Luminant

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March 8, 2024

Francisco J. Herrera
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1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794

Re: Illinois Power Generating Company - Newton Power Plant
Log No. 2021-100018
Bureau ID # W0798070001
CCR Surface Impoundment Operating and Construction Permit Application Review Letter Response

Mr. Herrara:

Illinois Power Generating Company (IPGC) received the Newton Power Plant CCR Surface Impoundment Operating and Construction Permit Application Review Letter dated October 10, 2023. At this time, we are submitting the below responses to Illinois Environmental Protection Agency's (IEPA's) initial comments set forth in the review letter.

As discussed more specifically below, IPGC will produce data and information requested by IEPA in two productions, starting concurrently with this letter by producing data and information that is reasonably and readily available and producing the remaining information, as indicated in the below responses, when it is available. All documents and responses will be provided in hard copy, as requested by IEPA, as well as through a courtesy email and temporary file-sharing service. As noted below, IPGC will also be producing electronic data deliverables ("EDDs"), which can only be shared electronically and will be provided via the temporary file-sharing service.

Within the below responses, IPGC requests additional information and clarification regarding several comments. To further discuss those requests, IPGC would like to schedule an in-person meeting with IEPA to ensure IPGC is providing complete responses.

Initial Operating Permit Application

History of Construction [35 Ill. Adm. Code 845.230(d)(2)(A)]

Comment 1: *To comply with the application requirements of 35 Ill. Adm. Code 845.230(d)(2)(A), the applicant must provide a written history of construction containing the information specified in 35 Ill. Adm. Code 845.220(a)(1). The* *history of construction information submitted in the initial operating permit application at Attachment B has items indicated as "not reasonable and readily available" and were not provided in the updated history of construction dated October 11, 2021 in Attachment U. A written history of construction needs to be submitted to the Agency in accordance with the requirements of 35 Ill. Adm. Code 845.220(a)(1).*

Response: In preparing its Operating Permit application, IPGC reviewed all available files and identified and interviewed all employees that could potentially have relevant information. Despite its efforts and due to the age of the Primary Ash Pond, IPGC was unable to find information related to the topics within the History of Construction that it previously identified as "not reasonably and readily available." Specifically, IPGC was unable to locate information related to the following for the Primary Ash Pond and, given the age of the unit, is not able to generate this information:

- Method of site preparation and construction;
- Area of capacity curves; and
- Construction specifications.

Waste Characterization and CCR Characterization [35 Ill. Adm. Code 845.230(d)(2)(B) and 845.230(d)(2)(C)]

Comment 2: *The CCR waste characterization must include all waste streams as defined by SW846, incorporated by reference in Section 845.150, which includes appropriate number of samples to characterize each waste type and identification of all waste types which includes solids, semi-solids, liquids, and air born parts that come from the CCR. The date and time sampled, number of samples collected, constituents analyzed for each sample, statistics or data reduction technical explanations, and laboratory reports for the analytical data for the following waste streams must be provided:*

- *CCR solids and semi-solids*
- *Leachate water, if any*
- *Surface water, if any*
- *Any other waste stream as defined by SW846 Compendium*

Response: The existing characterization is consistent with Part 845. While it is true that SW846 is incorporated by reference into Part 845 by Section 845.150, inclusion in the general "incorporations by reference" section of Part 845 does not create an affirmative obligation to use SW846 in all circumstances. The Board has explained that where Illinois rules incorporate analytical methods by reference via a "centralized listing of incorporations by reference" such as Section 845.150, "Illinois rules further indicate where each method is used *in the body of the substantive provisions*." *See In the Matter of: SDWA Update, USEPA Amendments (January 1, 2013 through June 30, 2013)*, R 2014-008, Opinion of the Board at 24–25 (Jan. 23, 2014) (emphasis added).

Further, Chapter 2 of SW846 states that the methods in that document are not "mandatory" unless the regulation itself specifically indicates the method. United States Environmental Protection Agency ("USEPA"), *SW-846 Update V* at 1 (July 2014).[1] USEPA guidance also makes clear that SW846 is only legally required where "explicitly specified" in a regulation. USEPA, *Disclaimer for Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)* at 1 (July 2014).[2] The only substantive provision of Part 845 specifically requiring analysis using SW846 is Section 845.640(e), which applies to analyzing groundwater monitoring samples under a groundwater monitoring program and is not at issue here. 35 Ill. Admin. Code § 845.640(e). There is no requirement to use SW846 under Section 845.230(d)(2). The plain language of Part 845 does not require the utilization of SW846 for purposes of waste and CCR characterization.

IPGC followed best practices in the industry in conducting its "analysis of the chemical constituents found within the CCR to be placed in the CCR surface impoundment" and "analysis of the chemical constituents of all waste streams, chemical additives and sorbent materials entering or contained in the CCR surface impoundment." IPGC collected porewater, which is the most representative of the chemical constituents from the leachate of the impoundment. Testing of the actual porewater from a CCR surface impoundment is more appropriate than SW846's use of leach test results performed under variable conditions collected from any number of locations within the CCR surface impoundment. The porewater analysis used is the best and most accurate scientifically available information for source characterization. *See, e.g.*, US EPA, Industrial Environmental Research Laboratory, Chemical and Biological Characterization of Leachates from Coal Solid Wastes, EPA-600/7-80-039, March 1980; US EPA & TVA, Effects of Coal-ash Leachate on Ground Water Quality, EPA-600/7-80-066, March 1980; US EPA, Office of Research and Development, Characterization of Coal Combustion Residues from Electric Utilities – Leaching and Characterization Data, EPA-600/R-09/151, December 2009; *see also* X.Wang, *et al., Leaching and Geochemical Evaluation of Oxyanion Partitioning Within an Active Coal Ash Management Unit,* Chemical Engineering Journal, Vol. 454, Part 4, at 140406 (Feb. 15, 2023).

The approach for characterization of the CCR was included as Attachment 2 in a Letter from Luminant *Re: Alternative Source Demonstration ("ASD") for Newton Power Plant Primary Ash Pond* dated November 3, 2023. An excerpt from that Attachment is as follows:

> *Prior to performing hydrogeologic investigations in 2021, Ramboll completed a review of existing data to determine whether sufficient information existed to meet the requirements of 35 I.A.C. § 845.*

[1] Available at https://www.epa.gov/sites/default/files/2015-10/documents/chap2_1.pdf.
[2] Available at https://www.epa.gov/sites/default/files/2015-10/documents/disclaim.pdf.

> *Based on the review, Ramboll developed an approach to fully characterize the CCR material as part of the 2021 investigation. Five locations for porewater wells were selected by evaluating the extent of ash through time on aerial photographs (Figure 1), identifying visible differences (color) in surficial materials, and capturing a representative spatial distribution. Porewater was encountered at an elevation of approximately 540 feet in 2021 (Ramboll, 2021). For the purpose of visualization, Figure 2 shows the areas within the SI that were not accessible for potential sampling and testing as illustrated by different colored portions of the Primary Ash Pond. Of the 404 acre unit only about 12% was accessible. A total of four porewater wells were installed in 2021, because the fifth location was not able to be accessed safely after evaluation with contractors in the field.*

The Figures referenced in the above excerpt are included in Attachment A.

Emergency Action Plan [35 Ill. Adm. Code 845.230(d)(2)(G)]

Comment 3: *The Emergency Action Plan must be updated to include all contact information of emergency responders including internal contacts and must state how the annual coordination meetings will be documented in the facility's operating record.*

Response: The submitted Emergency Action Plan satisfies the requirements of Section 845.520(b) and need not be revised. IPGC submitted as Attachment F to its Primary Ash Pond Operating Permit Application an Emergency Action Plan. Page 7 of that Emergency Action Plan lists internal and external emergency responder contact information, as required by 35 Ill. Admin. Code § 845.520(b)(3). Further, Section 845.520 does not require, as IEPA purports, that the Emergency Action Plan state how the annual coordination meetings will be documented in the facility's operating record. *See* 35 Ill. Admin. Code § 845.520(b) (minimum requirements for the Emergency Action Plan). It simply requires that such documentation be placed in the operating record. 35 Ill. Admin. Code § 845.520(g). As required by Section 845.520(g), IPGC has committed in the Emergency Action Plan to conduct annual "coordination meeting[s] . . . between representatives of the [IPGC] and local emergency responders." Newton Ash Pond Operating Permit Application (Oct. 25, 2021), Attachment F at 14. Additionally, as required by Sections 845.520(g) and 845.800(d)(10), IPGC will place documentation of the annual meeting in the facility's operating record.

Hydrogeologic Site Characterization [35 Ill. Adm. Code 845.230(d)(2)(I)(i)]

Comment 4: *The initial operating permit application states that well APW10 has a higher groundwater elevation than Newton Lake as well as the uppermost aquifer. The application also states that the uppermost aquifer may interact with upgradient groundwater since it intersects Newton Lake. Environmental data as to whether* *there is interaction between the uppermost aquifer and Newton Lake must be provided.*

Response: Based on the interpretations of the uppermost aquifer stratigraphy, measured groundwater elevations in APW10, and surface water elevations, groundwater migrates to Newton Lake. However, surface water data collected in 2021, and provided in the Human Health and Ecological Risk Assessment (Gradient, 2022, Appendix A in the Closure Plan) indicate that current conditions do not pose a risk to human health or the environment. Additional discussion and evaluation regarding groundwater interaction with Newton Lake will be provided in the Nature and Extent Report that is currently being prepared and will be submitted in conjunction with the Corrective Measures Assessment due to IEPA on April 5, 2024.

Comment 5: *The initial operating permit application provides multiple well logs to 100 ft. and wells SB310, XPW04, and G217 are missing soil/rock descriptions and geologic origins at varying depths. Complete well logs must be provided or an explanation for the missing descriptions.*

Response: Recovery of material during soil borings is variable based on the selected drilling methods, drilling subcontractor, and soil type. It is common to encounter intervals where only partial recovery of a sample, or no sample is obtained. A field geologist logs the recovered material and interprets the geology at a soil boring location. There is no boring SB310, so it is assumed that Comment 5 is referring to soil boring SB301 located just outside the northwest corner of the Primary Ash Pond. Intervals without an entry (pg. 285 of 1025 of the Operating Permit) from the boring logs were either those sent to a laboratory for analysis (e.g. a shelby tube where the interval could not be field logged) or an interval where there was no recovery. The number of intervals without an entry is limited, both within an individual boring and across the site, indicating there is sufficient data to interpret the geologic structure and hydrogeologic characteristics of the site.

