg(For)2(aq)	3.174e-39	3.624e-34	1.0000	-38.4984
Ca(For)2(aq)	2.959e-39	3.845e-34	1.0000	-38.5288
Na(For)2-	1.690e-41	1.907e-36	0.8605	-40.8375
Mn(For)2(aq)	3.587e-42	5.194e-37	1.0000	-41.4452
HS-	4.087e-43	1.350e-38	0.8576	-42.4553
H2S(aq)	2.831e-43	9.638e-39	1.0000	-42.5480
K(For)2-	2.386e-43	3.078e-38	0.8605	-42.6875
Formaldehyde(aq)	7.356e-45	2.206e-40	1.0000	-44.1334
S2O6--	2.385e-46	3.815e-41	0.5444	-45.8866
ClO-	1.575e-47	8.092e-43	0.8605	-46.8680
S2O3--	5.684e-48	6.366e-43	0.5444	-47.5094
Methane(aq)	9.965e-49	1.597e-44	1.0000	-48.0015
S--	5.809e-49	1.860e-44	0.5583	-48.4890
Methanol(aq)	1.892e-49	6.056e-45	1.0000	-48.7230
HO2-	8.197e-51	2.702e-46	0.8605	-50.1516
S2O5--	5.829e-52	8.390e-47	0.5444	-51.4985
Acetate	9.134e-54	5.386e-49	0.8632	-53.1032
Glycolate	4.036e-55	3.025e-50	0.8605	-54.4593
MgCH3COO+	3.242e-55	2.699e-50	0.8605	-54.5544
CaCH3COO+	1.608e-55	1.592e-50	0.8605	-54.8590
FeCH3COO+	7.558e-56	8.673e-51	0.8605	-55.1869
Ca(Glyc)+	4.041e-56	4.646e-51	0.8605	-55.4588
Fe(Glyc)+	3.004e-56	3.927e-51	0.8605	-55.5875
Acetic_acid(aq)	2.423e-56	1.453e-51	1.0000	-55.6156
NaCH3COO(aq)	1.986e-56	1.627e-51	1.0000	-55.7020
Mg(Glyc)+	1.431e-56	1.419e-51	0.8605	-55.9098
O2(aq)	6.413e-57	2.050e-52	1.0000	-56.1929
HSO5-	4.956e-57	5.597e-52	0.8605	-56.3701
Na(Glyc)(aq)	1.264e-57	1.238e-52	1.0000	-56.8982
KCH3COO(aq)	2.335e-58	2.289e-53	1.0000	-57.6317
Glycolic_acid(aq	1.305e-58	9.914e-54	1.0000	-57.8843
MnCH3COO+	1.159e-58	1.319e-53	0.8605	-58.0012
K(Glyc)(aq)	2.087e-59	2.379e-54	1.0000	-58.6806
Mn(Glyc)+	1.227e-59	1.593e-54	0.8605	-58.9763
LiCH3COO(aq)	7.534e-60	4.965e-55	1.0000	-59.1229
S2O4--	2.798e-60	3.581e-55	0.5583	-59.8062
Malonate	4.525e-62	4.611e-57	0.5444	-61.6085
H-Malonate	7.159e-64	7.368e-59	0.8605	-63.2104
MnO4--	2.496e-67	2.965e-62	0.5444	-66.8668
Malonic_acid(aq)	2.386e-68	2.480e-63	1.0000	-67.6222
S2O8--	2.146e-72	4.118e-67	0.5444	-71.9325
MnO4-	1.660e-76	1.972e-71	0.8576	-75.8465
Acetaldehyde(aq)	1.152e-76	5.069e-72	1.0000	-75.9385
S3O6--	1.510e-78	2.899e-73	0.5444	-78.0851
S2--	1.489e-78	9.534e-74	0.5444	-78.0913
ClO2-	5.394e-84	3.634e-79	0.8605	-83.3334
Ethanol(aq)	7.000e-86	3.221e-81	1.0000	-85.1549
Ethane(aq)	1.746e-89	5.243e-85	1.0000	-88.7579

Ethylene(aq)	1.269e-90	3.555e-86	1.0000	-89.8966
Lactate	1.639e-91	1.458e-86	0.8605	-90.8507
Propanoate	2.453e-92	1.790e-87	0.8605	-91.6755
Fe(Lac)+	1.077e-92	1.559e-87	0.8605	-92.0330
Ca(Lac)+	9.653e-93	1.245e-87	0.8605	-92.0806
Mg(Lac)+	5.930e-93	6.714e-88	0.8605	-92.2922
Na(Lac)(aq)	5.226e-94	5.848e-89	1.0000	-93.2819
Fe(Prop)+	4.666e-94	6.007e-89	0.8605	-93.3964
Ca(Prop)+	2.398e-94	2.710e-89	0.8605	-93.6854
Mg(Prop)+	2.355e-94	2.290e-89	0.8605	-93.6934
S4O6--	2.207e-94	4.943e-89	0.5444	-93.9203
Propanoic_acid(a	8.738e-95	6.464e-90	1.0000	-94.0586
Na(Prop)(aq)	7.713e-95	7.400e-90	1.0000	-94.1128
Lactic_acid(aq)	5.578e-95	5.019e-90	1.0000	-94.2535
K(Lac)(aq)	8.627e-96	1.104e-90	1.0000	-95.0641
Mn(Lac)+	3.525e-96	5.069e-91	0.8605	-95.5182
K(Prop)(aq)	1.273e-96	1.426e-91	1.0000	-95.8951
Mn(Prop)+	3.625e-97	4.635e-92	0.8605	-96.5059
Ethyne(aq)	1.028e-98	2.673e-94	1.0000	-97.9881
Succinate	4.867e-99	5.641e-94	0.5444	-98.5769
H-Succinate	7.205e-101	8.424e-96	0.8605	-100.2077
Succinic_acid(aq	5.719e-104	6.745e-99	1.0000	-103.2427
ClO3-	5.263e-106	4.386e-101	0.8576	-105.3455
Ca(CH3COO)2(aq)	2.165e-107	3.420e-102	1.0000	-106.6645
Mg(CH3COO)2(aq)	1.811e-107	2.576e-102	1.0000	-106.7420
Fe(CH3COO)2(aq)	1.159e-107	2.014e-102	1.0000	-106.9358
S3--	3.308e-108	3.178e-103	0.5444	-107.7445
Fe(Glyc)2(aq)	5.931e-109	1.220e-103	1.0000	-108.2268
Ca(Glyc)2(aq)	2.540e-109	4.824e-104	1.0000	-108.5952
Na(CH3COO)2-	9.959e-110	1.403e-104	0.8605	-109.0671
Mg(Glyc)2(aq)	5.386e-110	9.381e-105	1.0000	-109.2687
Acetone(aq)	2.656e-110	1.541e-105	1.0000	-109.5758
Mn(CH3COO)2(aq)	6.904e-111	1.193e-105	1.0000	-110.1609
K(CH3COO)2-	7.832e-112	1.230e-106	0.8605	-111.1714
Na(Glyc)2-	5.452e-112	9.423e-107	0.8605	-111.3287
Li(CH3COO)2-	9.152e-113	1.143e-107	0.8605	-112.1038
Mn(Glyc)2(aq)	3.141e-113	6.432e-108	1.0000	-112.5029
K(Glyc)2-	7.869e-114	1.487e-108	0.8605	-113.1693
Propanal(aq)	1.136e-114	6.589e-110	1.0000	-113.9446
1-Propanol(aq)	2.138e-124	1.283e-119	1.0000	-123.6700
1-Propene(aq)	6.757e-127	2.840e-122	1.0000	-126.1702
Propane(aq)	2.156e-128	9.493e-124	1.0000	-127.6664
2-Hydroxybutanoa	1.815e-130	1.869e-125	0.8605	-129.8065
Butanoate	2.141e-131	1.862e-126	0.8605	-130.7346
BH4-	2.066e-131	3.063e-127	0.8605	-130.7501
ClO4-	2.064e-132	2.050e-127	0.8576	-131.7520
1-Propyne(aq)	4.366e-133	1.747e-128	1.0000	-132.3599
Fe(But)+	4.204e-133	6.002e-128	0.8605	-132.4416
Ca(But)+	1.436e-133	1.824e-128	0.8605	-132.9080
Mg(But)+	1.345e-133	1.496e-128	0.8605	-132.9367

Na(But)(aq)	6.466e-134	7.109e-129	1.0000	-133.1894
Butanoic_acid(aq	6.139e-134	5.402e-129	1.0000	-133.2119
2-Hydroxybutanoi	5.474e-134	5.691e-129	1.0000	-133.2617
K(But)(aq)	1.067e-135	1.345e-130	1.0000	-134.9716
Mn(But)+	2.696e-136	3.824e-131	0.8605	-135.6345
Glutarate	3.527e-137	4.583e-132	0.5444	-136.7166
S4--	4.343e-138	5.564e-133	0.5444	-137.6263
H-Glutarate	3.065e-139	4.013e-134	0.8605	-138.5789
S5O6--	6.799e-140	1.741e-134	0.5444	-139.4316
Glutaric_acid(aq	3.119e-142	4.115e-137	1.0000	-141.5060
Ethylacetate(aq)	5.102e-143	4.490e-138	1.0000	-142.2922
Butanal(aq)	3.531e-155	2.542e-150	1.0000	-154.4522
Mn(CH3COO)3-	2.112e-163	4.894e-158	0.8605	-162.7406
1-Butanol(aq)	3.566e-164	2.640e-159	1.0000	-163.4478
1-Butene(aq)	3.588e-166	2.010e-161	1.0000	-165.4452
n-Butane(aq)	2.326e-167	1.350e-162	1.0000	-166.6334
S5--	3.362e-168	5.384e-163	0.5444	-167.7375
2-Hydroxypentano	3.013e-169	3.525e-164	0.8605	-168.5862
Pentanoate	2.225e-170	2.248e-165	0.8605	-169.7178
Fe(Pent)+	4.082e-172	6.400e-167	0.8605	-171.4544
1-Butyne(aq)	3.600e-172	1.945e-167	1.0000	-171.4437
Ca(Pent)+	8.837e-173	1.246e-167	0.8605	-172.1189
Mg(Pent)+	8.087e-173	1.013e-167	0.8605	-172.1575
Na(Pent)(aq)	7.090e-173	8.788e-168	1.0000	-172.1494
Pentanoic_acid(a	6.943e-173	7.082e-168	1.0000	-172.1585
2-Hydroxypentano	5.371e-173	6.337e-168	1.0000	-172.2700
K(Pent)(aq)	1.170e-174	1.639e-169	1.0000	-173.9317
Mn(Pent)+	2.164e-175	3.373e-170	0.8605	-174.7299
Adipate	9.642e-178	1.388e-172	0.5444	-177.2799
H-Adipate	8.194e-180	1.188e-174	0.8605	-179.1517
Fe(Lac)2(aq)	7.754e-182	1.812e-176	1.0000	-181.1105
Ca(Lac)2(aq)	1.585e-182	3.455e-177	1.0000	-181.7999
Mg(Lac)2(aq)	9.839e-183	1.989e-177	1.0000	-182.0071
Adipic_acid(aq)	9.705e-183	1.416e-177	1.0000	-182.0130
Fe(Prop)2(aq)	1.220e-184	2.462e-179	1.0000	-183.9135
Na(Lac)2-	9.359e-185	1.880e-179	0.8605	-184.0941
Mg(Prop)2(aq)	1.148e-185	1.955e-180	1.0000	-184.9399
Ca(Prop)2(aq)	8.820e-186	1.640e-180	1.0000	-185.0545
Mn(Lac)2(aq)	6.189e-186	1.441e-180	1.0000	-185.2084
Na(Prop)2-	1.368e-186	2.311e-181	0.8605	-185.9291
K(Lac)2-	1.351e-186	2.930e-181	0.8605	-185.9347
Mn(Prop)2(aq)	4.638e-188	9.314e-183	1.0000	-187.3337
K(Prop)2-	1.971e-188	3.647e-183	0.8605	-187.7705
Phenol(aq)	4.579e-192	4.304e-187	1.0000	-191.3392
Pentanal(aq)	6.416e-194	5.520e-189	1.0000	-193.1927
Benzene(aq)	1.338e-199	1.044e-194	1.0000	-198.8735
1-Pentanol(aq)	6.766e-202	5.957e-197	1.0000	-201.1696
Benzoate	7.821e-203	9.460e-198	0.8710	-202.1668
1-Pentene(aq)	2.907e-205	2.036e-200	1.0000	-204.5366
Benzoic_acid(aq)	5.932e-206	7.235e-201	1.0000	-205.2268

n-Pentane(aq)	2.077e-206	1.497e-201	1.0000	-205.6825
2-Hydroxyhexanoa	2.075e-208	2.717e-203	0.8605	-207.7483
Hexanoate	1.846e-209	2.123e-204	0.8605	-208.7990
o-Phthalate	1.446e-209	2.370e-204	0.5444	-209.1040
1-Pentyne(aq)	3.075e-211	2.092e-206	1.0000	-210.5121
Hexanoic_acid(aq	6.026e-212	6.991e-207	1.0000	-211.2200
2-Hydroxyhexanoi	5.271e-212	6.958e-207	1.0000	-211.2781
Pimelate	1.371e-215	2.165e-210	0.5444	-215.1272
H-Pimelate	1.180e-217	1.876e-212	0.8605	-216.9933
Pimelic_acid(aq)	1.667e-220	2.666e-215	1.0000	-219.7782
Hexanal(aq)	5.097e-233	5.099e-228	1.0000	-232.2927
Toluene(aq)	9.986e-236	9.190e-231	1.0000	-235.0006
p-Toluate	1.232e-238	1.662e-233	0.8605	-237.9748
m-Toluate	6.708e-239	9.054e-234	0.8605	-238.2387
o-Toluate	6.326e-241	8.538e-236	0.8605	-240.2641
p-Toluic_acid(aq	1.354e-241	1.841e-236	1.0000	-240.8685
1-Hexanol(aq)	1.161e-241	1.185e-236	1.0000	-240.9350
m-Toluic_acid(aq	5.758e-242	7.829e-237	1.0000	-241.2398
1-Hexene(aq)	3.723e-244	3.129e-239	1.0000	-243.4291
o-Toluic_acid(aq	2.150e-244	2.923e-239	1.0000	-243.6676
n-Hexane(aq)	1.378e-245	1.186e-240	1.0000	-244.8607
2-Hydroxyheptano	2.031e-247	2.945e-242	0.8605	-246.7575
Heptanoate	2.099e-248	2.708e-243	0.8605	-247.7432
1-Hexyne(aq)	2.089e-250	1.714e-245	1.0000	-249.6800
Heptanoic_acid(a	7.434e-251	9.665e-246	1.0000	-250.1288
2-Hydroxyheptano	5.173e-251	7.552e-246	1.0000	-250.2863
Suberate	5.262e-256	9.048e-251	0.5444	-255.5430
H-Suberate	4.392e-258	7.597e-253	0.8605	-257.4226
Suberic_acid(aq)	6.514e-261	1.133e-255	1.0000	-260.1861
Fe(But)2(aq)	9.187e-263	2.111e-257	1.0000	-262.0368
Mg(But)2(aq)	3.725e-264	7.386e-259	1.0000	-263.4288
Ca(But)2(aq)	3.231e-264	6.914e-259	1.0000	-263.4907
Na(But)2-	9.177e-265	1.807e-259	0.8605	-264.1026
Mn(But)2(aq)	2.494e-266	5.707e-261	1.0000	-265.6031
K(But)2-	1.322e-266	2.816e-261	0.8605	-265.9440
Heptanal(aq)	4.978e-273	5.677e-268	1.0000	-272.3029
1-Heptanol(aq)	8.942e-282	1.038e-276	1.0000	-281.0485
1-Heptene(aq)	3.473e-283	3.405e-278	1.0000	-282.4593
n-Heptane(aq)	1.343e-284	1.344e-279	1.0000	-283.8718
2-Hydroxyoctanoa	1.988e-286	3.162e-281	0.8605	-285.7667
Octanoate	3.447e-287	4.930e-282	0.8605	-286.5279
1-Heptyne(aq)	1.294e-289	1.243e-284	1.0000	-288.8881
Octanoic_acid(aq	1.237e-289	1.782e-284	1.0000	-288.9075
2-Hydroxyoctanoi	5.076e-290	8.121e-285	1.0000	-289.2945
Azelate	3.783e-297	7.034e-292	0.5444	-296.6863
H-Azelate	3.095e-299	5.786e-294	0.8605	-298.5746
Azelaic_acid(aq)	4.798e-302	9.019e-297	1.0000	-300.0000
Octanal(aq)	2.261e-311	2.896e-306	1.0000	-300.0000
n-Propylbenzene(	1.376e-313	1.652e-308	1.0000	-300.0000
1-Octanol(aq)	1.714e-320	2.230e-315	1.0000	-300.0000

1-Octene(aq)	2.322e-322	2.602e-317	1.0000	-300.0000
n-Octane(aq)	1.482e-323	1.691e-318	1.0000	-300.0000
2-Hydroxynonanoi	0.000	0.000	1.0000	-300.0000
Nonanoic_acid(aq	0.000	0.000	1.0000	-300.0000
Nonanoate	0.000	0.000	0.8605	-300.0000
Nonanal(aq)	0.000	0.000	1.0000	-300.0000
2-Hydroxynonanoa	0.000	0.000	0.8605	-300.0000
Na(Pent)2-	0.000	0.000	0.8605	-300.0000
Fe(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
Mn(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
2-Hydroxydecanoi	0.000	0.000	1.0000	-300.0000
Mg(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
2-Hydroxydecanoa	0.000	0.000	0.8605	-300.0000
Ethylbenzene(aq)	0.000	0.000	1.0000	-300.0000
1-Octyne(aq)	0.000	0.000	1.0000	-300.0000
Dodecanoic_acid(	0.000	0.000	1.0000	-300.0000
Dodecanoate	0.000	0.000	0.8605	-300.0000
Decanoic_acid(aq	0.000	0.000	1.0000	-300.0000
Decanoate	0.000	0.000	0.8605	-300.0000
Decanal(aq)	0.000	0.000	1.0000	-300.0000
2-Hexanone(aq)	0.000	0.000	1.0000	-300.0000
K(Pent)2-	0.000	0.000	0.8605	-300.0000
2-Heptanone(aq)	0.000	0.000	1.0000	-300.0000
n-Pentylbenzene(	0.000	0.000	1.0000	-300.0000
n-Octylbenzene(a	0.000	0.000	1.0000	-300.0000
2-Pentanone(aq)	0.000	0.000	1.0000	-300.0000
2-Butanone(aq)	0.000	0.000	1.0000	-300.0000
n-Hexylbenzene(a	0.000	0.000	1.0000	-300.0000
n-Heptylbenzene(	0.000	0.000	1.0000	-300.0000
n-Butylbenzene(a	0.000	0.000	1.0000	-300.0000
2-Octanone(aq)	0.000	0.000	1.0000	-300.0000
Undecanoic_acid(	0.000	0.000	1.0000	-300.0000
Undecanoate	0.000	0.000	0.8605	-300.0000
Sebacic_acid(aq)	0.000	0.000	1.0000	-300.0000
Sebacate	0.000	0.000	0.5444	-300.0000
Ca(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
H-Sebacate	0.000	0.000	0.8605	-300.0000

Surface species	molality	moles	Boltzman fct.	log molality
>(w)FeOH	0.01116	0.003760	1.0000	-1.9522
>(w)FeOH2+	0.003089	0.001040	3.7411	-2.5102
>(w)FeOMg+	0.002111	0.0007109	3.7411	-2.6756
>(w)FeOHSO4--	0.002075	0.0006987	0.071449	-2.6830
>(w)FeO-	0.0009243	0.0003113	0.26730	-3.0342
>(s)FeOHCa++	0.0004122	0.0001388	13.996	-3.3849
>(w)FeSO4-	0.0002877	9.690e-05	0.26730	-3.5410
>(w)FeOCa+	0.0001563	5.266e-05	3.7411	-3.8059
>(w)FeH2BO3	8.075e-05	2.719e-05	1.0000	-4.0929
>(s)FeOMn+	4.266e-05	1.437e-05	3.7411	-4.3700

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 >(s)FeOH             3.139e-05     1.057e-05        1.0000     -4.5032
 >(w)FeOMn+           1.205e-05     4.059e-06        3.7411     -4.9190
 >(s)FeOH2+           8.685e-06     2.925e-06        3.7411     -5.0612
 >(s)FeO-             2.599e-06     8.753e-07       0.26730     -5.5852
  (Boltzman factor = exp(zF PSI/RT),  where PSI is surface potential)

Mineral saturation states
                   log Q/K                          log Q/K
----------------------------------------------------------------
 Magnetite        11.6010s/sat   MgSO4            -11.0301
 Hematite         11.5075s/sat   B2O3             -11.1929
 Goethite          5.2885s/sat   Thermonatrite    -11.3632
 Siderite          1.3663s/sat   Na2CO3           -11.6737
 Dolomite-ord      1.1993s/sat   Portlandite      -11.6944
 Dolomite          1.1993s/sat   MnSO4            -11.9559
 Ferrite-Mg        1.1404s/sat   Borax            -12.9526
 Ferrite-Ca        0.9070s/sat   Hydromagnesite   -13.3295
 Calcite           0.0999s/sat   MnCl2:4H2O       -15.3112
 Fe(OH)3           0.0000 sat    MgOHCl           -15.5116
 Aragonite        -0.0451        MnCl2:2H2O       -16.7334
 Ice              -0.0916        MgCl2:4H2O       -16.8112
 Dolomite-dis     -0.4385        Pyrolusite       -18.2287
 Magnesite        -0.6074        MnCl2:H2O        -18.3985
 Monohydrocalcite -0.7041        Bixbyite         -18.9938
 Powellite        -0.7245        Lawrencite       -19.4506
 Gypsum           -0.8768        C                -20.6566
 Anhydrite        -1.1754        Hydrophilite     -21.3997
 Rhodochrosite    -1.2886        Scacchite        -21.7885
 Bassanite        -1.8241        Lime             -22.2096
 CaSO4:0.5H2O(bet -2.0082        Hausmannite      -22.3309
 Boric_acid       -2.4456        MgCl2:2H2O       -22.5882
 Wustite          -3.1708        Fe               -22.6449
 FeO              -3.2184        Ferrite-Dicalciu -24.1663
 Huntite          -3.3847        MgCl2:H2O        -26.1363
 Fe(OH)2          -3.5120        S                -30.7125
 Melanterite      -3.6418        KMgCl3:2H2O      -31.0698
 Nesquehonite     -3.6932        Chloromagnesite  -32.1771
 Jarosite         -4.5695        Troilite         -34.8325
 Nahcolite        -4.7067        Pyrrhotite       -34.9358
 Brucite          -5.4234        KMgCl3           -38.7725
 Mirabilite       -5.9841        Molysite         -39.6522
 Artinite         -6.9061        Alabandite       -41.1191
 Halite           -7.2158        Fe2(SO4)3        -44.0714
 Thenardite       -7.3820        Mn               -50.2823
 Mn(OH)2(am)      -7.6729        Mo               -50.7844
 Sylvite          -8.0969        Na               -51.4711
 Mg1.25SO4(OH)0.5 -8.5315        Pyrite           -54.6915
 Arcanite         -9.1432        K                -56.8921
 FeSO4            -9.2784        Na2O             -60.5968
 Natron           -9.4347        Li               -61.0223
```

Mg1.5SO4(OH)	-9.8136	B	-75.0214
Na2CO3:7H2O	-9.9590	K2O	-81.2349
NaFeO2	-10.0804	Mg	-88.3959
Manganosite	-10.4668	Ca	-106.1760
Periclase	-10.7546	o-Phthalic_acid	-213.6992

Gases	partial press. (bar)	fugacity	fug. coef.	log fug.
H2O(g)	0.01274	0.01193	0.9364	-1.9235
CO2(g)	0.01082	0.01076	0.9942	-1.9682
H2(g)	9.234e-18	9.241e-18	1.001	-17.0343
HCl(g)	5.087e-18	5.087e-18	1.000*	-17.2936
CO(g)	3.286e-23	3.286e-23	1.000*	-22.4834
SO2(g)	5.610e-30	5.508e-30	0.9819	-29.2590
H2S(g)	1.966e-42	1.949e-42	0.9913	-41.7103
CH4(g)	5.379e-46	5.368e-46	0.9980	-45.2702
Cl2(g)	4.512e-53	4.512e-53	1.000*	-52.3456
O2(g)	3.957e-54	3.954e-54	0.9992	-53.4030
Na(g)	1.718e-66	1.718e-66	1.000*	-65.7650
K(g)	6.945e-69	6.945e-69	1.000*	-68.1583
S2(g)	5.048e-77	5.048e-77	1.000*	-76.2969
Li(g)	3.957e-85	3.957e-85	1.000*	-84.4026
C2H4(g)	1.922e-88	1.922e-88	1.000*	-87.7163
Mg(g)	6.163e-110	6.163e-110	1.000*	-109.2102
Ca(g)	1.826e-133	1.826e-133	1.000*	-132.7384
C(g)	1.977e-144	1.977e-144	1.000*	-143.7039
B(g)	2.619e-171	2.619e-171	1.000*	-170.5819

*no data, gas taken to be ideal

Original basis	total moles	In fluid moles	In fluid mg/kg	Sorbed moles	Sorbed mg/kg	Kd L/kg
H2O	18.8	18.7	9.99e+05	-0.000124	-6.63	
B(OH)3(aq)	0.000617	0.000590	108.	2.72e-05	4.99	
Ca++	0.00156	0.00137	163.	0.000191	22.8	
Cl-	0.000278	0.000278	29.2			
Fe++	0.0337	0.000219	36.3			
H+	-0.0668	0.000172	0.515	4.60e-05	0.138	
HCO3-	0.00169	0.00169	305.			
K+	2.28e-05	2.28e-05	2.64			
Li+	1.57e-07	1.57e-07	0.00323			
Mg++	0.00179	0.00107	77.5	0.000711	51.2	
Mn++	1.89e-05	4.98e-07	0.0811	1.84e-05	3.00	
MoO4--	6.80e-07	6.80e-07	0.322			
Na+	0.00120	0.00120	81.5			
O2(aq)	0.00838	1.22e-12	1.16e-07			
SO4--	0.00251	0.00171	487.	0.000796	227.	
>(s)FeOH	0.000168					
>(w)FeOH	0.00670					

Sorbed	fraction	log fraction
B(OH)3(aq)	0.04409	-1.356
Ca++	0.1227	-0.911
Mg++	0.3981	-0.400
Mn++	0.9737	-0.012
SO4--	0.3174	-0.498

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Boron	0.0006168	0.0005896	18.90	2.719e-05	0.8718
Calcium	0.001561	0.001370	162.8	0.0001915	22.75
Carbon	0.001686	0.001686	60.03		
Chlorine	0.0002777	0.0002777	29.19		
Hydrogen	37.49	37.39	1.118e+05	-0.0001206	-0.3604
Iron	0.03373	0.0002191	36.28		
Lithium	1.569e-07	1.569e-07	0.003229		
Magnesium	0.001786	0.001075	77.45	0.0007109	51.24
Manganese	1.892e-05	4.980e-07	0.08112	1.843e-05	3.002
Molybdenum	6.799e-07	6.799e-07	0.1934		
Oxygen	18.81	18.71	8.876e+05	0.003140	149.0
Potassium	2.279e-05	2.279e-05	2.642		
Sodium	0.001196	0.001196	81.53		
Sulfur	0.002506	0.001711	162.7	0.0007956	75.66

MW-07R Spec8 Output

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Temperature =  13.1 C     Pressure =  1.013 bars
pH =  7.320               log fO2 =  -50.638
Eh =   0.0969 volts       pe =   1.7068
Ionic strength      =    0.069287 molal
Charge imbalance    =    0.015968 eq/kg (22.31% error)
Activity of water   =    0.999994
Solvent mass        =     0.33632 kg
Solution mass       =     0.33743 kg
Mineral mass        =      1.7760 kg
Solution density    =    1.023    g/cm3
Solution viscosity  =    0.012    poise
Chlorinity          =    0.000173 molal
Dissolved solids    =        3303 mg/kg sol'n
Elect. conductivity =     3301.01 uS/cm (or umho/cm)
Hardness            =     2633.64 mg/kg sol'n as CaCO3
  carbonate         =       51.02 mg/kg sol'n as CaCO3
  non-carbonate     =     2582.62 mg/kg sol'n as CaCO3
Carbonate alkalinity=       51.02 mg/kg sol'n as CaCO3
Water type          =    Ca-SO4
Bulk volume         =    1.00e+03 cm3
Fluid volume        =        330. cm3
Mineral volume      =        1.15 cm3
Inert volume        =        669. cm3
Porosity            =        33.0 %
Permeability        =    8.80e-09 cm2
HFO sorbing surface:
  Surface charge    =        1.68 uC/cm2
  Surface potential =        26.7 mV
  Surface area      =    2.15e+07 cm2
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Minerals in system	moles	log moles	grams	volume (cm3)
Fe(OH)3	0.03351	-1.475	3.581	1.151
(total)			3.581	670.0

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
Ca++	0.01744	696.8	0.4514	-2.1037
SO4--	0.01334	1277.	0.4074	-2.2648
CaSO4(aq)	0.005221	708.5	1.0000	-2.2822
B(OH)3(aq)	0.003261	201.0	1.0000	-2.4866
Mg++	0.002410	58.37	0.4899	-2.9280
Na+	0.002198	50.36	0.8027	-2.7535
K+	0.001451	56.55	0.7904	-2.9405
MgSO4(aq)	0.001221	146.5	1.0000	-2.9133
HCO3-	0.0009245	56.22	0.8027	-3.1296
Cl-	0.0001725	6.095	0.7904	-3.8654
Fe++	0.0001375	7.655	0.4514	-4.2070

CO2(aq)	9.814e-05	4.305	1.0000	-4.0082
CaHCO3+	8.355e-05	8.419	0.8027	-4.1735
Li+	8.114e-05	0.5614	0.8236	-4.1750
KSO4-	5.841e-05	7.869	0.8027	-4.3289
Mn++	4.959e-05	2.715	0.4514	-4.6500
BO2-	3.558e-05	1.518	0.8027	-4.5442
MnSO4(aq)	2.438e-05	3.669	1.0000	-4.6130
MgHCO3+	1.217e-05	1.035	0.8027	-5.0103
CaCO3(aq)	7.176e-06	0.7159	1.0000	-5.1441
MoO4--	5.466e-06	0.8714	0.4190	-5.6401
NaHCO3(aq)	2.363e-06	0.1979	1.0000	-5.6265
CO3--	1.294e-06	0.07737	0.4190	-6.2660
MgCO3(aq)	5.434e-07	0.04566	1.0000	-6.2649
CaCl+	2.710e-07	0.02040	0.8027	-6.6624
MgCl+	1.574e-07	0.009372	0.8027	-6.8985
OH-	9.923e-08	0.001682	0.7967	-7.1020
H+	5.645e-08	5.670e-05	0.8480	-7.3200
NaCl(aq)	3.771e-08	0.002197	1.0000	-7.4235
HSO4-	2.301e-08	0.002227	0.8027	-7.7334
FeCl+	7.222e-09	0.0006572	0.8027	-8.2368
MnCl+	5.854e-09	0.0005274	0.8027	-8.3280
NaCO3-	5.451e-09	0.0004509	0.8027	-8.3590
KCl(aq)	3.963e-09	0.0002945	1.0000	-8.4019
LiCl(aq)	2.654e-10	1.121e-05	1.0000	-9.5761
CaCl2(aq)	3.941e-11	4.360e-06	1.0000	-10.4044
NaOH(aq)	2.403e-11	9.580e-07	1.0000	-10.6192
FeCO3+	2.351e-12	2.715e-07	0.8027	-11.7241
HCl(aq)	1.373e-12	4.991e-08	1.0000	-11.8622
KHSO4(aq)	1.265e-12	1.717e-07	1.0000	-11.8978
FeCl2(aq)	3.905e-15	4.934e-10	1.0000	-14.4083
Fe+++	9.472e-16	5.273e-11	0.2155	-15.6901
FeSO4+	7.996e-17	1.211e-11	0.8027	-16.1925
FeCl++	5.828e-21	5.303e-16	0.4190	-20.6123
Formate	9.574e-22	4.296e-17	0.7967	-21.1176
FeCl4--	5.417e-22	1.067e-16	0.4074	-21.6562
H2(aq)	3.944e-22	7.924e-19	1.0000	-21.4041
Ca(For)+	2.197e-22	1.863e-17	0.8027	-21.7536
Mg(For)+	3.850e-23	2.660e-18	0.8027	-22.5100
Fe(For)+	4.970e-24	4.997e-19	0.8027	-23.3990
SO3--	1.729e-24	1.380e-19	0.4190	-24.1401
Na(For)(aq)	1.582e-24	1.072e-19	1.0000	-23.8008
Mn(For)+	1.238e-24	1.233e-19	0.8027	-24.0027
K(For)(aq)	9.088e-25	7.619e-20	1.0000	-24.0415
HSO3-	6.261e-25	5.059e-20	0.8027	-24.2988
Formic_acid(aq)	2.131e-25	9.776e-21	1.0000	-24.6714
CO(aq)	3.701e-28	1.033e-23	1.0000	-27.4317
Mn+++	7.987e-29	4.373e-24	0.1487	-28.9253
Oxalate	2.767e-29	2.427e-24	0.4074	-28.9480
SO2(aq)	1.370e-30	8.747e-26	1.0000	-29.8633
H-Oxalate	1.126e-32	9.993e-28	0.8027	-32.0438

Oxalic_acid(aq)	7.874e-39	7.066e-34	1.0000	-38.1038
Ca(For)2(aq)	1.152e-42	1.495e-37	1.0000	-41.9384
Mg(For)2(aq)	2.411e-43	2.747e-38	1.0000	-42.6178
Fe(For)2(aq)	6.245e-44	9.081e-39	1.0000	-43.2044
Mn(For)2(aq)	1.148e-44	1.659e-39	1.0000	-43.9400
Na(For)2-	1.022e-45	1.151e-40	0.8027	-45.0860
K(For)2-	5.042e-46	6.490e-41	0.8027	-45.3928
S2O6--	8.566e-47	1.367e-41	0.4074	-46.4572
ClO-	8.210e-47	4.210e-42	0.8027	-46.1811
HS-	5.168e-48	1.703e-43	0.7967	-47.3854
Formaldehyde(aq)	3.245e-48	9.710e-44	1.0000	-47.4888
H2S(aq)	2.950e-48	1.002e-43	1.0000	-47.5302
HO2-	2.550e-49	8.389e-45	0.8027	-48.6889
S2O3--	2.011e-52	2.248e-47	0.4074	-52.0865
S--	1.013e-53	3.236e-49	0.4302	-53.3610
S2O5--	9.835e-54	1.413e-48	0.4074	-53.3972
Methanol(aq)	3.885e-54	1.241e-49	1.0000	-53.4106
O2(aq)	3.703e-54	1.181e-49	1.0000	-53.4314
Methane(aq)	9.353e-55	1.496e-50	1.0000	-54.0290
HSO5-	3.167e-55	3.569e-50	0.8027	-54.5949
Acetate	1.862e-60	1.096e-55	0.8084	-59.8224
Glycolate	1.802e-60	1.347e-55	0.8027	-59.8398
Ca(Glyc)+	7.180e-61	8.238e-56	0.8027	-60.2393
CaCH3COO+	1.314e-61	1.298e-56	0.8027	-60.9769
MgCH3COO+	5.199e-62	4.319e-57	0.8027	-61.3795
Mg(Glyc)+	5.023e-62	4.974e-57	0.8027	-61.3944
Fe(Glyc)+	2.217e-62	2.893e-57	0.8027	-61.7496
MnO4--	1.063e-62	1.260e-57	0.4074	-62.3635
Acetic_acid(aq)	4.168e-63	2.494e-58	1.0000	-62.3801
Na(Glyc)(aq)	3.050e-63	2.980e-58	1.0000	-62.5157
FeCH3COO+	2.572e-63	2.945e-58	0.8027	-62.6852
NaCH3COO(aq)	2.198e-63	1.797e-58	1.0000	-62.6579
S2O4--	2.179e-63	2.782e-58	0.4302	-63.0282
Mn(Glyc)+	1.799e-63	2.330e-58	0.8027	-62.8405
K(Glyc)(aq)	1.752e-63	1.993e-58	1.0000	-62.7564
KCH3COO(aq)	8.999e-64	8.803e-59	1.0000	-63.0458
MnCH3COO+	7.796e-64	8.857e-59	0.8027	-63.2035
Glycolic_acid(aq	4.891e-64	3.708e-59	1.0000	-63.3106
LiCH3COO(aq)	2.355e-64	1.549e-59	1.0000	-63.6280
Malonate	2.363e-69	2.404e-64	0.4074	-69.0165
S2O8--	4.022e-70	7.701e-65	0.4074	-69.7856
H-Malonate	2.708e-71	2.781e-66	0.8027	-70.6629
MnO4-	2.470e-71	2.928e-66	0.7967	-70.7060
Malonic_acid(aq)	7.581e-76	7.863e-71	1.0000	-75.1203
ClO2-	6.962e-82	4.681e-77	0.8027	-81.2527
S3O6--	1.170e-82	2.242e-77	0.4074	-82.3217
Acetaldehyde(aq)	9.760e-85	4.286e-80	1.0000	-84.0105
S2--	5.755e-87	3.679e-82	0.4074	-86.6299
Ethanol(aq)	2.802e-95	1.287e-90	1.0000	-94.5525
Ethylene(aq)	5.197e-100	1.453e-95	1.0000	-99.2843

Ethane(aq)	3.249e-100	9.737e-96	1.0000	-99.4883
Lactate	1.429e-101	1.268e-96	0.8027	-100.9406
S4O6--	3.553e-102	7.941e-97	0.4074	-101.8394
Ca(Lac)+	3.350e-102	4.312e-97	0.8027	-101.5704
ClO3-	1.607e-102	1.337e-97	0.7967	-101.8926
Mg(Lac)+	4.078e-103	4.608e-98	0.8027	-102.4850
Fe(Lac)+	1.552e-103	2.242e-98	0.8027	-102.9046
Propanoate	9.879e-104	7.195e-99	0.8027	-103.1007
Na(Lac)(aq)	2.461e-104	2.749e-99	1.0000	-103.6089
K(Lac)(aq)	1.414e-104	1.806e-99	1.0000	-103.8495
Mn(Lac)+	1.009e-104	1.448e-99	0.8027	-104.0917
Lactic_acid(aq)	4.085e-105	3.668e-100	1.0000	-104.3888
Ca(Prop)+	3.856e-105	4.348e-100	0.8027	-104.5093
Mg(Prop)+	7.430e-106	7.212e-101	0.8027	-105.2244
Fe(Prop)+	3.111e-106	3.998e-101	0.8027	-105.6025
Propanoic_acid(a	2.958e-106	2.184e-101	1.0000	-105.5291
Na(Prop)(aq)	1.678e-106	1.607e-101	1.0000	-105.7752
K(Prop)(aq)	9.641e-107	1.078e-101	1.0000	-106.0159
Ethyne(aq)	9.483e-107	2.461e-102	1.0000	-106.0231
Mn(Prop)+	4.795e-107	6.118e-102	0.8027	-106.4146
Succinate	4.978e-111	5.760e-106	0.4074	-110.6929
H-Succinate	5.320e-113	6.209e-108	0.8027	-112.3695
Succinic_acid(aq	3.542e-116	4.168e-111	1.0000	-115.4508
Ca(Glyc)2(aq)	1.741e-119	3.300e-114	1.0000	-118.7592
Ca(CH3COO)2(aq)	3.126e-120	4.928e-115	1.0000	-119.5050
S3--	2.748e-120	2.634e-115	0.4074	-119.9510
Fe(Glyc)2(aq)	1.680e-120	3.447e-115	1.0000	-119.7748
Mg(Glyc)2(aq)	7.269e-121	1.263e-115	1.0000	-120.1385
Mg(CH3COO)2(aq)	5.108e-121	7.250e-116	1.0000	-120.2917
Fe(CH3COO)2(aq)	6.934e-122	1.202e-116	1.0000	-121.1590
Mn(Glyc)2(aq)	1.776e-122	3.629e-117	1.0000	-121.7506
Mn(CH3COO)2(aq)	8.204e-123	1.415e-117	1.0000	-122.0860
Na(Glyc)2-	5.815e-123	1.003e-117	0.8027	-122.3309
Acetone(aq)	4.371e-123	2.531e-118	1.0000	-122.3594
K(Glyc)2-	2.930e-123	5.525e-118	0.8027	-122.6285
Na(CH3COO)2-	2.234e-123	3.142e-118	0.8027	-122.7463
K(CH3COO)2-	6.140e-124	9.620e-119	0.8027	-123.3073
Li(CH3COO)2-	5.772e-124	7.193e-119	0.8027	-123.3341
Propanal(aq)	1.891e-127	1.095e-122	1.0000	-126.7232
ClO4-	1.498e-127	1.484e-122	0.7967	-126.9233
BH4-	3.307e-136	4.892e-132	0.8027	-135.5760
1-Propanol(aq)	1.683e-138	1.008e-133	1.0000	-137.7739
1-Propene(aq)	5.412e-141	2.270e-136	1.0000	-140.2666
Propane(aq)	7.906e-144	3.475e-139	1.0000	-143.1020
2-Hydroxybutanoa	3.119e-145	3.205e-140	0.8027	-144.6015
1-Propyne(aq)	7.818e-146	3.122e-141	1.0000	-145.1069
Butanoate	1.699e-147	1.475e-142	0.8027	-146.8652
2-Hydroxybutanoi	7.905e-149	8.202e-144	1.0000	-148.1021
Ca(But)+	4.552e-149	5.770e-144	0.8027	-148.4373
Mg(But)+	8.365e-150	9.288e-145	0.8027	-149.1730

Fe(But)+	5.523e-150	7.869e-145	0.8027	-149.3533
Butanoic_acid(aq	4.100e-150	3.601e-145	1.0000	-149.3872
Na(But)(aq)	2.772e-150	3.041e-145	1.0000	-149.5573
K(But)(aq)	1.592e-150	2.003e-145	1.0000	-149.7979
Mn(But)+	7.027e-151	9.949e-146	0.8027	-150.2486
S5O6--	2.429e-151	6.206e-146	0.4074	-151.0046
S4--	7.756e-154	9.915e-149	0.4074	-153.5004
Glutarate	7.097e-154	9.203e-149	0.4074	-153.5389
H-Glutarate	4.458e-156	5.826e-151	0.8027	-155.4463
Glutaric_acid(aq	3.812e-159	5.019e-154	1.0000	-158.4189
Ethylacetate(aq)	3.508e-159	3.080e-154	1.0000	-158.4550
Butanal(aq)	1.165e-172	8.374e-168	1.0000	-171.9336
Mn(CH3COO)3-	5.058e-182	1.170e-176	0.8027	-181.3914
1-Butanol(aq)	5.546e-183	4.098e-178	1.0000	-182.2560
1-Butene(aq)	5.672e-185	3.172e-180	1.0000	-184.2463
n-Butane(aq)	1.682e-187	9.743e-183	1.0000	-186.7742
S5--	1.292e-187	2.064e-182	0.4074	-187.2788
2-Hydroxypentano	1.020e-188	1.191e-183	0.8027	-188.0867
1-Butyne(aq)	1.272e-189	6.856e-185	1.0000	-188.8956
Pentanoate	3.482e-191	3.509e-186	0.8027	-190.5537
2-Hydroxypentano	1.530e-192	1.801e-187	1.0000	-191.8154
Ca(Pent)+	5.520e-193	7.768e-188	0.8027	-192.3535
Fe(Pent)+	1.056e-193	1.653e-188	0.8027	-193.0717
Mg(Pent)+	9.916e-194	1.240e-188	0.8027	-193.0991
Pentanoic_acid(a	9.142e-194	9.306e-189	1.0000	-193.0390
Na(Pent)(aq)	5.984e-194	7.403e-189	1.0000	-193.2230
K(Pent)(aq)	3.438e-194	4.805e-189	1.0000	-193.4637
Mn(Pent)+	1.111e-194	1.729e-189	0.8027	-194.0496
Adipate	3.847e-199	5.526e-194	0.4074	-198.8049
H-Adipate	2.364e-201	3.420e-196	0.8027	-200.7218
Ca(Lac)2(aq)	4.150e-202	9.026e-197	1.0000	-201.3819
Fe(Lac)2(aq)	8.377e-203	1.954e-197	1.0000	-202.0769
Mg(Lac)2(aq)	5.085e-203	1.026e-197	1.0000	-202.2937
Adipic_acid(aq)	2.354e-204	3.429e-199	1.0000	-203.6282
Mn(Lac)2(aq)	1.334e-204	3.099e-199	1.0000	-203.8749
Na(Lac)2-	3.806e-205	7.629e-200	0.8027	-204.5150
K(Lac)2-	1.917e-205	4.152e-200	0.8027	-204.8127
Ca(Prop)2(aq)	4.948e-208	9.185e-203	1.0000	-207.3055
Fe(Prop)2(aq)	2.821e-208	5.679e-203	1.0000	-207.5496
Mg(Prop)2(aq)	1.256e-208	2.134e-203	1.0000	-207.9009
Mn(Prop)2(aq)	2.134e-209	4.276e-204	1.0000	-208.6709
Na(Prop)2-	1.187e-209	2.001e-204	0.8027	-209.0211
K(Prop)2-	5.970e-210	1.102e-204	0.8027	-209.3195
Phenol(aq)	5.292e-215	4.964e-210	1.0000	-214.2763
Pentanal(aq)	4.172e-216	3.582e-211	1.0000	-215.3796
Benzene(aq)	7.284e-224	5.671e-219	1.0000	-223.1376
1-Pentanol(aq)	2.066e-225	1.815e-220	1.0000	-224.6849
Benzoate	9.102e-228	1.099e-222	0.8236	-227.1251
1-Pentene(aq)	9.065e-229	6.337e-224	1.0000	-228.0426
Benzoic_acid(aq)	5.878e-231	7.154e-226	1.0000	-230.2308

n-Pentane(aq)	2.964e-231	2.132e-226	1.0000	-230.5281
2-Hydroxyhexanoa	1.386e-232	1.812e-227	0.8027	-231.9536
1-Pentyne(aq)	2.143e-233	1.455e-228	1.0000	-232.6691
Hexanoate	5.698e-235	6.540e-230	0.8027	-234.3397
o-Phthalate	4.319e-235	7.064e-230	0.4074	-234.7546
2-Hydroxyhexanoi	2.961e-236	3.900e-231	1.0000	-235.5286
Hexanoic_acid(aq	1.565e-237	1.812e-232	1.0000	-236.8055
Pimelate	1.074e-241	1.693e-236	0.4074	-241.3590
H-Pimelate	6.692e-244	1.062e-238	0.8027	-243.2699
Pimelic_acid(aq)	7.946e-247	1.268e-241	1.0000	-246.0999
Hexanal(aq)	6.538e-260	6.527e-255	1.0000	-259.1845
Toluene(aq)	1.063e-264	9.761e-260	1.0000	-263.9735
p-Toluate	2.825e-268	3.805e-263	0.8027	-267.6445
m-Toluate	1.541e-268	2.076e-263	0.8027	-267.9076
1-Hexanol(aq)	7.036e-270	7.165e-265	1.0000	-269.1527
o-Toluate	1.458e-270	1.964e-265	0.8027	-269.9317
p-Toluic_acid(aq	2.608e-271	3.539e-266	1.0000	-270.5837
m-Toluic_acid(aq	1.111e-271	1.508e-266	1.0000	-270.9543
1-Hexene(aq)	2.289e-272	1.920e-267	1.0000	-271.6404
o-Toluic_acid(aq	4.179e-274	5.671e-269	1.0000	-273.3790
n-Hexane(aq)	3.877e-275	3.330e-270	1.0000	-274.4115
2-Hydroxyheptano	2.677e-276	3.873e-271	0.8027	-275.6679
1-Hexyne(aq)	2.872e-277	2.351e-272	1.0000	-276.5418
Heptanoate	1.278e-278	1.645e-273	0.8027	-277.9891
2-Hydroxyheptano	5.729e-280	8.348e-275	1.0000	-279.2419
Heptanoic_acid(a	3.806e-281	4.939e-276	1.0000	-280.4195
Suberate	8.170e-287	1.402e-281	0.4074	-286.4777
H-Suberate	4.932e-289	8.513e-284	0.8027	-288.4025
Suberic_acid(aq)	6.150e-292	1.068e-286	1.0000	-291.2111
Fe(But)2(aq)	8.250e-296	1.892e-290	1.0000	-295.0836
Ca(But)2(aq)	7.050e-296	1.506e-290	1.0000	-295.1518
Mg(But)2(aq)	1.585e-296	3.136e-291	1.0000	-295.7999
Mn(But)2(aq)	4.460e-297	1.019e-291	1.0000	-296.3507
Na(But)2-	3.092e-297	6.077e-292	0.8027	-296.6052
K(But)2-	1.555e-297	3.306e-292	0.8027	-296.9037
Heptanal(aq)	1.264e-304	1.438e-299	1.0000	-300.0000
1-Heptanol(aq)	1.073e-314	1.242e-309	1.0000	-300.0000
1-Heptene(aq)	4.210e-316	4.120e-311	1.0000	-300.0000
n-Heptane(aq)	7.455e-319	7.445e-314	1.0000	-300.0000
2-Hydroxyoctanoa	5.167e-320	8.199e-315	0.8027	-300.0000
1-Heptyne(aq)	3.513e-321	3.367e-316	1.0000	-300.0000
Octanoate	4.101e-322	5.853e-317	0.8027	-300.0000
2-Hydroxyoctanoi	9.881e-324	1.578e-318	1.0000	-300.0000
H-Azelate	0.000	0.000	0.8027	-300.0000
Octanoic_acid(aq	0.000	0.000	1.0000	-300.0000
Octanal(aq)	0.000	0.000	1.0000	-300.0000
2-Hydroxynonanoi	0.000	0.000	1.0000	-300.0000
Nonanoic_acid(aq	0.000	0.000	1.0000	-300.0000
Nonanoate	0.000	0.000	0.8027	-300.0000
Nonanal(aq)	0.000	0.000	1.0000	-300.0000

2-Hydroxynonanoa	0.000	0.000	0.8027	-300.0000
Na(Pent)2-	0.000	0.000	0.8027	-300.0000
Fe(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
Mn(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
2-Hydroxydecanoi	0.000	0.000	1.0000	-300.0000
Mg(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
2-Hydroxydecanoa	0.000	0.000	0.8027	-300.0000
Ethylbenzene(aq)	0.000	0.000	1.0000	-300.0000
Azelate	0.000	0.000	0.4074	-300.0000
1-Octyne(aq)	0.000	0.000	1.0000	-300.0000
Dodecanoic_acid(	0.000	0.000	1.0000	-300.0000
Azelaic_acid(aq)	0.000	0.000	1.0000	-300.0000
Dodecanoate	0.000	0.000	0.8027	-300.0000
Decanoic_acid(aq	0.000	0.000	1.0000	-300.0000
Decanoate	0.000	0.000	0.8027	-300.0000
Decanal(aq)	0.000	0.000	1.0000	-300.0000
2-Hexanone(aq)	0.000	0.000	1.0000	-300.0000
1-Octene(aq)	0.000	0.000	1.0000	-300.0000
K(Pent)2-	0.000	0.000	0.8027	-300.0000
2-Heptanone(aq)	0.000	0.000	1.0000	-300.0000
n-Propylbenzene(	0.000	0.000	1.0000	-300.0000
n-Pentylbenzene(	0.000	0.000	1.0000	-300.0000
n-Octylbenzene(a	0.000	0.000	1.0000	-300.0000
n-Octane(aq)	0.000	0.000	1.0000	-300.0000
2-Pentanone(aq)	0.000	0.000	1.0000	-300.0000
2-Butanone(aq)	0.000	0.000	1.0000	-300.0000
1-Octanol(aq)	0.000	0.000	1.0000	-300.0000
n-Hexylbenzene(a	0.000	0.000	1.0000	-300.0000
n-Heptylbenzene(	0.000	0.000	1.0000	-300.0000
n-Butylbenzene(a	0.000	0.000	1.0000	-300.0000
2-Octanone(aq)	0.000	0.000	1.0000	-300.0000
Undecanoic_acid(	0.000	0.000	1.0000	-300.0000
Undecanoate	0.000	0.000	0.8027	-300.0000
Sebacic_acid(aq)	0.000	0.000	1.0000	-300.0000
Sebacate	0.000	0.000	0.4074	-300.0000
Ca(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
H-Sebacate	0.000	0.000	0.8027	-300.0000

Surface species	molality	moles	Boltzman fct.	log molality
>(w)FeOH	0.009586	0.003224	1.0000	-2.0184
>(w)FeOH2+	0.003164	0.001064	2.8270	-2.4997
>(w)FeOHSO4--	0.002567	0.0008635	0.12512	-2.5905
>(w)FeOMg+	0.002100	0.0007064	2.8270	-2.6777
>(w)FeOCa+	0.0007880	0.0002650	2.8270	-3.1035
>(w)FeO-	0.0006652	0.0002237	0.35373	-3.1771
>(w)FeOMn+	0.0005015	0.0001687	2.8270	-3.2997
>(w)FeSO4-	0.0004248	0.0001429	0.35373	-3.3718
>(s)FeOHCa++	0.0002877	9.677e-05	7.9921	-3.5410
>(s)FeOMn+	0.0002061	6.931e-05	2.8270	-3.6860

```
 >(w)FeH2BO3         0.0001303     4.383e-05       1.0000     -3.8850
 >(s)FeOH            3.129e-06     1.052e-06       1.0000     -5.5046
 >(s)FeOH2+          1.033e-06     3.474e-07       2.8270     -5.9859
 >(s)FeO-            2.171e-07     7.302e-08      0.35373     -6.6633
  (Boltzman factor = exp(zF PSI/RT),  where PSI is surface potential)

 Mineral saturation states
                   log Q/K                        log Q/K
----------------------------------------------------------------
  Hematite         11.4965s/sat   MgSO4            -10.7071
  Magnetite        10.9266s/sat   Periclase        -10.7260
  Goethite          5.2825s/sat   Portlandite      -10.9671
  Ferrite-Ca        1.6250s/sat   Na2CO3:7H2O      -11.0853
  Ferrite-Mg        1.1579s/sat   Borax            -12.2600
  Dolomite-ord      0.4169s/sat   Thermonatrite    -12.4764
  Dolomite          0.4169s/sat   Na2CO3           -12.7837
  Powellite         0.1914s/sat   Bixbyite         -14.3787
  Gypsum            0.1267s/sat   MnCl2:4H2O       -15.2141
  Calcite           0.0597s/sat   Pyrolusite       -15.2409
  Fe(OH)3           0.0000 sat    Hausmannite      -16.0857
  Siderite         -0.0511        MgOHCl           -16.2494
  Aragonite        -0.0852        Hydromagnesite   -16.2660
  Ice              -0.0932        MnCl2:2H2O       -16.6303
  Anhydrite        -0.1676        MnCl2:H2O        -18.2912
  Rhodochrosite    -0.4131        MgCl2:4H2O       -18.3269
  Monohydrocalcite -0.7451        Lime             -21.4646
  Bassanite        -0.8161        Lawrencite       -21.6304
  CaSO4:0.5H2O(bet -0.9996        Scacchite        -21.6754
  Dolomite-dis     -1.2176        Hydrophilite     -22.2012
  Magnesite        -1.3469        Ferrite-Dicalciu -22.6988
  Boric_acid       -2.1771        C                -24.0507
  Jarosite         -2.6145        MgCl2:2H2O       -24.0911
  Wustite          -3.7231        Fe               -24.6113
  FeO              -3.8766        MgCl2:H2O        -27.6319
  Melanterite      -4.0205        KMgCl3:2H2O      -31.9848
  Fe(OH)2          -4.1729        Chloromagnesite  -33.6620
  Nesquehonite     -4.4275        S                -34.3793
  Brucite          -5.4054        KMgCl3           -39.6727
  Huntite          -5.6402        Troilite         -40.4933
  Nahcolite        -5.6414        Pyrrhotite       -40.5965
  Mn(OH)2(am)      -6.0370        Molysite         -41.9078
  Mirabilite       -6.0740        Fe2(SO4)3        -43.1170
  Arcanite         -6.1401        Alabandite       -44.4796
  Thenardite       -7.4523        Mn               -49.9177
  Sylvite          -7.5102        Na               -52.2485
  Artinite         -7.6343        Mo               -54.5156
  Halite           -8.1657        K                -56.1258
  Mg1.25SO4(OH)0.5 -8.2097        Li               -59.3365
  Manganosite      -8.8248        Na2O             -60.8824
  Mg1.5SO4(OH)     -9.4871        Pyrite           -64.0383
```

FeSO4	-9.6348	B	-76.6450
MnSO4	-10.0186	K2O	-78.4193
NaFeO2	-10.2495	Mg	-89.5856
Natron	-10.5683	Ca	-106.6400
B2O3	-10.6403	o-Phthalic_acid	-239.4482

Gases	partial press. (bar)	fugacity	fug. coef.	log fug.
H2O(g)	0.01309	0.01226	0.9369	-1.9114
CO2(g)	0.001987	0.001975	0.9942	-2.7044
HCl(g)	9.316e-19	9.316e-19	1.000*	-18.0308
H2(g)	4.581e-19	4.585e-19	1.001	-18.3387
CO(g)	2.986e-25	2.986e-25	1.000*	-24.5249
SO2(g)	5.840e-31	5.735e-31	0.9820	-30.2415
H2S(g)	2.074e-47	2.056e-47	0.9913	-46.6870
O2(g)	2.306e-51	2.304e-51	0.9992	-50.6376
CH4(g)	5.099e-52	5.088e-52	0.9980	-51.2934
Cl2(g)	3.428e-53	3.428e-53	1.000*	-52.4650
Na(g)	3.073e-67	3.073e-67	1.000*	-66.5124
K(g)	4.293e-68	4.293e-68	1.000*	-67.3673
Li(g)	2.126e-83	2.126e-83	1.000*	-82.6725
S2(g)	2.539e-84	2.539e-84	1.000*	-83.5953
C2H4(g)	7.966e-98	7.966e-98	1.000*	-97.0987
Mg(g)	4.379e-111	4.379e-111	1.000*	-110.3586
Ca(g)	7.037e-134	7.037e-134	1.000*	-133.1526
C(g)	1.256e-147	1.256e-147	1.000*	-146.9011
B(g)	8.915e-173	8.915e-173	1.000*	-172.0499

*no data, gas taken to be ideal

Original basis	total moles	In fluid moles	In fluid mg/kg	Sorbed moles	Sorbed mg/kg	Kd L/kg
H2O	18.8	18.7	9.97e+05	-0.000187	-9.97	
B(OH)3(aq)	0.00115	0.00111	203.	4.38e-05	8.03	
Ca++	0.00802	0.00765	909.	0.000362	43.0	
Cl-	5.82e-05	5.82e-05	6.11			
Fe++	0.0336	4.63e-05	7.66			
H+	-0.0672	1.80e-05	0.0538	-0.000226	-0.674	
HCO3-	0.000380	0.000380	68.7			
K+	0.000508	0.000508	58.8			
Li+	2.73e-05	2.73e-05	0.561			
Mg++	0.00193	0.00123	88.3	0.000706	50.9	
Mn++	0.000263	2.49e-05	4.05	0.000238	38.7	
MoO4--	1.84e-06	1.84e-06	0.871			
Na+	0.000740	0.000740	50.4			
O2(aq)	0.00838	1.98e-13	1.88e-08			
SO4--	0.00769	0.00668	1.90e+03	0.00101	286.	
>(s)FeOH	0.000168					
>(w)FeOH	0.00670					

Sorbed	fraction	log fraction
B(OH)3(aq)	0.03803	-1.420
Ca++	0.04514	-1.345
Mg++	0.3657	-0.437
Mn++	0.9054	-0.043
SO4--	0.1309	-0.883

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Boron	0.001153	0.001109	35.53	4.383e-05	1.404
Calcium	0.008015	0.007653	909.0	0.0003618	42.97
Carbon	0.0003799	0.0003799	13.52		
Chlorine	5.818e-05	5.818e-05	6.112		
Hydrogen	37.44	37.34	1.115e+05	-0.0004677	-1.397
Iron	0.03356	4.625e-05	7.655		
Lithium	2.729e-05	2.729e-05	0.5614		
Magnesium	0.001932	0.001225	88.26	0.0007064	50.88
Manganese	0.0002629	2.488e-05	4.051	0.0002380	38.75
Molybdenum	1.838e-06	1.838e-06	0.5227		
Oxygen	18.80	18.70	8.866e+05	0.003970	188.2
Potassium	0.0005077	0.0005077	58.83		
Sodium	0.0007400	0.0007400	50.41		
Sulfur	0.007688	0.006682	634.9	0.001006	95.63

MW-08R Spec8 Output