Comment 6: *During the 2011 drilling of well G224, the boring log shows there are two areas of no recovery around 502 ft and 462 ft. The well logs of nearby wells or an explanation to validate if there are unstable soils or other actions must be provided.*

Response: As discussed in the previous comment, it is common to encounter intervals where only partial recovery of a sample, or no sample is obtained. The boring was advanced to depth using a 5’ continuous sampler to collect materials for visual description, which was followed by hollow-stem augers to enlarge the borehole to facilitate well installation. In the interval prior to the missing samples, materials consisted of silty clay with gravel, or silt, silty sand and sand with gravel. If gravel is large enough, it may not enter the core sampler, and instead push the lower materials out of the path of the boring resulting in an area of no recovery. Alternatively, if there is sand present and it is not densely packed into the sampler, it can fall out of the sampler when it is retrieved from the boring. At this location, during advancement of the hollow-stem augers following the attempted core sample, the boring log indicates harder drilling. This comment and the preceding lithology (presence of gravel) provides evidence that the lack of sample is likely due to coarse grain material obstructing the sampler and does not indicate unstable soils.

Groundwater Sampling and Analysis Program [35 Ill. Adm. Code 845.230(d)(2)(I)(iii)]

Comment 7: *The laboratory reports, field stabilization records, and purge documentation must be provided to sufficiently address the requirements in Section 845.640(a). The state-certified laboratory used during the time of groundwater sampling must also be identified.*

Response: On December 19, 2023, IPGC technical staff and IEPA met to discuss IEPA's Initial Review Letter. Pursuant to that discussion, IPGC is producing the EDD responsive to the above request concurrently with this response. Given the data to be shared, IPGC will provide IEPA with a link to a temporary file-sharing service containing the EDD.

Comment 8: *The appropriate minimum detection limits for each constituent must be used to evaluate the constituent statistically and to compare against the numerical groundwater protection standard in 35 IAC 845.600(a)(1). The following constituents have a calculated groundwater protection/background value that does not exhibit the correct use of the statistics:*

- *Arsenic*
- *Radium 226 and 228*

Response: IPGC has received and is reviewing IEPA's December 28, 2023, letter regarding its Comments on Statistical Methods Proposed in Initial Operating Permit. IPGC requests a meeting with IEPA to further discuss this comment in the initial review letter and the comments in IEPA's December 28 letter. Following that meeting, IPGC will provide IEPA written responses to the December 28 letter, which will also serve as its response to the above comment.

Preliminary Written Closure Plan [35 IAC 845.230(d)(2)(J)]

Comment 9: *To comply with the application requirements of 35 Ill. Adm. Code 845.230(d)(2)(J), the applicant must provide a preliminary written closure plan containing the information specified in 35 Ill. Adm. Code 845.720(a). A preliminary written closure plan was not provided in the initial operating permit application.*

Response: The Newton Primary Ash Pond is required to close under 35 Ill. Admin. Code § 845.700. Therefore, a preliminary written closure plan is not required for the unit. Section 845.720(a)(1) requires a preliminary written closure plan only for those units "***not required to close under Section 845.700***." 35 Ill. Admin. Code § 845.720(a)(1) (emphasis added).

Liner Status or Statement [35 IAC 845.230(d)(2)(L)]

Comment 10: *To comply with the application requirements of 35 Ill. Adm. Code 845.230(d)(2)(L), the applicant must provide a certification from a qualified professional engineer attesting that the CCR surface impoundment meets the requirements of Section 845.400(a) or provided a statement that the CCR surface impoundment does not have a liner that meets the requirements of Section 845.400(b) or (c). No certification or statement of the CCR surface impoundment meeting or not meeting requirements under Section 845.400 was provided in the initial operating permit application.*

Response: As required by Section 845.230(d)(2)(L), IPGC states that the Primary Ash Pond does not have a liner that meets the requirements of Section 845.400(b) or (c).

History of Known Groundwater Exceedances [35 IAC 845.230(d)(2)(M)]

Comment 11: *The appropriate minimum detection limits for each constituent must be used to evaluate the constituent statistically and to compare against the numerical groundwater protection standard in 35 IAC 845.600(a)(1). The following constituents have a calculated groundwater protection/background value that does not exhibit the correct use of the statistics:*

- *Arsenic*
- *Lower end of pH*
- *Radium 226 and 228*

Response: IPGC has received and is reviewing IEPA's December 28, 2023, letter regarding its Comments on Statistical Methods Proposed in Initial Operating Permit. IPGC requests a meeting with IEPA to further discuss this comment in the initial review letter and the comments in IEPA's December 28 letter. Following that meeting, IPGC will provide IEPA written responses to the December 28 letter, which will also serve as its response to the above comment.

Comment 12: *The history of known groundwater exceedances in Attachment M does not contain actual data for review by the Agency. The laboratory reports and raw data used as inputs for the statistical analyses must be provided for the Agency to review and approve.*

Response: On December 19, 2023, IPGC technical staff and IEPA met to discuss IEPA's Initial Review Letter. Pursuant to that discussion, IPGC is producing EDD responsive to the above request concurrently with this response. Given the nature of the data to be shared, IPGC will provide IEPA with a link to a temporary file-sharing service containing the EDD.

Hazard Potential Classification Assessment and Certification [35 IAC 845.230(d)(2)(M)]

Comment 13: *The hazard potential classification assessment in Attachment O and addendum in Attachment U indicate a classification of a significant hazard potential for the CCR* *surface impoundment in accordance with 40 CFR 257.73(a)(2). The hazard potential classification assessment for the CCR surface impoundment must be in accordance with Section 845.440.*

Please explain how the initial hazard potential classification assessment provided in the initial operating permit application meets Section 845.210(d)(3).

Response: Part 845 allows a previous hazard potential classification assessment to be submitted under Section 845.210(d)(3) if the previously completed assessment was completed less than five years ago, and it meets the applicable requirements of Section 845.440. Section 845.440 requires classification of a unit as either a "Class 1 or Class 2 CCR surface impoundment." IPGC submitted as Attachment O to its Primary Ash Pond Operating Permit Application an Initial Hazard Potential Classification Assessment conducted on October 12, 2016, pursuant to 40 CFR 257.73(a)(2). Additionally, Attachment U of the Primary Ash Pond Operating Permitting Application includes a Periodic Hazard Potential Assessment, dated October 11, 2021, in which an introductory letter notes that the periodic assessment was conducted to meet all the necessary requirements of 40 C.F.R. § 257.73(a)(2) and Section 845.440. The initial and periodic assessment classify the Primary Ash Pond as a "significant" hazard potential under 40 C.F.R. § 257.73(a)(2), which Attachment U further notes is equivalent to a "Class 1" hazard potential under Section 845.440(a)(1). The initial and periodic assessments are also certified by a qualified professional engineer, satisfying Section 845.440(b). Therefore, the initial and periodic hazard potential classification assessment provided in the initial operating permit application meets the requirements of Sections 845.210(d)(3) and 845.440.

Structural Stability Assessment and Certification [35 IAC 845.230(d)(2)(P)]

Comment 14: *The initial structural stability assessment in Attachment P must use a hazard potential classification in accordance with Section 845.440. The structural stability assessment must also document compliance with Section 845.450(a)(6) with respect to negative affects to the CCR surface impoundments.*

Please explain how the initial structural stability assessment provided in the initial operating permit application meets Section 845.210(d)(3).

Response: As an initial note, IPGC states that the Agency's comment is unclear. Section 845.450 is not dependent on the hazard potential classification determined under Section 845.440 and neither incorporates nor requires the classifications use during the structural stability assessment.

Further, Part 845 allows a previous structural stability assessment to be submitted if, under Section 845.210(d)(3), the previously completed assessment was completed less than five years ago and meets the applicable requirements of Section 845.450. IPGC submitted as Attachment P to its Primary Ash Pond Operating Permit Application an Initial Structural Stability Assessment conducted on October

13, 2016, pursuant to 40 C.F.R. § 257.73(d)(1). Further, Attachment U of the Primary Ash Pond Operating Permitting Application includes a Periodic Structural Stability Assessment, dated October 11, 2021, in which an introductory letter notes that the periodic assessment was conducted to meet all the necessary requirements of 40 C.F.R. § 257.73(d)(1) and Section 845.450. Specifically, the Initial Structural Stability Assessment satisfies Section 845.450(a)(6) by stating that the pipes were inspected by visual observation. The outfall piping was observed by lowering the Secondary Pond level while keeping the discharge flowing in the pipes. This was completed to detect any "piping" of water around the outfall. No piping was detected. The results of the 2016 remote televising showed the sliplined pipe had no defects. If there were defects, then piping would have been observed. Also, the clay soils of the dike or embankment are not susceptible to catastrophic erosion as they are low plasticity compressible clay (CL) and CL/CH (high plasticity) soils. As such, it was the determination of the qualified professional engineer that the embankment and hydraulic structure of the outfall are stable and meet Section 845.450.

Additional details concerning structural stability are included in the 2016 AECOM CCR Certification Report included as Attachment B to this letter.

Safety Factor Assessment and Certification [35 IAC 845.230(d)(2)(Q)]

Comment 15: *Please explain how the initial safety factor assessment provided in the initial operating permit application meets Section 845.210(d)(3).*

Response: Part 845 allows a previous safety factor assessment to be submitted if, under Section 845.210(d)(3), the previously completed assessment was completed less than five years ago and meets the applicable requirements of Section 845.460(a) & (b). IPGC submitted as Attachment Q to its Primary Ash Pond Operating Permit Application an Initial Safety Factor Assessment conducted on October 13, 2016, pursuant to 40 C.F.R. § 257.73(e). Additionally, Attachment U of the Primary Ash Pond Operating Permitting Application includes the Periodic Safety Factor Assessment, dated October 11, 2021, in which an introductory letter notes that the periodic assessment was conducted to meet all the necessary requirements of Section 845.460 and 40 C.F.R. § 257.73(e). The requirements contained in Section 845.460 are identical to those required by 40 C.F.R. § 257.73(e), and the initial and periodic assessments are also certified by a qualified professional engineer, satisfying Section 845.460(b).

Additional details concerning the safety factor assessment are included in the 2016 AECOM CCR Certification Report included as Attachment B to this letter.

Inflow Design Flood Control System Plan and Certification [35 IAC 845.230(d)(2)(R)]

Comment 16: *The inflow design flood control system plan must use a hazard potential classification in accordance with Section 845.440 and specify how discharges from the CCR surface impoundment will be handled with in accordance with Section 845.110(b)(3).*

The inflow design flood control system plan certification must be certified by a qualified professional engineer to meet the requirements of Section 845.510.

Response: The Inflow Design Flood Control System Plan attached to the initial operating permit application as Attachment R, satisfies all the requirements of Section 845.510 and is certified by a qualified professional engineer. *See* Initial Operating Permit Newton Ash Pond, Attachment R. Additional details pertinent to the Inflow Design Flood Control System Plan and Certification are included in the 2016 AECOM CCR Certification Report included as Attachment B to this letter.