```
Temperature =  11.8 C     Pressure =  1.013 bars
pH =  7.193               log fO2 =  -47.727
Eh =   0.1505 volts       pe =   2.6622
Ionic strength      =    0.022848 molal
Charge imbalance    =    0.002308 eq/kg (9.083% error)
Activity of water   =    0.999994
Solvent mass        =     0.33700 kg
Solution mass       =     0.33740 kg
Mineral mass        =      1.7760 kg
Solution density    =    1.022    g/cm3
Solution viscosity  =    0.013    poise
Chlorinity          =    0.000156 molal
Dissolved solids    =        1195 mg/kg sol'n
Elect. conductivity =     1279.51 uS/cm (or umho/cm)
Hardness            =      708.44 mg/kg sol'n as CaCO3
  carbonate         =      154.00 mg/kg sol'n as CaCO3
  non-carbonate     =      554.44 mg/kg sol'n as CaCO3
Carbonate alkalinity=      154.00 mg/kg sol'n as CaCO3
Water type          =    Ca-SO4
Bulk volume         =    1.00e+03 cm3
Fluid volume        =        330. cm3
Mineral volume      =        1.15 cm3
Inert volume        =        669. cm3
Porosity            =        33.0 %
Permeability        =    8.80e-09 cm2
HFO sorbing surface:
  Surface charge    =        1.19 uC/cm2
  Surface potential =        32.3 mV
  Surface area      =    2.15e+07 cm2
```

Minerals in system	moles	log moles	grams	volume (cm3)
Fe(OH)3	0.03351	-1.475	3.581	1.151
(total)			3.581	670.0

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
Ca++	0.004817	192.8	0.5854	-2.5498
SO4--	0.004207	403.6	0.5600	-2.6279
HCO3-	0.002963	180.6	0.8664	-2.5906
B(OH)3(aq)	0.002447	151.1	1.0000	-2.6113
Na+	0.001560	35.81	0.8664	-2.8693
Mg++	0.001059	25.72	0.6081	-3.1910
CaSO4(aq)	0.0008058	109.6	1.0000	-3.0938
CO2(aq)	0.0004664	20.50	1.0000	-3.3312
K+	0.0003339	13.04	0.8610	-3.5414
MgSO4(aq)	0.0002795	33.61	1.0000	-3.5536
Cl-	0.0001561	5.529	0.8610	-3.8715

CaHCO3+	9.626e-05	9.720	0.8664	-4.0788
Li+	3.686e-05	0.2555	0.8761	-4.4910
Fe++	3.457e-05	1.928	0.5854	-4.6939
MgHCO3+	2.134e-05	1.819	0.8664	-4.7330
BO2-	1.786e-05	0.7636	0.8664	-4.8105
NaHCO3(aq)	6.422e-06	0.5389	1.0000	-5.1923
CaCO3(aq)	6.265e-06	0.6263	1.0000	-5.2031
KSO4-	5.874e-06	0.7931	0.8664	-5.2933
Mn++	3.531e-06	0.1937	0.5854	-5.6847
MoO4--	2.573e-06	0.4111	0.5666	-5.8362
CO3--	2.391e-06	0.1433	0.5666	-5.8681
MnSO4(aq)	9.633e-07	0.1453	1.0000	-6.0162
MgCO3(aq)	7.323e-07	0.06167	1.0000	-6.1353
CaCl+	8.880e-08	0.006699	0.8664	-7.1139
MgCl+	7.909e-08	0.004721	0.8664	-7.1642
H+	7.214e-08	7.262e-05	0.8882	-7.1933
OH-	6.128e-08	0.001041	0.8637	-7.2763
NaCl(aq)	2.829e-08	0.001652	1.0000	-7.5483
HSO4-	1.198e-08	0.001162	0.8664	-7.9838
NaCO3-	1.001e-08	0.0008299	0.8664	-8.0618
FeCl+	2.150e-09	0.0001960	0.8664	-8.7299
KCl(aq)	9.551e-10	7.112e-05	1.0000	-9.0200
MnCl+	4.800e-10	4.333e-05	0.8664	-9.3811
LiCl(aq)	1.258e-10	5.325e-06	1.0000	-9.9005
FeCO3+	1.752e-11	2.027e-06	0.8664	-10.8188
CaCl2(aq)	1.400e-11	1.552e-06	1.0000	-10.8538
NaOH(aq)	1.244e-11	4.970e-07	1.0000	-10.9051
HCl(aq)	1.821e-12	6.631e-08	1.0000	-11.7397
KHSO4(aq)	1.756e-13	2.389e-08	1.0000	-12.7554
Fe+++	1.694e-15	9.452e-11	0.3384	-15.2415
FeCl2(aq)	1.234e-15	1.562e-10	1.0000	-14.9087
FeSO4+	8.668e-17	1.315e-11	0.8664	-16.1244
FeCl++	1.121e-20	1.022e-15	0.5666	-20.1971
FeCl4--	1.207e-22	2.382e-17	0.5600	-22.1703
Formate	6.512e-23	2.928e-18	0.8637	-22.2499
H2(aq)	8.160e-24	1.643e-20	1.0000	-23.0883
Ca(For)+	5.426e-24	4.611e-19	0.8664	-23.3278
Mg(For)+	1.474e-24	1.020e-19	0.8664	-23.8939
Fe(For)+	1.134e-25	1.143e-20	0.8664	-25.0075
Na(For)(aq)	8.975e-26	6.096e-21	1.0000	-25.0470
Formic_acid(aq)	2.112e-26	9.711e-22	1.0000	-25.6752
K(For)(aq)	1.673e-26	1.406e-21	1.0000	-25.7765
SO3--	1.160e-26	9.273e-22	0.5666	-26.1824
Mn(For)+	7.937e-27	7.924e-22	0.8664	-26.1626
HSO3-	6.971e-27	5.645e-22	0.8664	-26.2190
CO(aq)	3.565e-29	9.974e-25	1.0000	-28.4479
Mn+++	3.135e-29	1.720e-24	0.2849	-29.0491
Oxalate	5.077e-30	4.463e-25	0.5600	-29.5463
SO2(aq)	2.148e-32	1.375e-27	1.0000	-31.6679
H-Oxalate	3.497e-33	3.109e-28	0.8664	-32.5186

Oxalic_acid(aq)	3.528e-39	3.173e-34	1.0000	-38.4525
Ca(For)2(aq)	2.301e-45	2.990e-40	1.0000	-44.6381
ClO-	1.910e-45	9.817e-41	0.8664	-44.7812
Mg(For)2(aq)	7.609e-46	8.690e-41	1.0000	-45.1187
Fe(For)2(aq)	1.170e-46	1.705e-41	1.0000	-45.9318
Mn(For)2(aq)	5.993e-48	8.677e-43	1.0000	-47.2224
Na(For)2-	4.073e-48	4.598e-43	0.8664	-47.4524
HO2-	3.960e-48	1.306e-43	0.8664	-47.4646
K(For)2-	6.445e-49	8.313e-44	0.8664	-48.2531
S2O6--	3.756e-49	6.006e-44	0.5600	-48.6772
Formaldehyde(aq)	6.653e-51	1.995e-46	1.0000	-50.1770
O2(aq)	3.099e-51	9.905e-47	1.0000	-50.5088
HSO5-	3.808e-54	4.301e-49	0.8664	-53.4815
HS-	7.832e-55	2.587e-50	0.8637	-54.1698
H2S(aq)	6.813e-55	2.319e-50	1.0000	-54.1666
S2O5--	1.038e-57	1.494e-52	0.5600	-57.2357
Methanol(aq)	1.974e-58	6.317e-54	1.0000	-57.7047
S2O3--	1.434e-59	1.606e-54	0.5600	-59.0952
Methane(aq)	1.241e-60	1.989e-56	1.0000	-59.9062
S--	8.523e-61	2.730e-56	0.5730	-60.3112
MnO4--	1.384e-61	1.644e-56	0.5600	-61.1108
Glycolate	2.917e-64	2.187e-59	0.8664	-63.5973
Ca(Glyc)+	4.222e-65	4.855e-60	0.8664	-64.4367
Acetate	7.841e-66	4.624e-61	0.8689	-65.1667
Mg(Glyc)+	4.488e-66	4.454e-61	0.8664	-65.4102
Fe(Glyc)+	1.207e-66	1.578e-61	0.8664	-65.9807
Na(Glyc)(aq)	4.111e-67	4.025e-62	1.0000	-66.3861
CaCH3COO+	1.982e-67	1.963e-62	0.8664	-66.7651
MgCH3COO+	1.218e-67	1.014e-62	0.8664	-66.9767
Glycolic_acid(aq	1.151e-67	8.740e-63	1.0000	-66.9391
K(Glyc)(aq)	7.663e-68	8.737e-63	1.0000	-67.1156
Mn(Glyc)+	2.736e-68	3.552e-63	0.8664	-67.6252
Acetic_acid(aq)	2.532e-68	1.518e-63	1.0000	-67.5966
NaCH3COO(aq)	7.660e-69	6.277e-64	1.0000	-68.1158
S2O4--	5.529e-69	7.076e-64	0.5730	-68.4992
FeCH3COO+	3.564e-69	4.090e-64	0.8664	-68.5103
MnO4-	3.105e-69	3.689e-64	0.8637	-68.5715
S2O8--	1.994e-69	3.827e-64	0.5600	-68.9520
KCH3COO(aq)	1.016e-69	9.959e-65	1.0000	-68.9931
LiCH3COO(aq)	5.244e-70	3.456e-65	1.0000	-69.2803
MnCH3COO+	3.059e-70	3.482e-65	0.8664	-69.5767
Malonate	2.603e-74	2.653e-69	0.5600	-73.8363
H-Malonate	5.068e-76	5.216e-71	0.8664	-75.3575
ClO2-	4.286e-79	2.887e-74	0.8664	-78.4303
Malonic_acid(aq)	2.059e-80	2.140e-75	1.0000	-79.6863
S3O6--	5.338e-90	1.025e-84	0.5600	-89.5245
Acetaldehyde(aq)	1.240e-91	5.455e-87	1.0000	-90.9066
ClO3-	3.020e-98	2.517e-93	0.8637	-97.5836
S2--	4.905e-99	3.142e-94	0.5600	-98.5612
Ethanol(aq)	8.429e-104	3.878e-99	1.0000	-103.0742

Ethylene(aq)	1.460e-108	4.090e-104	1.0000	-107.8357
Lactate	1.364e-109	1.213e-104	0.8664	-108.9276
Ethane(aq)	2.429e-110	7.297e-106	1.0000	-109.6145
Ca(Lac)+	1.161e-110	1.497e-105	0.8664	-109.9976
Mg(Lac)+	2.130e-111	2.412e-106	0.8664	-110.7339
Fe(Lac)+	4.983e-112	7.212e-107	0.8664	-111.3648
Na(Lac)(aq)	1.958e-112	2.192e-107	1.0000	-111.7081
Lactic_acid(aq)	5.653e-113	5.086e-108	1.0000	-112.2477
K(Lac)(aq)	3.651e-113	4.674e-108	1.0000	-112.4376
Propanoate	2.388e-113	1.743e-108	0.8664	-112.6843
Ethyne(aq)	9.342e-114	2.430e-109	1.0000	-113.0296
Mn(Lac)+	9.043e-114	1.301e-108	0.8664	-113.1060
S4O6--	1.887e-114	4.226e-109	0.5600	-113.9761
Ca(Prop)+	3.355e-115	3.792e-110	0.8664	-114.5366
Propanoic_acid(a	1.035e-115	7.656e-111	1.0000	-114.9852
Mg(Prop)+	1.003e-115	9.751e-111	0.8664	-115.0612
Na(Prop)(aq)	3.382e-116	3.244e-111	1.0000	-115.4709
Fe(Prop)+	2.516e-116	3.240e-111	0.8664	-115.6616
K(Prop)(aq)	6.304e-117	7.063e-112	1.0000	-116.2004
Mn(Prop)+	1.087e-117	1.390e-112	0.8664	-117.0261
Succinate	3.205e-120	3.715e-115	0.5600	-119.7460
ClO4-	8.423e-122	8.367e-117	0.8637	-121.1381
H-Succinate	5.873e-122	6.868e-117	0.8664	-121.2934
Succinic_acid(aq	5.701e-125	6.724e-120	1.0000	-124.2440
Ca(Glyc)2(aq)	1.971e-127	3.744e-122	1.0000	-126.7053
Fe(Glyc)2(aq)	1.789e-128	3.680e-123	1.0000	-127.7474
Mg(Glyc)2(aq)	1.265e-128	2.203e-123	1.0000	-127.8979
Na(Glyc)2-	1.306e-130	2.258e-125	0.8664	-129.9462
Mn(Glyc)2(aq)	5.203e-131	1.065e-125	1.0000	-130.2838
Ca(CH3COO)2(aq)	2.360e-131	3.728e-126	1.0000	-130.6271
K(Glyc)2-	2.116e-131	3.999e-126	0.8664	-130.7367
Mg(CH3COO)2(aq)	6.070e-132	8.634e-127	1.0000	-131.2168
Fe(CH3COO)2(aq)	4.883e-133	8.483e-128	1.0000	-132.3113
Na(CH3COO)2-	3.361e-134	4.736e-129	0.8664	-133.5358
Acetone(aq)	3.325e-134	1.929e-129	1.0000	-133.4782
Mn(CH3COO)2(aq)	1.612e-134	2.786e-129	1.0000	-133.7926
Li(CH3COO)2-	5.623e-135	7.022e-130	0.8664	-134.3123
K(CH3COO)2-	2.961e-135	4.649e-130	0.8664	-134.5908
S3--	2.468e-137	2.372e-132	0.5600	-136.8594
Propanal(aq)	1.390e-138	8.062e-134	1.0000	-137.8570
BH4-	1.832e-143	2.715e-139	0.8664	-142.7994
1-Propanol(aq)	2.922e-151	1.754e-146	1.0000	-150.5343
1-Propene(aq)	8.927e-154	3.752e-149	1.0000	-153.0493
1-Propyne(aq)	4.625e-157	1.851e-152	1.0000	-156.3349
2-Hydroxybutanoa	1.705e-157	1.756e-152	0.8664	-156.8304
Propane(aq)	3.390e-158	1.493e-153	1.0000	-157.4698
2-Hydroxybutanoi	6.263e-161	6.513e-156	1.0000	-160.2032
Butanoate	2.356e-161	2.050e-156	0.8664	-160.6901
Ca(But)+	2.271e-163	2.884e-158	0.8664	-162.7061
Butanoic_acid(aq	8.200e-164	7.216e-159	1.0000	-163.0862

Mg(But)+	6.469e-164	7.198e-159	0.8664	-163.2514
Na(But)(aq)	3.207e-164	3.526e-159	1.0000	-163.4939
Fe(But)+	2.565e-164	3.663e-159	0.8664	-163.6531
K(But)(aq)	5.979e-165	7.536e-160	1.0000	-164.2234
Mn(But)+	9.141e-166	1.297e-160	0.8664	-165.1013
Glutarate	2.637e-167	3.427e-162	0.5600	-166.8307
S5O6--	1.235e-168	3.161e-163	0.5600	-168.1603
H-Glutarate	2.828e-169	3.703e-164	0.8664	-168.6109
Glutaric_acid(aq	3.504e-172	4.624e-167	1.0000	-171.4554
Ethylacetate(aq)	6.437e-173	5.664e-168	1.0000	-172.1913
S4--	7.329e-176	9.389e-171	0.5600	-175.3868
Butanal(aq)	4.828e-188	3.477e-183	1.0000	-187.3163
Mn(CH3COO)3-	4.362e-199	1.011e-193	0.8664	-198.4226
1-Butanol(aq)	5.484e-200	4.060e-195	1.0000	-199.2609
1-Butene(aq)	5.342e-202	2.994e-197	1.0000	-201.2723
1-Butyne(aq)	4.304e-205	2.325e-200	1.0000	-204.3661
2-Hydroxypentano	3.203e-205	3.747e-200	0.8664	-204.5568
n-Butane(aq)	4.132e-206	2.399e-201	1.0000	-205.3838
2-Hydroxypentano	6.940e-209	8.188e-204	1.0000	-208.1587
Pentanoate	2.767e-209	2.795e-204	0.8664	-208.6202
Ca(Pent)+	1.580e-211	2.228e-206	0.8664	-210.8637
Pentanoic_acid(a	1.048e-211	1.069e-206	1.0000	-210.9798
Mg(Pent)+	4.399e-212	5.511e-207	0.8664	-211.4189
Na(Pent)(aq)	3.982e-212	4.937e-207	1.0000	-211.3999
Fe(Pent)+	2.820e-212	4.422e-207	0.8664	-211.6120
K(Pent)(aq)	7.424e-213	1.040e-207	1.0000	-212.1294
Mn(Pent)+	8.303e-214	1.294e-208	0.8664	-213.1430
S5--	1.281e-214	2.051e-209	0.5600	-214.1444
Adipate	8.051e-217	1.159e-211	0.5600	-216.3460
Ca(Lac)2(aq)	1.627e-218	3.546e-213	1.0000	-217.7887
H-Adipate	8.441e-219	1.224e-213	0.8664	-218.1359
Fe(Lac)2(aq)	3.098e-219	7.240e-214	1.0000	-218.5090
Mg(Lac)2(aq)	3.038e-219	6.143e-214	1.0000	-218.5174
Na(Lac)2-	2.974e-221	5.974e-216	0.8664	-220.5890
Mn(Lac)2(aq)	1.359e-221	3.164e-216	1.0000	-220.8667
Adipic_acid(aq)	1.216e-221	1.775e-216	1.0000	-220.9152
K(Lac)2-	4.817e-222	1.045e-216	0.8664	-221.3795
Ca(Prop)2(aq)	1.228e-227	2.284e-222	1.0000	-226.9107
Fe(Prop)2(aq)	6.639e-228	1.339e-222	1.0000	-227.1779
Mg(Prop)2(aq)	4.933e-228	8.398e-223	1.0000	-227.3069
Na(Prop)2-	5.958e-229	1.006e-223	0.8664	-228.2872
Mn(Prop)2(aq)	1.393e-229	2.799e-224	1.0000	-228.8559
K(Prop)2-	9.633e-230	1.782e-224	0.8664	-229.0785
Phenol(aq)	6.311e-234	5.932e-229	1.0000	-233.1999
Pentanal(aq)	9.925e-236	8.538e-231	1.0000	-235.0033
Benzene(aq)	2.077e-244	1.620e-239	1.0000	-243.6826
1-Pentanol(aq)	1.186e-246	1.044e-241	1.0000	-245.9260
Benzoate	8.474e-248	1.025e-242	0.8761	-247.1294
1-Pentene(aq)	4.884e-250	3.422e-245	1.0000	-249.3112
Benzoic_acid(aq)	7.827e-251	9.547e-246	1.0000	-250.1064

1-Pentyne(aq)	4.150e-253	2.823e-248	1.0000	-252.3820
2-Hydroxyhexanoa	2.487e-253	3.258e-248	0.8664	-252.6666
n-Pentane(aq)	4.160e-254	2.998e-249	1.0000	-253.3809
o-Phthalate	1.066e-254	1.747e-249	0.5600	-254.2242
2-Hydroxyhexanoi	7.690e-257	1.015e-251	1.0000	-256.1140
Hexanoate	2.589e-257	2.978e-252	0.8664	-256.6491
Hexanoic_acid(aq	1.026e-259	1.191e-254	1.0000	-258.9887
Pimelate	1.302e-263	2.057e-258	0.5600	-263.1372
H-Pimelate	1.381e-265	2.196e-260	0.8664	-264.9220
Pimelic_acid(aq)	2.373e-268	3.797e-263	1.0000	-267.6247
Hexanal(aq)	8.897e-284	8.901e-279	1.0000	-283.0508
Toluene(aq)	1.780e-289	1.638e-284	1.0000	-288.7497
p-Toluate	1.549e-292	2.090e-287	0.8664	-291.8724
m-Toluate	8.406e-293	1.135e-287	0.8664	-292.1377
o-Toluate	7.878e-295	1.063e-289	0.8664	-294.1659
1-Hexanol(aq)	2.270e-295	2.317e-290	1.0000	-294.6440
p-Toluic_acid(aq	2.074e-295	2.820e-290	1.0000	-294.6833
m-Toluic_acid(aq	8.793e-296	1.196e-290	1.0000	-295.0559
1-Hexene(aq)	7.069e-298	5.943e-293	1.0000	-297.1506
o-Toluic_acid(aq	3.235e-298	4.399e-293	1.0000	-297.4901
1-Hexyne(aq)	3.180e-301	2.609e-296	1.0000	-300.0000
2-Hydroxyheptano	2.750e-301	3.988e-296	0.8664	-300.0000
n-Hexane(aq)	3.119e-302	2.685e-297	1.0000	-300.0000
2-Hydroxyheptano	8.521e-305	1.244e-299	1.0000	-300.0000
Heptanoate	3.326e-305	4.292e-300	0.8664	-300.0000
Heptanoic_acid(a	1.431e-307	1.860e-302	1.0000	-300.0000
Suberate	5.592e-313	9.617e-308	0.5600	-300.0000
H-Suberate	5.758e-315	9.961e-310	0.8664	-300.0000
Suberic_acid(aq)	1.039e-317	1.807e-312	1.0000	-300.0000
Ca(But)2(aq)	4.941e-324	1.057e-318	1.0000	-300.0000
Fe(But)2(aq)	4.941e-324	1.135e-318	1.0000	-300.0000
H-Azelate	0.000	0.000	0.8664	-300.0000
2-Hydroxyoctanoa	0.000	0.000	0.8664	-300.0000
Octanoic_acid(aq	0.000	0.000	1.0000	-300.0000
Octanoate	0.000	0.000	0.8664	-300.0000
Octanal(aq)	0.000	0.000	1.0000	-300.0000
2-Hydroxynonanoi	0.000	0.000	1.0000	-300.0000
Nonanoic_acid(aq	0.000	0.000	1.0000	-300.0000
Nonanoate	0.000	0.000	0.8664	-300.0000
Nonanal(aq)	0.000	0.000	1.0000	-300.0000
2-Hydroxynonanoa	0.000	0.000	0.8664	-300.0000
Na(Pent)2-	0.000	0.000	0.8664	-300.0000
Na(But)2-	0.000	0.000	0.8664	-300.0000
Fe(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
Mn(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
Mn(But)2(aq)	0.000	0.000	1.0000	-300.0000
2-Hydroxydecanoi	0.000	0.000	1.0000	-300.0000
1-Heptanol(aq)	0.000	0.000	1.0000	-300.0000
Mg(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
2-Hydroxydecanoa	0.000	0.000	0.8664	-300.0000

Ethylbenzene(aq)	0.000	0.000	1.0000	-300.0000
Mg(But)2(aq)	0.000	0.000	1.0000	-300.0000
Azelate	0.000	0.000	0.5600	-300.0000
1-Octyne(aq)	0.000	0.000	1.0000	-300.0000
Dodecanoic_acid(	0.000	0.000	1.0000	-300.0000
Azelaic_acid(aq)	0.000	0.000	1.0000	-300.0000
Dodecanoate	0.000	0.000	0.8664	-300.0000
Decanoic_acid(aq	0.000	0.000	1.0000	-300.0000
Decanoate	0.000	0.000	0.8664	-300.0000
Decanal(aq)	0.000	0.000	1.0000	-300.0000
2-Hexanone(aq)	0.000	0.000	1.0000	-300.0000
1-Octene(aq)	0.000	0.000	1.0000	-300.0000
1-Heptyne(aq)	0.000	0.000	1.0000	-300.0000
K(Pent)2-	0.000	0.000	0.8664	-300.0000
2-Heptanone(aq)	0.000	0.000	1.0000	-300.0000
K(But)2-	0.000	0.000	0.8664	-300.0000
n-Propylbenzene(	0.000	0.000	1.0000	-300.0000
n-Pentylbenzene(	0.000	0.000	1.0000	-300.0000
n-Octylbenzene(a	0.000	0.000	1.0000	-300.0000
n-Octane(aq)	0.000	0.000	1.0000	-300.0000
2-Pentanone(aq)	0.000	0.000	1.0000	-300.0000
2-Butanone(aq)	0.000	0.000	1.0000	-300.0000
1-Octanol(aq)	0.000	0.000	1.0000	-300.0000
n-Hexylbenzene(a	0.000	0.000	1.0000	-300.0000
n-Heptylbenzene(	0.000	0.000	1.0000	-300.0000
n-Heptane(aq)	0.000	0.000	1.0000	-300.0000
n-Butylbenzene(a	0.000	0.000	1.0000	-300.0000
Heptanal(aq)	0.000	0.000	1.0000	-300.0000
2-Octanone(aq)	0.000	0.000	1.0000	-300.0000
Undecanoic_acid(	0.000	0.000	1.0000	-300.0000
Undecanoate	0.000	0.000	0.8664	-300.0000
Sebacic_acid(aq)	0.000	0.000	1.0000	-300.0000
Sebacate	0.000	0.000	0.5600	-300.0000
Ca(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
H-Sebacate	0.000	0.000	0.8664	-300.0000
2-Hydroxyoctanoi	0.000	0.000	1.0000	-300.0000
1-Heptene(aq)	0.000	0.000	1.0000	-300.0000

Surface species	molality	moles	Boltzman fct.	log molality
>(w)FeOH	0.01147	0.003865	1.0000	-1.9405
>(w)FeOH2+	0.004075	0.001373	3.5162	-2.3898
>(w)FeOHSO4--	0.002060	0.0006941	0.080881	-2.6862
>(w)FeOMg+	0.0008237	0.0002776	3.5162	-3.0842
>(w)FeO-	0.0007395	0.0002492	0.28440	-3.1311
>(s)FeOHCa++	0.0004015	0.0001353	12.364	-3.3963
>(w)FeSO4-	0.0003668	0.0001236	0.28440	-3.4356
>(w)FeOCa+	0.0002028	6.833e-05	3.5162	-3.6930
>(w)FeH2BO3	0.0001170	3.943e-05	1.0000	-3.9318
>(s)FeOMn+	6.889e-05	2.322e-05	3.5162	-4.1618

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 >(w)FeOMn+           3.327e-05     1.121e-05        3.5162     -4.4779
 >(s)FeOH             1.886e-05     6.357e-06        1.0000     -4.7244
 >(s)FeOH2+           6.703e-06     2.259e-06        3.5162     -5.1737
 >(s)FeO-             1.216e-06     4.099e-07       0.28440     -5.9150
  (Boltzman factor = exp(zF PSI/RT),  where PSI is surface potential)

Mineral saturation states
                   log Q/K                          log Q/K
----------------------------------------------------------------
 Hematite         11.5294s/sat   Periclase        -11.3650
 Magnetite        10.1482s/sat   MgSO4            -11.4034
 Goethite          5.3004s/sat   MnSO4            -11.4655
 Ferrite-Ca        0.8481s/sat   Portlandite      -11.7718
 Ferrite-Mg        0.5517s/sat   Thermonatrite    -12.3180
 Dolomite-ord      0.4864s/sat   Na2CO3           -12.6349
 Dolomite          0.4864s/sat   Borax            -13.1789
 Calcite           0.0065s/sat   Pyrolusite       -15.0626
 Fe(OH)3           0.0000 sat    Bixbyite         -15.5436
 Ice              -0.0885        MnCl2:4H2O       -16.2700
 Aragonite        -0.1385        Hydromagnesite   -16.4266
 Siderite         -0.1506        MgOHCl           -16.7408
 Powellite        -0.4525        MnCl2:2H2O       -17.7041
 Gypsum           -0.6806        Hausmannite      -18.6022
 Monohydrocalcite -0.7958        MgCl2:4H2O       -18.6365
 Anhydrite        -0.9879        MnCl2:H2O        -19.3776
 Rhodochrosite    -1.0515        Lawrencite       -22.1952
 Dolomite-dis     -1.1581        Lime             -22.3220
 Magnesite        -1.2326        Hydrophilite     -22.7225
 Bassanite        -1.6369        Scacchite        -22.7789
 CaSO4:0.5H2O(bet -1.8221        Ferrite-Dicalciu -24.3468
 Boric_acid       -2.2851        MgCl2:2H2O       -24.4388
 Jarosite         -3.5063        C                -26.6238
 Nesquehonite     -4.3289        Fe               -27.1153
 Wustite          -4.4218        MgCl2:H2O        -28.0014
 FeO              -4.7033        KMgCl3:2H2O      -32.9274
 Melanterite      -4.8595        Chloromagnesite  -34.0635
 Fe(OH)2          -4.9912        S                -39.3599
 Nahcolite        -5.2032        KMgCl3           -40.6595
 Huntite          -5.3600        Molysite         -41.5951
 Brucite          -6.0130        Fe2(SO4)3        -43.5001
 Mirabilite       -6.6093        Troilite         -47.8956
 Mn(OH)2(am)      -7.4061        Pyrrhotite       -47.9992
 Arcanite         -7.6820        Alabandite       -52.4427
 Thenardite       -8.0459        Mn               -53.0743
 Sylvite          -8.1013        Na               -53.5318
 Artinite         -8.1076        K                -57.9039
 Halite           -8.2832        Mo               -59.4019
 Mg1.25SO4(OH)0.5 -9.0408        Li               -60.8511
 Manganosite     -10.2119        Na2O             -61.6549
 Natron          -10.3490        Pyrite           -76.3637
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Mg1.5SO4(OH)	-10.4706	B	-79.4785
FeSO4	-10.5405	K2O	-80.2227
NaFeO2	-10.5575	Mg	-92.1705
Na2CO3:7H2O	-10.8878	Ca	-109.4708
B2O3	-10.9028	o-Phthalic_acid	-258.6393

Gases	partial press. (bar)	fugacity	fug. coef.	log fug.
H2O(g)	0.01206	0.01128	0.9352	-1.9476
CO2(g)	0.009050	0.008997	0.9941	-2.0459
HCl(g)	1.071e-18	1.071e-18	1.000*	-17.9702
H2(g)	9.379e-21	9.386e-21	1.001	-20.0275
CO(g)	2.802e-26	2.802e-26	1.000*	-25.5525
SO2(g)	8.684e-33	8.525e-33	0.9817	-32.0693
O2(g)	1.878e-48	1.876e-48	0.9992	-47.7267
Cl2(g)	1.564e-51	1.564e-51	1.000*	-50.8059
H2S(g)	4.614e-54	4.574e-54	0.9912	-53.3397
CH4(g)	6.568e-58	6.554e-58	0.9979	-57.1835
Na(g)	1.303e-68	1.303e-68	1.000*	-67.8850
K(g)	6.035e-70	6.035e-70	1.000*	-69.2193
Li(g)	4.796e-85	4.796e-85	1.000*	-84.3192
S2(g)	2.182e-94	2.182e-94	1.000*	-93.6612
C2H4(g)	2.159e-106	2.159e-106	1.000*	-105.6658
Mg(g)	8.581e-114	8.581e-114	1.000*	-113.0665
Ca(g)	7.381e-137	7.381e-137	1.000*	-136.1319
C(g)	8.685e-151	8.685e-151	1.000*	-150.0612
B(g)	4.491e-176	4.491e-176	1.000*	-175.3477

*no data, gas taken to be ideal

Original basis	total moles	In fluid moles	In fluid mg/kg	Sorbed moles	Sorbed mg/kg	Kd L/kg
H2O	18.8	18.7	9.99e+05	-0.000163	-8.71	
B(OH)3(aq)	0.000870	0.000831	152.	3.94e-05	7.23	
Ca++	0.00213	0.00193	229.	0.000204	24.2	
Cl-	5.27e-05	5.27e-05	5.54			
Fe++	0.0335	1.17e-05	1.93			
H+	-0.0660	0.000148	0.442	0.000869	2.60	
HCO3-	0.00120	0.00120	217.			
K+	0.000114	0.000114	13.3			
Li+	1.24e-05	1.24e-05	0.256			
Mg++	0.000736	0.000459	33.0	0.000278	20.0	
Mn++	3.59e-05	1.51e-06	0.247	3.44e-05	5.61	
MoO4--	8.67e-07	8.67e-07	0.411			
Na+	0.000528	0.000528	36.0			
O2(aq)	0.00838	1.48e-12	1.40e-07			
SO4--	0.00260	0.00179	508.	0.000818	233.	
>(s)FeOH	0.000168					
>(w)FeOH	0.00670					

Sorbed	fraction	log fraction
B(OH)3(aq)	0.04532	-1.344
Ca++	0.09546	-1.020
Mg++	0.3770	-0.424
Mn++	0.9579	-0.019
SO4--	0.3141	-0.503

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Boron	0.0008702	0.0008307	26.62	3.943e-05	1.263
Calcium	0.002133	0.001929	229.2	0.0002036	24.19
Carbon	0.001201	0.001201	42.74		
Chlorine	5.268e-05	5.268e-05	5.536		
Hydrogen	37.52	37.42	1.118e+05	0.0006615	1.976
Iron	0.03352	1.165e-05	1.928		
Lithium	1.242e-05	1.242e-05	0.2555		
Magnesium	0.0007363	0.0004587	33.04	0.0002776	20.00
Manganese	3.594e-05	1.515e-06	0.2466	3.443e-05	5.606
Molybdenum	8.672e-07	8.672e-07	0.2466		
Oxygen	18.82	18.72	8.877e+05	0.003226	153.0
Potassium	0.0001145	0.0001145	13.27		
Sodium	0.0005277	0.0005277	35.96		
Sulfur	0.002603	0.001786	169.7	0.0008177	77.71

MW-36 Spec8 Output

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Temperature =  11.9 C     Pressure =  1.013 bars
pH =  7.133               log fO2 =  -51.228
Eh =   0.1041 volts       pe =   1.8406
Ionic strength      =    0.036872 molal
Charge imbalance    =    0.002285 eq/kg (5.755% error)
Activity of water   =    0.999976
Solvent mass        =     0.33687 kg
Solution mass       =     0.33747 kg
Mineral mass        =      1.7760 kg
Solution density    =    1.023    g/cm3
Solution viscosity  =    0.013    poise
Chlorinity          =    0.000672 molal
Dissolved solids    =        1770 mg/kg sol'n
Elect. conductivity =     1952.70 uS/cm (or umho/cm)
Hardness            =     1145.27 mg/kg sol'n as CaCO3
  carbonate         =      135.36 mg/kg sol'n as CaCO3
  non-carbonate     =     1009.91 mg/kg sol'n as CaCO3
Carbonate alkalinity=      135.36 mg/kg sol'n as CaCO3
Water type          =    Ca-SO4
Bulk volume         =    1.00e+03 cm3
Fluid volume        =        330. cm3
Mineral volume      =        1.15 cm3
Inert volume        =        669. cm3
Porosity            =        33.0 %
Permeability        =    8.80e-09 cm2
HFO sorbing surface:
  Surface charge    =        1.39 uC/cm2
  Surface potential =        30.0 mV
  Surface area      =    2.15e+07 cm2
```

Minerals in system	moles	log moles	grams	volume (cm3)
Fe(OH)3	0.03351	-1.475	3.581	1.151
(total)			3.581	670.0

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
SO4--	0.007734	741.7	0.4944	-2.4175
Ca++	0.006786	271.5	0.5273	-2.4463
HCO3-	0.002576	156.9	0.8406	-2.6645
Mg++	0.002060	49.98	0.5565	-2.9406
Na+	0.002011	46.14	0.8406	-2.7721
CaSO4(aq)	0.001661	225.7	1.0000	-2.7797
B(OH)3(aq)	0.001250	77.14	1.0000	-2.9032
MgSO4(aq)	0.0008091	97.22	1.0000	-3.0920
Cl-	0.0006709	23.74	0.8328	-3.2528
CO2(aq)	0.0004512	19.82	1.0000	-3.3456
Fe++	0.0003810	21.24	0.5273	-3.6970

K+	0.0003507	13.69	0.8328	-3.5345
CaHCO3+	0.0001062	10.71	0.8406	-4.0494
MgHCO3+	3.301e-05	2.812	0.8406	-4.5567
Li+	2.745e-05	0.1902	0.8543	-4.6298
Mn++	2.260e-05	1.240	0.5273	-4.9238
KSO4-	9.987e-06	1.347	0.8406	-5.0760
MnSO4(aq)	9.024e-06	1.360	1.0000	-5.0446
BO2-	8.199e-06	0.3504	0.8406	-5.1616
NaHCO3(aq)	6.765e-06	0.5673	1.0000	-5.1698
CaCO3(aq)	5.858e-06	0.5853	1.0000	-5.2322
CO3--	1.981e-06	0.1187	0.5030	-6.0015
MoO4--	1.467e-06	0.2342	0.5030	-6.1320
MgCO3(aq)	9.594e-07	0.08075	1.0000	-6.0180
MgCl+	6.027e-07	0.03595	0.8406	-6.2953
CaCl+	4.827e-07	0.03639	0.8406	-6.3917
NaCl(aq)	1.472e-07	0.008586	1.0000	-6.8322
FeCl+	9.143e-08	0.008333	0.8406	-7.1143
H+	8.452e-08	8.504e-05	0.8710	-7.1330
OH-	5.544e-08	0.0009411	0.8368	-7.3336
HSO4-	2.308e-08	0.002236	0.8406	-7.7122
MnCl+	1.188e-08	0.001072	0.8406	-8.0006
NaCO3-	9.473e-09	0.0007849	0.8406	-8.0989
KCl(aq)	4.041e-09	0.0003007	1.0000	-8.3936
LiCl(aq)	3.798e-10	1.607e-05	1.0000	-9.4205
CaCl2(aq)	3.066e-10	3.397e-05	1.0000	-9.5134
FeCO3+	1.977e-11	2.286e-06	0.8406	-10.7794
NaOH(aq)	1.363e-11	5.443e-07	1.0000	-10.8654
HCl(aq)	8.693e-12	3.164e-07	1.0000	-11.0608
KHSO4(aq)	3.338e-13	4.537e-08	1.0000	-12.4765
FeCl2(aq)	2.117e-13	2.679e-08	1.0000	-12.6743
Fe+++	3.066e-15	1.709e-10	0.2809	-15.0650
FeSO4+	2.183e-16	3.310e-11	0.8406	-15.7364
FeCl4--	4.051e-19	7.994e-14	0.4944	-18.6983
FeCl++	7.913e-20	7.212e-15	0.5030	-19.4001
Formate	3.298e-21	1.482e-16	0.8368	-20.5592
H2(aq)	4.755e-22	9.569e-19	1.0000	-21.3228
Ca(For)+	3.479e-22	2.956e-17	0.8406	-21.5339
Mg(For)+	1.324e-22	9.161e-18	0.8406	-21.9536
Fe(For)+	5.686e-23	5.725e-18	0.8406	-22.3206
Na(For)(aq)	5.506e-24	3.738e-19	1.0000	-23.2591
Mn(For)+	2.312e-24	2.307e-19	0.8406	-23.7114
SO3--	1.235e-24	9.868e-20	0.5030	-24.2069
Formic_acid(aq)	1.190e-24	5.469e-20	1.0000	-23.9243
K(For)(aq)	8.343e-25	7.006e-20	1.0000	-24.0787
HSO3-	7.808e-25	6.319e-20	0.8406	-24.1829
CO(aq)	2.013e-27	5.628e-23	1.0000	-26.6962
Oxalate	2.381e-28	2.092e-23	0.4944	-27.9292
Mn+++	3.550e-29	1.947e-24	0.2202	-29.1069
SO2(aq)	2.687e-30	1.718e-25	1.0000	-29.5707
H-Oxalate	1.715e-31	1.524e-26	0.8406	-30.8410

Oxalic_acid(aq)	1.929e-37	1.734e-32	1.0000	-36.7146
Ca(For)2(aq)	7.017e-42	9.114e-37	1.0000	-41.1539
Mg(For)2(aq)	3.246e-42	3.705e-37	1.0000	-41.4886
Fe(For)2(aq)	2.786e-42	4.057e-37	1.0000	-41.5550
Mn(For)2(aq)	8.297e-44	1.201e-38	1.0000	-43.0811
Na(For)2-	1.261e-44	1.423e-39	0.8406	-43.9746
K(For)2-	1.623e-45	2.093e-40	0.8406	-44.8650
ClO-	1.463e-46	7.514e-42	0.8406	-45.9102
S2O6--	8.702e-47	1.391e-41	0.4944	-46.3663
Formaldehyde(aq)	2.185e-47	6.549e-43	1.0000	-46.6605
HS-	1.691e-47	5.584e-43	0.8368	-46.8491
H2S(aq)	1.633e-47	5.555e-43	1.0000	-46.7871
HO2-	6.402e-50	2.109e-45	0.8406	-49.2691
S2O3--	6.328e-52	7.083e-47	0.4944	-51.5047
Methanol(aq)	3.734e-53	1.194e-48	1.0000	-52.4278
S--	1.749e-53	5.599e-49	0.5114	-53.0484
S2O5--	1.388e-53	1.997e-48	0.4944	-53.1635
Methane(aq)	1.348e-53	2.159e-49	1.0000	-52.8702
O2(aq)	9.743e-55	3.112e-50	1.0000	-54.0113
HSO5-	1.319e-55	1.489e-50	0.8406	-54.9550
Acetate	7.400e-59	4.362e-54	0.8443	-58.2043
Glycolate	4.799e-59	3.595e-54	0.8406	-58.3942
Ca(Glyc)+	8.807e-60	1.012e-54	0.8406	-59.1305
CaCH3COO+	2.377e-60	2.352e-55	0.8406	-59.6993
MgCH3COO+	2.045e-60	1.702e-55	0.8406	-59.7647
Fe(Glyc)+	1.967e-60	2.570e-55	0.8406	-59.7816
Mg(Glyc)+	1.313e-60	1.302e-55	0.8406	-59.9571
FeCH3COO+	3.342e-61	3.832e-56	0.8406	-60.5514
Acetic_acid(aq)	2.667e-61	1.599e-56	1.0000	-60.5740
NaCH3COO(aq)	8.784e-62	7.193e-57	1.0000	-61.0563
Na(Glyc)(aq)	8.204e-62	8.029e-57	1.0000	-61.0860
Mn(Glyc)+	2.593e-62	3.364e-57	0.8406	-61.6617
Glycolic_acid(aq	2.110e-62	1.601e-57	1.0000	-61.6758
MnCH3COO+	1.666e-62	1.895e-57	0.8406	-61.8538
K(Glyc)(aq)	1.243e-62	1.416e-57	1.0000	-61.9055
KCH3COO(aq)	9.470e-63	9.278e-58	1.0000	-62.0236
S2O4--	4.231e-63	5.412e-58	0.5114	-62.6648
LiCH3COO(aq)	3.489e-63	2.298e-58	1.0000	-62.4573
MnO4--	1.662e-64	1.973e-59	0.4944	-64.0854
Malonate	2.285e-67	2.328e-62	0.4944	-66.9470
H-Malonate	4.652e-69	4.786e-64	0.8406	-68.4077
S2O8--	1.425e-70	2.734e-65	0.4944	-70.1520
MnO4-	5.181e-73	6.151e-68	0.8368	-72.3630
Malonic_acid(aq)	2.107e-73	2.188e-68	1.0000	-72.6764
ClO2-	5.853e-82	3.941e-77	0.8406	-81.3080
S3O6--	5.109e-82	9.802e-77	0.4944	-81.5976
Acetaldehyde(aq)	7.607e-83	3.345e-78	1.0000	-82.1188
S2--	4.202e-86	2.690e-81	0.4944	-85.6824
Ethanol(aq)	2.988e-93	1.374e-88	1.0000	-92.5247
Ethylene(aq)	5.197e-98	1.455e-93	1.0000	-97.2842

Ethane(aq)	4.960e-98	1.489e-93	1.0000	-97.3045
Lactate	4.204e-99	3.738e-94	0.8406	-98.4517
Ca(Lac)+	4.537e-100	5.850e-95	0.8406	-99.4186
Fe(Lac)+	1.522e-100	2.202e-95	0.8406	-99.8929
Mg(Lac)+	1.169e-100	1.322e-95	0.8406	-100.0078
S4O6--	7.407e-101	1.658e-95	0.4944	-100.4363
Propanoate	4.236e-101	3.090e-96	0.8406	-100.4485
Na(Lac)(aq)	7.324e-102	8.193e-97	1.0000	-101.1353
Lactic_acid(aq)	1.943e-102	1.747e-97	1.0000	-101.7116
Mn(Lac)+	1.606e-102	2.309e-97	0.8406	-101.8697
K(Lac)(aq)	1.110e-102	1.420e-97	1.0000	-101.9547
Ca(Prop)+	7.550e-103	8.528e-98	0.8406	-102.1974
ClO3-	7.297e-103	6.079e-98	0.8368	-102.2142
Fe(Prop)+	4.423e-103	5.692e-98	0.8406	-102.4296
Mg(Prop)+	3.160e-103	3.072e-98	0.8406	-102.5757
Propanoic_acid(a	2.046e-103	1.513e-98	1.0000	-102.6891
Na(Prop)(aq)	7.276e-104	6.977e-99	1.0000	-103.1381
Mn(Prop)+	1.111e-104	1.419e-99	0.8406	-104.0298
K(Prop)(aq)	1.103e-104	1.235e-99	1.0000	-103.9576
Ethyne(aq)	5.826e-105	1.514e-100	1.0000	-104.2347
Succinate	5.276e-108	6.113e-103	0.4944	-107.5837
H-Succinate	1.010e-109	1.181e-104	0.8406	-109.0709
Succinic_acid(aq	1.093e-112	1.288e-107	1.0000	-111.9615
Ca(Glyc)2(aq)	6.360e-117	1.207e-111	1.0000	-116.1965
Fe(Glyc)2(aq)	4.506e-117	9.264e-112	1.0000	-116.3462
Ca(CH3COO)2(aq)	2.514e-117	3.969e-112	1.0000	-116.5997
Mg(CH3COO)2(aq)	9.049e-118	1.286e-112	1.0000	-117.0434
Mg(Glyc)2(aq)	5.720e-118	9.958e-113	1.0000	-117.2426
Fe(CH3COO)2(aq)	4.063e-118	7.054e-113	1.0000	-117.3912
S3--	8.728e-119	8.381e-114	0.4944	-118.3650
Mn(CH3COO)2(aq)	7.799e-120	1.347e-114	1.0000	-119.1080
Mn(Glyc)2(aq)	7.626e-120	1.561e-114	1.0000	-119.1177
Na(Glyc)2-	4.282e-120	7.397e-115	0.8406	-119.4438
Acetone(aq)	3.819e-120	2.214e-115	1.0000	-119.4180
Na(CH3COO)2-	3.636e-120	5.120e-115	0.8406	-119.5148
K(Glyc)2-	5.641e-121	1.065e-115	0.8406	-120.3240
Li(CH3COO)2-	3.526e-121	4.401e-116	0.8406	-120.5281
K(CH3COO)2-	2.606e-121	4.089e-116	0.8406	-120.6595
Propanal(aq)	1.600e-124	9.276e-120	1.0000	-123.7959
ClO4-	3.601e-128	3.575e-123	0.8368	-127.5210
1-Propanol(aq)	1.944e-135	1.166e-130	1.0000	-134.7114
BH4-	1.002e-136	1.485e-132	0.8406	-136.0745
1-Propene(aq)	5.958e-138	2.503e-133	1.0000	-137.2249
Propane(aq)	1.299e-140	5.720e-136	1.0000	-139.8862
2-Hydroxybutanoa	9.873e-142	1.016e-136	0.8406	-141.0810
1-Propyne(aq)	5.399e-143	2.159e-138	1.0000	-142.2677
Butanoate	7.846e-144	6.821e-139	0.8406	-143.1808
2-Hydroxybutanoi	4.041e-145	4.200e-140	1.0000	-144.3935
Ca(But)+	9.593e-146	1.218e-140	0.8406	-145.0934
Fe(But)+	8.466e-146	1.208e-140	0.8406	-145.1477

Mg(But)+	3.828e-146	4.258e-141	0.8406	-145.4924
Butanoic_acid(aq	3.044e-146	2.677e-141	1.0000	-145.5165
Na(But)(aq)	1.295e-146	1.423e-141	1.0000	-145.8876
K(But)(aq)	1.963e-147	2.473e-142	1.0000	-146.7071
Mn(But)+	1.754e-147	2.486e-142	0.8406	-146.8315
S5O6--	2.013e-149	5.150e-144	0.4944	-149.0022
Glutarate	8.146e-150	1.058e-144	0.4944	-149.3950
S4--	1.070e-151	1.370e-146	0.4944	-151.2767
H-Glutarate	9.132e-152	1.195e-146	0.8406	-151.1148
Glutaric_acid(aq	1.261e-154	1.663e-149	1.0000	-153.8992
Ethylacetate(aq)	2.403e-155	2.113e-150	1.0000	-154.6193
Butanal(aq)	1.044e-168	7.518e-164	1.0000	-167.9811
Mn(CH3COO)3-	1.989e-177	4.607e-172	0.8406	-176.7769
1-Butanol(aq)	6.852e-179	5.070e-174	1.0000	-178.1642
1-Butene(aq)	6.695e-181	3.750e-176	1.0000	-180.1742
n-Butane(aq)	2.974e-183	1.725e-178	1.0000	-182.5267
2-Hydroxypentano	3.480e-184	4.069e-179	0.8406	-183.5338
S5--	7.717e-185	1.235e-179	0.4944	-184.4185
1-Butyne(aq)	9.434e-186	5.094e-181	1.0000	-185.0253
Pentanoate	1.730e-186	1.746e-181	0.8406	-185.8373
2-Hydroxypentano	8.407e-188	9.914e-183	1.0000	-187.0754
Fe(Pent)+	1.747e-188	2.738e-183	0.8406	-187.8331
Ca(Pent)+	1.253e-188	1.766e-183	0.8406	-187.9775
Pentanoic_acid(a	7.302e-189	7.445e-184	1.0000	-188.1365
Mg(Pent)+	4.887e-189	6.119e-184	0.8406	-188.3863
Na(Pent)(aq)	3.019e-189	3.741e-184	1.0000	-188.5201
K(Pent)(aq)	4.575e-190	6.404e-185	1.0000	-189.3396
Mn(Pent)+	2.990e-190	4.658e-185	0.8406	-189.5997
Adipate	4.675e-194	6.726e-189	0.4944	-193.6362
H-Adipate	5.124e-196	7.423e-191	0.8406	-195.3658
Fe(Lac)2(aq)	2.740e-197	6.401e-192	1.0000	-196.5622
Ca(Lac)2(aq)	1.844e-197	4.017e-192	1.0000	-196.7343
Mg(Lac)2(aq)	4.829e-198	9.758e-193	1.0000	-197.3162
Adipic_acid(aq)	8.226e-199	1.200e-193	1.0000	-198.0848
Mn(Lac)2(aq)	6.997e-200	1.628e-194	1.0000	-199.1551
Na(Lac)2-	3.423e-200	6.873e-195	0.8406	-199.5410
K(Lac)2-	4.509e-201	9.778e-196	0.8406	-200.4213
Fe(Prop)2(aq)	1.945e-202	3.921e-197	1.0000	-201.7111
Ca(Prop)2(aq)	4.611e-203	8.572e-198	1.0000	-202.3362
Mg(Prop)2(aq)	2.591e-203	4.409e-198	1.0000	-202.5865
Mn(Prop)2(aq)	2.374e-204	4.766e-199	1.0000	-203.6245
Na(Prop)2-	2.269e-204	3.832e-199	0.8406	-203.7195
K(Prop)2-	2.984e-205	5.519e-200	0.8406	-204.6005
Phenol(aq)	2.471e-209	2.322e-204	1.0000	-208.6071
Pentanal(aq)	4.031e-211	3.466e-206	1.0000	-210.3946
Benzene(aq)	4.696e-218	3.661e-213	1.0000	-217.3283
1-Pentanol(aq)	2.779e-220	2.445e-215	1.0000	-219.5561
Benzoate	1.657e-221	2.003e-216	0.8543	-220.8491
1-Pentene(aq)	1.149e-223	8.047e-219	1.0000	-222.9395
Benzoic_acid(aq)	1.714e-224	2.090e-219	1.0000	-223.7660

n-Pentane(aq)	5.622e-226	4.049e-221	1.0000	-225.2501
2-Hydroxyhexanoa	5.076e-227	6.645e-222	0.8406	-226.3699
o-Phthalate	1.942e-228	3.182e-223	0.4944	-228.0176
1-Pentyne(aq)	1.708e-228	1.161e-223	1.0000	-227.7676
Hexanoate	3.040e-229	3.494e-224	0.8406	-228.5926
2-Hydroxyhexanoi	1.749e-230	2.308e-225	1.0000	-229.7571
Hexanoic_acid(aq	1.343e-231	1.558e-226	1.0000	-230.8718
Pimelate	1.419e-235	2.240e-230	0.4944	-235.1541
H-Pimelate	1.573e-237	2.500e-232	0.8406	-236.8786
Pimelic_acid(aq)	3.013e-240	4.818e-235	1.0000	-239.5210
Hexanal(aq)	6.785e-254	6.784e-249	1.0000	-253.1684
Toluene(aq)	7.543e-258	6.938e-253	1.0000	-257.1224
p-Toluate	5.698e-261	7.686e-256	0.8406	-260.3197
m-Toluate	3.094e-261	4.174e-256	0.8406	-260.5849
o-Toluate	2.901e-263	3.914e-258	0.8406	-262.6128
1-Hexanol(aq)	1.000e-263	1.020e-258	1.0000	-263.0000
p-Toluic_acid(aq	8.504e-264	1.156e-258	1.0000	-263.0704
m-Toluic_acid(aq	3.607e-264	4.902e-259	1.0000	-263.4429
1-Hexene(aq)	3.123e-266	2.624e-261	1.0000	-265.5054
o-Toluic_acid(aq	1.329e-266	1.806e-261	1.0000	-265.8765
n-Hexane(aq)	7.914e-269	6.808e-264	1.0000	-268.1016
2-Hydroxyheptano	1.054e-269	1.527e-264	0.8406	-269.0527
1-Hexyne(aq)	2.457e-271	2.015e-266	1.0000	-270.6095
Heptanoate	7.332e-272	9.454e-267	0.8406	-271.2102
2-Hydroxyheptano	3.639e-273	5.311e-268	1.0000	-272.4390
Heptanoic_acid(a	3.515e-274	4.568e-269	1.0000	-273.4540
Suberate	1.145e-279	1.968e-274	0.4944	-279.2472
H-Suberate	1.232e-281	2.131e-276	0.8406	-280.9846
Suberic_acid(aq)	2.478e-284	4.309e-279	1.0000	-283.6059
Fe(But)2(aq)	6.592e-288	1.514e-282	1.0000	-287.1810
Ca(But)2(aq)	7.591e-289	1.624e-283	1.0000	-288.1197
Mg(But)2(aq)	3.776e-289	7.482e-284	1.0000	-288.4230
Na(But)2-	6.854e-290	1.349e-284	0.8406	-289.2395
Mn(But)2(aq)	5.744e-290	1.314e-284	1.0000	-289.2408
K(But)2-	9.012e-291	1.919e-285	0.8406	-290.1206
Heptanal(aq)	1.396e-297	1.591e-292	1.0000	-296.8551
1-Heptanol(aq)	1.621e-307	1.880e-302	1.0000	-300.0000
1-Heptene(aq)	6.176e-309	6.053e-304	1.0000	-300.0000
n-Heptane(aq)	1.635e-311	1.635e-306	1.0000	-300.0000
2-Hydroxyoctanoa	2.187e-312	3.475e-307	0.8406	-300.0000
1-Heptyne(aq)	3.222e-314	3.093e-309	1.0000	-300.0000
Octanoate	2.555e-314	3.652e-309	0.8406	-300.0000
2-Hydroxyoctanoi	7.570e-316	1.211e-310	1.0000	-300.0000
Octanoic_acid(aq	1.242e-316	1.788e-311	1.0000	-300.0000
H-Azelate	0.000	0.000	0.8406	-300.0000
Octanal(aq)	0.000	0.000	1.0000	-300.0000
2-Hydroxynonanoi	0.000	0.000	1.0000	-300.0000
Nonanoic_acid(aq	0.000	0.000	1.0000	-300.0000
Nonanoate	0.000	0.000	0.8406	-300.0000
Nonanal(aq)	0.000	0.000	1.0000	-300.0000

2-Hydroxynonanoa	0.000	0.000	0.8406	-300.0000
Na(Pent)2-	0.000	0.000	0.8406	-300.0000
Fe(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
Mn(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
2-Hydroxydecanoi	0.000	0.000	1.0000	-300.0000
Mg(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
2-Hydroxydecanoa	0.000	0.000	0.8406	-300.0000
Ethylbenzene(aq)	0.000	0.000	1.0000	-300.0000
Azelate	0.000	0.000	0.4944	-300.0000
1-Octyne(aq)	0.000	0.000	1.0000	-300.0000
Dodecanoic_acid(	0.000	0.000	1.0000	-300.0000
Azelaic_acid(aq)	0.000	0.000	1.0000	-300.0000
Dodecanoate	0.000	0.000	0.8406	-300.0000
Decanoic_acid(aq	0.000	0.000	1.0000	-300.0000
Decanoate	0.000	0.000	0.8406	-300.0000
Decanal(aq)	0.000	0.000	1.0000	-300.0000
2-Hexanone(aq)	0.000	0.000	1.0000	-300.0000
1-Octene(aq)	0.000	0.000	1.0000	-300.0000
K(Pent)2-	0.000	0.000	0.8406	-300.0000
2-Heptanone(aq)	0.000	0.000	1.0000	-300.0000
n-Propylbenzene(	0.000	0.000	1.0000	-300.0000
n-Pentylbenzene(	0.000	0.000	1.0000	-300.0000
n-Octylbenzene(a	0.000	0.000	1.0000	-300.0000
n-Octane(aq)	0.000	0.000	1.0000	-300.0000
2-Pentanone(aq)	0.000	0.000	1.0000	-300.0000
2-Butanone(aq)	0.000	0.000	1.0000	-300.0000
1-Octanol(aq)	0.000	0.000	1.0000	-300.0000
n-Hexylbenzene(a	0.000	0.000	1.0000	-300.0000
n-Heptylbenzene(	0.000	0.000	1.0000	-300.0000
n-Butylbenzene(a	0.000	0.000	1.0000	-300.0000
2-Octanone(aq)	0.000	0.000	1.0000	-300.0000
Undecanoic_acid(	0.000	0.000	1.0000	-300.0000
Undecanoate	0.000	0.000	0.8406	-300.0000
Sebacic_acid(aq)	0.000	0.000	1.0000	-300.0000
Sebacate	0.000	0.000	0.4944	-300.0000
Ca(Pent)2(aq)	0.000	0.000	1.0000	-300.0000
H-Sebacate	0.000	0.000	0.8406	-300.0000

Surface species	molality	moles	Boltzman fct.	log molality
>(w)FeOH	0.01015	0.003419	1.0000	-1.9936
>(w)FeOH2+	0.004534	0.001528	3.2130	-2.3435
>(w)FeOHSO4--	0.002470	0.0008322	0.096865	-2.6073
>(w)FeOMg+	0.001236	0.0004162	3.2130	-2.9081
>(w)FeSO4-	0.0005532	0.0001863	0.31123	-3.2572
>(w)FeO-	0.0005204	0.0001753	0.31123	-3.2836
>(s)FeOHCa++	0.0002985	0.0001005	10.324	-3.5251
>(w)FeOCa+	0.0002169	7.306e-05	3.2130	-3.6638
>(s)FeOMn+	0.0001851	6.235e-05	3.2130	-3.7326
>(w)FeOMn+	0.0001617	5.448e-05	3.2130	-3.7912

```
 >(w)FeH2BO3          5.288e-05     1.781e-05        1.0000      -4.2767
 >(s)FeOH             9.226e-06     3.108e-06        1.0000      -5.0350
 >(s)FeOH2+           4.122e-06     1.389e-06        3.2130      -5.3849
 >(s)FeO-             4.731e-07     1.594e-07       0.31123      -6.3250
  (Boltzman factor = exp(zF PSI/RT),  where PSI is surface potential)

 Mineral saturation states
                   log Q/K                          log Q/K
----------------------------------------------------------------
  Hematite          11.5273s/sat   MgSO4            -10.9382
  Magnetite         11.0269s/sat   Periclase        -11.2274
  Goethite           5.2993s/sat   B2O3             -11.4856
  Ferrite-Ca         0.8360s/sat   Portlandite      -11.7822
  Siderite           0.7136s/sat   Thermonatrite    -12.2564
  Ferrite-Mg         0.6872s/sat   Na2CO3           -12.5727
  Dolomite-ord       0.5746s/sat   MnCl2:4H2O       -14.2711
  Dolomite           0.5746s/sat   Borax            -14.2766
  Fe(OH)3            0.0000 sat    MnCl2:2H2O       -15.7040
  Calcite           -0.0230        Hydromagnesite   -15.8173
  Ice               -0.0888        MgOHCl           -15.9260
  Aragonite         -0.1680        Bixbyite         -16.0110
  Gypsum            -0.3669        Pyrolusite       -16.1739
  Rhodochrosite     -0.4239        MgCl2:4H2O       -17.1465
  Powellite         -0.6446        MnCl2:H2O        -17.3767
  Anhydrite         -0.6733        Hausmannite      -18.4252
  Monohydrocalcite  -0.8255        Lawrencite       -19.9567
  Dolomite-dis      -1.0692        Scacchite        -20.7769
  Magnesite         -1.1143        Hydrophilite     -21.3775
  Bassanite         -1.3223        Lime             -22.3290
  CaSO4:0.5H2O(bet  -1.5074        MgCl2:2H2O       -22.9464
  Boric_acid        -2.5780        C                -23.1148
  Jarosite          -2.9012        Ferrite-Dicalciu -24.3650
  Melanterite       -3.6530        Fe               -24.4685
  Wustite           -3.6800        MgCl2:H2O        -26.5076
  FeO               -3.8215        KMgCl3:2H2O      -30.8101
  Fe(OH)2           -4.1100        Chloromagnesite  -32.5676
  Nesquehonite      -4.2096        S                -33.7440
  Huntite           -5.0340        KMgCl3           -38.5393
  Nahcolite         -5.1809        Molysite         -39.5549
  Brucite           -5.8775        Troilite         -39.6381
  Mirabilite        -6.2083        Pyrrhotite       -39.7417
  Mn(OH)2(am)       -6.7606        Fe2(SO4)3        -42.5037
  Arcanite          -7.4592        Alabandite       -44.4204
  Sylvite           -7.4766        Mn               -50.6566
  Halite            -7.5675        Na               -52.5994
  Thenardite        -7.6411        Mo               -54.2875
  Artinite          -7.8550        K                -57.0612
  Mg1.25SO4(OH)0.5  -8.5428        Li               -60.1528
  FeSO4             -9.3297        Na2O             -61.5626
  Manganosite       -9.5652        Pyrite           -62.4940
```

Mg1.5SO4(OH)	-9.9387	B	-77.1104
Natron	-10.2913	K2O	-80.3071
MnSO4	-10.4911	Mg	-90.2507
NaFeO2	-10.5164	Ca	-107.6938
Na2CO3:7H2O	-10.8287	o-Phthalic_acid	-232.3138

Gases	partial press. (bar)	fugacity	fug. coef.	log fug.
H2O(g)	0.01213	0.01134	0.9353	-1.9453
CO2(g)	0.008779	0.008728	0.9941	-2.0591
HCl(g)	5.161e-18	5.161e-18	1.000*	-17.2873
H2(g)	5.469e-19	5.474e-19	1.001	-18.2617
CO(g)	1.585e-24	1.585e-24	1.000*	-23.8001
SO2(g)	1.090e-30	1.070e-30	0.9817	-29.9706
H2S(g)	1.108e-46	1.099e-46	0.9912	-45.9591
CH4(g)	7.148e-51	7.133e-51	0.9979	-50.1467
Cl2(g)	6.364e-52	6.364e-52	1.000*	-51.1963
O2(g)	5.914e-52	5.909e-52	0.9992	-51.2285
Na(g)	1.130e-67	1.130e-67	1.000*	-66.9469
K(g)	4.248e-69	4.248e-69	1.000*	-68.3718
S2(g)	3.778e-83	3.778e-83	1.000*	-82.4227
Li(g)	2.441e-84	2.441e-84	1.000*	-83.6124
C2H4(g)	7.704e-96	7.704e-96	1.000*	-95.1133
Mg(g)	7.265e-112	7.265e-112	1.000*	-111.1388
Ca(g)	4.514e-135	4.514e-135	1.000*	-134.3454
C(g)	3.058e-147	3.058e-147	1.000*	-146.5146
B(g)	1.122e-173	1.122e-173	1.000*	-172.9498

*no data, gas taken to be ideal

Original basis	total moles	In fluid moles	In fluid mg/kg	Sorbed moles	Sorbed mg/kg	Kd L/kg
H2O	18.8	18.7	9.98e+05	-0.000204	-10.9	
B(OH)3(aq)	0.000442	0.000424	77.6	1.78e-05	3.26	
Ca++	0.00306	0.00288	342.	0.000174	20.6	
Cl-	0.000226	0.000226	23.8			
Fe++	0.0336	0.000128	21.2			
H+	-0.0659	0.000146	0.437	0.000934	2.79	
HCO3-	0.00107	0.00107	194.			
K+	0.000122	0.000122	14.1			
Li+	9.25e-06	9.25e-06	0.190			
Mg++	0.00139	0.000978	70.5	0.000416	30.0	
Mn++	0.000127	1.07e-05	1.74	0.000117	19.0	
MoO4--	4.94e-07	4.94e-07	0.234			
Na+	0.000680	0.000680	46.3			
O2(aq)	0.00838	1.67e-12	1.58e-07			
SO4--	0.00446	0.00344	980.	0.00102	290.	
>(s)FeOH	0.000168					
>(w)FeOH	0.00670					

Sorbed	fraction	log fraction
B(OH)3(aq)	0.04034	-1.394
Ca++	0.05679	-1.246
Mg++	0.2985	-0.525
Mn++	0.9164	-0.038
SO4--	0.2282	-0.642

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Boron	0.0004416	0.0004238	13.58	1.781e-05	0.5707
Calcium	0.003057	0.002883	342.4	0.0001736	20.62
Carbon	0.001072	0.001072	38.14		
Chlorine	0.0002265	0.0002265	23.79		
Hydrogen	37.50	37.40	1.117e+05	0.0005788	1.729
Iron	0.03364	0.0001284	21.24		
Lithium	9.247e-06	9.247e-06	0.1902		
Magnesium	0.001394	0.0009783	70.46	0.0004162	29.98
Manganese	0.0001275	1.066e-05	1.735	0.0001168	19.02
Molybdenum	4.942e-07	4.942e-07	0.1405		
Oxygen	18.82	18.72	8.874e+05	0.003923	186.0
Potassium	0.0001215	0.0001215	14.08		
Sodium	0.0006797	0.0006797	46.30		
Sulfur	0.004462	0.003444	327.2	0.001019	96.78

Geosyntec consultants

ATTACHMENT P

Corrective Action Plan (CAP) (845.670)

Monitored Natural Attenuation Evaluation – Long-Term Monitoring and Contingency Plan

Prepared for

Dynegy Midwest Generation, LLC
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

CORRECTIVE ACTION PLAN

CCR SURFACE IMPOUNDMENTS
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

Prepared by

Geosyntec consultants

engineers | scientists | innovators

134 N. Lasalle Street, Suite 300
Chicago, Illinois 60602

Project Number CHE8404B

January 2022

Geosyntec
consultants

TABLE OF CONTENTS

1. Introduction 1
   1.1. Plant and Site Information 1
   1.2. Permit Status 1
   1.3. Facility Information 2

2. Corrective Action Overview 3
   2.1. Closure Alternatives Analysis 3
   2.2. Corrective Measures Assessment/Corrective Action Alternatives Assessment 3

3. Corrective Action Plan 5
   3.1. General Requirements 5
   3.2. Remedy Selection 6
      3.2.1. Long-term and Short-term Effectiveness and Protectiveness 7
      3.2.2. Source Control Effectiveness 9
      3.2.3. Ease of Implementation 9
      3.2.4. Community Concerns 10
      3.2.5. Schedule for Implementation 11
      3.2.6. Other Relevant Factors 15

TABLE OF CONTENTS

TABLES

Table 3-1 Part 845 Reference Spreadsheet

APPENDICES

Appendix 1 Monitored Natural Attenuation Evaluation – Long-Term Monitoring and Contingency Plan

1. INTRODUCTION

1.1. Plant and Site Information

Dynegy Midwest Generation, LLC (Dynegy) is the owner of the inactive coal-fired Vermilion Power Plant (Plant), also referred to as Vermilion Power Station, located approximately 13 miles Northwest of Danville, Illinois. According to the Illinois Environmental Protection Agency (IEPA), this power plant has three surface impoundments: Old East Ash Pond (OEAP), North Ash Pond (NAP), and New East Ash Pond (NEAP). The IEPA assigned identification numbers assigned to these impoundments are: W1838000002-03 for the OEAP; W1838000002-01 for the NAP; and W1838000002-04 for the NEAP. There are no National Inventory of Dams (NID) numbers assigned for the OEAP or NAP by the Illinois Department of Natural Resources (IDNR). The NID number for the NEAP is IL50291.

This Corrective Action Plan (CAP) was developed in accordance with 35 Ill. Admin. Code 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845), to address groundwater impacts for the OEAP and NAP.

Potential groundwater impacts have been identified downgradient of the OEAP and NAP. The IEPA has issued an Agreed Interim Order in June 2021 (Interim Order) (Illinois Attorney General, 2021). Actions taken to meet the Interim Order are generally separate from this CAP but may be referenced. For example, the Interim Order requires installation of a groundwater collection trench ("collection trench") downgradient of the OEAP. This is considered an "Interim Corrective Action" under Part 845. The operation and maintenance of the collection trench is described separately from this CAP.

1.2. Permit Status

Two Operating Permit (OP) Applications have been submitted for: i) combined OEAP and NAP, and ii) NEAP. Two Construction Permit (CP) Applications are being submitted concurrently with this CAP: one for the NEAP and another for the combined OEAP and NAP. In summary, the CP Applications describe the Closure-by-Removal (CBR) of all CCR impoundments and the disposal of the CCR and demolition materials from the plant and associated structures into a new onsite Landfill (Landfill). This CAP will be an attachment to the OEAP and NAP CP Applications.

A combined Closure Alternatives Analysis (CAA) (Section 845.710 (b)) and Corrective Measures Assessment (CMA) (Section 845.660)/Corrective Action Alternatives Analysis (CAAA) (Section 845.670) is also included in the CP Application in Attachment N. This CAP will reference details of the CAA and CMA/CAAA.

1.3. Facility Information

Facility:	Vermilion Power Plant 10188 East 2150 North Road Oakwood, IL 61858
Owner/Operator:	Dynegy Midwest Generation, LLC 1500 Eastport Plaza Drive Collinsville, IL 62234 Phil Morris, Sr. Director Corporate Environmental 618-606-7788 phil.morris@vistracorp.com

2. CORRECTIVE ACTION OVERVIEW

The objective of the CMA/CAAA is to evaluated potential corrective measures and corrective action alternatives to determine the optimal alternative to remediate groundwater and comply with Groundwater Protection Standards (GWPS) specified under Section 845.600.

2.1. Closure Alternatives Analysis

Dynegy evaluated CBR as a remedial approach for source control for the OEAP and NAP as required in the Interim Order. Two specific closure methods were considered: CBR with On-Site CCR Disposal and CBR with Off-Site CCR Disposal. CBR with On-Site CCR Disposal was selected. The selected closure method includes the following:

(1) Excavation of the CCR from the former OEAP and NAP impoundments and transporting it to an on-site Landfill for disposal;

(2) Construction and operation of a groundwater collection trench that will be installed and operated until closure has been completed, as required by the Interim Order (Illinois, Attorney General, 2021);

(3) Demolition of the Vermilion Power Plant; and

(4) Construction of an on-site Landfill.

The collection trench, required by the Interim Order, will intercept seeps and discolored water prior to reaching the Middle Fork of the Vermilion River.

2.2. Corrective Measures Assessment/Corrective Action Alternatives Assessment

Five corrective measures were considered in the CMA for this Site, which included the following:

(1) Source Control with Monitored Natural Attenuation (Source Control-MNA);

(2) Source Control with Groundwater Extraction (Source Control-GE);

(3) Source Control with Monitored Natural Attenuation and Groundwater Extraction (Source Control-MNA/GE);

(4) Source Control with Construction of a Cutoff Wall (Source Control-CW); and

(5) Source Control with Construction of a Permeable Reactive Barrier (Source Control-PRB).

Based on the CMA, two corrective measures (Source Control-MNA and Source-Control MNA/GE) were identified as potentially viable corrective actions for the Site. These two corrective actions were included in the CAAA, and Source Control-MNA was selected as the remedy. Source Control-MNA includes removing CCR (source material) using CBR (as described in Section 2.1 of this CAP) and addressing groundwater concentrations of dissolved constituents via natural physical and chemical attenuation in areas downgradient of the OEAP and NAP. Active monitoring will be performed to verify and document the remediation progress as described in the long-term monitoring plan provided in Appendix 1 to this CAP.

3. CORRECTIVE ACTION PLAN

The requirements of the CAP are discussed individually in this section. Because a CMA/CAAA have been prepared and included in the CP Application Attachment N, the requirements in the CAP will be cross-referenced to those documents for each Section 845.670 requirement. The cross-reference spreadsheet is included in **Table 3-1**. The cross-reference spreadsheet may be used as a compliance checklist verifying that all requirements of Section 845.670 have been met.

3.1. General Requirements

<u>Section 845.670(a):</u> *The owner or operator must prepare a semi-annual report describing the progress in selecting a remedy and developing a corrective action plan. The semi-annual report must be submitted to the Agency and placed in the operating record as required by Section 845.800(d)(17).*

Dynegy will prepare a semi-annual report describing the progress of the selected remedy (Source Control-MNA), which will be submitted to the Agency and placed in the operating record.

<u>Section 845.670(b):</u> *Within one year after completing the assessment of corrective measures as specified in Section 845.660, and after completion of the public meeting in Section 845.660(d), the owner or operator of the CCR surface impoundment must submit, in a construction permit application to the Agency, a corrective action plan 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.*

The CP Application for the selected remedy will be submitted to the Agency in January 2022 concurrently with this CAP. Two public meetings, as specified in Section 845.660(d) were held on December 9, 2021. The CMA/CAAA is included in the CP Application as Attachment N CCR Final Closure Plan, Appendix 1.

<u>Section 845.670(c):</u> *The corrective action plan must meet the following requirements:*

> *(1) Be based on the results of the corrective measures assessment conducted under Section 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).*

The results of the CMA/CAAA identified Source Control-MNA as the most appropriate corrective action at this Site and is the preferred remedy as discussed in the CMA/CAAA. The CMA/CAAA is included in Attachment N CCR Final Closure Plan, Appendix 1 to the CP Application. The proposed schedule for implementation is also included as Table 2-1 in Attachment N in the CP Application.

Section 3.2 and Table 3-1 of this CAP describe compliance with Section 845.670(c)(2), (3) and (4).

The selected remedy meets the requirements of 845.670(d), 845.670(e), and 845.670(f) as noted in Sections 3.2 of this CAP.

3.2. Remedy Selection

Section 845.670(d): *The selected remedy in the 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, taking into account 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).*

The selected corrective action (Source Control-MNA) is discussed in Sections 3 and 4 of the CMA/CAAA and was evaluated against various factors, including the performance, reliability, and ease of implementation; its potential impacts on human health and the environment; and its ability to address concerns raised by residents. Long-term management associated with groundwater sampling is required to continue until GWPS have been achieved or until it is determined that the measure is not meeting the requirements of Section 845.670(d).

Table 3-1 identifies the locations in the CP Application reports that addresses 845.670(d)(1) through (5).

3.2.1. Long-term and Short-term Effectiveness and Protectiveness

Section 845.670(e): *Corrective Action Alternatives Analysis. 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:*

The following sections describe the factors that the corrective action alternatives were evaluated against.

Section 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:*

(A) Magnitude of reduction of existing risks;

(B) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;

(C) The type and degree of long-term management required, including monitoring, operation, and maintenance;

(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;

(E) Time until groundwater protection standards in Section 845.600 are achieved;

(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;

(G) The long-term reliability of the engineering and institutional controls, including an analysis of any off-site, nearby destabilizing activities; and

(H) Potential need for replacement of the remedy.

The CAAA discusses requirements pursuant to Section 845.670(e) for the selected remedy (Source Control-MNA). This includes factors such as 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 residents. The CAAA addresses paragraphs A through H from above as summarized below:

A) There are no current risks to any human or ecological receptors at the Site. Because dissolved constituent concentrations are expected to decline due to source control and corrective actions, there would also be no future risks to human and ecological receptors.

B) There would be no likelihood of CCR releases occurring post-closure because CBR was closure method selected.

C) Minimal long-term O&M efforts would be required for implementation of source control-MNA as a corrective action because it does not require the installation, operation, or maintenance of any engineered systems or structures other than monitoring wells. Groundwater sampling would continue until GWPS have been achieved.

D) Minimal impacts to worker safety, air quality, and surface water and sediment quality would be expected under Source Control-MNA, due to the minimal nature of the construction activities required as noted in Tables S.2 and S.3 of the CMA/CAAA and CAA Report in Appendix 1 of Attachment N of the CP Application. The constituent mass flux that flows from groundwater into surface water would decline over time after CBR has been completed.

E) Results of the modeling indicate that groundwater will attain the GWPS for all constituents identified as potential exceedances in the primary migration pathway within approximately 50 years after closure in the uppermost aquifer and approximately 100 years after closure in a lower potential migration pathway.

F) There would be no risk of CCR releases occurring post-closure because CBR is part of the selected remedy. Potential risks to workers that come in contact with secondary sources of CCR associated constituents would be managed through the use of appropriate safety protocols and personal protective equipment.

G) High long-term reliability would be expected for Source Control-MNA, because this remedy would rely on source removal, natural attenuation processes, and active monitoring.

H) Replacement of Source Control-MNA would likely be unnecessary. The MNA evaluation notes that a contingency plan will identify the circumstances under which replacement of the remedy may be appropriate; the contingency plan has been developed and is included in Appendix 1. The MNA evaluation is included in the Monitored Natural Attenuation Evaluation (Geosyntec, January 2022) Report which is Attachment O of the CP Application.

Table 3-1 identifies the locations in the CP Application reports that addresses 845.670 (e)(1)(A) through (H).

3.2.2. Source Control Effectiveness

Section 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:*

A) The extent to which containment practices will reduce further releases; and

B) The extent to which treatment technologies may be used.

The CCR source will be removed. The subgrade will be regraded with onsite soil and revegetated, thereby providing an element of containment/covering. Additional containment practices, such as an engineered low permeability, cover would provide no further protection because all the source of potential releases will have been eliminated.

The Source Control-MNA remedy would effectively eliminate the potential for CCR within the impoundments to impact groundwater. However, impacted soils underlying the impoundments can potentially act as a secondary source of CCR-associated impacts to groundwater even after the primary source (CCR) has been excavated and hauled to a landfill for disposal. Under the Source Control-MNA remedy, the attenuation of dissolved constituent concentrations remaining after source control would be achieved through natural processes. An analysis by Geosyntec demonstrates that MNA would likely perform well at this Site, both within the secondary source area and downgradient (Geosyntec, January 2022).

Because Source Control-MNA would rely on natural attenuation processes, no treatment technologies would be required under this alternative.

Table 3-1 identifies the locations in the CP Application reports that addresses 845.670(e)(2)(A) and (B).

3.2.3. Ease of Implementation

Section 845.670(e)(3): *The ease or difficulty of implementing each potential remedy based on consideration of the following types of factors:*

A) Degree of difficulty associated with constructing the technology;

B) Expected operational reliability of the technologies;

C) Need to coordinate with and obtain necessary approvals and permits from other agencies;

D) Availability of necessary equipment and specialists; and

E) Available capacity and location of needed treatment, storage, and disposal services.

The CAAA discusses Section 845.670(e)(3)(A) through (E).

A) The Source Control-MNA remedy would rely on natural processes and therefore would not pose any significant construction challenges. This alternative would only require the installation of monitoring wells.

B) The selected remedy would be highly reliable with respect to operational controls because it would rely on natural processes, rather than the installation, operation, and maintenance of engineered systems or structures (other than monitoring wells). Engineering failure would not occur and no O&M activities would be required to ensure the success of the remedy.

C) The remedy would require regulatory approvals; however, no additional permits would be needed. If groundwater and seep water collected from the groundwater collection trench needs to be treated prior to discharge, then modification of the Site's existing NPDES permit may be needed. However, if needed, NPDES permit modifications related to the operation of the trench would likely be undertaken during closure activities, rather than during the implementation of corrective actions (i.e., the ongoing operation of the trench post-closure).

D) The Source Control-MNA alternative would require standard environmental monitoring equipment. MNA specialists would be available to evaluate the data, once they are collected.

E) The remedy would generate a minimal amount of investigation-derived waste (IDW) that could be managed by a standard waste management contractor.

Table 3-1 identifies the locations in the CP Application reports that addresses 845.670(e)(3)(A) and (E).

3.2.4. Community Concerns

<u>Section 845.670(e)(4):</u> *The degree to which community concerns are addressed by each potential remedy.*

Several citizen action groups representing community members near the Site have campaigned for complete excavation of the CCR impoundments at the Site, including the Eco-Justice Collaborative, Earthjustice, American Rivers, and the Prairie Rivers Network. Both corrective action alternatives evaluated in the CAAA would include source control, thereby addressing the major concerns raised by these groups.

Table 3-1 identifies the locations in the CP Application reports that addresses 845.670(e)(4).

3.2.5. Schedule for Implementation

Section 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 the closure is included in Table 2-1 of the CP Application Attachment N CCR Final Closure Plan. This includes the removal of the source material and hauling from the impoundments. Long-term monitoring of the selected source-control MNA remedy will begin within 90 days of approval of the CAP, in accordance with Section 845.680(a)(1). The schedule for groundwater monitoring associated with MNA is included in **Appendix 1** of this CAP.

Table 3-1 identifies the locations in the CP Application reports that addresses 845.670 (f)(1) through (6).

Section 845.670(f)(1): *Extent and nature of contamination, as determined by the characterization required under Section 845.650(d);*

The Hydrogeologic Site Characterization Report (HCR) is included in Attachment H of the CP Application and details exceedances of groundwater protection standards. The following items were detected at concentrations greater than the GWPS: Arsenic, Beryllium, Boron, Chromium, Cobalt, Lead, Lithium, Molybdenum, Sulfate, Thallium, Total Dissolved Solids, and Radium 226 and 228 (Combined) for at least one location during at least one sampling event.

Section 845.670(f)(2): *Reasonable probabilities of remedial technologies achieving compliance with the groundwater protection standards established by Section 845.600 and other objectives of the remedy;*

In the CAAA, different remedies were evaluated and it was determined that the selected remedy is expected to achieve compliance with the Section 845.600. Groundwater modeling was performed to evaluate future groundwater quality in the vicinity of the OEAP and NAP impoundments. The modeling assumed that seasonal fluctuations in groundwater and river elevations do not affect groundwater flow and transport over the long term. 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 middle groundwater unit) within approximately 50 years after closure. Furthermore, flux to the Middle Fork of the Vermilion River from the middle groundwater unit will be reduced by approximately 50% 10 years after closure is completed and by approximately 80% 35 years after closure is completed. The lower groundwater unit, which has much lower boron concentrations, is estimated to take approximately another 50 years to reach the GWPS due to the longer flow paths through low-permeability deposits.

Section 845.670(f)(3): *Availability of treatment or disposal capacity for CCR managed during implementation of the remedy;*

The remedy includes CBR to an on-site Landfill constructed for this purpose. The Landfill capacity will be sufficient for the quantities at the Site. The Landfill feasibility study is included in Attachment R of the Construction Permit Application.

Section 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 in Appendix A of the CAA and CMA/CAAA Report. The overall conclusion is that groundwater from the OEAP and NAP impoundments and potential groundwater contributions to surface water and sediment constituents of interest (COI) concentrations in the Middle Fork of the Vermilion River pose no unacceptable risks to human health or the environment. This conclusion is based on modeled and detected maximum concentrations of all COIs in surface water and sediment in the Middle Fork of the Vermilion River that were below conservative risk-based screening benchmarks. This conclusion was reached using methodology consistent with applicable US EPA 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.

Section 845.670(f)(5): *Resource value of the aquifer, including:*

A) Current and future uses, including potential residential, agricultural, commercial industrial and ecological uses;

B) Proximity and withdrawal rate of users;

C) Groundwater quantity and quality;

D) The potential impact to the subsurface ecosystem, wildlife, other natural resources, crops, vegetation, and physical structures caused by exposure to CCR constituents;

E) The hydrogeologic characteristic of the facility and surrounding land; and

F) The availability of alternative water supplies; and

The aquifer is discussed in the Hydrogeologic Site Characterization Report (HCR) that is included in the Construction Permit Application as Appendix H.

A) Current uses and users of the groundwater are discussed in the HCR Section 5.1 and Appendix A/B. A water well inventory was completed in 2021 utilizing federal and state databases to assess nearby pumping wells, drinking water receptors, and other uses of water in the vicinity of the OEAP and NAP. Based on records obtained from IEPA, ISGS, and ISWS, there are 42 wells located within 1,000-meters of either the OEAP or NAP. These included two coal test wells, fifteen farm/domestic private water wells, one test hole, one municipal water supply, one semi-private/farm domestic well, and 22 monitoring wells for Illinois Power and Dynegy. Groundwater flow in the unlithified materials in the vicinity of the OEAP and NAP is generally to the east. Based on west to east groundwater flow immediately toward the receiving surface water body (Middle Fork) and no wells between the OEAP and NAP and surface water body, none of the 42 identified wells are downgradient of the OEAP and NAP or in the prevailing direction of groundwater flow and are not likely to be impacted by groundwater from the OEAP and NAP.