Safety and Health Plan (35 IAC 845.230(d)(2)(S))

Comment 17: *The Safety and Health Plan in Attachment S must address the response and procedure for using, inspecting, repairing, and replacing facility emergency and monitoring requirements in accordance with Section 845.530(c).*

Response: IPGC has provided as Attachment C to this letter a revised Safety and Health Plan dated December 2023 that addresses these requirements in Section 3.4 "Emergency and Monitoring Equipment Training" as requested by IEPA.

Construction Permit Application

History of Construction [35 Ill. Adm. Code 845.220(a)(1)]

Comment 18: *To comply with the application requirements of 35 Ill. Adm. Code 845.220(a)(1), the applicant must provide a written history of construction containing the information specified in 35 Ill. Adm. Code 845.220(a)(1). The history of construction information submitted in the initial operating permit application at Attachment B has items indicated as "not reasonable and readily available" and were not provided in the updated history of construction dated October 11, 2021 in Attachment U. A written history of construction needs to be submitted to the Agency in accordance with the requirements of 35 Ill. Adm. Code 845.220(a)(1).*

Response: In preparing its Construction Permit application, IPGC reviewed all available files and identified and interviewed all employees that could potentially have relevant information. Despite its efforts and due to the age of the Primary Ash Pond, IPGC was unable to find information related to the topics within the History of Construction that it previously identified as "not reasonably and readily available." Specifically, IPGC was unable to locate information related to the following for the Primary Ash Pond and given the age of the unit is not able to generate this information:

- Method of site preparation and construction;
- Area of capacity curves; and
- Construction specifications.

Comment 19: *The geotechnical explorations and laboratory testing used to create Tables 1 and 2 in Attachment C must be provided.*

Response: The certified geotechnical sampling, testing and analyses are included as Attachment B to this letter and provides the requested information.

Comment 20: *The investigation conducted by Hanson Professional Service, Inc. for the presence of more voids and a discussion of whether the actions taken fixed the area in the CCR surface impoundment must be provided.*

Response: Hanson completed a Site visit in September 2008 to evaluate a sinkhole that was identified following a significant rain event. The opening was located above corrugated metal pipes that connected the primary and secondary pond. The observed opening was approximately 12 feet in diameter and 10-12 feet in depth. Recommendations included in the Hanson Report included repair of the sinkhole by filling with soil and compacting, evaluation of the corrugated pipe, and evaluation of options to investigate for additional voids along the piping.

In 2009 the pipe was sliplined to prevent further progression of the sinkhole and the sinkhole was backfilled. Detailed geotechnical investigations and CCTV camera surveys of the outfall pipe were undertaken in 2015 and 2016 to support the 40 C.F.R. §§ 257.73 and 257.82 Initial Certifications for structural stability. These structural stability certifications included the sufficiency of dike compaction and hydraulic structure integrity and were performed by a Registered Professional Engineer in 2016 and are included as Attachment B to this letter.

The structural stability of the PAP dikes was then re-evaluated in 2021 as a Periodic Certification, per 40 C.F.R. §§ 257.73 and 257.82, and certified by a different qualified professional engineer. The Periodic Certification Report was included in the Operating Permit Application provided to IEPA. Additionally, annual inspections of the PAP dike, including the outfall structures and this area, have been performed since 2015 and are certified by a different qualified professional engineer than the Initial and Periodic Certifications. Therefore, it can be concluded that past actions successfully remediated the 2008 sinkhole as the observed performance of the dikes and the outfall structure over the past 9 years has been satisfactory, as evidenced by the 11 separate certified inspections performed by three different Registered Professional Engineers.

Narrative Description of the Facility [35 Ill. Adm. Code 845.220(a)(2)]

Comment 21: *To comply with the application requirements of 35 Ill. Adm. Code 845.220(a)(2), the applicant must provide all the types of CCR expected in the CCR surface impoundment including a chemical analysis of each type and the rate of non-CCR waste streams entering the CCR surface impoundment in accordance with Sections 845.220(a)(2)(A) and (C). The CCR characterization must be sampled in compliance with SW846, incorporated by reference in Section 845.150*

Response: The existing characterization is consistent with Part 845. While it is true that SW846 is incorporated by reference into Part 845 by Section 845.150, inclusion in the general "incorporations by reference" section of Part 845 does not create an affirmative obligation to use SW846 in all circumstances. The Board has explained that where Illinois rules incorporate analytical methods by reference via a "centralized listing of incorporations by reference" such as Section 845.150, "Illinois rules further indicate where each method is used *in the body of the substantive provisions*." *See In the Matter of: SDWA Update, USEPA Amendments (January 1, 2013 through June 30, 2013)*, R 2014-008, Opinion of the Board at 24–25 (Jan. 23, 2014) (emphasis added).

Further, Chapter 2 of SW846 states that the methods in that document are not "mandatory" unless specifically specified as such by regulation. United States Environmental Protection Agency ("USEPA"), *SW-846 Update V* at 1 (July 2014).[3] USEPA guidance also makes clear that SW846 is only legally required where "explicitly specified" in a regulation. USEPA, *Disclaimer for Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)* at 1 (July 2014).[4] The only substantive provision of Part 845 specifically requiring analysis using SW846 is Section 845.640(e), which applies to analyzing groundwater monitoring samples under a groundwater monitoring program and is not at issue here. 35 Ill. Admin. Code § 845.640(e). There is no requirement to use SW846 under Section 845.220(a). The plain language of Part 845 does not require the utilization of SW846 for purposes of waste and CCR characterization.

IPGC followed best practices in the industry in conducting its "analysis of the chemical constituents found within the CCR to be placed in the CCR surface impoundment" and "analysis of the chemical constituents of all waste streams, chemical additives and sorbent materials entering or contained in the CCR surface impoundment." IPGC collected porewater, which is the most representative of the chemical constituents from the leachate of the impoundment. Testing of the actual porewater from a CCR surface impoundment to be the cause of a detected exceedance observed is more appropriate than SW846's use of leach test results. The porewater analysis used is the best and most accurate scientifically available information for source characterization. See, e.g., US EPA, Industrial Environmental Research Laboratory, Chemical and Biological Characterization of Leachates from Coal Solid Wastes, EPA-600/7-80-039, March 1980; US EPA & TVA, Effects of Coal-ash Leachate on Ground Water Quality, EPA-600/7-80-066, March 1980; US EPA, Office of Research and Development, Characterization of Coal Combustion Residues from Electric Utilities – Leaching and Characterization Data, EPA-600/R-09/151, December 2009; *see also* X.Wang, *et al., Leaching and Geochemical Evaluation of Oxyanion Partitioning Within an Active Coal Ash*

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[3] Available at https://www.epa.gov/sites/default/files/2015-10/documents/chap2_1.pdf.
[4] Available at https://www.epa.gov/sites/default/files/2015-10/documents/disclaim.pdf.

Management Unit, Chemical Engineering Journal, Vol. 454, Part 4, at 140406 (Feb. 15, 2023).

The approach for characterization of the CCR was included as Attachment 2 in a Letter from Luminant *Re: Alternative Source Demonstration ("ASD") for Newton Power Plant Primary Ash Pond* dated November 3, 2023. An excerpt from that Attachment is as follows:

> *Prior to performing hydrogeologic investigations in 2y021, Ramboll completed a review of existing data to determine whether sufficient information existed to meet the requirements of 35 I.A.C. § 845. Based on the review, Ramboll developed an approach to fully characterize the CCR material as part of the 2021 investigation. Five locations for porewater wells were selected by evaluating the extent of ash through time on aerial photographs (Figure 1), identifying visible differences (color) in surficial materials, and capturing a representative spatial distribution. Porewater was encountered at an elevation of approximately 540 feet in 2021 (Ramboll, 2021). For the purpose of visualization, Figure 2 shows the areas within the SI that were not accessible for potential sampling and testing as illustrated by different colored portions of the Primary Ash Pond. Of the 404 acre unit only about 12% was accessible. A total of four porewater wells were installed in 2021, because the fifth location was not able to be accessed safely after evaluation with contractors in the field.*

The Figures referenced in the above excerpt are included in Attachment A.

Final Closure Plan and Closure Alternatives Analysis [35 Ill. Adm. Code 845.220(d)(2)]

Comment 22: *The final protection layer must meet the requirements of Section 845.750(c)(2) or demonstrate that another final protective layer construction technique or material provides equivalent or superior performance to the requirements of Section 845.750(c)(2) and is approved by the Agency. Please explain how the proposed final protective layer with a thickness of 2 feet meets Section 845.750(c)(2)*

Response: Attachment E of the Final Closure Plan includes a demonstration that the proposed alternative final protective layer provides equivalent or superior performance to the default final protective layer in satisfaction of Section 845.750. The proposed alternative final protective layer includes a low permeability geomembrane layer and a geocomposite drainage layer that provides equivalent or superior performance to the default cover system set forth in Section 845.750(c). *See* Newton Primary Ash Pond Closure Construction Permit Application (July 28, 2022), Attachment G (Final Closure Plan) at Attachment E.

Comment 23: *The proposed cover system soils must come from a borrow source that has been tested to ensure contaminants are not being introduced to the site and contribute to exceedances of groundwater protection standards, in Section 845.600, at the waste boundary. Borrow source material must be certified "uncontaminated soil" to ensure that the borrow source material does not pose a risk to human health and the environment. Borrow source sampling must also include soils testing to prove that the soils are adequate for the intended application.*

Response: Part 845 does not require IPGC to verify that the proposed cover system soils come from an uncontaminated borrow source or, alternatively, to certify the borrow source as "uncontaminated soil." Further, to the extent IEPA is relying on 35 Ill. Admin. Code Part 1100 to require certified "uncontaminated soil" to be used as fill material at the site, it does not. Part 1100's application is limited to uncontaminated soil fill operations and clean construction demolition debris (CCDD) fill operations. The Primary Ash Pond is neither. None the less, IPGC is committed to using borrow sourced from a location that has no known surface soil contamination of such a level to pose a significant risk to human health or the environment.

Comment 24: *The laboratory documents used to create Tables 2.2 and 2.3 in Attachment A of Attachment G must be provided to validate the groundwater and surface water summary tables. The groundwater data in Tables 2.2, 3.1, and 3.2 in Attachment A of Attachment G must include concentrations for pH.*

Response: IPGC technical staff and IEPA met to discuss IEPA's Initial Review Letter. Pursuant to that discussion, IPGC is producing the EDD responsive to the above request concurrently with this response. Given the nature of the data to be shared, IPGC will provide IEPA with a link to a temporary file-sharing service containing the EDD. Note that the EDD will only contain groundwater data, and that the surface water data will be provided in the Nature and Extent Report that is currently being prepared and will be submitted in conjunction with the Corrective Measures Assessment due to IEPA on April 5, 2024.