B) See Paragraph A above for discussion of proximity and withdrawal rate of users.

C) Groundwater quality is discussed in the HCR Section 4.2 and Table 4-1. Arsenic, beryllium, boron, chromium, cobalt, lead, lithium, molybdenum, pH, sulfate, thallium, TDS and radium 226 and 228 combined were detected above the GWPS in downgradient wells screened in the middle groundwater unit and/or the lower groundwater unit. Results for these parameters were compared directly to the GWPS, without an evaluation of background concentrations or application of statistical methods. Evaluation of background groundwater quality will be completed as part of the GMP, and compliance with Part 845 will be determined following the first round of groundwater sampling.

D) Potential surface receptors are discussed in the HCR Sections 5.2 and 5.3. A survey to identify surface water features, nature preserves, and historic sites was conducted for a 1,000-meter radius around the OEAP and NAP. Section 4.3 of the Human Health and Ecological Risk Assessment included as Appendix A of the CAA and CMA/CAAA Report discusses the ecological risk evaluation.

   a. Ecological receptors exposed to surface water include aquatic and marsh plants, amphibians, reptiles, and fish. The risk evaluation showed that none of the COIs in surface water exceeded protective screening benchmarks.

   b. 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.

c. 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). Based on US EPA Region 4 Ecological Risk Assessment Supplemental Guidance (March 2018), mercury and selenium were identified as bioaccumulative COIs. However, the maximum detected concentration for mercury and the maximum detection limit for selenium (which was undetected) in surface water were below benchmarks protective of bioaccumulative effects. In addition, modeled sediment concentrations were also below benchmarks protective of bioaccumulative exposures.

d. Overall, this evaluation demonstrated that none of the COIs evaluated are expected to pose an unacceptable risk to ecological receptors.

E) The hydrogeologic characteristic of the facility and surrounding land are discussed in Section 3 of the HCR.

a. There are five layers of unlithified material present above the bedrock in addition to the CCR, which were categorized into hydrostratigraphic units:

i. Upper Unit: clayey sands to sandy clays of the Cahokia Alluvium which are the uppermost unit in the Middle Fork bottomlands.

ii. Middle Groundwater Unit: alluvial deposits of coarser grained material encountered at the base of the Cahokia Alluvium. This unit is laterally continuous below the OEAP and NAP and is designated as the uppermost aquifer.

iii. Upper Confining Unit: a low permeability till composed of clay with isolated sand lenses. This unit is present both below the OEAP and NAP, and in the uplands, and limits vertical migration of groundwater.

iv. Lower Groundwater Unit: glacial outwash and re-worked glacial deposits of the Henry Formation is the lowermost, laterally extensive coarse grained unlithified deposit identified beneath the Site and in the uplands. Based on permeability and continuous lateral extent, this unit is identified as a potential migration pathway.

v. Lower Confining Unit: composed of silty or sandy clay with isolated sand lenses and is the lowermost unlithified deposit. Low permeability unit limits vertical migration of groundwater.

vi. Bedrock Confining Unit: lowermost unit identified at the site and underlies all unlithified deposits. This unit occurs within Pennsylvanian shale which is the uppermost lithified unit at the Site.

F) As discussed in subsection A), there are no extraction wells within 1,000 meters downgradient of the Site. Therefore, an alternate water supply is not necessary.

Table 3-1 identifies the locations in the CP Application reports that addresses 845.670(f)(1) through (5).

3.2.6. Other Relevant Factors

<u>Section 845.670(f)(6):</u> *Other relevant factors.*

No additional factors were considered.

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TABLES

TABLE 3-1 COMPLIANCE CROSS-REFERENCE MATRIX

Project: Vermilion Power Plant Surface Imoundment Construction Permit Application Corrective Action Plan

Area: OEAP and NAP

Remedy: Closure By Removal, Source Control MNA

This Spreadsheet is to demonstrate that all of the requirements for the Corrective Action Plan (CAP) are met in accordance with Part 845.670 and cross-referenced sections of Part 845.

Section	Rule Text	Location of Required Information
845.670(a)	The owner or operator must prepare a semi-annual report describing the progress in selecting a remedy and developing a corrective action plan. The semi-annual report must be submitted to the Agency and placed in the operating record as required by Section 845.800(d)(17).	Not applicable.
845.670(b)	Within one year after completing the assessment of corrective measures as specified in Section 845.660, and after completion of the public meeting in Section 845.660(d), the owner or operator of the CCR surface impoundment must submit, in a construction permit application to the Agency, a corrective action plan 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.	CP Application Attachment N CCR Final Closure Plan, Appendix 1.
845.670(c)	The corrective action plan must meet the following requirements:	Not applicable.
845.670(c)(1)	Be based on the results of the corrective measures assessment conducted under Section 845.660;	CAA and CMA and CAAA Report Section 3.5 and Section 4.4 (CP Application Attachment N, Appendix 1).
845.670(c)(2)	Identify a selected remedy that at a minimum, meets the standards listed in subsection (d);	CAA and CMA and CAAA Report Section 4 and Table S.3 (CP Application Attachment N, Appendix 1).
845.670(c)(3)	Contain the corrective action alternatives analysis specified in subsection (e); and	CAA and CMA and CAAA Report Section 4 and Table S.3 (CP Application Attachment N, Appendix 1).
845.670(c)(4)	Contain proposed schedules for implementation, including an analysis of the factors in subsection (f).	CP Application Attachment N CCR Final Closure Plan, Table 2-1 CCR Proposed Closure Schedule.
845.670(d)	The selected remedy in the corrective action plan must:	Not applicable.
845.670(d)(1)	Be protective of human health and the environment;	CAA and CMA and CAAA Report Table S.3, Section 4.1.1, Appendix A 2020 Human Health and Ecological Risk Assessment and Appendix B 2021 Update to 2020 Human Health and Ecological Risk Assessment (CP Application Attachment N, Appendix 1).
845.670(d)(2)	Attain the groundwater protection standards specified in Section 845.600;	CAA and CMA and CAAA Report Section 4.1.6 and Table S.3 (CP Application Attachment N, Appendix 1).
845.670(d)(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;	CAA/CMA/CAAA Table S.3 and Section 4.1.3 of the CAAA (CP Application Attachment N, Appendix 1).
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	CAA/CMA/CAAA Table S.3 and Section 4.1.4 of the CAAA (CP Application Attachment N, Appendix 1).
845.670(d)(5)	Comply with standards for management of wastes as specified in Section 845.680(d).	CAA/CMA/CAAA Table S.3 and Section 4.1.5 of the CAAA (CP Application Attachment N, Appendix 1).
845.67(e)	Corrective Action Alternatives Analysis. 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:	Not applicable.
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:	CAA and CMA and CAAA Report Section 4.1 and Table S.3 (CP Application Attachment N, Appendix 1).
845.670(e)(1)(A)	Magnitude of reduction of existing risks;	CAA and CMA and CAAA Report Section 4.1.1 and Table S.3 (CP Application Attachment N, Appendix 1).
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;	CAA and CMA and CAAA Report Section 4.1.3 and Table S.3 (CP Application Attachment N, Appendix 1).
845.670(e)(1)(C)	The type and degree of long-term management required, including monitoring, operation, and maintenance;	CAA and CMA and CAAA Report Section 4.1.4 and Table S.3 (CP Application Attachment N, Appendix 1).
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;	CAA and CMA and CAAA Report Section 4.1.5 and Table S.3 (CP Application Attachment N, Appendix 1).
845.670(e)(1)(E)	Time until groundwater protection standards in Section 845.600 are achieved;	CAA and CMA and CAAA Report Section 4.1.6 and Table S.3 (CP Application Attachment N, Appendix 1).
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;	CAA and CMA and CAAA Report Section 4.1.7, Table S.3, and Appendix A/B (CP Application Attachment N, Appendix 1).
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	CAA and CMA and CAAA Report Section 4.1.8 and Table S.3 (CP Application Attachment N, Appendix 1).

845.670(e)(1)(H)	Potential need for replacement of the remedy.	CAA and CMA and CAAA Report Section 4.1.9 and Table S.3 (CP Application Attachment N, Appendix 1). The MNA Report (CP Application Attachment P).
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:	Not applicable.
845.670(e)(2)(A)	The extent to which containment practices will reduce further releases; and	CAA and CMA and CAAA Report Section 4.1.2 and Table S.3 (CP Application Attachment N, Appendix 1).
845.670(e)(2)(B)	The extent to which treatment technologies may be used.	CAA and CMA and CAAA Report Section 4.1.2 and Table S.3 (CP Application Attachment N, Appendix 1).
845.670(e)(3)	The ease or difficulty of implementing each potential remedy based on consideration of the following types of factors:	CAA and CMA and CAAA Report Section 4.2 and Table S.3 (CP Application Attachment N, Appendix 1).
845.670(e)(3)(A)	Degree of difficulty associated with constructing the technology;	CAA and CMA and CAAA Report Section 4.2.1 and Table S.3 (CP Application Attachment N, Appendix 1).
845.670(e)(3)(B)	Expected operational reliability of the technologies;	CAA and CMA and CAAA Report Section 4.2.2 and Table S.3 (CP Application Attachment N, Appendix 1).
845.670(e)(3)(C)	Need to coordinate with and obtain necessary approvals and permits from other agencies;	CAA and CMA and CAAA Report Section 4.2.3 and Table S.3 (CP Application Attachment N, Appendix 1).
845.670(e)(3)(D)	Availability of necessary equipment and specialists; and	CAA and CMA and CAAA Report Section 4.2.4 and Table S.3 (CP Application Attachment N, Appendix 1).
845.670(e)(3)(E)	Available capacity and location of needed treatment, storage, and disposal services.	CAA and CMA and CAAA Report Section 4.2.5 and Table S.3 (CP Application Attachment N, Appendix 1).
845.670(e)(4)	The degree to which community concerns are addressed by each potential remedy.	CAA and CMA and CAAA Report Section 4.3 and Table S.3 (CP Application Attachment N, Appendix 1).
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:	CCR Final Closure Plan Table 2-1 (CP Application Attachment N) and GMP Table E (CP Application Attachment I).
845.670(f)(1)	Extent and nature of contamination, as determined by the characterization required under Section 845.650(d);	Hydrogeologic Site Characterization Report Section 4.2 (CP Application Attachment H).
845.670(f)(2)	Reasonable probabilities of remedial technologies achieving compliance with the groundwater protection standards established by Section 845.600 and other objectives of the remedy;	CAA and CMA and CAAA Report Section 4.1.6 (CP Application Attachment N, Appendix 1).
845.670(f)(3)	Availability of treatment or disposal capacity for CCR managed during implementation of the remedy;	Landfill Feasiblity Study (CP Application Attachment Q).
845.670(f)(4)	Potential risks to human health and the environment from exposure to contamination before completion of the remedy;	CAA and CMA and CAAA Report, Appendix A Human Health and Ecological Risk Assessment (CP Application Attachment N, Appendix 1).
845.670(f)(5)	Resource value of the aquifer, including:	Hydrogeologic Site Characterization Report Sections 3, 4, 5, and Appendix A (CP Application Attachment H).
845.670(f)(5)(A)	Current and future uses, including potential residential, agricultural, commercial industrial and ecological uses;	Hydrogeologic Site Characterization Report Section 5.1 and Appendix A/B (CP Application Attachment H).
845.670(f)(5)(B)	Proximity and withdrawal rate of users;	Hydrogeologic Site Characterization Report Section 5.1 and Appendix A/B (CP Application Attachment H).
845.670(f)(5)(C)	Groundwater quantity and quality;	Hydrogeologic Site Characterization Report Section 4.2 and Table 4-1 (CP Application Attachment H).
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;	Hydrogeologic Site Characterization Report Sections 5.2 and 5.3 (CP Application Attachment H).
845.670(f)(5)(E)	The hydrogeologic characteristic of the facility and surrounding land; and	Hydrogeologic Site Characterization Report Section 3 (CP Application Attachment H).
845.670(f)(5)(F)	The availability of alternative water supplies; and	Hydrogeologic Site Characterization Report Section 5.1 and Appendix A/B (CP Application Attachment H).
845.670(f)(6)	Other relevant factors.	Not applicable.

APPENDIX 1

Monitored Natural Attenuation Evaluation – Long-Term Monitoring and Contingency Plan

Geosyntec
consultants

Prepared for

Dynegy Midwest Generation
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Monitored Natural Attenuation Evaluation – Long-Term Corrective Action Monitoring and Contingency Plans

Vermilion Power Plant
North Ash Pond (CCR Unit #910) and Old East Ash Pond (CCR Unit #911) Areas

Prepared by

Geosyntec
consultants

engineers | scientists | innovators

134 N. Lasalle Street, Suite 300
Chicago, Illinois 60602

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TABLE OF CONTENTS

1 Introduction 1
  1.1 Facility Background and Description 1
  1.2 Objective and Scope 1
2 Field Sampling and Analytical Plan 3
  2.1 Sampling Methods 3
  2.2 Quality Assurance/Quality Control 3
  2.3 Statistical Evaluation 4
  2.4 Sampling Schedule 4
3 Contingency Plan 6
4 References 7

LIST OF TABLES

Table 1 Well Network Construction Details

Table 2 Sampling and Analysis Summary

LIST OF FIGURES

Figure 1 Long-Term Monitoring Well Sampling Location Map

LIST OF ACRONYMS

Acronym	Definition
CAAA	Corrective Action Alternatives Analysis
CAP	Corrective Action Plan
CMA	Corrective Measures Assessment
COC	Constituent of Concern
GMP	Groundwater Monitoring Plan
GWPS	Groundwater Protection Standard
HCR	Hydrogeologic Site Characterization Report
IAC	Illinois Administrative Code
IDNR	Illinois Department of Natural Resources
IDW	Investigation-Derived Waste
IEPA	Illinois Environmental Protection Agency
LCS	Laboratory Control Sample
LGU	Lower Groundwater Unit
LTM	Long Term Monitoring
MGU	Middle Groundwater Unit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NAP	North Ash Pond
OEAP	Old East Ash Pond
ORP	Oxidation Reduction Potential
PRB	Permeable Reactive Barrier
QA/QC	Quality Assurance/Quality Control
SAP	Sampling and Analysis Plan
TDS	Total Dissolved Solids
VPP	Vermilion Power Plant

1 INTRODUCTION

Geosyntec Consultants (Geosyntec) has prepared this long-term groundwater monitoring (LTM) plan on behalf of the former Vermilion Power Plant (VPP), owned by Dynegy Midwest Generation, LLC (DMG), to evaluate the performance of the source control-monitored natural attenuation (MNA) corrective action selected to address groundwater impacts associated with the retired North Ash Pond[1] and Old East Ash Pond[2]. Combined, the NAP and OEAP are considered the VPP impoundment system (the Site) addressed by this LTM.

1.1 Facility Background and Description

The 37-acre NAP and 21-acre OEAP are inactive, unlined surface impoundments located adjacent to each other in the northern portion of the VPP. The impoundments overlap and have a separator berm constructed of ash for prior operational purposes. The NAP is bordered to the north by fallow fields owned by the Illinois Department of Natural Resources (IDNR), to the east by the Middle Fork of the Vermilion River, to the southeast by the OEAP, and to the south and west by steep bluffs that include the Illinois Department of Conservation-designated Orchid Hill Natural Heritage Landmark. The Orchid Hill National Heritage Landmark is partially within the VPP property boundary but is administered by IDNR. The OEAP is bordered to the north and northeast by the Middle Fork, to the southeast, south, and west by steep bluffs, and to the northwest by the NAP. The NAP and OEAP are both located on terraces adjacent to the Middle Fork, which is bordered to the east and west by steep bluffs.

A Hydrogeologic Site Characterization Report (HCR) detailing the Site and regional geology and hydrogeology was included in the Operating Permit submittal for the NAP/OEAP (Ramboll, 2021a). The Middle Groundwater Unit (MGU), which is continuous below the NAP/OEAP, was designated as the uppermost aquifer. The Lower Groundwater Unit (LGU), which is separated from the MGU by a low-permeability confining unit, was identified as a potential migration pathway.

1.2 Objective and Scope

An MNA evaluation was completed to support the corrective action selection process. This evaluation identified the need for long-term monitoring if MNA was selected as a component of the corrective action (Geosyntec, 2022). This LTM sampling and analysis plan (SAP) is designed to document the approach to long-term groundwater sampling and sample analysis at the Site and evaluate the performance of the source control-MNA corrective action at the Site.

Previous assessments completed at the Site have identified boron, lithium, molybdenum, sulfate, and total dissolved solids (TDS) as constituents of concern (COCs). The corrective measures

[1] NAP; Illinois Environmental Protection Agency [IEPA] identification [ID] number [No.] W1838000002-01.
[2] OEAP; IEPA ID No. W1838000002-03.

assessment/corrective action alternatives analysis (CMA/CAAA)[3] identified source control-MNA as the most appropriate corrective action at the Site (Gradient, 2022).

Groundwater modeling completed to support the CMA/CAAA found that source control-MNA would achieve groundwater concentrations below the GWPS within approximately 50 years in the MGU and approximately 100 years in the LGU. The extended time frame in the LGU is due to the longer flow paths through low-permeability deposits located between the MGU and LGU (Ramboll, 2022). LTM is needed to evaluate if the selected source control-MNA corrective action performs as anticipated and that groundwater concentrations are reduced to below the groundwater protection standard (GWPS). The GWPS will be established in accordance with 35 I.A.C. § 845.600.

This LTM plan documents the corrective action groundwater monitoring program in accordance with 35 I.A.C. § 845.680(a)(1). Ongoing groundwater monitoring[4] will be completed as described in the Groundwater Monitoring Plan (GMP; Ramboll, 2021b). Samples collected as part of the ongoing groundwater monitoring efforts may be used for the purposes of the LTM evaluation if they meet the requirements of this LTM SAP. Should additional COCs be identified during ongoing groundwater, a separate CMA will be performed in accordance with 35 I.A.C. § 845.660.

[3] Prepared in accordance with Illinois Administrative Code (I.A.C.) Title 35 Sections 845.660 and 845.670.
[4] Completed in accordance with 35 I.A.C. § Part 845.650.

2 FIELD SAMPLING AND ANALYTICAL PLAN

2.1 Sampling Methods

The long-term groundwater monitoring proposed in this plan will use the network of monitoring wells described in the GMP (Ramboll, 2021b) and shown in **Figure 1**. In summary, the groundwater monitoring network includes ten monitoring wells screened in the MGU (wells 04, 05, 07R, 08R, 17, 20, 36, 38, 40, 41) and nine wells screened in the LGU (wells 02, 03R, 21, 34, 37, 42, 43, 101, 103). Of the 19 wells, five are background (shown in brown in **Figure 1**) and 14 are compliance wells (shown in blue in **Figure 1**). They will be used to monitor groundwater COC concentrations within the hydrostratigraphic units. Monitoring well depths and construction details are listed in **Table 1**.

The LTM program includes sampling and analysis procedures that are designed to provide an accurate representation of groundwater quality at the background and compliance wells as required by 35 I.A.C. § 845.630. The proposed monitoring wells are expected to yield groundwater samples that represent the quality of downgradient groundwater at the CCR boundary[5]. Groundwater sampling procedures have been developed and the collection of groundwater sampling will be implemented to meet the requirements of 35 I.A.C. § 845.640. Samples will be collected on a quarterly basis and submitted for the groundwater constituents included in 35 I.A.C. § 845.600. Sample collection and storage details are listed in **Table 2**.

2.2 Quality Assurance/Quality Control

The SAP includes procedures and techniques for quality assurance/quality control (QA/QC) consistent with the requirements of 35 I.A.C. § 845.640(a)(5). As listed in **Table 2**, 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 (LCS) and/or quality control check standards that have been spiked, and analyses to monitor the performance of the analytical method.

[5] As required in 35 I.A.C. § 845.630(a)(2).

- Matrix spike/matrix spike duplicate (MS/MSD) 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 laboratory contamination.

These samples will be analyzed as part of the field protocols and the laboratory's normal QA/QC protocols.

2.3 Statistical Evaluation

The reported analytical COC concentrations from the individual long-term monitoring events will be compared to the GWPS established in accordance with the GMP (Ramboll, 2021b). To monitor progress towards completion of the corrective action, trend tests will be completed to evaluate if decreasing trends are observed for the COCs as predicted by the groundwater modeling (Ramboll, 2022).

Calculation of trend tests will only begin following completion of the source control portion of the source control-MNA corrective action, as source control is expected to result in changing groundwater conditions at the Site. Source control measures are expected to take approximately nine years, with construction of the on-site landfill requiring approximately 1.8 years, followed by construction activities to close the NAP/OEAP which are expected to be completed in approximately 7.1 years (Gradient, 2022).

2.4 Sampling Schedule

The sampling laid out in this LTM plan will be initiated within 90 days after the IEPA's approval of the corrective action plan (CAP) submitted under 35 I.A.C. § 845.670. Groundwater sampling of the LTM well network will initially be performed quarterly following approval of the CAP.

Following five years of quarterly groundwater monitoring, semi-annual monitoring will begin pending IEPA approval of a demonstration that groundwater concentrations are below the GWPS 600 and:

- data are not exhibiting statistically significant increasing trends,

- monitoring effectiveness is not compromised by a semi-annual schedule, and

- sufficient data has been collected to characterize groundwater.

Quarterly or semiannual sampling schedules will be established on a well-by-well basis. Should detection of a statistically significant increasing trend in groundwater concentrations or an exceedance of the GWPS occur at a well approved for semiannual sampling, quarterly monitoring shall be resumed.

As provided in 35 I.A.C. § 845.680(c), the LTM will be considered complete when:

- Compliance with the GWPS has been achieved at all points with the plume of contamination that lies beyond the waste boundary;
- Compliance with the GWPS has been achieved by demonstrating that COC concentrations have not exceeded GWPS for a period of three (3) consecutive years, using statistical procedures and performance standards in 35 I.A.C. § 845.640(f) and (g); and,
- All actions required to complete the source control-MNA corrective action have been satisfied.

3 CONTINGENCY PLAN

Uncertainty associated with estimated rates of attenuation over extended periods of time is a key consideration for corrective actions which incorporate MNA. If the selected source control-MNA corrective action is not performing as anticipated after the first five consecutive calendar years following completion of source control activities, as indicated by decreasing trends of COCs, Site conditions will be reevaluated to assess whether there are changes which require further study to evaluate the anticipated success of the source control-MNA corrective action. This may include additional data collection to understand if pH or redox conditions have changed, which would affect chemical attenuation mechanisms and rates. A review of hydraulic conditions post-closure may also be required to assess if observed conditions are comparable to the pre-closure groundwater flow model. If differences in site conditions are identified, the attenuation rate and predicted time frame to achieve GWPS may need to be adjusted to support the continued use of source control-MNA as the selected groundwater corrective action.

If reevaluation indicates that the MNA remedy is no longer viable, alternative remedial technologies may need to be considered. Alternative groundwater remedial technologies were evaluated in the CMA/CAAA, including pump and treat, installation of a groundwater cutoff wall, or installation of a permeable reactive barrier (PRB) (Gradient, 2022). The CMA/CAAA may need to be updated to incorporate updated site conditions which are characterized in the MNA reevaluation, which may include an updated risk evaluation. If an alternative corrective measure is selected, MNA may be considered as a supplemental process to that alternative.

4 REFERENCES

Geosyntec. 2022. *Monitored Natural Attenuation Evaluation – Vermilion Power Plant. North Ash Pond (CCR Unit #910) and Old East Ash Pond (CCR Unit #911) Areas.* January.

Gradient. 2022. *Closure Alternatives Analysis and Corrective Measures Assessment/Preliminary Corrective Action Alternatives Analysis for the Vermilion Power Plant*. Oakwood, Illinois. January.

Ramboll Americas Engineering Solutions, Inc. (Ramboll). 2021a. *Hydrogeologic Site Characterization Report – Vermilion North Ash Pond and Old East Ash Pond, Vermilion Power Plant, Oakwood, Illinois.* Report to Dynegy Midwest Generation, LLC., August.

Ramboll. 2021b. *Groundwater Monitoring Plan – Vermilion North Ash Pond and Old East Ash Pond.* October.

Ramboll, 2022. *Groundwater Modeling Report – Vermilion North Ash Pond and Old East Ash Pond.* January.

Tables

Table 1. Well Network Construction Details
Vermilion Power Plant

Location	Elevation (ft)	Depth to Bottom of Screen (ft bgs)	Depth to Top of Screen (ft bgs)	Total Depth of Well (ft bgs)	Screen Length (ft)	Geologic Unit	Northing	Easting
04	587.4	13.5	8.7	13.5	4.8	UA	1282354.20	1148646.18
05	592.3	13.9	9.1	13.9	4.8	UA	1282628.72	1148029.85
07R	589.2	12	7.2	12	4.8	UA	1280880.71	1148966.07
08R	587.9	14.5	9.5	18	5	UA	1281529.66	1148326.00
17	619.6	59	54	60	5	UA	1280782.02	1148178.35
20	590.2	17.5	12.5	18.5	5	UA	1282559.28	1149090.38
36	587.8	21	16	21	5	UA	1281167.78	1148445.57
38	589.1	31	21	31	10	UA	1283326.04	1148648.68
40	589.6	17.5	12.5	17.5	5	UA	1280855.20	1149198.89
41	585.1	31	21	31	10	UA	1282007.83	1148555.77
02	590.4	39.7	30.1	39.7	9.6	PMP	1280877.28	1148956.24
03R	587.8	34	29	35.3	5	PMP	1281524.44	1148327.06
21	670.7	109	104	110	5	PMP	1279908.94	1148653.39
34	590.1	54.1	49.1	54.3	5	PMP	1282549.17	1149083.82
37	587.8	53	48	53	5	PMP	1281164.76	1148447.89
42	605.4	60	50	60	10	PMP	1281034.19	1147692.64
43	605.3	65	55	65	10	PMP	1281796.23	1147229.11
101	704.1	151	141	151	10	PMP	1279698.18	1146097.60
103	717.4	165	155	165	10	PMP	1279960.01	1147526.10

Notes
- All well screens are 2 inches in diameter
- Elevation is feet above mean sea level
- Gray highlight indicates background wells
- Geologic Unit indicates unit across which each well is screened
- ft bgs = feet below ground surface
- UA = upper aquifer
- PMP = potential migration pathway

Table 2. Sampling and Analysis Summary
Vermilion Power Plant

Parameter	Analytical Method[1]	No. of Samples	Field Duplicates[2]	Field Blanks[3]	Equipment Blanks[3]	MS/MSD[4]	Total	Container Type	Preservation (Cool to 4 °C for all samples)	Sample Hold Time from Collection Date
Metals										
Metals[5]	6020, Li - EPA 200.7	19	3	0	0	2	24	plastic	HNO_3 to pH<2	6 months
Mercury	7470A or 6020	19	3	0	0	2	24	plastic	HNO_3 to pH<2	28 days
Inorganic Parameters										
Fluoride	9214 or EPA 300	19	3	0	0	2	24	plastic	Cool to 4 °C	28 days
Chloride	9251 or EPA 300	19	3	0	0	2	24	plastic	Cool to 4 °C	28 days
Sulfate	9036 or EPA 300	19	3	0	0	2	24	plastic	Cool to 4 °C	28 days
Total Dissolved Solids	SM 2540 C	19	3	0	0	2	24	plastic	Cool to 4 °C	7 days
Radium										
Radium 226	9315 or EPA 903	19	0	0	0	0	19	plastic	HNO_3 to pH<2	6 months
Radium 228	9320 or EPA 904	19	0	0	0	0	19	plastic	HNO_3 to pH<2	6 months
Field Parameters										
pH	SM 4500-H+ B	19	N/A	N/A	N/A	N/A	19	flow-through cell	none	immediately
Dissolved Oxygen	SM 4500-O/405.1	19	N/A	N/A	N/A	N/A	19	flow-through cell	none	immediately
Temperature	SM 2550	19	N/A	N/A	N/A	N/A	19	flow-through cell	none	immediately
Oxidation-Reduction Potential	SM 2580 B	19	N/A	N/A	N/A	N/A	19	flow-through cell	none	immediately
Specific Conductance	SM 2510 B	19	N/A	N/A	N/A	N/A	19	flow-through cell	none	immediately
Turbidity[6]	SM 2130 B	19	N/A	N/A	N/A	N/A	19	flow-through cell or hand-held turbidity meter	none	immediately

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 frequencey of one per group of ten or fewer investigative water sample. 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 one 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 samples per CCR unit/multi-unit. Additional volume to be determined by laboratory.

[5]Metals = antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, lead, lithium, molybdenum, selenium, thalllium.

Metals may be analyzed via ICP/ICP-MS USEPA methods 6010 or 6020 depending on laboratory instrument availability

[6]If turbidity exceeds 10 NTUs, 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

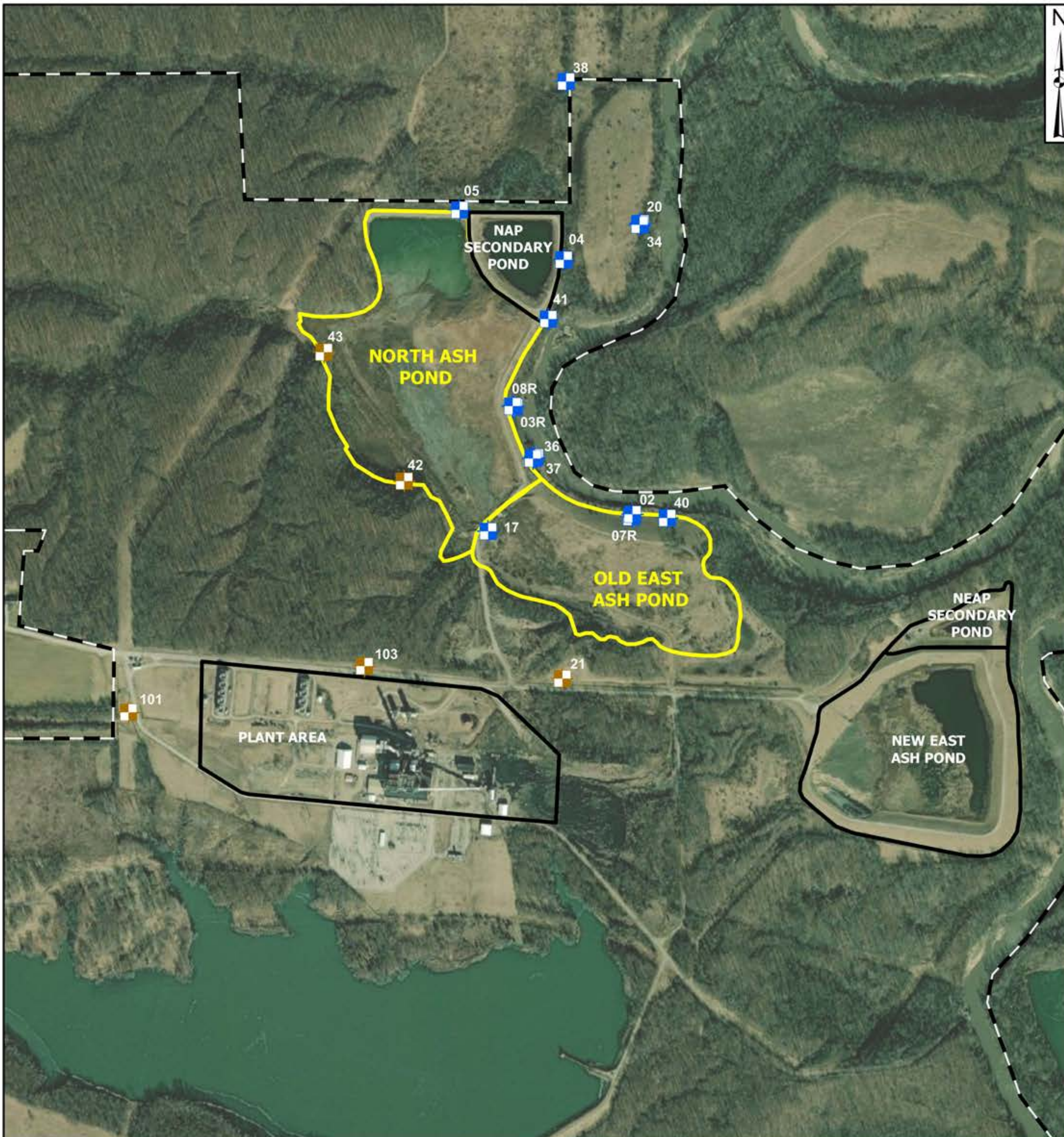
HNO_3 = nitric acid

mL = milliliter

N/A = not applicable

NTU = nephelometric turbidity unit

Figures



Legend

- Compliance Well
- Background Well
- Part 845 Regulated Unit (Subject Unit)
- Site Feature
- Property Boundary

Notes

- Figure originally from "Groundwater Monitoring Plan - North Ash Pond and Old East Ash Pond, Vermilion Power Plant." (Ramboll, 2021).

1,000 500 0 1,000 Feet

Long-Term Monitoring Well Sampling Location Map

Vermilion Power Plant
Oakwood, Illinois

Geosyntec consultants

Ann Arbor, Michigan | January 2022

Figure 1

Y:\Company\Projects_post_2014\CHE8404_VPS_Closure_RIA_Sprt\500 - Technical\572 - MNA and GSI Evaluation\MNA Report\LTM Plan\Figures\20211227_Well_Locations.svg. CWallace. 12/27/2021. CHE8404B

ATTACHMENT Q

New Onsite Landfill Feasibility Assessment

PROPOSED ON-SITE
LANDFILL FEASIBILITY STUDY
Vermilion Power Plant
Oakwood, IL

Submitted to

Dynegy Midwest Generation, LLC

1500 Eastport Plaza Drive

Collinsville, IL 62234

Submitted by

Geosyntec consultants

engineers | scientists | innovators

134 N La Salle Street

Suite 300

Chicago, Illinois 60602

January 2022

TABLE OF CONTENTS

EXECUTIVE SUMMARY ii

SECTION 1 INTRODUCTION 1-1

SECTION 2 EVALUATION OF LANDFILL LOCATION STANDARDS...............2-1

SECTION 3 LANDFILL CONCEPTUAL DESIGN 3-1

3.1 Design Overview 3-1
3.2 Evaluation of Design Elements...3-3

SECTION 4 CONCLUSIONS..4-1

LIST OF FIGURES

Figure 1 Existing Conditions
Figure 2 Top of LCS
Figure 3 Top of Waste
Figure 4 Site Cross-Sections
Figure 5 Floodplain Bluffs Delineation

LIST OF APPENDICES

Appendix A Field and Laboratory Data
Appendix B Inundation Map

EXECUTIVE SUMMARY

A new on-site landfill (New Landfill) is being considered to be constructed in the area of the retired power plant at the Vermilion Power Plant (Power Plant Property[1]). The power plant will be demolished, and substructures will be removed. The New Landfill will meet the state requirements of 35 Illinois Administrative Code (IAC) Part 811 and the applicable federal requirements of 40 Code of Federal Regulations (CFR) Part 257 Subpart D (Federal CCR rule). The New Landfill will have an approximate 27-acre waste footprint and a 40-acre facility footprint (Facility), which encompasses the associated haul roads and space needed for ditches, a stormwater basin, and leachate structures. The New Landfill will have sufficient disposal "air space" to accommodate the needs of the on-site ash pond closure by removal construction and power plant demolition. The Feasibility Study (FS) will summarize the following:

1. An overview of the New Landfill;

2. Evaluation of applicable landfill location standards;

3. Description and details of the New Landfill environmental control systems including: bottom liner system, leachate collection system, stormwater management, final cover system, and cell layout; and

4. Evaluation of other design elements, including location overview, geology and hydrogeology, uppermost aquifer, excavation, stability, construction, and landfill filling schedule, source material management, operating plan, long-term leachate management, landfill gas management (not applicable), access road, and closure and post-closure care.

---

[1] Power Plant Property includes the area of the power plant, ancillary areas, a cooling lake, and nearby CCR surface impoundments.

SECTION 1

INTRODUCTION

This FS evaluates the feasibility of the conceptual design of the New Landfill under consideration at Power Plant Property. This FS is presented in support of a closure alternatives analysis (CAA) that is being prepared in accordance with 35 IAC Part 845.710(b)[2]. The CAA is being conducted for the closure of the following coal combustion residual (CCR) surface impoundments: Old East Ash Pond area (OEAP)/North Ash Pond area (NAP), and New East Ash Pond (NEAP). The CAA and this FS will be included in the Final Closure Plan prepared under Part 845.720(b) that is a part of the ash ponds closure Construction Permit Applications prepared under Part 845.220.