Groundwater Monitoring Program and Modeling [35 Ill. Adm. Code 845.220(a)(7), 845.220(d)(3), and Subpart F]

Comment 25: *The groundwater information in Attachment B must be revised to address comments made above for the initial operating permit application.*

Response: Any pertinent changes or updates to the groundwater documents (HCR, GMP, SAP, or other) included in the Operating Permit will be carried into those same documents included in the Closure Permit Application.

Comment 26: *The groundwater information must also include a new or updated groundwater monitoring program that includes groundwater sampling and analysis program including the statistical procedures meeting requirements of Section 845.640 and 845.650.*

Response: IPGC has received and is reviewing IEPA's December 28, 2023, letter regarding its Comments on Statistical Methods Proposed in Initial Operating Permit. IPGC requests a meeting with IEPA to further discuss this comment in the initial review letter and the comments in IEPA's December 28 letter. Following that meeting, IPGC will provide IEPA written responses to the December 28 letter, which will also serve as its response to the above comment.

Comment 27: *Laboratory documents to validate the groundwater and surface water summary tables must be provided. SW846, incorporated by reference in Section 845.150, requires environmental data to be provided as evidence of actions taken at the site.*

Response: On December 19, 2023, IPGC technical staff and IEPA met to discuss IEPA's Initial Review Letter. Pursuant to that discussion, IPGC is producing the EDD responsive to the above request concurrently with this response. Given the nature of the data to be shared, IPGC will provide IEPA with a link to a temporary file-sharing service containing the EDD.

IPGC reasserts its statement the only substantive provision of Part 845 requiring analysis using SW846 is Section 845.640(e), which applies to analyzing groundwater monitoring samples under a groundwater monitoring program and is not at issue here. 35 Ill. Admin. Code § 845.640(e). SW846 has not been blanketly incorporated to apply to all of Part 845.

Comment 28: *The groundwater model only uses sulfate to determine the results over time. The Agency requires all the constituent listed in Section 845.600 that have been found to be present in the CCR at the CCR surface impoundment to be assess in the groundwater model. Sulfate does not represent all constituents flow rate and leachability. The groundwater modeling report must be revised to include all the applicable constituents listed in Section 845.600.*

Response: Part 845 does not require that groundwater models developed in support of the closure alternative analysis evaluate all constituents listed in Section 845.600 that have been found to be present in the CCR surface impoundment. Part 845 requires that groundwater modeling evaluate only "how the closure alternative will achieve compliance with the applicable groundwater protection standards" 35 Ill. Admin. Code § 845.710(d)(2). There is no language in Part 845 requiring that the groundwater model must evaluate all constituents that have been detected in a surface impoundment. Further, as discussed in Attachment D to this letter, modeling selected constituents is a common industry approach for evaluation of environmental systems and is sufficient to achieve the modeling objectives in support of the closure alternatives analysis. Attachment D at 4. IPGC selected, as a surrogate, sulfate as the constituent at the site that will likely require the longest time to achieve the groundwater protection standards. *Id.* This surrogate constituent is appropriate to determine when the closure of each unit is expected to achieve the groundwater protection standards as required by Section 845.710(d)(2). Id. at 5, 9–11.

In addition, IPGC will be providing hydrogeologic and geochemical conceptual site models as components of the nature and extent report required by 35 Ill. Admin. Code § 845.650(d)(1). The nature and extent report will be submitted concurrent with the corrective measures assessment report (due no later than May 2024 for all units). Further, IPGC will be conducting fate and transport modeling for evaluation of potential corrective measures in the corrective action alternatives analysis (CAAA) report (due no later than December 2024 for all units) using boron as a surrogate constituent. A geochemical evaluation report will also be submitted concurrently with the CAAA that discusses the expected fate and transport of all 845.600 constituents that have been detected above the GWPS and are attributable to a CCR unit.

Comment 29: *Appendix C of Attachment B provides a technical memorandum for batch attenuation testing on wells APW-04 and APW-14. The results for groundwater and soil/water ratio show dissolved boron, lithium, and sulfate. Any groundwater sampling must use total recoverable metals when determining groundwater quality. The groundwater modeling report must be revised with total recoverable metals for the groundwater model.*

Response: Batch adsorption testing was conducted to generate site specific partition coefficient results for lithium and sulfate and were not used in the groundwater modeling or to evaluate exceedances of the groundwater protection standards. A sorption coefficient represents the relative proportions of a chemical in the solid versus the dissolved phase. Therefore, dissolved (i.e., filtered) measurements must be used (see OECD 106 for an example of batch test methodology). The goal of the batch test is to evaluate the extent of chemical sorption to the solid phase under site specific conditions, and not to evaluate groundwater quality. The values from the batch test were not used in the groundwater modeling.

The details of the batch test to determine Newton site-specific partition coefficients are as follows. The laboratory methodology to conduct batch adsorption testing requires a mass of soil sample as measured in kilograms. In this specific case aquifer material was sampled adjacent to screened intervals adjacent to monitoring wells APW-04 (soil sample N-SB-05 at 60.0-67.1 ft bgs) and APW-14 (soil sample N-SB-04 at12.0-18.0 ft bgs), with an aliquot of the soil samples removed for each test as measured in kilograms. The second part of this laboratory testing requires groundwater sampled from each of the monitoring well locations to be brought into contact with a soil sample. The water/soil microcosms are then spiked with the constituents of interest to achieve a target concentration. Utilizing varying quantities of soil (kilograms) and groundwater (liters), the batch attenuation testing is conducted at various soil to groundwater ratios and the results used to calculate adsorption isotherms for each constituent of interest (sulfate and lithium), with the units for isotherms presented as liters per kilogram. The important item to note is that the groundwater samples are being mixed with soil samples and then spiked with additional concentration, so use of totals analysis for constituents in the resulting contact water would bias the results and the calculated partition coefficient results would be inaccurate. It is agreed that totals metals analysis is necessary for groundwater samples that are being compared to the Groundwater Protection Standard (GWPS), but when conducting batch adsorption testing the use of totals metals is not applicable and would result in incorrect results due to failure to follow the proper sampling and testing methodology.

Training Program Statement [35 Ill. Adm. Code 845.500, 845.520, and 845.530]

Comment 30: *A certification or statement must be provided that ensures personnel and contractors/subcontractors will comply with Sections 845.500, 845.520, and 845.530.*

Response: Section 845.220 does not require such a statement or certification to be submitted with the closure construction permit application. Further, Sections 845.500, 845.520, and 845.530 similarly do not require such a statement or certification. IPGC further notes that an Emergency Action Plan (Section 845.520) and a Safety and Health Plan (Section 845.530) are not required to be submitted with a closure construction permit application. *See* 35 Ill. Admin. Code 845.220(d).

Should you have any questions or comments regarding the above responses, please contact Phil Morris at phil.morris@vistracorp.com or (618) 606-7788.

Sincerely,

Phil Morris, P.E.
Sr. Director, Environmental

From:	Fuller, Rhys
To:	Davies, Sam
Subject:	FW: Newton Part 845 Response to Comments (Log No. 2021-100018)
Date:	Friday, March 8, 2024 11:06:44 AM
Attachments:	image001.png image002.png

fyi

From: Fuller, Rhys
Sent: Friday, March 8, 2024 11:02 AM
To: Herrera, Francisco <Francisco.Herrera@Illinois.gov>
Cc: LeCrone, Darin <Darin.LeCrone@Illinois.gov>; Hunt, Lauren <Lauren.Hunt@Illinois.gov>; EPA.CCR.Part845.Coordinator@Illinois.gov; Morris, Phil <Phil.Morris@vistracorp.com>
Subject: Newton Part 845 Response to Comments (Log No. 2021-100018)

Francisco,

Please find at the link provided below a copy of our initial response to the review letter provided by IEPA concerning our Part 845 operating and closure construction permit applications for the Newton Power Plant's Primary Ash Pond. A hard copy of the submittal is scheduled to be delivered to IEPA's Springfield Office on Monday. Also linked below is a folder containing the electronic data deliverables which can only be shared electronically.

Newton 845 Permit Application Response to Comments.pdf

EDD Files

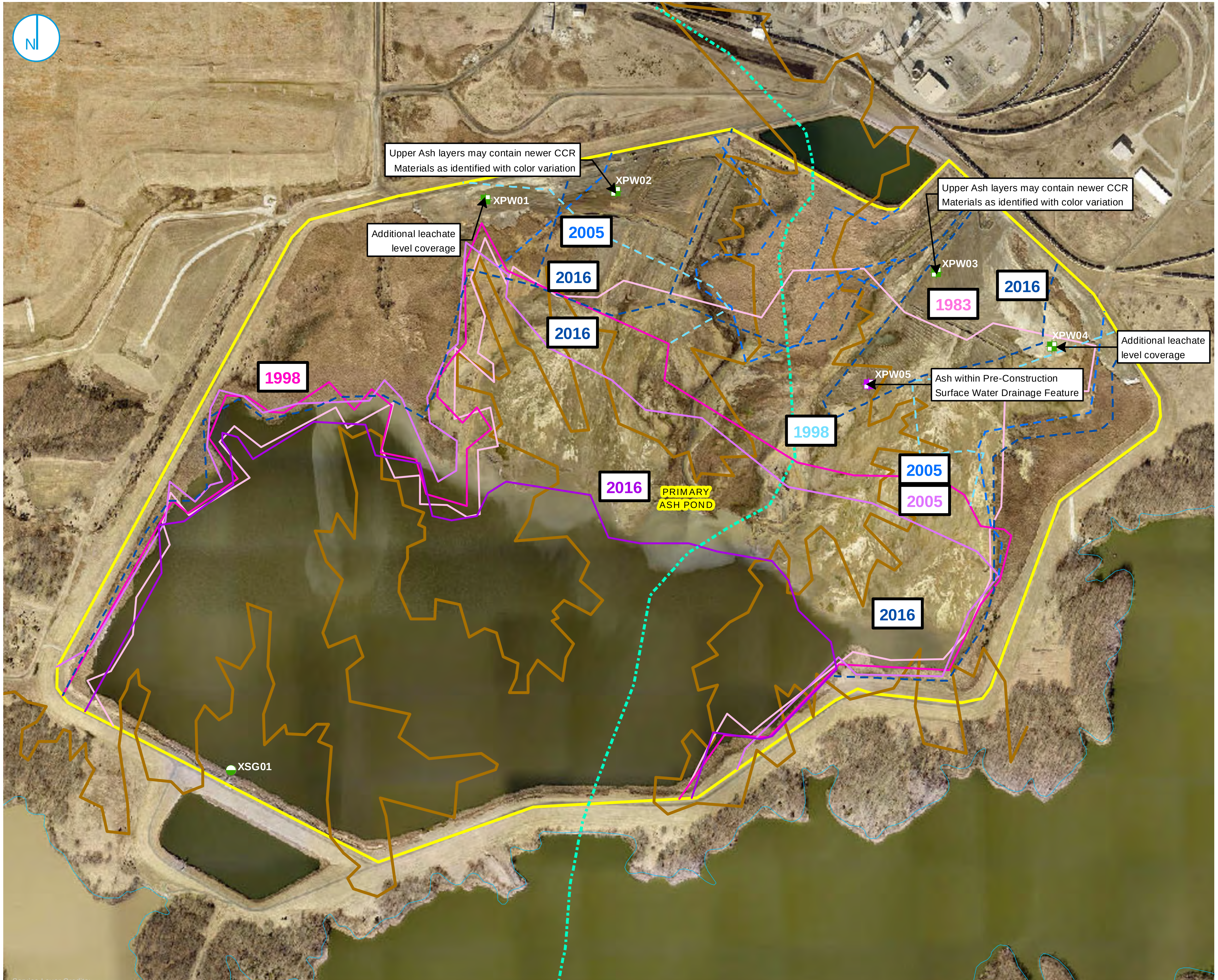
We would also like to request a meeting with IEPA groundwater staff to further discuss comments pertaining to CCR characterization and statistical methods. We would prefer to conduct this meeting in-person at IEPA's office and offer the week of March 18th as an option. Please let me know of specific days or times that would work for the Agency or if another week is better.

Please let us know if you have any additional questions or if you have difficulty accessing the files via the links above.

Thanks,

Rhys Fuller
Vistra Corp.
618-975-1799

Attachment A



PORE WATER WELL

STAFF GAGE, CCR UNIT

PROPOSED LOCATION COULD NOT BE ACCESSED

APPROXIMATE LOCATION OF STREAM BASED ON 1953 TOPOGRAPHIC MAP (BASE OF STREAM ELEVATION DECREASES SOUTH TOWARD NEWTON LAKE)

APPROXIMATE LOCATION OF 530 FOOT GROUND SURFACE ELEVATION CONTOUR BASED ON 1953 TOPOGRAPHIC MAP (PRE-CONSTRUCTION SURFACE WATER DRAINAGE FEATURE)

APPROXIMATE LIMITS OF ASH BASED ON 1983 AERIAL

APPROXIMATE LIMITS OF ASH BASED ON 1998 AERIAL

APPROXIMATE LIMITS OF ASH BASED ON 2005 AERIAL

APPROXIMATE LIMITS OF ASH BASED ON 2016 AERIAL

APPROXIMATE LIMITS OF VARIANCE IN CCR MATERIAL COLORATION AS OBSERVED IN 1998 AERIAL

APPROXIMATE LIMITS OF VARIANCE IN CCR MATERIAL COLORATION AS OBSERVED IN 2005 AERIAL

APPROXIMATE LIMITS OF VARIANCE IN CCR MATERIAL COLORATION AS OBSERVED IN 2016 AERIAL

SURFACE WATER FEATURE

CCR MONITORED UNIT, SUBJECT SITE

0 275 550 Feet

CCR CHARACTERIZATION

NEWTON PRIMARY ASH POND (UNIT ID: 501)

NEWTON POWER STATION
NEWTON, ILLINOIS

FIGURE 1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845\Newton\2023\INTERACTIVE_Figure 1_Newton_CCR Characterization.mxd

PROJECT: 169000XXXX | DATED: 11/3/2023 | DESIGNER: GALARNMC

PORE WATER WELL
STAFF GAGE, CCR UNIT
PROPOSED LOCATION COULD NOT BE COMPLETED
540 ELEVATION CONTOUR
ACTIVE SLUICE AREA
LIMITED ACCESS AREA
LOW LYING VEGETATION AREA
RECENT SLUICE AREA
ELEVATION BELOW 540FT
REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE

0 275 550 Feet

2022 CONDITIONS

NEWTON POWER PLANT
NEWTON, ILLINOIS

FIGURE 2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

Y:\Mapping\Projects\22\2285\MXD\845\Newton\2023\Figure 2_NEW 2022 Conditions.mxd

PROJECT: 169000XXXX | DATED: 11/3/2023 | DESIGNER: GALARNMC

Attachment B

AECOM

Submitted to
Illinois Power Generating Company
6725 North 500th Street
Newton, IL 62448

Submitted by
AECOM
1001 Highlands Plaza Drive West, Suite 300
St. Louis, MO 63110

October 2016

CCR Certification Report: Initial Structural Stability Assessment, Initial Safety Factor Assessment, and Initial Inflow Design Flood Control System Plan

For

Primary Ash Pond

At Newton Power Station

Table of Contents

Tables

Figures

Appendices

Executive Summary

The initial structural stability assessment, initial safety factor assessment, and initial inflow design flood control system plan for the Primary Ash Pond at the Newton Power Station have been prepared in accordance with the United States Environmental Protection Agency (USEPA) Coal Combustion Residual (CCR) Rule 40 Code of Federal Regulations (CFR) §257.73(d), §257.73(e), and §257.82, respectively. These regulations require that the specified structural stability, safety factor, and hydrologic and hydraulic (supporting the inflow design flood control system plan) assessments for an existing CCR surface impoundment be completed by October 17, 2016.

The engineering investigations, analyses, and evaluations determined that the Primary Ash Pond meets all requirements for the structural stability assessment, safety factor assessment, and hydrologic and hydraulic analysis, as summarized in Table ES-1.

Table ES-1 – Certification Summary

Report Section	CCR Rule Reference	Requirement Summary	Requirement Met?	Comments
Initial Structural Stability Assessment				
3.1	§257.73(d)(1)(i)	Stable foundations and abutments	Yes	Foundations were found to be stable. Abutments are not present.
3.2	§257.73(d)(1)(ii)	Adequate slope protection	Yes	Slope protection is adequate.
3.3	§257.73(d)(1)(iii)	Sufficiency of dike compaction	Yes	Dike compaction is sufficient for expected ranges in loading conditions.
3.4	§257.73(d)(1)(iv)	Presence and condition of slope vegetation	Yes	Vegetation is present on interior and exterior slopes and is maintained.
3.5	§257.73(d)(1)(v)(A) and (B)	Adequacy of spillway design and management	Yes	Spillways are adequately designed and constructed and adequately manage flow during 1,000-year flood.
3.6	§257.73(d)(1)(vi)	Structural integrity of hydraulic structures	Yes	Hydraulic structures passing through the dike were inspected and found to maintain structural integrity.
3.7	§257.73(d)(1)(vii)	Stability of downstream slopes inundated by water body	Yes	Downstream slopes adjacent to Newton Lake and the Secondary Pond are expected to remain stable during inundation.
Initial Safety Factor Assessment				
4.1	§257.73(e)(1)(i)	Maximum storage pool safety factor must be at least 1.50	Yes	Safety factors were calculated to be 1.66 and higher.
4.2	§257.73(e)(1)(ii)	Maximum surcharge pool safety factor must be at least 1.40	Yes	Safety factors were calculated to be 1.66 and higher.
4.3	§257.73(e)(1)(iii)	Seismic safety factor must be at least 1.00	Yes	Safety factors were calculated to be 1.07 and higher.
4.4	§257.73(e)(1)(iv)	For dikes constructed of soils that have susceptibility to liquefaction safety factor must be at least 1.20	Not Applicable	Dike soils are not susceptible to liquefaction.
Initial Inflow Design Flood Control System Plan				
5.1	§257.82(a)(1), (2), (3)	Adequacy of inflow design flood control system	Yes	Flood control system adequately manages inflow and peak discharge during the 1,000-year, 24-hour Inflow Design Flood.
5.2	§257.82(b)	Discharge from the CCR Unit	Yes	Discharge from the CCR Unit is routed through a NPDES-permitted outfall both normal and 1,000-year, 24-hour, Inflow Design Flood conditions.

1 Introduction

This report documents that the structural stability assessment, safety factor assessment, and inflow design flood control system plan meet the requirements specified in 40 CFR §257.73(d), §257.73(e), and §257.82, respectively, to support the certification required under each of those regulatory provisions for the Newton Power Station Primary Ash Pond. The Primary Ash Pond is an existing CCR surface impoundment as defined by 40 CFR §257.53. The CCR Rule requires that the specified initial structural stability assessment, initial safety factor assessment, and initial inflow design flood control system plan (i.e., hydrologic and hydraulic analysis) for an existing CCR surface impoundment be completed by October 17, 2016.

The Newton Power Station has one existing CCR surface impoundment, the Primary Ash Pond. The Primary Ash Pond has been evaluated to determine whether the structural stability, safety factor, and inflow design flood control system plan requirements are met. The following sections describe the evaluations performed and the results from the analyses, as supported by the underlying data and analyses included in the appendices.

2 Facility Description and Location Map

2.1 Overview of Existing Surface Impoundments

The Newton Power Station (Station) is a coal-fired power plant located approximately 7.5 miles southwest of Newton, Illinois in Jasper County. The Newton Power Station is located adjacent to the Newton Lake and the Primary Ash Pond is located approximately 0.2 miles southeast of the Newton Power Station. A site location map showing the Newton Power Station is in **Figure 1**. **Figure 2** presents the Newton Power Station site plan.