The New Landfill under consideration will contain CCR material generated on-site by the Owner's own activities such as: closure by removal of existing CCR surface impoundments and non-hazardous wastes from demolition and clean-up of a retired coal fired power plant. Therefore, it will be necessary to meet the requirements of Section 21(d)(1) of the Illinois Environmental Protection Act (IL Act) which does not require local siting approval for municipal solid waste landfills and CCR surface impoundments when the wastes generated by the person's own activities are disposed of within the site where such wastes are generated.

The New Landfill under consideration must meet the technical and permitting requirements of 35 IAC Part 811. The New Landfill is expected to meet the requirements of 35 IAC Part 811 and applicable Federal CCR rule requirements based on this FS and Geosyntec's experience. Documentation demonstrating compliance with 35 IAC Parts 811 and 812 will be performed through submittal of a permit application to Illinois Environmental Protection Agency (IEPA).

The New Landfill under consideration will be located where the current power plant and associated structures stand and to the area west of the plant structures. The power plant and its structures will be removed prior to development of the New Landfill. The New Landfill under consideration will be bordered by existing site roads to the north and south. A stormwater basin is proposed to be located southwest of the New Landfill and the existing southern access road. The New Landfill location under consideration is depicted in **Figure 1**.

---

[2] Illinois Pollution Control Board, Title 35: Environmental Protection, Subtitle G: Waste Disposal, Chapter I: Pollution Control Board, Subchapter j: Coal Combustion Waste Surface Impoundments, April 2021.

SECTION 2

EVALUATION OF LANDFILL LOCATION STANDARDS

The Illinois location standards for the New Landfill under consideration are established in 35 IAC Sections 811.102[3] and 811.302[4]. Additional federal requirements for CCR units under 40 CFR Part 257 Subpart D will also be addressed. **Table 1** summarizes the Illinois and Federal CCR rule location standards. The New Landfill under consideration meets the requirements of state and federal location standards based on currently available data. It is expected that all location standards will be verified following additional studies such as a wetland delineation, archaeological survey, and other studies. The Facility boundary is shown on **Figure 1**.

Table 1
Illinois Landfill Location (35 IAC 811) and Federal CCR Landfill Location Standards (40 CFR Part 257 Subpart D)

Location Standards	Setback Requirements	Regulatory Citation	Meets	Does Not Meet	Requires Additional Evaluation	Notes
Airport	• 10,000-foot setback from any runway with turbojet aircraft • 5,000-foot setback from any runway with piston aircraft • Notify FAA if within 5 miles of airport runway • 6-mile setback for new landfills for public use airports designed for 60 passengers or less	35 IAC 811.302 (c) and (f) Wendall Ford Act (49 U.S.C. 44718(d))	X			The nearest airport is the Vermilion County Airport, which is located over 7 miles to the northwest of the New Landfill.
Floodplain	The facility shall not be located in 100-year floodplain	35 IAC 811.102 (b)	X			The New Landfill is approximately 108-feet above and 1,200-feet outside of the 100-year floodplain based on a 2021 Inundation Map from Illinois State LiDAR data.

[3] Subpart A: General Standards for all Landfills
[4] Subpart C: Putrescible and Chemical Waste Landfills

Table 1
Illinois Landfill Location (35 IAC 811) and Federal CCR Landfill Location Standards (40 CFR Part 257 Subpart D)

Location Standards	Setback Requirements	Regulatory Citation	Meets	Does Not Meet	Requires Additional Evaluation	Notes
Placement above the uppermost aquifer	Five feet above the upper limit of the uppermost aquifer	§257.60	X		X	The proposed New Landfill excavation grades will range from 672 ft MSL on the north end of each cell to approximately 668 ft MSL on the south side. The estimated uppermost aquifer elevation (based on 2011 borings) is estimated to be at least 135 feet below ground surface in the vicinity of the New Landfill. The uppermost aquifer will have to be confirmed during the hydrogeologic investigation.
Wetlands/Waters of U.S.	The facility shall not cause a violation of Section 404 of the Clean Water Act	35 IAC 811.102(e) And §257.61	X		X	Based on the developed nature of the Facility and its location (uplands) there is a low probability of the existence of wetlands. A wetland delineation study will be performed on the New Landfill area as part of the IEPA permitting process.
Fault	The landfill unit will not be located within 200 feet of a Holocene fault	35 IAC 811.304 And §257.62	X			There are no Holocene faults within 200 feet of the New Landfill.
Seismic Impact Zones	The facility shall not be located in a seismic impact zone (10% or greater chance of exceeding 0.10 g in 250 years) unless all containment structures are designed	35 IAC 811.304 And §257.63	X			The peak ground acceleration is 0.0806g at the Facility; and therefore, the New Landfill is not in a seismic impact zone.
Unstable Areas	The facility shall not be located in an unstable area unless engineering measures have been incorporated	35 IAC 811.305 And §257.64	X		X	There are no reported karst areas near the Facility. Coal mining was previously performed near the Vermilion River. Previous studies indicate that mining was adjacent to the River. A site-specific investigation will be included in the hydrogeologic investigation in the New Landfill IEPA permit application.

Table 1
Illinois Landfill Location (35 IAC 811) and Federal CCR Landfill Location Standards (40 CFR Part 257 Subpart D)

Location Standards	Setback Requirements	Regulatory Citation	Meets	Does Not Meet	Requires Additional Evaluation	Notes
Wild and Scenic Rivers	The facility shall meet all requirements under the Wild and Scenic River Act	35 IAC 811.102(a)	X			The Middle Fork of the Vermilion River is designated as a wild and scenic river. Based on correspondence from the National Park Service, they recommend landfill development outside of a ¼ mile radius of national wild or scenic rivers. The final design of the landfill unit footprint or boundary can and will be located outside of this setback.
Historic and Natural Areas	The facility shall not be located in areas where it may pose a threat of harm to historical or natural area as designated as a Dedicated Illinois Nature Preserve.	35 IAC 811.102	X		X	The EcoCAT survey identified several historic or natural areas within the vicinity of the New Landfill. The nearest historic or natural area is the Kickapoo State Recreation Area located 0.5 miles south. A Phase I Archaeological Survey is recommended for the New Landfill to verify that no historic or natural areas are present in the New Landfill facility boundary.
Endangered Species	The facility shall not be located in areas where it may jeopardize the continued existence of endangered species	35 IAC 811.102 (d)	X			Multiple protected resources were identified in the vicinity of the project location per an EcoCAT due to the Middle Fork of the Vermilion River but not within the proposed New Landfill area. The design report, CQA and operating plans, that will be developed during the IEPA permitting process, will include documentation on how the New Landfill will not impact endangered species.
Water Quality Management Plan	The facility shall not cause a violation of any area-wide or state-wide water quality management plan	35 IAC 811.102(f)	X			The New Landfill design will incorporate stormwater design elements that will improve existing stormwater quality.

Table 1 Illinois Landfill Location (35 IAC 811) and Federal CCR Landfill Location Standards (40 CFR Part 257 Subpart D)						
Location Standards	**Setback Requirements**	**Regulatory Citation**	**Meets**	**Does Not Meet**	**Requires Additional Evaluation**	**Notes**
Water Supply Wells Setback	• LF unit, 200 feet for off-site water supply wells • LF Unit, 2,500 feet from a community supply well (Section 14.2 and 14.3)	35 IAC 811.302(a)	X			The nearest community supply well is in Danville located over four miles (>20,000 ft) to the east.
Sole-Source Aquifers	No part of the LF unit shall be located within 1,200 feet vertically or horizontally of a sole source aquifer, unless an impermeable situation exists below the unit.	35 811.302(b)	X			The Mahomet aquifer is designated as a sole source aquifer and is within 1 mile of the New Landfill, but the proposed New Landfill is outside of the regulatory 1,200-foot setback.
Road and Highways	The facility must have a 500-foot setback of any county road, state, or interstate or have operations screened by a barrier	35 IAC 811.302 (c)	X			The New Landfill will be designed and developed with a 500-foot setback from all county, state or interstate roads.
Occupied Dwellings, Schools, Hospitals, Etc.	The landfill unit must have a 500-foot setback unless special permission is granted by the owner.	35 IAC 811.302 (d)	X			The New Landfill will be designed and developed with a 500-foot setback from all occupied dwellings, schools, hospitals, etc. There are no schools or hospitals within 4,600 feet of the proposed New Landfill area.

SECTION 3

LANDFILL CONCEPTUAL DESIGN

3.1 Design Overview

The conceptual layout of the New Landfill under consideration is shown on **Figures 2** and **3**. The estimated waste footprint or boundary is approximately 27 acres. The New Landfill will provide a waste volume of approximately 3,100,000 cu yds of "airspace" (i.e., storage volume). The Landfill may accept an estimated 50,000 cubic yards (cy) of material from the coal yard, 2,163,000 cy of coal combustion residuals (CCR) from the North Ash Pond area (NAP) and Old East Ash Pond area (OEAP) closure[5], 376,000 cy of CCR from the New East Ash Pond (NEAP) closure, and 35,000 cy of non-hazardous construction demolition debris from the demolition of the power plant. The total waste volume includes an approximate 20 percent contingency in waste volume capacity.

The design elements of the proposed New Landfill have been implemented at many other modern landfill facilities and have demonstrated to be protective of the public health, safety and welfare and compliant with Illinois landfill regulations. All landfill design and construction elements will be overseen and certified by a third party licensed professional engineer in the State of Illinois. Some of the design features of the New Landfill under consideration include:

- **Composite Bottom Liner System –** The proposed New Landfill will be designed with a composite liner system consisting of a minimum three-foot thick, low permeability soil liner. The low permeability soil liner will be installed in lifts and compacted to achieve a permeability no greater than 1×10^{-7} cm/sec. The three-foot thick compacted soil liner will be overlain by a 60-mil thick high-density polyethylene (HDPE) geomembrane liner.

- **Leachate Collection System (LCS) –** The liquids that come into contact with the waste are defined as "leachate" or "contact water" and are managed so these liquids do not impact groundwater or surface water sources. The New Landfill under consideration will be designed with a one-foot-thick granular drainage layer or a geocomposite drainage layer that will be installed directly above the composite bottom liner system. The leachate collection system will drain to collection points (i.e., leachate sumps) located along the

[5] A portion of the OEAP area and NAP area are co-located over the southern end of NAP and northern end of OEAP and are considered as one surface impoundment for the construction permit.

base of the landfill. The conceptual design (see **Figure 2**) has five leachate sumps, associated with five landfill cells, located on the southern edge of the New Landfill.

Contact water during construction will be pumped from the sumps to either a leachate pond or above ground storage tank(s) located adjacent to the landfill. The leachate will be discharged through either of the Facility's NPDES permitted outfall(s). The NPDES permit would require a modification should it receive landfill contact water/leachate. After closure, the leachate will be managed and discharged either through the Power Plant Property's NPDES permitted outfall(s) or transported to a permitted wastewater treatment plant (WWTP).

- **Final Cover System –** The final cover system will cover the entire New Landfill and will tie-into the bottom liner system at the perimeter to fully encapsulate the waste mass. The final cover system design will include a low permeability layer to prevent precipitation from entering the waste mass to minimize leachate generation. The low permeability layer will consist of two components: (1) 1-foot low permeability cohesive soil/clay layer, and (2) 40-mil linear low-density polyethylene (LLDPE) geomembrane. A geocomposite drainage layer will be installed directly on top of the geomembrane if necessary, to minimize the liquid head on the final cover system, thereby reducing final cover infiltration and improving stability of the final cover system. A three-foot protective cover soil layer will be placed over the geocomposite drainage layer. The upper six inches of the protective cover soil layer will be suitable for supporting vegetation. The final cover will be vegetated. Any stormwater runoff that occurs after placement of the one-foot-thick low permeability cohesive soil/clay layer will be non-contact stormwater.

- **Disposal Cell Layout –** The New Landfill will incorporate five cells, oriented from west to east. The bottom liner will be graded in a sawtooth configuration to promote the flow of leachate from north to south and prevent ponding. The side slopes of the bottom liner and LCS grades will be constructed at 3H:1V. The LCS pipe will be sloped from an approximate elevation of 674 ft MSL at the southern end of Cell 1 and 672 ft MSL at the southern end of Cells 2 through 5, up to an elevation of 676 ft MSL at the northern end of each cell. Leachate in each cell will drain at a minimum 2.0 percent slope to a center LCS pipe in each cell. The LCS pipes will slope at a minimum 1.0 percent from north to south to a sump located at the south end of each cell. The sumps will be located at an approximate elevation of 672 ft MSL.

  The final waste elevation will be approximately 811 ft MSL (see **Figure 3**), and the final cover will be constructed to a maximum elevation of 815 ft MSL with an upper plateau slope of 20H:1V and maximum side slopes of 3H:1V. The side slopes may be reduced to 4H:1V if the required waste volume is less than currently anticipated during CCR surface impoundment closure.

Figure 4 shows the conceptual New Landfill cross section and depicts the slopes and elevations of the proposed New Landfill.

3.2 Evaluation of Design Elements

The following evaluation is provided for the elements of the geologic setting, landfill design, operations, closure and post-closure.

- **Geologic Setting – Unconsolidated Deposits –** During the spring of 2021, borings were completed for new groundwater monitoring wells (MW-101, -102, -103, -104, and -105), which surround the New Landfill under consideration. The borings (**Appendix A**) show the foundation soil underlying the New Landfill primarily consists of clay alluvium. The soils are generally lean clays and silty clays with varying amounts of sand and gravel ranging from very soft to hard with an average of being very stiff. Laboratory testing indicates that the clay alluvium exhibits an average vertical hydraulic conductivity less than $1x10^{-6}$ cm/sec.

  There are thin and discontinuous seams of sand alluvium present in the clay alluvium. The sand alluvium consists of fine to coarse-grained sands and gravels. The shallow sand alluvium around the New Landfill is monitored and located at elevations between approximately 617 to 654 feet above mean sea level (ft MSL). While the shallow sand alluvium may contain groundwater, it is not the uppermost aquifer for the Power Plant Property, as it is discontinuous and not used as a water supply. The deep sand alluvium around the New Landfill corresponds with the lower groundwater unit (LGU) and is monitored and located at elevations 540 to 561 ft MSL. The LGU is considered to be the uppermost aquifer under the New Landfill.

- **Uppermost Aquifer** – While the Power Plant Property consists of various localized groundwater bearing units, the uppermost aquifer at the Facility is the LGU. The LGU underlies most of the alluvial deposits and is located above the bedrock. The top of the bedrock is up to 150 feet below the ground surface in the area of the New Landfill.

- **Groundwater Flow** – There are three groundwater units under the Power Plant Property: the upland groundwater unit (UGU), middle groundwater unit (MGU) and LGU. Based on the 2012 hydrogeologic study in the area of the OEAP, the UGU is located between elevations 565 and 552 ft MSL (discontinuous), the MGU is between 586 and 559 ft MSL, and the LGU is between 563 and 536 ft MSL. The MGU and LGU are the primary water bearing units at the Power Plant Property. They are comprised of alluvial sands and gravel and glacial outwash. Groundwater at the New Landfill flows through the LGU from west to the east on the west side of the New Landfill and from north to the south on the east side of the New Landfill, before discharging to the existing Illinois Power Company Lake located south of the New Landfill. Groundwater levels are expected to fluctuate due to seasonal changes, precipitation events, and other factors. A hydrogeologic evaluation and groundwater impact assessment model will be completed for the New Landfill as part of the IEPA permit application.

- **Location** – The New Landfill will be located such that it meets the airport, floodplain, uppermost aquifer, wetlands/waters of the U.S., fault zone, seismic impact zone, unstable area, wild and scenic rivers, historic and natural areas, endangered species, water quality management plan, wet supply well setback, sole-source aquifer, road and highway, and occupied dwellings, schools, and hospitals location standards. The waste boundary of the New Landfill will be located 50 feet off the boundary of the access roads to allow for construction of perimeter ditches and groundwater monitoring well installation. The waste boundary will also be located away from any active utility easements. Additional evaluations will be completed to fully demonstrate compliance with the 35 IAC Part 811 and Federal CCR rule location standards.

- **Long Term Floodplain Impacts** – Geosyntec reviewed the historical aerial imagery, flood study data, geomorphology, geotechnical data, and proximity of the Middle Fork of the Vermilion River (River). Geosyntec's conclusion is that the location of the proposed New Landfill is in a stable location and not prone to be impacted by future meandering and erosion by the River.

  The River alignment and geologic floodplain have been constrained historically by the floodplain bluffs (sometimes referred to as alluvial terraces and valley walls) shown in historical imagery and topographic data dating back to 1940. The floodplain bluffs were formed at the end of the Pleistocene Epoch (end of the last period of glaciation around 11,000 years ago). **Figure 5** provides a delineation of the floodplain bluff alignment near the proposed New Landfill location.

  The existing ground surface elevation at the Landfill is approximately 700 ft. The ground surface elevation of the River overbank is approximately 590 ft. The water surface elevation of the 1,000-year flood event is 600 ft. The New Landfill will be approximately 100-feet in elevation above the River's 1,000-year flood event elevation (see **Appendix B**) and 110 ft above the current floodplain elevation of 590 ft. The nearest adjacent floodplain bluff is located approximately 650-feet northeast of the proposed New Landfill location, which is approximately 750-feet horizontally away from the River channel right descending bank. The proposed New Landfill would be located approximately 1,400-feet horizontally from the River.

  There has been no evidence, based on the geomorphology of the valley since the River channel was formed at the end of the Pleistocene Epoch, showing that the River has ever flowed through the location of the proposed New Landfill or overtopped the valley wall, and it is not expected to ever move significantly beyond the floodplain bluffs/valley walls.

- **Excavation** – The New Landfill will be constructed by first excavating down to a subgrade with the intention of using excavated soils in construction of the low permeability bottom and final liner system, cover protective layer and other berms and site features. The soils that were encountered in borings were silt, low plasticity clays that are suitable for low the expected purposes. Further, it is necessary that the design provide sufficient excavation volume for construction material, but it is not necessary to have a balanced cut and fill because any excess fill may be sold or used in the backfilling of excavations for the closure by removal of the surface impoundments. The preliminary cut and fill indicate an excess of 1,325,000 cu yd of fill.

- **Stability** – The stability of the excavation, side slopes, veneer (liner interfaces with different layers), and top cover grades have been selected with a high degree of confidence they will meet geotechnical criteria based on the on-site material properties and the properties of the expected manufactured layers. Geotechnical testing of the different materials at the Power Plant Property was completed and the summary data tables of the results of the investigation are presented in **Appendix A**. Based on a review of the material properties of the on-site foundation soils, it is Geosyntec's experience that the proposed New Landfill under consideration will meet the slope stability and settlement requirements. Further, it does not appear that there are any layers of loose saturated sand or silt that may be susceptible to liquefaction. Geotechnical calculations will be completed as part of the New Landfill design in the IEPA permit application and the design will be revised, if necessary, to meet the regulatory requirements.

- **Construction and Landfill Filling Schedule** – It is anticipated that site investigation, design and review for the proposed New Landfill will take a number of years. The New Landfill construction and filling will begin in the western most cell and progress to the east to allow plant demolition to occur simultaneously. It is estimated that construction and filling (approximately 3,100,000 cu yds of materials) of the landfill are estimated to take approximately 6 years. The closure of the landfill (approximately 27 acres) will occur as different areas reach final top of waste design elevations and will occur over a period of approximately two years.

- **Source of Materials** – The bottom liner soil layer, protective soil layer in the final cover system, daily cover, and intermediate cover materials are anticipated to be obtained primarily from on-site excavated soils from within the New Landfill footprint. The initial geotechnical laboratory data (**Appendix A**) and field boring log information indicates that excavated soils for landfill development are predominantly low plasticity silty clays and are suitable for these materials.

- **Operating Plan** – The facility will develop and implement an operating plan that meets the applicable landfill regulatory requirements under 35 IAC Part 811. All employees will be trained and managed to comply with the contents of the operating plan. The operating plan will discuss waste placement, cover materials and placement, leachate and stormwater management, dust controls maintenance program, and emergency procedures that will be implemented at the New Landfill to provide worker's safety and minimize impacts to on-site workers and the surrounding properties.

- **Long-Term Leachate Management** – The proposed New Landfill design includes a LCS to remove liquids from below the CCR and will be designed to minimize the formation of leachate and to prevent leachate from coming into contact with either surface water or groundwater sources. The New Landfill under consideration will be designed with the following elements to decrease potential precipitation infiltration and resulting leachate formation: (1) cover and landfill phasing practices, (2) intermediate and final landfill waste grading, and (3) final cover system. The final cover system will be placed as soon as practicable to minimize stormwater infiltration and reduce contact water runoff.

- **Stormwater Management** – The Owner will design, install and operate a stormwater management plan that meets all state and local requirements. Through the use of perimeter berms, rain flaps and diversion ditches, stormwater will be diverted around active landfill areas to the proposed stormwater basin located southwest of the Cell 1. After closure, the final grading plan and cover system will isolate precipitation (i.e., non-contact stormwater) and thereby significantly reducing leachate generation during post-closure.

- **Landfill Gas Management** – The New Landfill will primarily consist of CCR material; however, it will consist of some inert, non-hazardous construction demolition debris, and coal yard residuals. Gas generation at the New Landfill is anticipated to be minimal and a gas system may be incorporated, if necessary.

- **Access Road** – The existing access roads to the north, west and south of the proposed landfill will continue to be used and will provide access for filling, maintenance, and inspection purposes.

- **Closure and Post-Closure Care** – The New Landfill IEPA permit application will include closure and post-closure care plans that will describe how the New Landfill will be closed and what activities will be performed during post-closure care. The post-closure care plan will describe the maintenance, monitoring and inspection programs for the New Landfill during the post-closure care period. The anticipated post-closure care period for the New Landfill will be 30 years.

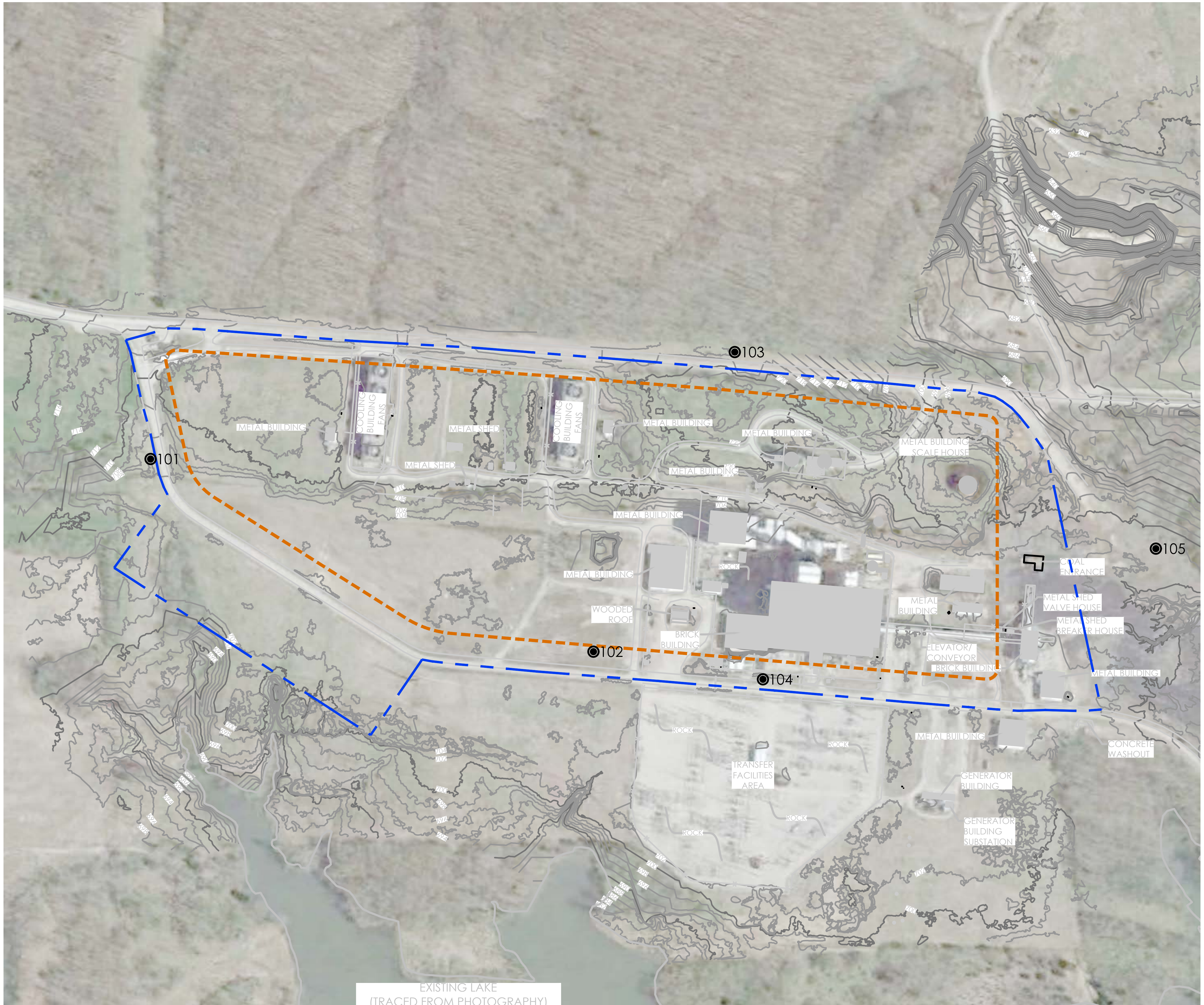
SECTION 4

CONCLUSIONS

Geosyntec has performed a FS at the New Landfill located on the conceptual Facility in support of the CAA. The conceptual design meets the requirements of 35 IAC Part 811 and applicable Federal CCR rule regulations. Additional studies and assessments will be conducted to verify that all of the location standards are fully met. Further documentation demonstrating compliance with 35 IAC Parts 811 and 812 will be performed through submittal of a permit application to the IEPA.

Based on a Geosyntec's understanding of Facility conditions, the conceptual New Landfill design, and the location demonstrations currently completed, it is Geosyntec's professional opinion that the New Landfill will meet the criteria of 35 IAC Part 811 and 40 CFR Part 257 Subpart D, and can be feasibly constructed, filled, and closed at the Power Plant Property

FIGURES



LEGEND

- PROPOSED FACILITY BOUNDARY
- PROPOSED WASTE BOUNDARY
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- EXISTING MONITORING WELL BORING LOCATION

NOTES:

1. THE DATE OF AERIAL IMAGE IS APRIL 20, 2019 OBTAINED FROM GOOGLE EARTH PRO.
2. SURROUNDING TOPOGRAPHY OBTAINED FROM 06-21-2021 SURVEY.
3. ALL LAYOUTS ARE CONCEPTUAL AND WILL CHANGE WITH FINAL DESIGN.

N

0 200' 400'

SCALE IN FEET

CONCEPTUAL NEW LANDFILL
VERMILION POWER PLANT
EXISTING CONDITIONS

Geosyntec consultants

PROJECT NO: CHE8404 | JANUARY 2022

FIGURE 1

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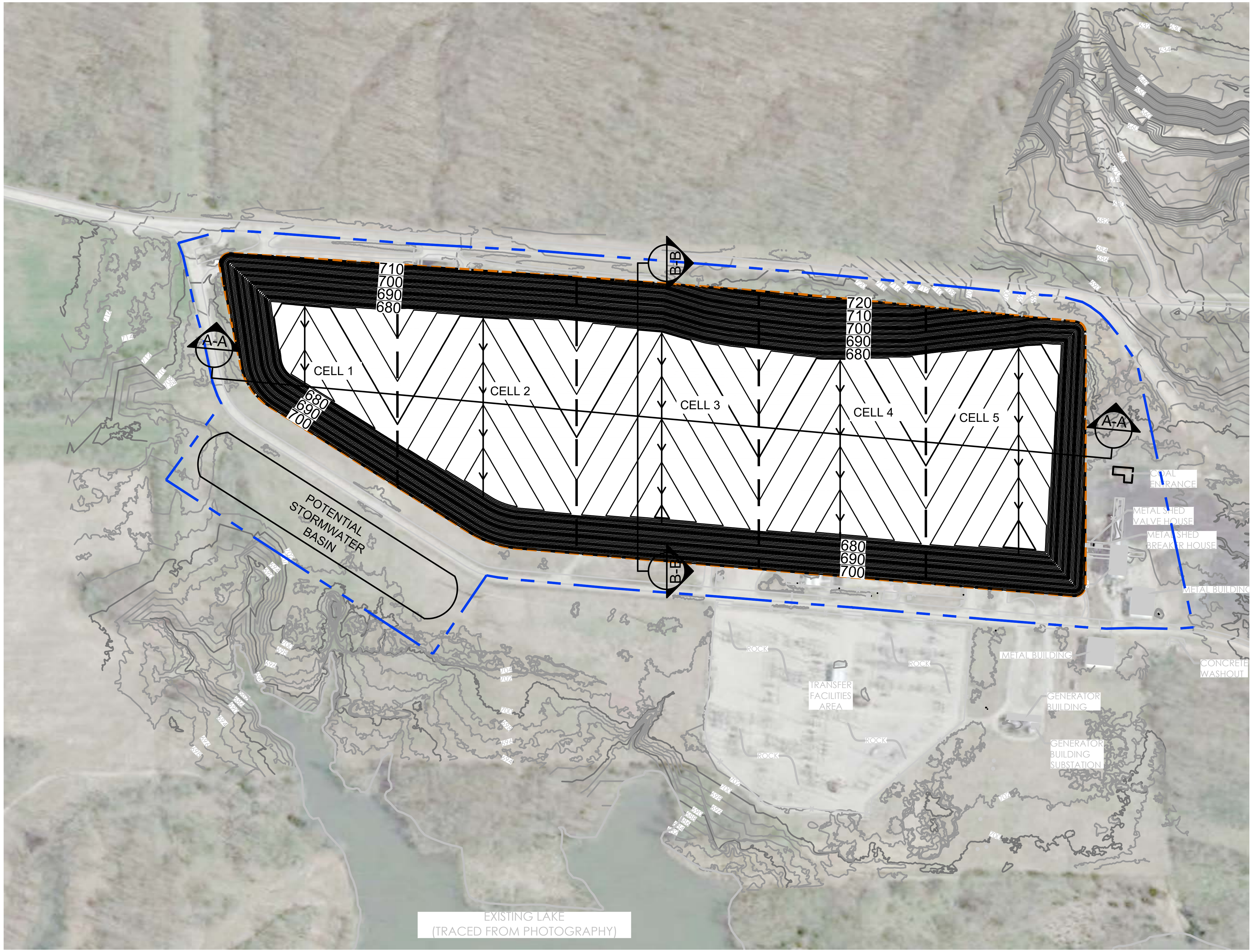

LEGEND

- PROPOSED FACILITY BOUNDARY
- PROPOSED WASTE BOUNDARY
- CONCEPTUAL LCS MAJOR CONTOUR
- CONCEPTUAL LCS MINOR CONTOUR
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- APPROXIMATE LCS PIPE FLOW DIRECTION
- APPROXIMATE CELL BOUNDARY

NOTES:

1. THE DATE OF AERIAL IMAGE IS APRIL 20, 2019 OBTAINED FROM GOOGLE EARTH PRO.
2. SURROUNDING TOPOGRAPHY OBTAINED FROM 06-21-2021 SURVEY.
3. ALL LAYOUTS ARE CONCEPTUAL AND WILL CHANGE WITH FINAL DESIGN.

N

0 200' 400'
SCALE IN FEET

Cut/Fill Summary

Name	Cut	Fill	Net
volume - total waste	0.00 Cu. Yd.	3137619.31 Cu. Yd.	3137619.31 Cu. Yd.<Fill>
Totals	0.00 Cu. Yd.	3137619.31 Cu. Yd.	3137619.31 Cu. Yd.<Fill>

CONCEPTUAL NEW LANDFILL
VERMILION POWER PLANT
TOP OF LCS

Geosyntec consultants

FIGURE 2

PROJECT NO: CHE8404
JANUARY 2022

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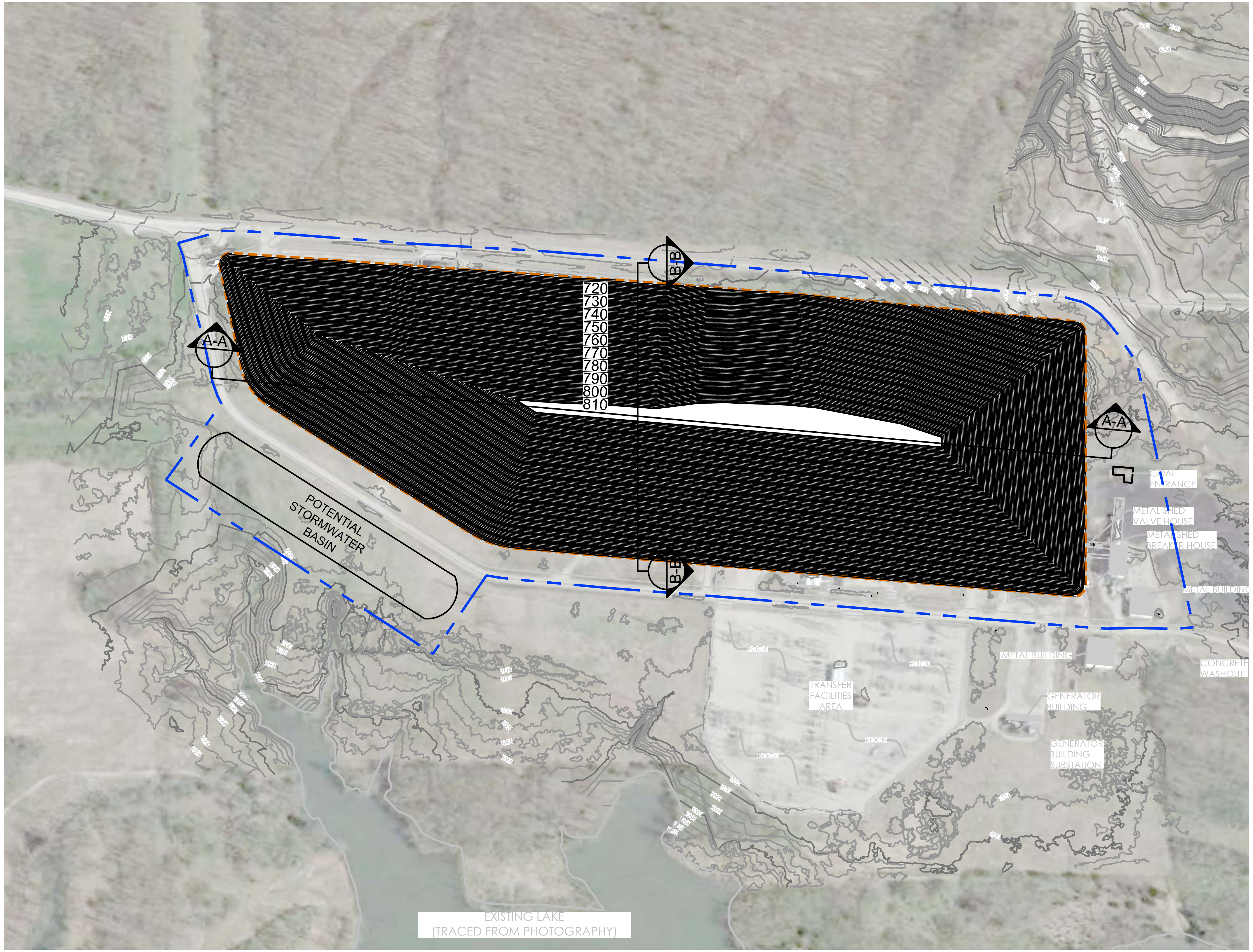

LEGEND

- PROPOSED FACILITY BOUNDARY
- PROPOSED WASTE BOUNDARY
- CONCEPTUAL WASTE MAJOR CONTOUR
- CONCEPTUAL WASTE MINOR CONTOUR
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR

NOTES:

1. THE DATE OF AERIAL IMAGE IS APRIL 20, 2019 OBTAINED FROM GOOGLE EARTH PRO.
2. SURROUNDING TOPOGRAPHY OBTAINED FROM 06-21-2021 SURVEY.
3. ALL LAYOUTS ARE CONCEPTUAL AND WILL CHANGE WITH FINAL DESIGN.