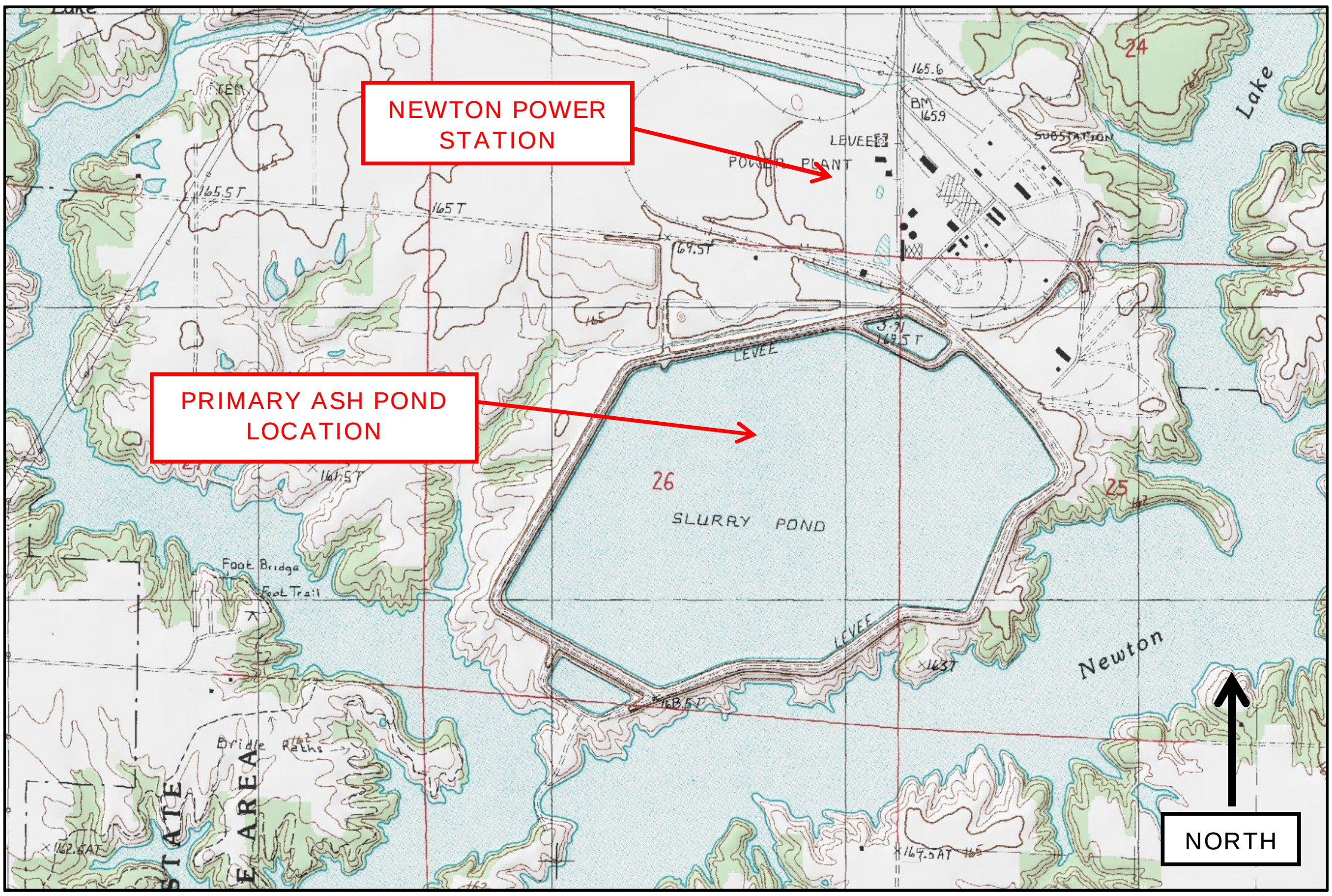


Figure 1 – Newton Power Station Location Map
(from United States Geological Survey Newton, Illinois 7.5' Topographic Map, 1985)

One active surface impoundment, the Primary Ash Pond, is utilized for managing CCR materials generated by the Newton Power Station. The Primary Ash Pond has a significant hazard potential, based on the initial hazard potential classification assessment performed by Stantec in 2016 in accordance with §257.73(a)(2).

The Primary Ash Pond receives fly ash, bottom ash, and other miscellaneous non-CCR process waters produced by the Newton Power Station. Bottom ash is sluiced from the north perimeter of the Primary Ash Pond on either side of the Secondary Settlement Pond, which is a non-CCR basin included within the footprint of the Primary Ash Pond. The outfall structure in the Primary Ash Pond discharges through the perimeter dike into the Secondary Pond, which is a non-CCR basin that ultimately discharges into Newton Lake via a NPDES-permitted outfall.

Two adjacent spillway structures are present at the Primary Ash Pond: the principal spillway structure and the secondary spillway structure. Only the principal structure is used to control outflow during both normal operational and flood conditions. The spillway structures are both identical square concrete riser structures, with inflow controlled by a series of stoplogs. Inflow into the structures is transmitted to the Secondary Pond through 30-inch corrugated metal pipes that have been sliplined and now have an inside diameter of 28 inches. The principal spillway structure is located at a lower elevation than the secondary spillway structure, with a top of weir box elevation of 537 feet and a pipe invert elevation of 512.5 feet (presumed to be NGVD29 datum based on the date of the design drawings). The secondary spillway structure is located directly upslope from the primary structure, and has a top of weir box elevation of 555 feet, which is the design crest elevation of the earthen embankment, and a pipe invert elevation of 533 feet. The 28-inch sliplined outlet pipes from both structures converge within the earthen embankment into a single 28-inch sliplined outlet pipe that discharges into the Secondary Pond. The purpose of the secondary spillway structure is to act as the primary spillway for the Primary Ash Pond under conditions where the pool level is significantly increased above the current normal pool to allow for additional storage volume. There are currently no plans to raise the pool level and utilize this secondary structure.

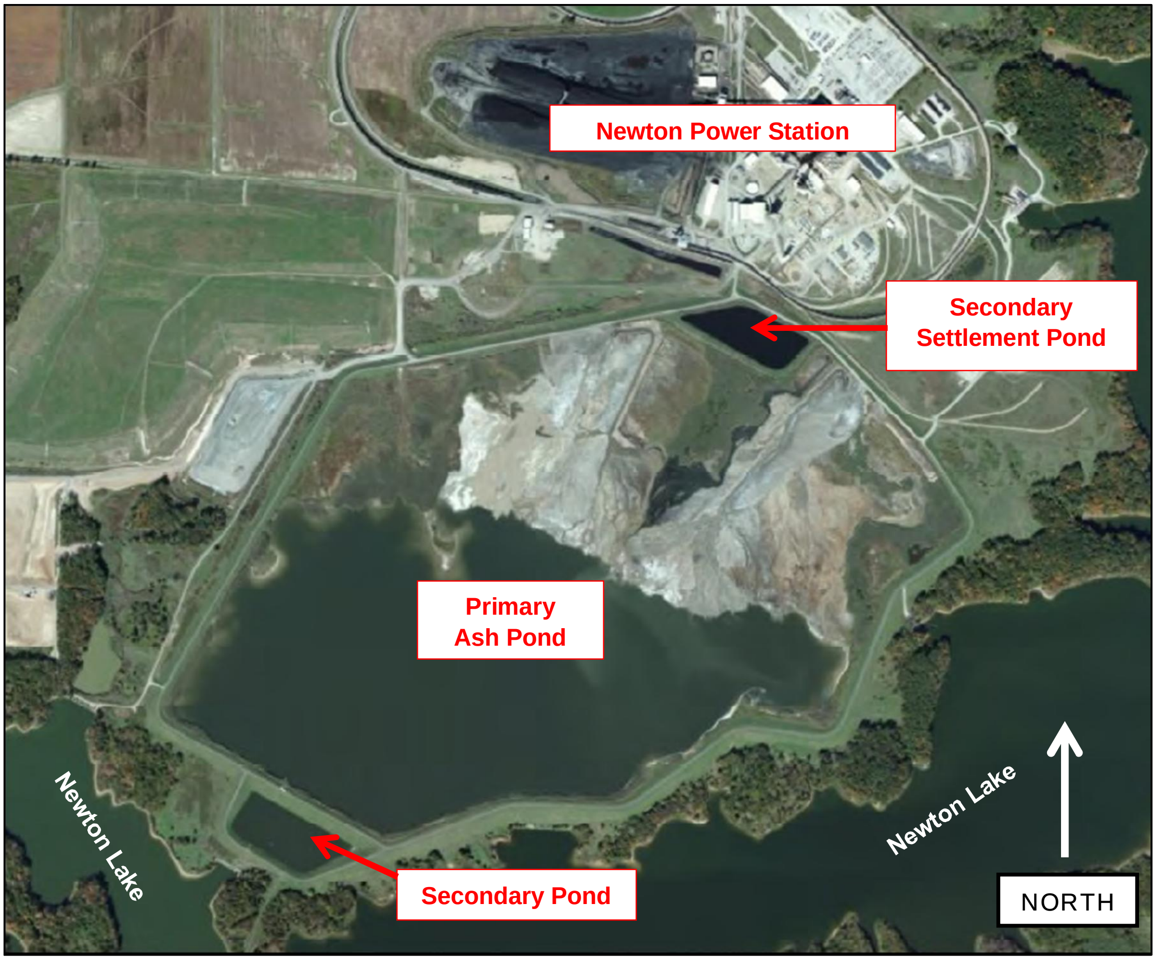


Figure 2 – Newton Power Station Site Plan
(Imagery from Google Earth Pro, 2016)

An engineered liner system is not present beneath the Primary Ash Pond. The surface area of the impoundment is approximately 400 acres, and the embankment is a continuous structure (a ring embankment), which has a total perimeter length of approximately 3.2 miles and a maximum height above the exterior grade of 72 feet where the downstream toe of the embankment is underneath the normal pool level of the downstream Newton Lake. Typical embankment heights, where the embankment is not inundated by Newton Lake, range from 14 to 42 feet. The embankment was constructed as a homogenous earthen structure with well-compacted clayey fill. Portions of the south embankment directly adjacent to Newton Lake include crushed stone near the waterline for erosion protection. The upstream and downstream slope orientations are typically 3H:1V (horizontal to vertical) but range from about 2.5H:1V to 3.4H:1V. Embankment crest widths range from approximately 12 to 50 feet, and the crest is covered with a gravel access road.

As currently operated, the normal pool elevation is approximately 534.0 feet (all subsequent elevations discussed in this report are in the NAVD88 datum, unless otherwise stated), as found from the 2015 Weaver Consultants survey of the site, and controlled by the configuration of the outflow structure and plant process inflows. Crest elevations range from approximately 553 to 555 feet, and the minimum crest elevation is 552.7 feet. Additional details about the geometry and configuration of the basins is provided in the Geotechnical Report in **Appendix B** and the Hydrologic and Hydraulic Report in **Appendix C.**

3 Initial Structural Stability Assessment

40 CFR §257.73(d)(1)
The owner or operator of the CCR unit must conduct initial and periodic structural stability assessments and document whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein. The assessment must, at a minimum, document whether the CCR unit has been designed, constructed, operated, and maintained with [the standards in (d)(1)(i)-(vii)].

Analyses completed for the initial structural stability assessment of the Newton Power Station's Primary Ash Pond are described in this section. Data and analysis results in the following subsections were developed using recent and historical data provided by Illinois Power Generating Company (IPGC), including impoundment design information, spillway design information, survey data, historical data, analysis reports, and information about operational and maintenance procedures. These data were supplemented with subsurface investigation and laboratory data collected by AECOM in 2015.

IPGC's operation of the Primary Ash Pond is consistent with the design and construction of the CCR unit. IPGC follows an established maintenance program that quickly identifies and resolves issues of concern.

3.1 Foundations and Abutments (§257.73(d)(1)(i))

CCR unit designed, constructed, operated, and maintained with stable foundations and abutments.

Stability of the foundations of the Primary Ash Pond was evaluated by reviewing soil consistencies and phreatic data estimated from Standard Penetration Test (SPT), cone penetration test (CPT) tip resistances, and collected soil laboratory test data from the 2015 AECOM field investigation, which is discussed in more detail in **Section 4**. Based on these data, foundation materials generally consist of 5 to 30 feet of stiff to hard clay overlying very stiff to very hard clay, silt, and sand (glacial till). Borings were terminated in the glacial till and were not extended to bedrock. The phreatic surface in the foundation is typically located several feet above the embankment/foundation interface. As the Primary Ash Pond is a ring dike structure, abutments are not present.

This information was used to perform slope stability analyses as required by §257.73(e)(1), which is discussed in more detail in **Section 4**. Safety factors for slip surfaces passing through the dike and foundation were found to meet or exceed the minimum requirements required by §257.73(e)(1), which indicates that the foundation of the Primary Ash Pond is stable.

Based on this evaluation, the Primary Ash Pond meets the requirements presented in §257.73(d)(1)(i). A detailed presentation of the field and laboratory data collected for the foundations and the completed slope stability analyses can be found in **Appendix B**.

3.2 Slope Protection (§257.73(d)(1)(ii))

CCR unit designed, constructed, operated, and maintained with adequate slope protection to protect against surface erosion, wave action and adverse effects of sudden drawdown.

The adequacy of slope protection present at the Primary Ash Pond was evaluated by reviewing design drawings, operational and maintenance procedures, and conditions observed in the field during AECOM's June 16 and 17, 2015 site visit.

The exterior dike slopes have a 3H:1V orientation and are covered with vegetation for slope protection. Areas of the exterior embankment adjacent to Newton Lake include crushed stone erosion protection near and above the waterline to protect against wave erosion. Where the exterior slopes are not adjacent to a downstream water body, they are not susceptible to wave action or sudden drawdown. IPGC regularly maintains the slopes, including repairing observed surface erosion and addressing areas of poor vegetation growth, as required. AECOM observed the vegetation to be adequately protecting against surface erosion.

The interior dike slopes have a 3H:1V orientation and are covered with vegetation with some limited areas of riprap. IPGC regularly maintains the interior slopes, including repairing observed surface erosion and addressing areas of poor vegetation growth, as required. AECOM observed the vegetation to be adequately protecting against surface erosion.

The pool level in the Primary Ash Pond is maintained by a concrete spillway structure and buried sliplined 28-inch spillway pipe. The spillway structure has stoplogs that control the pool level. Currently, the stoplogs are operated such that the normal pool elevation is EL. 534.0 feet, but removing all stoplogs would allow for the pool to be operated at a lower elevation. Although lowering the pool level below El. 534.0 feet is not anticipated, IPGC has instituted operational controls to limit the rate of pool lowering to 1 foot per week. This rate is expected to allow phreatic water from the embankments to drain concurrently with the pool in the Primary Ash Pond, and to reduce the potential for sudden drawdown conditions developing in the embankment. Therefore, sudden drawdown conditions are not expected to occur due to the operational controls, and slope protection to protect against the adverse effects of sudden drawdown is not required.

Based on this evaluation, the Primary Ash Pond meets the requirements in §257.73(d)(1)(ii).

3.3 Dike Compaction (§257.73(d)(1)(iii))

CCR unit designed, constructed, operated, and maintained with dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit.

Compaction of the Primary Ash Pond dikes was evaluated using field data obtained from the 2015 AECOM geotechnical investigation and by reviewing design drawings and operational and maintenance procedures. Based on the 2015 AECOM data, the dike materials consist of lean clay. SPT values and CPT tip resistances indicate that the dike material is generally stiff, with isolated areas of soft, medium stiff, and very stiff material, which is indicative of mechanically compacted dikes. Slope stability analyses as required by §257.73(e)(1) found acceptable safety factors for each required loading condition, as presented in **Section 4**. Therefore, the dike compaction and density is sufficient for withstanding required ranges in loading conditions.

Based on this evaluation, the Primary Ash Pond meets the requirements in §257.73(d)(1)(iii). A detailed presentation of the field and laboratory data collected for the dikes and the completed slope stability analyses can be found in **Appendix B**.

3.4 Vegetated Slopes (§257.73(d)(1)(iv))[1]

CCR unit designed, constructed, operated, and maintained with vegetated slopes of dikes and surrounding areas, except for slopes which have an alternate form or forms of slope protection.

The adequacy of slope vegetation at the Primary Ash Pond was evaluated by reviewing conditions observed in the field during AECOM's June 16 and 17, 2015 site visit and by reviewing design drawings and operational and maintenance procedures. At the time of the site visit, the exterior and interior slopes were vegetated and some areas on the exterior slope were covered in riprap, which is an alternate form of slope protection. The vegetation on the exterior and interior slopes is well-maintained. Regular maintenance manages the vegetation as described in this section.

Based on this evaluation, the Primary Ash Pond meets the requirements in §257.73(d)(1)(iv).

[1] As modified by court order issued June 14, 2016, Utility Solid Waste Activities Group v. EPA, D.C. Cir. No. 15-1219 (order granting remand and vacatur of specific regulatory provisions).

3.5 Spillways (§257.73(d)(1)(v))

CCR unit designed, constructed, operated, and maintained with a single spillway or a combination of spillways configured as specified in [paragraph (A) and (B)]:

(A) All spillways must be either:

(1) of non-erodible construction and designed to carry sustained flows; or

(2) earth- or grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected.

(B) The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a:

(1) Probable maximum flood (PMF) for a high hazard potential CCR surface impoundment; or

(2) 1000-year flood for a significant hazard potential CCR surface impoundment; or

(3) 100-year flood for a low hazard potential CCR surface impoundment.

The spillways at the Primary Ash Pond were evaluated using hydrologic and hydraulic analyses, conditions observed during AECOM's June 16 and 17, 2015 site visit, and historic design and construction information provided by IPGC. The Primary Ash Pond has a significant hazard potential; therefore, the 1,000-year storm event is the design flood event for the Primary Ash Pond, per §257.73(d)(1)(v)(B).

The principal and secondary spillway system for the Primary Ash Pond include two vertical square concrete riser drop inlet structures with 28-inch diameter sliplined outlet conduits. The concrete and sliplined pipes are both non-erodible materials. The capacity of the spillway was evaluated using hydrologic and hydraulic analyses. The analysis found that the principal spillway can adequately manage flow during peak discharge resulting from the 1,000-year storm event without overtopping of the embankments, as discussed in more detail in **Section 5**. The secondary spillway is not activated during the 1,000-year storm event.

Based on these evaluations, the Primary Ash Pond meets the requirements in §257.73(d)(1)(v). A detailed presentation of the hydraulic and hydrologic analyses can be found in **Appendix C**.

3.6 Stability and Structural Integrity of Hydraulic Structures (§257.73(d)(1)(vi))

CCR unit designed, constructed, operated, and maintained with hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure.

The structural stability and integrity of the Primary Ash Pond hydraulic structures were evaluated using design drawings, operational and maintenance procedures, conditions observed in the field, and inspection data collected and performed by AECOM. There are two hydraulic structures that pass through the dike of the Primary Ash Pond, the principal and secondary spillway outflow pipes, which are 28-inch sliplined pipes. No other hydraulic structures are known to pass through the dike of or underlie the base of the Primary Ash Pond.

Both sliplined CMP pipes were inspected on October 30, 2015, using CCTV inspection equipment. The inspection found that the outlet structures are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris accumulation that may negatively affect the hydraulic operation of the structure.

Based on these evaluations, the Primary Ash Pond meets the requirements in §257.73(d)(1)(vi). A detailed presentation of the pipe inspection report can be found in **Appendix A**.

3.7 Downstream Slope Inundation/Stability (§257.73(d)(1)(vii))

CCR unit designed, constructed, operated, and maintained with, for CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.

The structural stability of the downstream slope of the Primary Ash Pond was evaluated by comparing the location of the Primary Ash Pond relative to published flood maps for the area and by performing sudden drawdown slope stability analyses. Most of the Primary Ash Pond is outside the flood zone shown on the FEMA Federal Insurance Rate Map (FIRM) for Jasper County, Illinois (FEMA, 1985). However, some portions of the Primary Ash Pond embankments are adjacent to Newton Lake as well as the Secondary Pond, and may be subjected to pool fluctuations in both downstream water bodies.

Sudden drawdown slope stability analyses were performed at cross-sections B, C, D, I, and K (see **Section 4**), which are adjacent to the downstream water bodies. The sudden drawdown slope stability analyses considered complete drawdown in the downstream water body from normal pool to empty pool, thereby also evaluating the effects of a low pool. The analysis was performed as a staged analysis using drained and undrained soil strengths, but otherwise used the same methodology as the other slope stability analyses discussed in **Section 4**. The resulting factors of safety were compared to criteria presented in USACE EM 1110-2-1902 (a reference cited in the CCR Rule Preamble as a guiding resource for stability evaluations), as factor of safety criteria for sudden drawdown slope stability is not expressly stated as a requirement in §257.73(d)(1)(vii). The embankment was found to meet the minimum factors of safety listed in EM 1110-2-1902. The resulting factors of safety are presented in **Table 1**.

Table 1 – Summary of Factors of Safety – Sudden Drawdown Conditions

Cross-Section	Calculated Factor of Safety (USACE EM 1110-2-1902 Minimum = 1.3)*
B	1.6**
C	1.7
D	1.8
I	1.6**
K	1.9

*Corresponds to drawdown in Newton Lake from normal pool to empty pool

**Indicates critical cross sections (i.e., lowest calculated factor of safety out of the 5 cross sections analyzed)

Based on this assessment, the Primary Ash Pond meets the requirements in §257.73(d)(1)(vii).

4 Initial Safety Factor Assessment

40 CFR §257.73(e)(1)
The owner or operator must conduct initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified in (e)(1)(i) through (iv) of this section for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations.

A geotechnical investigation program and stability analyses were performed by AECOM in 2015 to evaluate the design, performance, and condition of the earthen dikes of the Primary Ash Pond. The exploration consisted of 15 hollow-stem auger borings, 14 vibrating-wire piezometers, 19 cone penetration tests with associated seismic shear wave velocity measurements and pore pressure dissipation testing, and laboratory program including strength, hydraulic conductivity, consolidation, and index testing. Data collected from the 2015 AECOM investigation, available design drawings, construction records, inspection reports, previous engineering investigations, and other pertinent historic documents were utilized to perform the safety factor assessment and geotechnical analyses.

In general, the subsurface conditions at the Primary Ash Pond consist of a compacted medium stiff to stiff clay dike overlying clayey foundation materials. The clayey foundation materials consist of 5 to 30 feet of stiff to hard clay (generally lean and fat clay, but with some sandy and silty zones) overlying glacial till, which is comprised of very stiff to very hard clay, silt, and sand. The phreatic surface is typically several feet above the embankment/foundation interface.