N

0 200' 400'
SCALE IN FEET

Cut/Fill Summary

Name	Cut	Fill	Net
volume - total waste	0.00 Cu. Yd.	3137619.31 Cu. Yd.	3137619.31 Cu. Yd.<Fill>
Totals	0.00 Cu. Yd.	3137619.31 Cu. Yd.	3137619.31 Cu. Yd.<Fill>

CONCEPTUAL NEW LANDFILL VERMILION POWER PLANT TOP OF WASTE

Geosyntec consultants

PROJECT NO: CHE8404

JANUARY 2022

FIGURE 3

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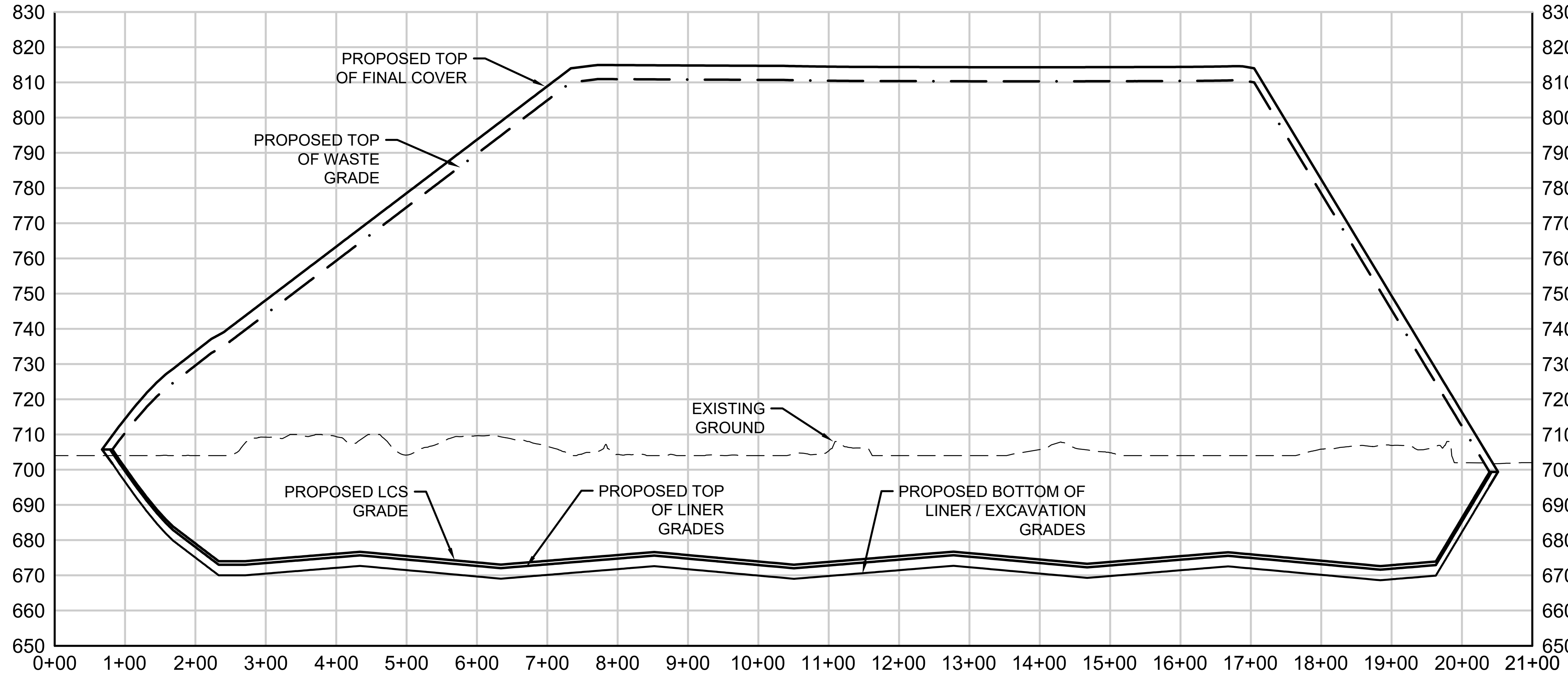
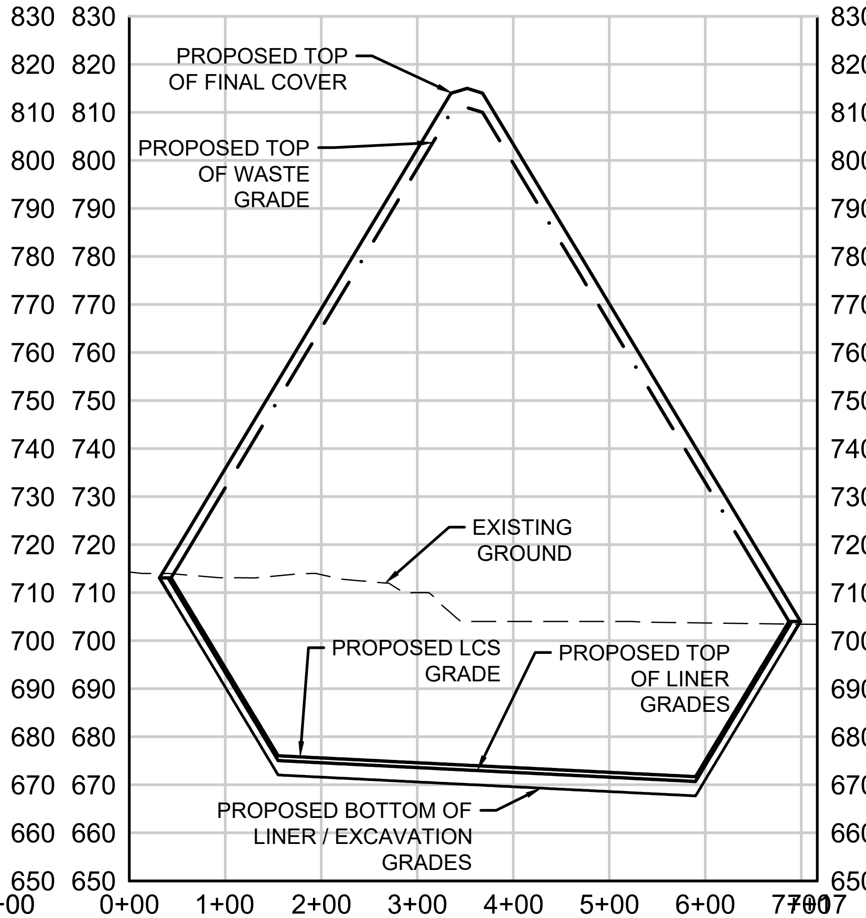


SECTION B-B
HORIZONTAL: 1" =200'
VERTICAL: 1" =40'



SECTION B-B (1)
HORIZONTAL: 1" =200'
VERTICAL: 1" =40'

CONCEPTUAL NEW LANDFILL
VERMILION POWER PLANT
SITE CROSS-SECTIONS

Geosyntec consultants

FIGURE 4

PROJECT NO: CHE8404 | JANUARY 2022

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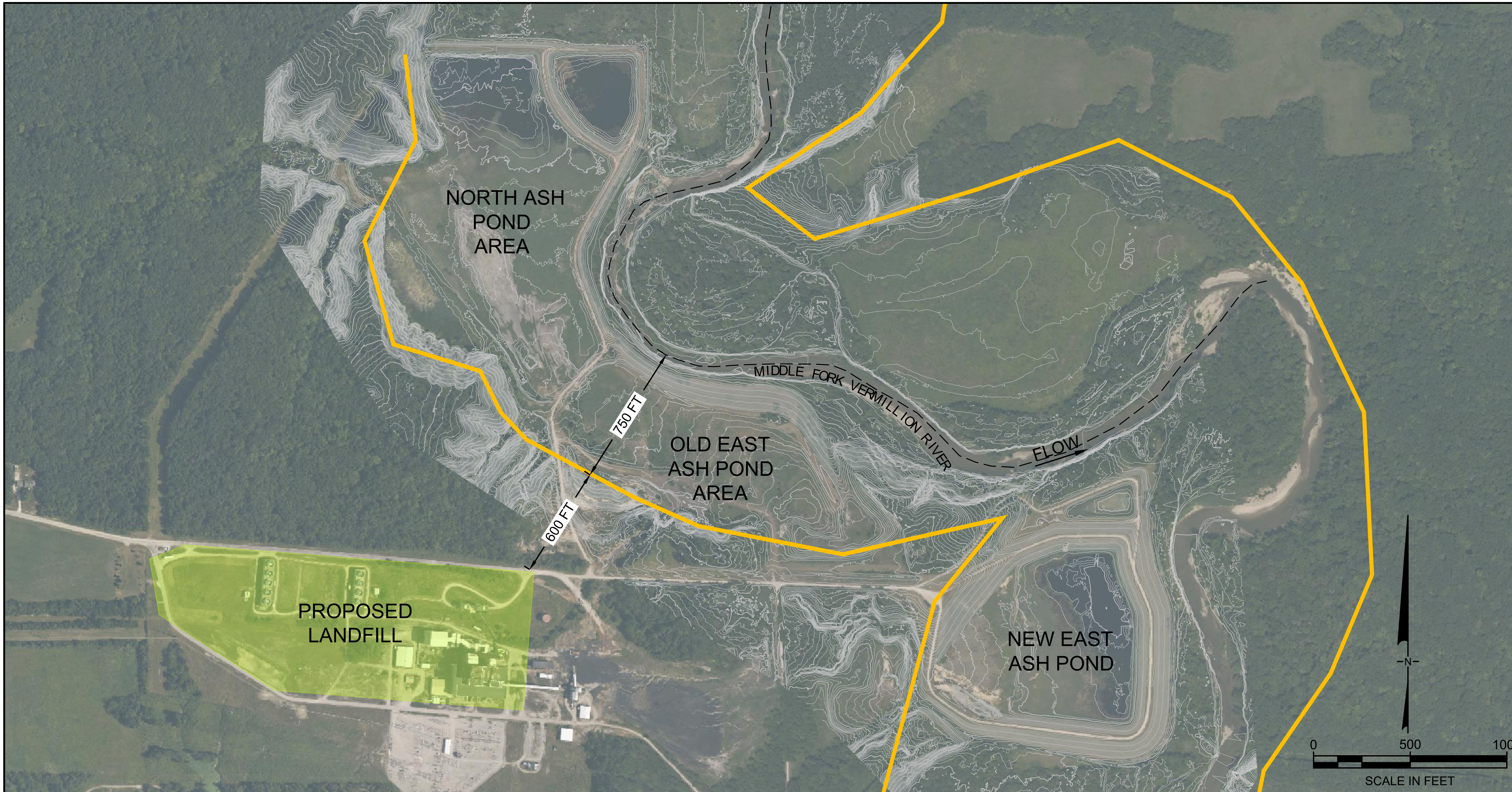


LEGEND

EXISTING MAJOR CONTOUR (10- FT INTERVAL)

EXISTING MINOR CONTOUR (2- FT INTERVAL)

MIDDLE FORK VERMILION RIVER CENTERLINE

FLOODPLAIN BLUFFS

CONCEPTUAL NEW LANDFILL
VERMILION POWER PLANT
VERMILION COUNTY, ILLINOIS

Geosyntec consultants

FIGURE 5

PROJECT NO: CHE8404B

JANUARY 2022

C:\PROJECTS\VERMILION\CHE8404B-FLOODPLAIN BLUFFS\CHE8404B-001 FIGURE - Last Saved by: MKatelieva on 10/29/21

APPENDIX A

FIELD AND LABORATORY DATA

Geosyntec consultants

engineers | scientists | innovators

Table A: Geotechnical Laborartory Testing Results

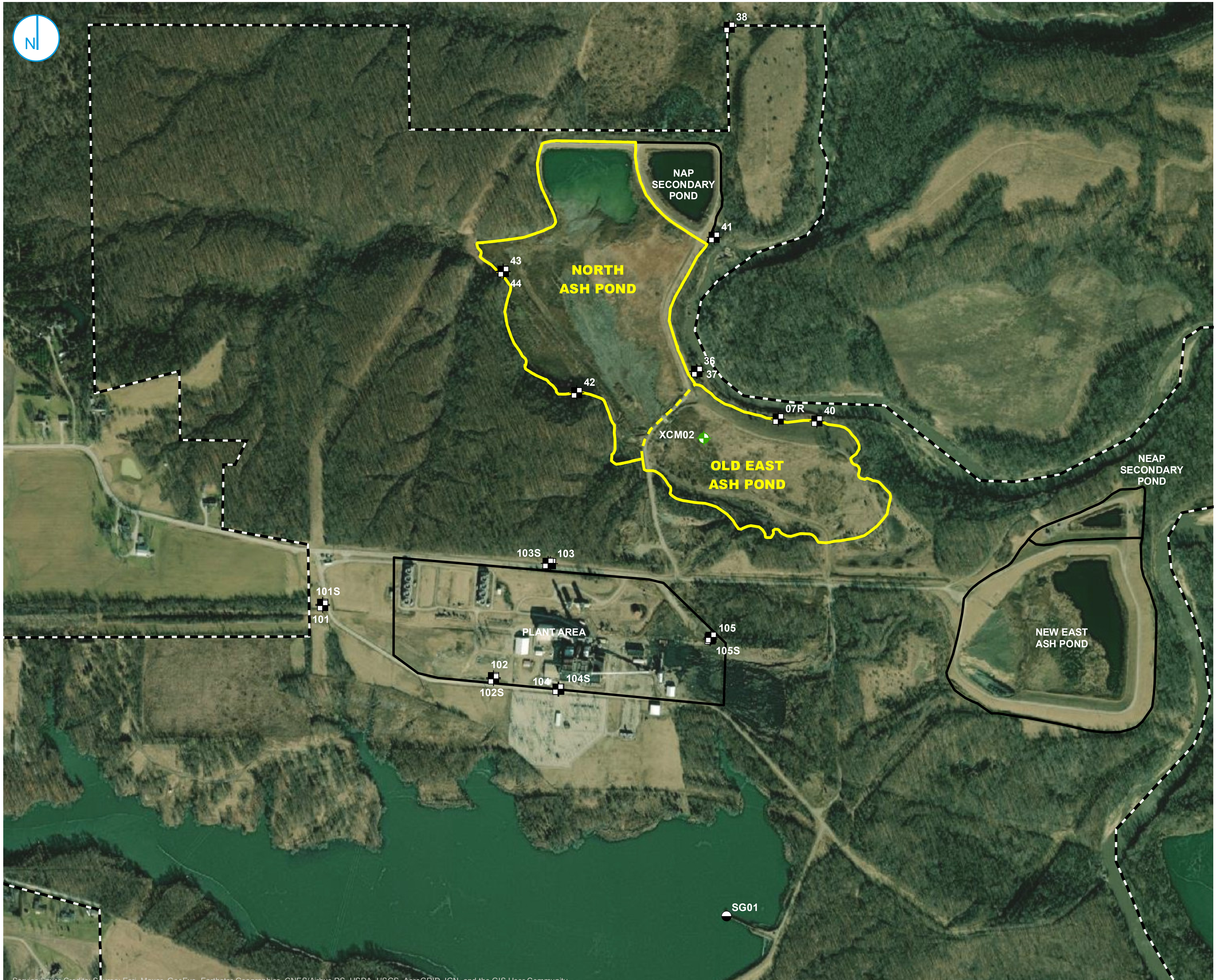
Vermilion Power Plant

Oakwood, IL

		ASTM D2216	ASTM D7263	ASTM D4318 Atterberg Limits			ASTM D1140	ASTM D2487	ASTM D5084	ASTM D2435 1-D Consolidation		ATSTM D4767 Consolidated - Undrained Triaxial Compression Test	
Boring Number	Depth (feet)	Moisture Content (%)	Dry Unit Weight (pcf)	Liquid Limit	Plastic Limit	Plasticity Index	Percent Passing No. 200	USCS Symbol	Hydraulic Conductivity (cm/sec)	Primary Compression Index, CC	Maximum Past-Pressure (psf)	Effective Stress Friction Angle, Φ (degrees)	Total Stress Friction Angle, Φ (degrees)
MW-101	10-12	15.6	--	22	15	7	82.2	CL-ML	--	--	--	--	--
MW-101	30-32	13.3	124.2	--	--	--	--	--	--	--	--	31	23
MW-101	32-33	15.3	--	28	15	13	85.5	CL	--	--	--	--	--
MW-101	60-62	12	127.4	--	--	--	--	--	1.0E-07	--	--	--	--
MW-101	62-63	11.9	--	24	13	11	75.7	CL	--	--	--	--	--
MW-101	92-93	11.4	--	25	13	12	71.3	CL	--	--	--	--	--
MW-101	132-133	11.3	--	20	12	8	54.0	CL	--	--	--	--	--
MW-102	10-12	16.2	--	28	16	12	83.9	CL	--	--	--	--	--
MW-102	28-30	14.9	--	24	14	10	81.7	CL	--	--	--	--	--
MW-102	30-32	15	120.6	--	--	--	--	--	1.6E-08	--	--	--	--
MW-102	60-62	12.5	127.0	--	--	--	--	--	--	--	--	31	27
MW-102	62-64	12.4	--	24	14	10	73.4	CL	--	--	--	--	--
MW-102	94-96	9.2	--	27	14	13	70.8	CL	--	--	--	--	--
MW-102	130-132	10.2	--	20	12	8	54.0	CL	--	--	--	--	--
MW-103	10-12	15	--	28	16	12	84.7	CL	--	--	--	--	--
MW-103	15-17	16.6	116.8	30	15	15	85.3	CL	3.61E-08	-	-	-	-
MW-103	28-30	13.5	--	21	13	8	69.8	CL	--	--	--	--	--
MW-103	30-32	13.2	125.2	--	--	--	--	--	6.1E-08	--	--	--	--
MW-103	60-62	15.8	118.00	--	--	--	--	--	--	--	--	31	20
MW-103	88-90	15.9	--	28	15	13	84.8	CL	--	--	--	--	--
MW-103	90-91	18.1	111.8	--	--	--	--	--	--	0.027	6219	--	--
MW-103	95.5-96	13.9	128.4	17	10	7	51.8	CL-ML	9.35E-06	-	-	-	-
MW-103	102-104	10.2	--	23	12	11	62.1	CL	--	--	--	--	--
MW-103	130-131	8.9	98.8	16	11	5	12.6	SC-SM	2.19E-05	-	-	-	-
MW-103	132.5-133	15.3	95.2	14	7	7	5.7	SP-SC	8.17E-05	-	-	-	-
MW-103	138-140	10.5	--	21	11	10	56.5	CL	--	--	--	--	--
MW-103	140.5-141	10.8	127.5	23	11	12	57.4	CL	3.82E-07	-	-	-	-
MW-103	163-163.5	13.8	109.5	17	11	6	35.2	SC-SM	4.31E-06	-	-	-	-
MW-104	10-12	14.5	--	26	15	11	81.8	CL	--	--	--	--	--
MW-104	30-32	15.2	119.7	--	--	--	--	--	--	0.056	5154	31	32
MW-104	60.5-61	12.4	--	20	13	7	70.9	CL-ML	--	--	--	--	--
MW-104	92-94	9.5	--	25	13	12	64.7	CL	--	--	--	--	--
MW-104	130-132	12.1	--	20	12	8	55.0	CL	--	--	--	--	--
MW-105	10-12	25.2	97.0	--	--	--	--	--	--	0.156	4600	28	16
MW-105	17-19	24.8	--	44	19	25	97.4	CL	--	--	--	--	--
MW-105	28-30	17.8	--	39	17	22	96.9	CL	--	--	--	--	--
MW-105	58-60	12.9	--	22	13	9	73.0	CL	--	--	--	--	--
MW-105	88-90	10.5	--	25	12	13	65.9	CL	--	--	--	--	--
MW-105	130-132	10.2	--	20	12	8	50.4	CL	--	--	--	--	--

Notes:

1. Source of data is from the May 7, 2021 Laboratory Testing Services for the Vermilion Landfill Feasibility Investigation received from Geotechnology, Inc.
2. The primary compression index was calculated by Geosyntec based on the one-dimensional consolidation of soils (ASTM D2435) test results.



MONITORING WELL
SOIL BORING
STAFF GAGE
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
PROPERTY BOUNDARY

0 300 600
Feet

FIELD INVESTIGATION LOCATIONS

HYDROGEOLOGIC SITE
CHARACTERIZATION REPORT
NORTH ASH POND AND OLD EAST ASH POND
VERMILION POWER PLANT
OAKWOOD, ILLINOIS

FIGURE 2-7

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 169000XXXX | DATED: 10/7/2021 | DESIGNER: STOLZSD

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Vermilion\NAP_OEAP\Figure 2-7_Field Investigation Locations.mxd

Facility/Project Name	License/Permit/Monitoring Number	Boring Number	
Vermilion Power Station		101D	
Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jason Greer Cascade Drilling	3/5/2021	3/5/2021	Mini Sonic
Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
101D	Feet (NAVD88)	704.09 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,698.18 N, 1,146,097.60 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location
Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 43			0 - 10.3' **SILTY CLAY:** CL/ML, brown (10YR 5/3), gray (10YR 5/1) mottling (5-10%), sand (0-10%), gravel (0-5%), firm to very stiff, no dilatancy, low to medium toughness, medium to low plasticity, moist.	CL/ML									CS= Core Sample
			1.5						0.75					
			3.0						2.5					
			4.5											
2 CS	60 48								2.5					
			6.0											
			7.5						2.75					
			9.0						2.5					
3 CS	120 120		10.5	10.3 - 49.5' **LEAN CLAY:** CL, gray (10YR 5/1), brown (7.5YR 5/3) mottling (0-5%), silt (15-25%), sand (0-5%), gravel (0-5%), stiff, no dilatancy, low toughness, medium plasticity, moist.	CL				1.5					
			12.0						2.25					
			13.5											
			15.0						1.75					
			16.5						2.25					
			18.0											
			19.5						1.75					

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 Street, Milwaukee,WI 53204
Tel: (414) 837-3607
Fax: (414) 837-3608

RAMBOLL

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
4 CS	120 108		21.0	10.3 - 49.5' **LEAN CLAY:** CL, gray (10YR 5/1), brown (7.5YR 5/3) mottling (0-5%), silt (15-25%), sand (0-5%), gravel (0-5%), stiff, no dilatancy, low toughness, medium plasticity, moist. *(continued)*					2.25					
			22.5	22' no mottling.					2.25					
			24.0						2.5					
			25.5											
			27.0						2.5					
			28.5						2.25					
5 SH	24 24		30.0											SH= Shelby Tube
6 CS	96 96		31.5											
			33.0						1.75					
			34.5		CL				2.25					
			36.0						2.5					
			37.5											
			39.0						1.75					
7 CS	120 120		40.5						1.75					
			42.0											
			43.5						1.75					
			45.0						1.75					
			46.5						2					
			48.0						1.5					
			49.5	49.5 - 50' **SILTY CLAY:** CL/ML, gray (10YR 5/1), firm to stiff, slow dilatancy, low toughness, low plasticity, wet.	CL/ML									
8 CS	120 120		51.0	50 - 58' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), stiff, no dilatancy, low toughness, medium plasticity, moist.	CL				2.5					
			52.5											

Boring Number 101D

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			54.0	50 - 58' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), stiff, no dilatancy, low toughness, medium plasticity, moist. *(continued)*	CL				2.25					
			55.5						1.75					
			57.0						2					
			58.5	58 - 77.6' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1) to gray (10YR 5/1), sand (0-5%), gravel (0-5%), stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist.	CL/ML				2.25					
9 SH	24 18		60.0											
10 CS	96 96		61.5											
			63.0						4.5					
			64.5											
			66.0						4.25					
			67.5											
			69.0						3.25					
11 CS	120 120		70.5						3.25					
			72.0											
			73.5	72.6' reddish brown (5YR 5/3) mottling (5-10%).					2.75					
			75.0						4.25					
			76.5						4.25					
			78.0	77.6 - 78.3' **POORLY-GRADED SAND:** SP, gray (10YR 5/1), rounded to subrounded, medium sand, silt (5-10%), clay (5-10%), loose, moist.	SP									
			79.5	78.3 - 78.6' **CLAYEY SILT** ML/CL, gray (10YR 5/1), hard, no dilatancy, medium toughness, non-plastic, moist.	ML/CL				4.5					
12 CS	120 120		81.0	78.6 - 144.2' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1) to gray (10YR 5/1), sand (0-5%), gravel (0-5%), hard, no dilatancy, medium to high toughness, medium plasticity, dry.	CL/ML				4.5					
			82.5						4.5					
			84.0											
			85.5	85.9' layer of cobbles.					4.5					

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)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			87.0	78.6 - 144.2' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1) to gray (10YR 5/1), sand (0-5%), gravel (0-5%), hard, no dilatancy, medium to high toughness, medium plasticity, dry. *(continued)*					4.5					
			88.5						4.5					
13 MC	24 24		90.0											MC= Modified California
			91.5											
14 CS	96 96		93.0						4.5					
			94.5						4.25					
			96.0						4.5					
			97.5											
			99.0						4.5					
15 CS	120 120		100.5						4.5					
			102.0	102' grayish brown (10YR 5/2), cobbles (0-5%).										
			103.5		CL/ML				4.25					
			105.0						4.5					
			106.5						4.5					
			108.0						4.5					
			109.5											
16 CS	120 120		111.0						4.5					
			112.5						4.5					
			114.0											
			115.5						4.5					
			117.0						4.5					
			118.5						4.5					
			120.0											

Boring Number 101D

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
17 CS	120 120			78.6 - 144.2' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1) to gray (10YR 5/1), sand (0-5%), gravel (0-5%), hard, no dilatancy, medium to high toughness, medium plasticity, dry. *(continued)*					4.5					
			123.0						4.5					
			124.5						4.5					
			126.0	126.2' olive (5Y 5/3) mottling.					4.5					
			127.5	127.4' -127.8' sand with silt, rounded to subrounded, medium to coarse sand, moist to wet.					4.5					
18 MC	24 24		130.5											
19 CS	96 96		132.0	132' stiff, moist.	CL/ML				1.5					
			135.0						1.75					
			136.5						1.5					
			138.0						1.25					
20 CS	120 120		141.0						1.5					
			142.5						1.25					
			144.0	144.2 - 146.8' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), rounded to subrounded, fine to medium sand, loose, wet.	SP-SM									
			147.0	146.8 - 147.3' **SILTY CLAY:** CL/ML, gray (10YR 5/1), sand (0-5%), gravel (0-5%), stiff, slow dilatancy, low toughness, medium plasticity, moist.	CL/ML				1.5					
			148.5	147.3 - 148.1' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), rounded to subrounded, fine to medium sand, loose, wet.	SP-SM									
21 CS	120 120		150.0	148.1 - 148.9' **SILTY CLAY:** CL/ML, gray (10YR 5/1), sand (0-5%), gravel (0-5%), stiff, slow dilatancy, low toughness, medium plasticity, moist.	CL/ML				1.5					
			151.5	148.9 - 149.5' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), rounded to subrounded, fine to medium sand, loose, wet.	SP-SM				2.25					
			153.0		CL/ML									

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
			154.5 156.0 157.5 159.0	149.5 - 160' **SILTY CLAY:** CL/ML, gray (10YR 5/1), sand (0-5%), gravel (0-5%), no to slow dilatancy, low toughness, medium plasticity, moist. *(continued)* 154' stiff to very stiff.	CL/ML				2.5 3.25 3.25 4.25					
				160' End of Boring.										

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Station		101S

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Dave Gordon Cascade Drilling	3/16/2021	3/16/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
101S	Feet (NAVD88)	704.14 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,705.42 N, 1,146,097.45 E (E)/ W
1/4 of 1/4 of Section , T N, R
Lat ____° ____' ____"
Long ____° ____' ____"
Local Grid Location: Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			0–10.3	0 - 10.3' **SILTY CLAY:** CL/ML, Blind drilled to 88 feet below ground surface (ft bgs). See boring log 101D for detailed lithology..	CL/ML									
			10.3–12	10.3 - 49.5' **LEAN CLAY:** CL.	CL									

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

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

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
				10.3 - 49.5' **LEAN CLAY:** CL. *(continued)*										
			13											
			14											
			15											
			16											
			17											
			18											
			19											
			20											
			21											
			22		CL									
			23											
			24											
			25											
			26											
			27											
			28											
			29											
			30											
			31											
			32											

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
			33–49	10.3 - 49.5' **LEAN CLAY:** CL. *(continued)*	CL									
			49.5–50	49.5 - 50' **SILTY CLAY:** CL/ML.	CL/ML									
			50–52	50 - 58' **LEAN CLAY:** CL.	CL									

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
			53–57	50 - 58' **LEAN CLAY:** CL. *(continued)*	CL									
			58–72	58 - 77.6' **SILTY CLAY:** CL/ML.	CL/ML									Sand observed 62-65 ft bgs

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
				58 - 77.6' **SILTY CLAY:** CL/ML. *(continued)* 72.6.	CL/ML									
			73–77											
			78	77.6 - 78.3' **POORLY-GRADED SAND:** SP.	SP									
				78.3 - 78.6' **CLAYEY SILT** ML/CL.	ML/CL									
			79–88	78.6 - 88' **SILTY CLAY:** CL/ML.	CL/ML									
			88	88' End of Boring.										

![RAMBOLL]

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Station		102D

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Dave Gordon Cascade Drilling	3/6/2021	3/7/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
102D	Feet (NAVD88)	702.98 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,245.48 N, 1,147,170.85 E (E)/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location
Feet ☐N ☐S Feet ☐E ☐W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	120 120		0–2	0 - 2.3' **WELL-GRADED GRAVEL WITH SAND:** (GW)s, very pale brown (10YR 7/4), subrounded, fine to coarse sand, moist.	(GW)s									CS= Core Sample
			3–6	2.3 - 6.6' **LEAN CLAY:** CL, grayish brown (10YR 5/2), brownish yellow (10YR 6/6) mottling (0-5%), silt (15-25%), gravel (5-15%), low plasticity, hard, dry.	CL				4.5 4.5					
			7–9	6.6 - 10' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (15-25%), gravel (0-5%), stiff, low plasticity, moist.	CL				1.5 1.5					
2 CS	240 240		10–16	10 - 18.7' **LEAN CLAY:** CL, grayish brown (10YR 5/2), silt (5-15%), gravel (0-5%), medium plasticity, very stiff, moist.	CL				2.5 2.5 2 2 2.5					

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

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

Boring Number 102D

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
			17–18.7	10 - 18.7' **LEAN CLAY:** CL, grayish brown (10YR 5/2), silt (5-15%), gravel (0-5%), medium plasticity, very stiff, moist. *(continued)*	CL				2.5 2					
			18.7–30	18.7 - 30' **LEAN CLAY:** CL, gray (10YR 5/1), silt (5-15%), gravel (0-5%), medium plasticity, very stiff, moist.	CL				2.5 2 2 2.5 2.5 2.5 2.5					
3 SH	24 24		30–32	30 - 32' **LEAN CLAY:** CL.	CL									SH= Shelby Tube
4 CS	216 216		32–42	32 - 60' **LEAN CLAY:** CL, gray (10YR 5/1), silt (5-15%), gravel (0-5%), medium plasticity, very stiff, moist. 32.5' - 33.8' sand (5-10%).	CL				2.5 2 2.5 2 2					

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			43	32 - 60' **LEAN CLAY:** CL, gray (10YR 5/1), silt (5-15%), gravel (0-5%), medium plasticity, very stiff, moist. *(continued)*					2.5					
			44											
			45						2					
			46											
			47						2.5					
			48											
			49						2.5					
5 CS	120 120		50											
			51		CL				2.5					
			52											
			53						2.5					
			54											
			55						2.5					
			56											
			57						2.5					
			58											
			59						2.5					
6 SH	24 24		60	60 - 62' **LEAN CLAY:** CL.										
			61		CL									
7 CS	96 96		62	62 - 70' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (5-15%), gravel (0-5%), medium plasticity, hard.										
			63						4.5					
			64											
			65						4.5					
			66		CL									
			67						4.5					
			68											
			69											

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Boring Number 102D

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
									4.5					
8 CS	240 240		70	70 - 71.4' **POORLY-GRADED SAND:** SP, dark gray (10YR 4/1), fine to medium sand, silt (0-5%), clay (0-5%), moist to wet.	SP									
			71.4	71.4 - 81.4' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (15-25%), gravel (0-5%), sand (0-5%), medium plasticity, very stiff, moist.	CL				3 2.75 2.5 3					
			81.4	81.4 - 85.3' **CLAYEY SILT** ML/CL, gray (10YR 5/1), sand (0-5%), moist to wet. 84.1' clay content decreasing with depth.	ML/CL									
			85.3	85.3 - 87.5' **SILT:** ML, gray (10YR 5/1), sand (5-15%), moist to wet.	ML									
			87.5	87.5 - 88.6' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), low plasticity, hard.	CL/ML									
			88.6	88.6 - 90' **SANDY LEAN CLAY WITH GRAVEL:** s(CL)g, dark gray (10YR 4/1), silt(30-45%), low plasticity, hard.	s(CL)g				4.5					
9 MC	24 24		90	90 - 93' **POORLY-GRADED SAND WITH SILT:** SP-SM, fine to medium sand, gravel (0-5%), wet.	SP-SM									MC= Modified California
10 MC	24 24		92											
			93	93 - 130' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), fine to coarse gravel (0-5%), low plasticity, hard.	CL									
11 CS	312 312		94						4.5					
			96											

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SOIL BORING LOG INFORMATION SUPPLEMENT

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
			97	93 - 130' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), fine to coarse gravel (0-5%), low plasticity, hard. *(continued)*					4.5					
			98											
			99						4.5					
			100											
			101						4.5					
			102											
			103						4.5					
			104											
			105						4.5					
			106											
			107						4.5					
			108											
			109		CL				4.5					
			110											
			111						4.5					
			112											
			113						4.5					
			114											
			115						4.5					
			116											
			117						4.5					
			118											
			119						4.5					
12 CS	360 360		120											
			121						4.5					
			122											

RAMBOLL

Boring Number 102D

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
			123	93 - 130' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), fine to coarse gravel (0-5%), low plasticity, hard. *(continued)*					4.5					
			124											
			125						4.5					
			126		CL									
			127						4.5					
			128	128.1' -128.4' layer of fine sand.										
			129						4.5					
			130	130 - 130.7' g(CL), gravelly clay.	g(CL)									
			131	130.7 - 149.4' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), fine to coarse gravel (0-5%), low plasticity, hard.					4.5					
			132											
			133						4.5					
			134											
			135						4.5					
			136											
			137						4.5					
			138											
			139						4.5					
			140		CL									
			141						4.5					
			142											
			143						4.5					
			144											
			145						4.5					
			146											
			147						4.5					
			148											
			149											

SOIL BORING LOG INFORMATION SUPPLEMENT

RAMBOLL

Boring Number 102D

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
				149' layer of well-graded sand with gravel (1" thick).					4.5					
13 CS	120 120		150	149.4 - 150' (SW)g, well-graded sand with gravel.	(SW)g									
			151	150 - 156' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), fine to coarse gravel (0-5%), low plasticity, hard.					4.5					
			152											
			153		CL				4.5					
			154											
			155	154.8' -155.1' layer of fine to medium sand.					4.5					
			156	156 - 156.7' **POORLY-GRADED SAND:** SP, fine to medium sand.	SP									
			157	156.7 - 160' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), fine to coarse gravel (0-5%), low plasticity, hard.					4.5					
			158											
			159		CL				4.5					
			160	160' End of Boring.										

SOIL BORING LOG INFORMATION

Facility/Project Name: Vermilion Power Station	License/Permit/Monitoring Number:	Boring Number: 102S

Boring Drilled By: Name of crew chief (first, last) and Firm: Dave Gordon, Cascade Drilling	Date Drilling Started: 3/16/2021	Date Drilling Completed: 3/16/2021	Drilling Method: Mini Sonic
Common Well Name: 102S	Final Static Water Level: Feet (NAVD88)	Surface Elevation: 702.92 Feet (NAVD88)	Borehole Diameter: 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,239.28 N, 1,147,169.25 E (E)/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location: Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample: Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			0 - 2.3	0 - 2.3' **WELL-GRADED GRAVEL WITH SAND:** (GW)s, Blind drilled to 90 feet below ground surface (ft bgs). See boring log 102D for detailed lithology..	(GW)s									
			2.3 - 6.6	2.3 - 6.6' **LEAN CLAY:** CL.	CL									
			6.6 - 10	6.6 - 10' **LEAN CLAY:** CL.	CL									
			10 - 12	10 - 18.7' **LEAN CLAY:** CL.	CL									

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

Signature: Seth Wk

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

Template: RAMBOLL_IL_BORING LOG - Project: 845_VERMILION_2021 (2).GPJ

RAMBOLL

Boring Number 102S

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
			13–18	10 - 18.7' **LEAN CLAY:** CL. *(continued)*	CL									
			19–29	18.7 - 30' **LEAN CLAY:** CL.	CL									
			30–32	30 - 32' **LEAN CLAY:** CL.	CL									

Boring Number 102S

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
				32 - 60' **LEAN CLAY:** CL. 32.5' - 33.8' sand (5-10%).	CL									
			33											
			34											
			35											
			36											
			37											
			38											
			39											
			40											
			41											
			42											
			43											
			44											
			45											
			46											
			47											
			48											
			49											
			50											
			51											
			52											

SOIL BORING LOG INFORMATION SUPPLEMENT

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
			52 - 60	32 - 60' **LEAN CLAY:** CL. *(continued)*	CL									
			60 - 62	60 - 62' **LEAN CLAY:** CL.	CL									
			62 - 70	62 - 70' **LEAN CLAY:** CL.	CL									
			70 - 71.4	70 - 71.4' **POORLY-GRADED SAND:** SP.	SP									
			71.4 - 72	71.4 - 81.4' **LEAN CLAY:** CL.	CL									

Boring Number 102S

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
				71.4 - 81.4' **LEAN CLAY:** CL. *(continued)*										
			73											
			74	73.5' -75' bgs. No other sand layers observed in boring.										Sand observed 73.5-75 ft bgs
			75											
			76											
			77		CL									
			78											
			79											
			80											
			81											
			82	81.4 - 85.3' **CLAYEY SILT** ML/CL.										
			83		ML/CL									
			84	84.1' clay content decreasing with depth.										
			85											
			86	85.3 - 87.5' **SILT:** ML.	ML									
			87											
			88	87.5 - 88.6' **SILTY CLAY:** CL/ML.	CL/ML									
			89	88.6 - 90' **SANDY LEAN CLAY WITH GRAVEL:** s(CL)g.	s(CL)g									
			90	90' End of Boring.										

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Station		103D

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jason Greer Cascade Drilling	3/7/2021	3/9/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
103D	Feet (NAVD88)	717.38 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,960.01 N, 1,147,526.10 E (E)/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location: Feet ☐N ☐S Feet ☐E ☐W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

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	PID 10.6 eV Lamp	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 44			0 - 1.2' **TOPSOIL:** ML/CL, dark brown (10YR 3/3), sand (0-5%), gravel (0-5%), roots (0-5%), firm, slow dilatancy, low toughness, low plasticity, moist.	ML/CL									CS= Core Sample
			1.5	1.2 - 15' **SILTY CLAY:** CL/ML, yellowish brown (10YR 5/4), gray (10YR5/1) mottling (5-10%), sand (0-10%), gravel (0-5%), very stiff, no dilatancy, low to medium toughness, medium plasticity, moist.					1.5					
			3.0						2.5					
			4.5											
2 CS	60 60								2.75					
			6.0	6' yellowish brown (10YR 5/6) mottling (0-5%).										
			7.5						3					
			9.0		CL/ML				3					
3 CS	60 60		10.5											
			12.0						2.75					
			13.5						3.25					
4 SH	24 18		15.0	15 - 17' **LEAN CLAY:** CL, grayish browon (10YR /2), sand (5-15%), silt (25-30%), high plasticity, moist.	CL				3.25	16.6	30	15	85.3	SH= Shelby Tube
			16.5											
5 CS	96 96		18.0	17 - 20' **SILTY CLAY:** CL/ML, yellowish brown (10YR 5/4), gray (10YR5/1) mottling (5-10%), sand (0-10%), gravel (0-5%), very stiff, no dilatancy, low to medium toughness, medium plasticity, moist.	CL/ML									
			19.5						2.5					

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 Street, Milwaukee,WI 53204
Tel: (414) 837-3607
Fax: (414) 837-3608

RAMBOLL

Boring Number 103D

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			21.0	20 - 36.1' **LEAN CLAY: to SILTY CLAY:** CL, gray (10YR 5/1), sand (0-10%), gravel (0-5%), stiff to very stiff, slow to no dilatancy, low toughness, medium plasticity, moist.					2.5					
			22.5						2.25					
			24.0											
6 CS	60 60		25.5						1.75					
			27.0						1.75					
			28.5		CL				2.25					
7 SH	24 24		30.0											
8 CS	96 96		31.5											
			33.0						1.75					
			34.5						1.5					
			36.0	36.1 - 36.3' **POORLY-GRADED GRAVEL WITH SILT AND SAND:** (GP-GM)s, gray (10YR 5/1), subrounded to subangular, loose, wet.	(GP-GM)s									
			37.5	36.3 - 63.7' **LEAN CLAY: to SILTY CLAY:** CL, gray (10YR 5/1), sand (0-10%), gravel (0-5%), stiff to very stiff, slow to no dilatancy, low toughness, medium plasticity, moist.					1.75					
			39.0						1.75					
9 CS	120 120		40.5											
			42.0						2.25					
			43.5						2.25					
			45.0		CL				2.5					
			46.5											
			48.0						2.5					
			49.5						2.5					
10 CS	120 120		51.0						2.75					
			52.5											

Boring Number 103D

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
			54.0	36.3 - 63.7' **LEAN CLAY: to SILTY CLAY:** CL, gray (10YR 5/1), sand (0-10%), gravel (0-5%), stiff to very stiff, slow to no dilatancy, low toughness, medium plasticity, moist. *(continued)*	CL				3.25					
			55.5						3					
			57.0						3.25					
			58.5						2.75					
11 SH	24 24		60.0											
12 CS	36 36		61.5											
			63.0						2.25					
			64.5	63.7 - 64.1' **SILTY SAND: to SANDY SILT:** SM, gray (10YR 5/1), subrounded to rounded, fine to medium sand, loose, wet.	SM									
13 CS	60 60		66.0	64.1 - 67.8' **LEAN CLAY: to SILTY CLAY:** CL, gray (10YR 5/1), sand (0-10%), gravel (0-5%), stiff to very stiff, slow to no dilatancy, low toughness, medium plasticity, moist.	CL				1.5					
			67.5						1.5					
			69.0	67.8 - 73.3' **SILT:** ML, gray (10YR 5/1), sand (0-5%), stiff, slow dilatancy, low toughness, non-plastic, moist to wet.	ML				1.25					
14 CS	60 60		70.5						1.5					
			72.0											
			73.5	73.3 - 92.3' **LEAN CLAY: to SILTY CLAY:** CL, gray (10YR 5/1), sand (0-5%), gravel (0-5%), very stiff, no dilatancy, medium toughness, dry to moist.	CL				3.25					
15 CS	60 60		75.0						3.25					
			76.5						3.25					
			78.0											
			79.5						3.25					
16 CS	60 60		81.0						2.75					
			82.5						3					
			84.0											
17 CS	60 60		85.5						2.25					

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			87.0	73.3 - 92.3' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1), sand (0-5%), gravel (0-5%), very stiff, no dilatancy, medium toughness, dry to moist. *(continued)*	CL				2.25					
			88.5						1.75					
18 SH	12 12		90.0											
19 CS	48 48		91.5											
			93.0	92.3 - 95.5' **POORLY-GRADED SAND:** SP, grayish brown (10YR 5/2), rounded to subrounded, fine sand, silt (5-10%), loose, wet.	SP									
			94.5											
20 MC	24 24			95.5 - 96' **SILTY CLAY:** CL/ML, grayish brown (10YR 5/2) to gray (10YR 5/1), olive (5Y 5/3) mottling (5-10%), sand (0-10%), gravel (0-5%), stiff to very stiff, no dilatancy, low to medium toughness, medium plasticity, dry to moist.	CL/ML					13.9	17	7	51.8	MC= Modified California
			96.0											
21 CS	36 36		97.5	96 - 130.5' **SILTY CLAY:** CL/ML, grayish brown (10YR 5/2) to gray (10YR 5/1), olive (5Y 5/3) mottling (5-10%), sand (0-10%), gravel (0-5%), stiff to very stiff, no dilatancy, low to medium toughness, medium plasticity, dry to moist.	CL/ML				4.25					
			99.0						4.25					
22 MC	24 24		100.5											
23 CS	96 96		102.0											
			103.5						2.5					
			105.0						4.5					
			106.5						4.5					
			108.0						4.5					
			109.5											
24 CS	240 240		111.0						4.25					
			112.5						4					
			114.0											
			115.5						4.5					
			117.0						4.5					
			118.5						4.5					
			120.0											

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			121.5	96 - 130.5' **SILTY CLAY:** CL/ML, grayish brown (10YR 5/2) to gray (10YR 5/1), olive (5Y 5/3) mottling (5-10%), sand (0-10%), gravel (0-5%), stiff to very stiff, no dilatancy, low to medium toughness, medium plasticity, dry to moist. *(continued)*	CL/ML				4.5					
			123.0						4.5					
			124.5						4.5					
			126.0											
			127.5						4.5					
			129.0	128.9' -129' layer of sand, grayish brown (10YR 5/2).					4.5					
25 MC	24 24		130.5	130.5 - 131' **CLAYEY SAND:** SC, gray (10YR 5/1), gravel (30-45%), silt (5-15%), clay (5-15%), medium plasticity loose, wet.	SC					8.9	16	5	5.7	
26 MC	24 24		132.0	131 - 132.5' **POORLY-GRADED SAND:** SP, grayish brown (10YR 5/2), rounded to subrounded, fine sand, silt (5-10%), loose, wet. 131.8' -132' layer of clay.	SP					15.3	14	7	35.2	
27 CS	72 72		133.5	132.5 - 133' **POORLY-GRADED SAND WITH CLAY:** SP-SC, grayish brown (10YR 5/2), silt (0-5%), clay (0-5%), low plasticity.	SP-SC									
			135.0	133 - 146.2' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), stiff to very stiff, no dilatancy, low to medium toughness, medium plasticity, dry to moist.	CL				2.5					
			136.5						3					
			138.0											
			139.5						3.25					
28 MC	24 24		141.0	140.5 - 141' **LEAN CLAY:** CL, grayish brown (10YR 5/2), silt (15-25%), clay (15-25%), medium plasticity, dry to moist.	CL					10.8	23	12	12.6	
29 CS	192 192		142.5	141 - 146.2' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), stiff to very stiff, no dilatancy, low to medium toughness, medium plasticity, dry to moist.	CL				3					
			144.0											
			145.5						2.25					
			147.0	146.2 - 148.6' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), subrounded to rounded, fine sand, loose, moist.	SP-SM									
			148.5	148.6 - 150.2' **SILT WITH SAND:** (ML)s, gray (10YR 5/1), firm, slow dilatancy, low toughness, non-plastic, moist.	(ML)s				0.75					
			150.0											
			151.5	150.2 - 158' **SILTY CLAY:** CL/ML, gray (10YR 5/1), sand (0-10%), gravel (0-5%), stiff to very stiff, no dilatancy, medium to low toughness, medium plasticity, moist to dry.	CL/ML				4					
			153.0											

RAMBOLL

Boring Number 103D

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			154.5, 156.0, 157.5	150.2 - 158' **SILTY CLAY:** CL/ML, gray (10YR 5/1), sand (0-10%), gravel (0-5%), stiff to very stiff, no dilatancy, medium to low toughness, medium plasticity, moist to dry. *(continued)*	CL/ML				3.5, 4.25, 4.25					
30 NR	24 0		159.0	158 - 160' No recovery.										NR= No recovery Core casing dropped to 160' below ground surface (bgs) while collecting sample
31 MC	24 6		160.5	160 - 161' **POORLY-GRADED SAND:** SP, gray (10YR 5/1), subrounded to rounded, fine sand, loose, wet.	SP									
32 MC	24 24		162.0	161 - 163' **SILTY SAND:** to **SANDY SILT:** SM.	SM									
33 CS	72 72		163.5	163 - 163.5' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), silt (15-25%), clay (15-25%), medium plasticity, dry to moist.	SP-SM					13.8	17	6	81.9	
			165.0	163.5 - 166.2' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1), sand (5-10%), gravel (0-5%), hard, no dilatancy, medium toughness, medium plasticity, dry to moist.	CL				4.5					
			166.5	166.2 - 167' **WELL-GRADED SAND:** SW, gray (10YR 5/1), subrounded to rounded, gravel (0-5%), loose, wet.	SW				4.5					
			168.0	167 - 169.5' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1), sand (5-10%), gravel (0-5%), hard, no dilatancy, medium toughness, medium plasticity, dry to moist.	CL				4.5					
34 CS	60 60		169.5	169.5 - 170.3' **WELL-GRADED SAND:** SW, gray (10YR 5/1), subrounded to rounded, fine to coarse sand, gravel (0-5%), loose, wet.	SW				3.5					
			171.0, 172.5, 174.0	170.3 - 175.5' **SILTY CLAY:** CL/ML, gray (10YR 5/1) to dark gray (10YR 4/1), sand (5-10%), gravel (0-5%), very stiff to hard, no dilatancy, medium toughness, medium plasticity, dry to moist.	CL/ML				4.5, 4.25					
35 MC	24 24		175.5	175.5 - 177' **POORLY-GRADED SAND:** SP.	SP									
			177.0	177' End of Boring.										

RAMBOLL

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number	
Vermilion Power Station		103S	
Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jason Greer Cascade Drilling	3/15/2021	3/15/2021	Mini Sonic
Common Well Name: 103S	Final Static Water Level: Feet (NAVD88)	Surface Elevation: 717.62 Feet (NAVD88)	Borehole Diameter: 6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,964.21 N, 1,147,511.40 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location: Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				0 - 1.2' **TOPSOIL:** ML/CL, Blind drilled to 80 feet below ground surface. See 103D boring log for detailed lithology..	ML/CL									No sand observed during drilling
			1.5	1.2 - 15' **SILTY CLAY:** CL/ML.	CL/ML									
			3.0											
			4.5											
			6.0											
			7.5											
			9.0											
			10.5											
			12.0											
			13.5											
			15.0	15 - 17' **LEAN CLAY:** CL.	CL									
			16.5											
				17 - 20' **SILTY CLAY:** CL/ML.	CL/ML									
			18.0											
			19.5											

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 Street, Milwaukee,WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

RAMBOLL

Boring Number 103S

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
			21.0–36.0	20 - 36.1' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									
			36.0	36.1 - 36.3' **POORLY-GRADED GRAVEL WITH SILT AND SAND:** (GP-GM)s.	(GP-GM)s									
			37.5–52.5	36.3 - 63.7' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									

Depth scale: 21.0, 22.5, 24.0, 25.5, 27.0, 28.5, 30.0, 31.5, 33.0, 34.5, 36.0, 37.5, 39.0, 40.5, 42.0, 43.5, 45.0, 46.5, 48.0, 49.5, 51.0, 52.5

RAMBOLL

Boring Number 103S

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
			54.0 55.5 57.0 58.5 60.0 61.5 63.0	36.3 - 63.7' **LEAN CLAY: to SILTY CLAY:** CL. *(continued)*	CL									
				63.7 - 64.1' **SILTY SAND: to SANDY SILT:** SM.	SM									
			64.5 66.0 67.5	64.1 - 67.8' **LEAN CLAY: to SILTY CLAY:** CL.	CL									
			69.0 70.5 72.0	67.8 - 73.3' **SILT:** ML.	ML									
			73.5 75.0 76.5 78.0 79.5	73.3 - 80' **LEAN CLAY: to SILTY CLAY:** CL.	CL									
				80' End of boring.										

RAMBOLL

SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number	
Vermilion Power Station		104D	
Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Dave Gordon Cascade Drilling	3/8/2021	3/8/2021	Mini Sonic
Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
104D	Feet (NAVD88)	703.24 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,172.79 N, 1,147,573.87 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R
Lat ___° ___' ___"
Long ___° ___' ___"
Local Grid Location: Feet ☐N ☐S Feet ☐E ☐W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	120 120		0	0 - 0.8' **SANDY LEAN CLAY:** s(CL), very dark brown (10YR 3/2), very fine to coarse sand, gravel (0-5%), low to meidum plasticity, stiff, moist.	s(CL)				1.5					CS= Core Sample
			1	0.8 - 20' **LEAN CLAY:** CL, grayish brown (10YR 5/2), silt (15-25%), gravel (5-10%), medium plasticity, very stiff to hard, moist.					3.5					
			2											
			3						3					
			4											
			5						4.5					
			6		CL									
			7						4					
			8											
			9						3.5					
2 CS	120 120		10	10' gray (10YR 5/1).										
			11						2					
			12											

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

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

Boring Number 104D

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
				0.8 - 20' **LEAN CLAY:** CL, grayish brown (10YR 5/2), silt (15-25%), gravel (5-10%), medium plasticity, very stiff to hard, moist. *(continued)*	CL				2, 2, 2.5, 2, 2.5					
3 CS	120 120		20	20 - 21' **CLAYEY GRAVEL:** GC, moist to wet.	GC				2					
			21	21 - 25.4' **LEAN CLAY:** CL, grayish brown (10YR 5/2), silt (15-25%), fine to coarse gravel (5-10%), medium plasticity, very stiff to hard, moist.	CL				2.5, 2, 2, 2.5					
			25.4	25.4 - 27.5' **CLAYEY SILT** ML/CL, grayish brown (10YR 5/2), low plasticity, moist.	ML/CL									
			27.5	27.5 - 30' **SILT:** ML, gray (10YR 5/1), sand (0-5%), clay (0-5%).	ML									
4 SH	24 24		30	30 - 32' **LEAN CLAY:** CL.	CL									SH= Shelby Tube

Boring Number 104D

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
5 CS	216 216			32 - 37' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), fine to coarse gravel (5-10%), low plasticity, very stiff.										
			33						2.5					
			34		CL									
			35						2					
			36											
			37	37 - 37.5' **SILT:** ML.	ML				2.5					
				37.5 - 38.5' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), fine to coarse gravel (5-10%), low plasticity, very stiff.	CL									
			38											
				38.5 - 39.5' **SILT:** ML.	ML									
			39						3.5					
				39.5 - 40' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-20%), fine to coarse gravel (5-10%), low plasticity, very stiff.	CL									
			40	40 - 60' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1) to dark gray (10YR 4/1), gravel (5-10%), low plasticity, hard.										
			41						4.5					
			42											
			43						4.5					
			44											
			45						4.5					
			46		CL									
			47						4.5					
			48											
			49						4.5					
6 CS	120 120		50											
			51						4.5					
			52											

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			53	40 - 60' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1) to dark gray (10YR 4/1), gravel (5-10%), low plasticity, hard. *(continued)*	CL				4.5					
			54											
			55						4.5					
			56											
			57						4.5					
			58											
			59						4.5					
7 MC	24 24		60	60 - 62' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									MC= Modified California
			61											
8 CS	96 96		62	62 - 70' **LEAN CLAY:** to **SILTY CLAY:** CL, gray (10YR 5/1) to dark gray (10YR 4/1), gravel (5-10%), low plasticity, hard.	CL									
			63						4.5					
			64											
			65						4.5					
			66											
			67						4.5					
			68											
			69						4.5					
9 CS	120 120		70	70 - 75.6' **SANDY SILT:** s(ML), dark gray (10YR 4/1), fine sand, clay (5-10%), wet, fine sand seams (0-5%).	s(ML)									
			71											
			72											

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			73–75	70 - 75.6' **SANDY SILT:** s(ML), dark gray (10YR 4/1), fine sand, clay (5-10%), wet, fine sand seams (0-5%). *(continued)*	s(ML)									
			76–80	75.6 - 80.6' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), fine sand, wet.	SP-SM									
10 CS	120 120		81–82	80.6 - 82.4' **SILT:** ML, gray (10YR 5/1), sand (0-5%), wet.	ML									
			83	82.4 - 83.5' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), fine to medium sand, wet.	SP-SM									
			84	83.5 - 84.1' **SILTY SAND:** SM, gray (10YR 5/1), medium sand, wet.	SM									
			85	84.1 - 85.5' **SILTY CLAY:** CL/ML, dark gray (10YR 5/2), gravel (0-5%), low plasticity, hard.	CL/ML									
			86–87	85.5 - 87.6' **SILTY SAND:** SM, gray (10YR 5/1), sand, moist to wet.	SM									
			88	87.6 - 88.6' **SILTY CLAY:** CL/ML, dark gray (10YR 4/1), gravel (0-5%), low plasticity, hard.	CL/ML									
			89	88.6 - 90' **SILT:** ML, gray (10YR 5/1), fine sand (0-10%), moist to wet.	ML									
11 MC	24 24		90–92	90 - 92' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									

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
12 CS	216 216			92 - 148.1' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), low plasticity, hard, dry.										
			93						4.5					
			94											
			95						4.5					
			96											
			97						4.5					
			98											
			99						4.5					
			100											
			101						4.5					
			102		CL									
			103						4.5					
			104											
			105						4.5					
			106											
			107						4.5					
			108											
			109						4.5					
13 CS	240 240		110											
			111						4.5					
			112											

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
				92 - 148.1' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), low plasticity, hard, dry. *(continued)*										
			113						4.5					
			114											
			115						4.5					
			116											
			117						4.5					
			118											
			119						4.5					
			120											
			121						4.5					
			122		CL									
			123						4.5					
			124											
			125						4.5					
			126											
			127						4.5					
			128											
			129						4.5					
14 CS	240 240		130											
			131						4.5					
			132											

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Boring Number 104D

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
				92 - 148.1' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), low plasticity, hard, dry. *(continued)*										
			133						4.5					
			134											
			135						4.5					
			136											
			137						4.5					
			138											
			139						4.5					
			140		CL									
			141						4.5					
			142											
			143						4.5					
			144											
			145						4.5					
			146											
			147	147.3' layer of fine sand, wet (1" thick).					4.5					
			148	148.1 - 150' **POORLY-GRADED SAND:** SP, fine to medium sand, gravel (0-5%), wet.										
			149	149.1' -149.4' layer of silty clay.	SP				4.5					
15 CS	120 120		150	150 - 154.9' **LEAN CLAY:** to **SILTY CLAY:** CL, dark gray (10YR 4/1), low plasticity, hard.										
			151		CL				4.5					
			152											

Boring Number 104D

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
			153, 154	150 - 154.9' **LEAN CLAY: to SILTY CLAY:** CL, dark gray (10YR 4/1), low plasticity, hard. *(continued)*	CL				4.5					
			155	154.9 - 155.6' **POORLY-GRADED SAND:** SP, wet.	SP				4.5					
			156, 157, 158	155.6 - 158.8' **LEAN CLAY: to SILTY CLAY:** CL, dark gray (10YR 4/1), low plasticity, hard. 157.1' layer of fine sand, wet.	CL				4.5					
			159	158.8 - 160' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), very fine to fine sand, clay (0-10%), wet.	SP-SM				4.5					
16 CS	120 120		160, 161, 162, 163, 164, 165, 166, 167, 168, 169	160 - 170' **LEAN CLAY: to SILTY CLAY:** CL, dark gray (10YR 4/1), fine to coarse gravel (0-10%), low plasticity, hard.	CL				4.5 4.5 4.5 4.5 4.5					
			170	170' End of Boring.										

RAMBOLL

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Station		104S

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Dave Gordon Cascade Drilling	3/15/2021	3/15/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
104S	Feet (NAVD88)	703.10 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,172.50 N, 1,147,579.42 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R
Lat ° ' "
Long ° ' "
Local Grid Location
Feet ☐N ☐S Feet ☐E ☐W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

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
			0–1	0 - 0.8' **SANDY LEAN CLAY:** s(CL), Blind drilled to 70 feet below ground surface. See 104D boring log for detailed lithology..	s(CL)									
			1–12	0.8 - 20' **LEAN CLAY:** CL.	CL									

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

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

Boring Number 104S

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
			13–20	0.8 - 20' **LEAN CLAY:** CL. *(continued)*	CL									
			20–21	20 - 21' **CLAYEY GRAVEL:** GC.	GC									
			21–25.4	21 - 25.4' **LEAN CLAY:** CL.	CL									
			25.4–27.5	25.4 - 27.5' **CLAYEY SILT** ML/CL.	ML/CL									
			27.5–30	27.5 - 30' **SILT:** ML.	ML									
			30–32	30 - 32' **LEAN CLAY:** CL.	CL									

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Boring Number 104S

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
			32 - 37	32 - 37' **LEAN CLAY:** CL.	CL									
			37 - 37.5	37 - 37.5' **SILT:** ML.	ML									
			37.5 - 38.5	37.5 - 38.5' **LEAN CLAY:** CL.	CL									
			38.5 - 39.5	38.5 - 39.5' **SILT:** ML.	ML									
			39.5 - 40	39.5 - 40' **LEAN CLAY:** CL.	CL									
			40 - 52	40 - 60' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									

Boring Number 104S

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
			53–60	40 - 60' **LEAN CLAY:** to **SILTY CLAY:** CL. *(continued)*	CL									
			60–62	60 - 62' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									
			62–70	62 - 70' **LEAN CLAY:** to **SILTY CLAY:** CL.	CL									
			70–72	70 - 74' **LEAN CLAY:** CL.	CL									

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
			73	70 - 74' **LEAN CLAY:** CL. *(continued)*	CL									
			74, 75	74 - 76' **POORLY-GRADED SAND:** ML, fine to medium sand.	ML									
			76, 77	76 - 77.6' **SILT:** ML, wet.	ML									
			78	77.6 - 78.8' **POORLY-GRADED SAND:** ML, fine to medium sand, silt (5-15%).	ML									
			79	78.8 - 80' **SILT WITH SAND:** ML.	ML									
			80, 81, 82, 83	80 - 84' **POORLY-GRADED SAND:** SP, fine to medium sand. 83' fine sand.	SP									
			84, 85	84 - 86' **SILT WITH SAND:** ML, wet.	ML									
			86, 87, 88	86 - 88.5' **LEAN CLAY:** CL.	CL									
			89	88.5 - 90' **SILT WITH SAND:** ML, dry.	ML									
			90	90' End of Boring.										

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Station		105D

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jason Greer Cascade Drilling	3/5/2021	3/6/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
105D	Feet (NAVD88)	698.46 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,498.42 N, 1,148,535.89 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R

Lat ° ' "
Long ° ' "

Local Grid Location
Feet ☐ N ☐ S
Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 36		0	0 - 0.4' ASH.	(FILL) ASH									Drilled 7" override casing to 15' below ground surface (bgs)
			0.4	0.4 - 5' **FILL, GRAVELLY SILT:** g(ML), brown (10YR 4/3), angular, gravel, clay (10-30%), non-plastic, moist.	(FILL) g(ML)									
2 CS	60 48		5	5 - 9.5' **FILL, GRAVELLY SILT:** g(ML), very dark gray (10YR 3/1), clay (5-15%), sand (5-10%), ash and slag-like material, non-plastic, moist.	(FILL) g(ML)									CS= Core Sample
			7	7' black (10YR 2/1).										
			9.5	9.5 - 10' **LEAN CLAY:** CL, gray (10YR 5/1), silt (5-15%), very stiff, medium plasticity, moist.	CL				2					
3 SH	24 24		10	10 - 12.										SH= Shelby Tube

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 Street, Milwaukee,WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
4 CS	60 0		12	12 - 17' No Recovery.										
			13											
			14											
			15											
			16											
5 CS	36 36		17	17 - 20' **LEAN CLAY:** CL, gray (10YR 6/1), gravel (5-10%), firm to stiff, high plasticity, moist.					1					
			18		CL									
			19						0.5					
6 CS	60 60		20	20 - 30' **LEAN CLAY:** CL, pale brown (10YR 6/3), silt (10-20%), hard, low plasticity, moist.										
			21						4.5					
			22											
			23						4.5					
			24	24' dark gray (10YR 4/1).										
7 CS	60 60		25	25' gravel (0-5%).	CL				4.5					
			26						4.5					
			27						4.5					
			28											
			29						4.5					
8 MC	24 24		30	30 - 32' Advanced Modified California sample.										MC= Modified California
			31											
			32											

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
9 CS	36 36			32 - 55.4' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (10-20%), gravel (5-15%), hard, low plasticity, moist.										
			33						4.5					
			34											
10 CS	60 60		35						4.5					
			36						4.5					
			37						4.5					
			38						4					
			39											
11 CS	60 60		40	40' very stiff to hard.					2					
			41						4					
			42		CL									
			43						4.5					
			44											
12 CS	60 60		45						3.5					
			46											
			47						3					
			48											
			49						3					
13 CS	60 60		50											
			51						1					
			52											

RAMBOLL

Boring Number 105D

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				32 - 55.4' **LEAN CLAY:** CL, dark gray (10YR 4/1), silt (10-20%), gravel (5-15%), hard, low plasticity, moist. *(continued)*	CL				3.5					
			53						2.5					
			54											
14 CS	60 60		55						3.5					
			56	55.4 - 56' **CLAYEY GRAVEL:** GC, gray (10YR 5/1), rounded, fine to coarse gravel, loose, moist to wet.	GC									
			57	56 - 60' **LEAN CLAY:** CL, gray (10YR 5/1), gravel (5-15%), hard, high plasticity, moist. 56.6' - 56.8' layer of fine gravel, wet.	CL				4					
			58											
			59						4.5					
15 MC	24 24		60	60 - 61.75' **POORLY-GRADED SAND WITH GRAVEL:** (SP)g, gray (10YR 5/1), subrounded, coarse sand, fine gravel, loose, wet.	(SP)g									
			61											
16 MC	24 18		62	61.75 - 70' **LEAN CLAY:** CL, gray (10YR 5/1), silt (10-20%), gravel (5-15%), hard, low plasticity, dry to moist.										
			63											
17 CS	72 72		64	64 - 70' **LEAN CLAY:** CL, gray (10YR 5/1), gravel (5-15%), hard, high plasticity, moist.										
			65						4.5					
			66		CL									
			67	67.3' -67.5 layer of fine to coarse sand, moist to wet.	CL				4.5					
			68											
			69						3.5					
18 CS	60 60		70	70 - 71' **CLAYEY SAND:** SC, gray (10YR 6/1), fine sand, loose, moist to wet.	SC									
			71	71 - 75' **SILTY CLAY:** CL/ML, gray (10YR 6/1), gravel (5-15%), hard, low plasticity, moist.	CL/ML									
			72											

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
			71 - 75	71 - 75' **SILTY CLAY:** CL/ML, gray (10YR 6/1), gravel (5-15%), hard, low plasticity, moist. *(continued)*	CL/ML				4.5 4.5					
19 CS	60 60		75 - 75.8	75 - 75.8' **SILT:** ML, gray (10YR 6/1), moist.	ML				4.5					
20 CS 21 CS	60 60 60 60		75.8 - 90	75.8 - 90' **LEAN CLAY:** CL, gray (10YR 5/1), gravel (5-15%), hard, low plasticity, moist.	CL				4.5 4.5 4.5 4.5 4.5 4.5					
22 MC	24 24		90 - 92	90 - 92.										

Boring Number 105D

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
23 CS	96 96			92 - 124.2' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist.										
			93						2.5					
			94											
			95						2.5					
			96											
			97						4.5					
			98											
			99	98.6' -99.0 layer of cobbles.					4.5					
24 CS	240 240		100											
			101						4					
			102		CL									
			103						4.25					
			104											
			105						4					
			106											
			107						3.75					
			108											
			109						4.25					
			110											
			111						4.5					
			112											

Sample Number and Type	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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			113	92 - 124.2' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist. *(continued)*	CL				4.5					
			115						4.5					
			117						4.5					
			119						4.5					
25 CS	240 240		121						4					
			123						3.75					
			124.2	124.2 - 124.6' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), rounded to subrounded, medium sand, gravel (0-5%), loose, wet.	SP-SM									
			125	124.6 - 126.4' gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist. 126.1' -126.4' layer of coarse sand.					4.25					
			127	126.4 - 137.2' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist.	CL				3.5					
			129						2.75					
			131						4					
			132											

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Boring Number 105D

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			133	126.4 - 137.2' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist. *(continued)*	CL				4					
			134											
			135						3.25					
			136											
			137						2.75					
				137.2 - 137.6' **POORLY-GRADED SAND WITH GRAVEL:** (SP)g, gray (10YR 5/1), subrounded to round, medium to coarse sand, loose, wet.	(SP)g									
			138	137.6 - 138.3' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist.	CL									
			139	138.3 - 138.7' **POORLY-GRADED SAND WITH SILT:** SP-SM, gray (10YR 5/1), subrounded to rounded, medium sand, silt (0-5%), clay nodules (0-5%), loose, wet.	SP-SM				2.75					
26 CS	240 240		140											
			141	138.7 - 160' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist.	CL				1.5					
			142											
			143						1.25					
			144											
			145						1.5					
			146											
			147						2.25					
			148											
			149						2.25					
			150											
			151						2.25					
			152											

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			153	138.7 - 160' **LEAN CLAY:** CL, gray (10YR 5/1), silt (15-25%), sand (0-5%), gravel (0-5%), very stiff to hard, no dilatancy, medium to high toughness, medium plasticity, dry to moist. *(continued)*					2.5					
			154											
			155						2.5					
			156		CL									
			157						2.5					
			158											
			159						2.5					
			160	160' End of Boring.										

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SOIL BORING LOG INFORMATION

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Vermilion Power Station		105S

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Jason Greer Cascade Drilling	3/16/2021	3/16/2021	Mini Sonic

Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
105S	Feet (NAVD88)	698.97 Feet (NAVD88)	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane 1,279,488.62 N, 1,148,530.35 E Ⓔ/ W
1/4 of 1/4 of Section , T N, R

Lat ° ' "
Long ° ' "

Local Grid Location
Feet ☐ N ☐ S
Feet ☐ E ☐ W

Facility ID	County	State	Civil Town/City/ or Village
	Vermilion	Illinois	Oakwood

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
			0	0 - 0.4' ASH, Blind drilled to 90 feet below ground surface. See 105D boring log for detailed lithology.	(FILL) ASH									No sand observed during drilling
			0.4	0.4 - 5' FILL, GRAVELLY SILT: g(ML).	(FILL) g(ML)									
			5	5 - 9.5' FILL, GRAVELLY SILT: g(ML).	(FILL) g(ML)									
			9.5	9.5 - 17' LEAN CLAY: CL.	CL									

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

Signature	Firm	
[signature]	Ramboll 234 W. Florida Street, Milwaukee,WI 53204	Tel: (414) 837-3607 Fax: (414) 837-3608

Boring Number 105S

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
			13, 14, 15, 16	9.5 - 17' **LEAN CLAY:** CL. *(continued)*	CL									
			17, 18, 19	17 - 20' **LEAN CLAY:** CL.	CL									
			20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32	20 - 32' **LEAN CLAY:** CL.	CL									

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	Compressive Strength (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			33–52	32 - 55.4' **LEAN CLAY:** CL.	CL									

Boring Number 105S

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
			52–55.4	32 - 55.4' **LEAN CLAY:** CL. *(continued)*	CL									
			55.4–56	55.4 - 56' **CLAYEY GRAVEL:** GC.	GC									
			56–60	56 - 60' **LEAN CLAY:** CL.	CL									
			60–61.75	60 - 61.75' **POORLY-GRADED SAND WITH GRAVEL:** (SP)g.	(SP)g									
			61.75–64	61.75 - 70' **LEAN CLAY:** CL.	CL									
			64–70	64 - 70' **LEAN CLAY:** CL.	CL									
			70–71	70 - 71' **CLAYEY SAND:** SC.	SC									
			71–72	71 - 75' **SILTY CLAY:** CL/ML.	CL/ML									

Boring Number 105S

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
			73–75	71 - 75' **SILTY CLAY:** CL/ML. *(continued)*	CL/ML									
			75–75.8	75 - 75.8' **SILT:** ML.	ML									
			76–90	75.8 - 90' **LEAN CLAY:** CL.	CL									
			90	90' End of Boring.										

APPENDIX B
INUNDATION MAP

NOTES
1) The estimated inundation areas represented on this map are based on topographic mapping from 2012 Illinois State LiDAR data and hydraulic modeling provided by others.
2) The flooding source is the Vermilion River.
3) On-site impoundments which are not directly connected to the Vermilion River based on elevations from the Illinois State LiDAR data are not assumed to be inundated.

Legend

- 100-year Profile Elevations
- 100-year Inundation Area
- 500-year Inundation Area
- 1000-year Inundation Area

250 0 250 500 Feet
1 inch = 250 feet

N S E W

DYNEGY
8/17/2021

Inundation Map

Vistra
Vermilion Power Station
Vermilion County, IL

19E0096C

Sheet 1 of 1

I:\19jobs\19E0096C\CAD\GIS\Projects\InundationMap.mxd

ATTACHMENT R

415 Illinois Compiled Statutes (ILCS) 5/22.59(b)(4) Certification Statement

Dianna Tickner
Dynegy Midwest Generation, LLC
Illinois Power Resources Generating, LLC
1500 Eastport Plaza Drive
Collinsville, IL 62234

January 14, 2022

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
Duck Power Plant GMF Pond (IEPA ID # W0578010001-04)
Duck Creek Power Plant Bottom Ash Basin (IEPA ID # W0578010001-03)
Hennepin Power Plant East Ash Pond (IEPA ID # W1550100002-05)
Vermilion Power Plant New East Ash Pond (IEPA ID # W1838000002-04)
Vermilion Power Plant North Ash Pond/Old East Ash Pond (IEPA ID # W1838000002- 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 and Illinois Power Resources Generating, 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
Illinois Power Resources Generating, LLC

Dianna Tickner

Dianna Tickner
Director, Decommissioning & Demolition