Ten (10) representative cross sections (A through K) were analyzed using GeoStudio SLOPE/W limit equilibrium slope stability analysis software to evaluate stability of the perimeter dike system and foundations. Slip surface search routines in SLOPE/W relied on circular slip surfaces using the entry and exit-based method to define the initial critical slip surface. The slip surface was then optimized to find a critical, non-circular slip surface, and factors of safety were calculated using the Spencer method. This methodology was selected as it evaluates a wide range of slip surface geometries through the dike system and foundation, and the Spencer method satisfies both moment and force equilibrium. The cross sections were selected to represent the most critical configurations along each side of the dike system, in terms of embankment height, slope, subsurface, and phreatic conditions. Each cross section was evaluated for each of the loading conditions stipulated in §257.73(e)(1).

The results of the initial safety factor assessment are summarized in the following sub-sections. A detailed presentation of the analyses performed, including development of site stratigraphy, strength parameters, stability analysis methodology, and figures showing the location of cross-sections and investigation locations can be found in **Appendix B**.

4.1 Factor of Safety: Maximum Storage Pool Loading (§257.73(e)(1)(i))

The calculated static factor of safety under long-term, maximum storage pool loading condition must equal or exceed 1.50.

This calculation models the dike stability under static, long-term conditions, under the normal storage water level (El. 534.0 feet) within the impoundments, which corresponds to the water level measured during the November 2015 survey of the site performed by Weaver Consultants. Drained (effective stress) shear strength parameters were used for all materials, and phreatic conditions were estimated based on available piezometer and boring data. The calculated minimum factors of safety are identified in **Table 2.**

Table 2 – Summary of Factors of Safety – Maximum Storage Pool Loading Condition

Cross Section	Calculated Factor of Safety (§257.73(e)(1)(i) Minimum = 1.50)
A	1.82
B	1.81
C	1.67
D	1.76
E	2.18
F	1.99
G	2.05
H	1.81
I	1.66*
K	1.92

*Indicates critical cross section (i.e., lowest calculated factor of safety out of the 10 cross sections analyzed)

The calculated factors of safety exceed 1.50 for all cross sections analyzed, which meets the requirements in §257.73(e)(1)(i).

4.2 Factor of Safety: Maximum Surcharge Pool Loading (§257.73(e)(1)(ii))

The calculated static factor of safety under maximum surcharge pool loading condition must equal or exceed 1.40.

This calculation models the dike stability under short-term, surcharge pool conditions. The pool level for analysis (El. 534.9 feet) was taken from the hydrologic and hydraulic analysis performed for the 1,000-year Inflow Design Flood (see **Section 5**). Drained soil strengths were used for analysis, as the relatively small increase in pool level is not expected to result in the development of undrained conditions in the downstream embankment slopes or foundation soils. Pore pressures in the embankment were assumed to be similar to the static drained conditions; however, the pool level in the Primary Ash Pond was increased to model additional loading from the surcharge pool. The calculated factors of safety are identified in **Table 3**.

Table 3 – Summary of Factors of Safety – Maximum Surcharge Pool Loading Condition

Cross Section	Calculated Factor of Safety (§257.73(e)(1)(ii) Minimum = 1.40)
A	1.82
B	1.81
C	1.67
D	1.76
E	2.18
F	1.95
G	2.04
H	1.81
I	1.66*
K	1.91

*Indicates critical cross section (i.e., lowest calculated factor of safety out of the 10 cross sections analyzed)

The calculated factors of safety exceed 1.40 for all cross sections analyzed, which meets the requirements in §257.73(e)(1)(ii).

4.3 Factor of Safety: Seismic (§257.73(e)(1)(iii))

The calculated seismic factor of safety must equal or exceed 1.00.

This calculation models the dike stability under short-term, seismic loading conditions during the design 2,500-year return period seismic event. Seismic loading is modeled as an horizontal force acting outward on the dike and foundation. This analysis is intended to model conditions during earthquake shaking. Therefore, peak undrained (total stress) shear strength parameters were used for the clayey embankment and foundation soils. The pool elevation and phreatic conditions were assumed to be the same as the Maximum Storage Pool case (**Section 4.1**), and correspond to normal operating conditions at the Primary Ash Pond. The calculated factors of safety are identified in **Table 4**.

Table 4 – Summary of Factors of Safety – Seismic Loading Condition

Cross Section	Calculated Factor of Safety (§257.73(e)(1)(iii) Minimum = 1.00)
A	1.26
B	1.07*
C	1.11
D	1.23
E	1.91
F	1.50
G	1.59
H	1.36
I	1.42
K	1.28

*Indicates critical cross section (i.e., lowest calculated factor of safety out of the 10 cross sections analyzed)

The calculated factors of safety exceed 1.00 for all cross sections analyzed, which meets the requirements in §257.73(e)(1)(iii).

4.4 Factor of Safety: Soils Susceptible to Liquefaction (§257.73(e)(1)(iv))

For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

The 2015 AECOM field investigation did not identify any soil layers susceptible to liquefaction within either the embankments or the foundations of the Primary Ash Pond. Therefore, the §257.73(e)(1)(iv) requirements are not applicable to the Primary Ash Pond at the Newton Power Station, and a liquefaction factor of safety analysis was not performed.

5 Initial Inflow Design Flood Control System Plan

40 CFR §257.82
(a) The owner or operator of an existing … CCR surface impoundment … must design, construct, operate, and maintain an inflow design flood control system as specified in paragraphs (a)(1) and (2) of this section.
(1) The inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood specified in paragraph (a)(3) of this section.
(2) The inflow design flood control system must adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood specified in paragraph (a)(3) of this section.
(3) The inflow design flood is:
(i) For a high hazard potential CCR surface impoundment, …, the probable maximum flood;
(ii) For a significant hazard potential CCR surface impoundment, …, the 1,000-year flood;
(iii) For a low hazard potential CCR surface impoundment, …, the 100-year flood; or
(iv) For an incised CCR surface impoundment, the 25-year flood.
(b) Discharge from the CCR unit must be handled in accordance with the surface water requirements under §257.3-3.

Analyses completed for the initial inflow design flood control system plan of the Primary Ash Pond are described in the following subsections. Data and analysis results in the following subsections are based on spillway design information shown on design drawings, construction information, topographic surveys, information about operational and maintenance procedures provided by IPGC and field measurements collected by AECOM. The analysis approach and results of the hydrologic and hydraulic analyses are presented in the following subsections. A detailed presentation of the analyses performed can be found in **Appendix C**.

The Primary Ash Pond has a significant hazard potential; therefore, the inflow design flood (IDF) is the 1,000-year flood.

5.1 Initial Inflow Design Flood Control Systems (§257.82(a))

An initial inflow design flood control system plan, supported by a hydraulic and hydrologic analysis, was developed for the Primary Ash Pond by evaluating the effects of a 24-hour duration design storm for the 1,000-year IDF using a hydraulic HydroCAD (Version 10) computer model and a starting water surface elevation of 534.0 feet, based on the pool level in the Primary Ash Pond surveyed by Weaver Consultants in 2015. The computer model evaluated the Primary Ash Pond's ability to collect and control the 1,000-year IDF under existing operational and maintenance procedures. Rainfall data for the 1,000-year IDF was obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14. The NOAA Atlas 14 rainfall depth is 9.01 inches.

The HydroCAD model results for the Primary Ash Pond indicate that the CCR unit has sufficient storage capacity and spillway structures to adequately manage (1) flow into the CCR unit during and following the peak discharge of the 1,000-year IDF and (2) flow from the CCR unit to collect and control the peak discharge resulting from the 1,000-year IDF. The peak water surface elevation is 534.9 feet during the IDF, and the minimum crest elevation of the Primary Ash Pond dike is 552.7 feet. Therefore, overtopping is not expected.

Based on this evaluation, the Primary Ash Pond meets the requirements in §257.82(a), and the hydrologic and hydraulic analysis is presented in **Appendix C**.

5.2 Discharge from the CCR Unit (§257.82(b))

40 CFR §257.82(b) provides that the discharge from the CCR unit must be handled in accordance with the surface water requirements under 40 CFR §257.3-3, which states the following:

> *(a) For purposes of section 4004(a) of the Act, a facility shall not cause a discharge of pollutants into waters of the United States that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES) under section 402 of the Clean Water Act, as amended.*
>
> *(b) For purposes of section 4004(a) of the Act, a facility shall not cause a discharge of dredged material or fill material to waters of the United States that is in violation of the requirements under section 404 of the Clean Water Act, as amended.*
>
> *(c) A facility or practice shall not cause non-point source pollution of waters of the United States that violates applicable legal requirements implementing an areawide or Statewide water quality management plan that has been approved by the Administrator under section 208 of the Clean Water Act, as amended.*
>
> *(d) Definitions of the terms Discharge of dredged material, Point source, Pollutant, Waters of the United States, and Wetlands can be found in the Clean Water Act, as amended, 33 U.S.C. 1251 et seq., and implementing regulations, specifically 33 CFR part 323 (42 FR 37122, July 19, 1977).*

The handling of discharge was evaluated by reviewing design drawings, operational and maintenance procedures, conditions observed in the field by AECOM, and the inflow design flood control system plan developed per §257.82(a).

Based on this evaluation, outflow from the Primary Ash Pond is ultimately routed through a NPDES-permitted discharge into Newton Lake. Hydraulic and hydrologic analyses performed as part of the initial inflow design flood control system plan found that the Primary Ash Pond adequately manages outflow during the 1,000-year IDF, as overtopping of the Primary Ash Pond embankments is not expected.

Discharge of pollutants in violation of the NPDES permit is not expected as all discharge is routed and controlled through the existing spillway system and NPDES-permitted outfall during both normal and IDF conditions. Based on this evaluation, the Primary Ash Pond meets the requirements in §257.82(b).

6 Conclusions

The Primary Ash Pond at the Newton Power Station was evaluated relative to the USEPA CCR Rule requirements for initial structural stability assessments (§257.73(d)), initial safety factor assessments (§257.73(e)), and initial inflow design flood control system plan (§257.82). Based on the evaluations presented herein, the referenced requirements are satisfied.

7 References

AECOM (2016). *Geotechnical Report-Newton Power Station, Newton Primary Ash Pond* Newton, Illinois.

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Federal Emergency Management Agency (FEMA). (1985). Flood Hazard Boundary Map, Jasper County, Illinois, Unincorporated Area, Panel 125 of 150. Community-Panel Number 170990 125 B.

U.S. Army Corps of Engineers [USACE], (2016). Slope Stability. EM 1110-2-1902, October 31, 2003.

U.S. Environmental Protection Agency [USEPA]. (2015). *Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments.* 40 CFR Part 257, Subpart D. 80 Fed. Reg. 21468 April 17, 2015.

Weaver Consultants Group. (2015). Newton 2015 Aerial Photography, Existing Site Conditions. December 1, 2015.

8 Appendices

A. Pipe Inspection Report

B. Geotechnical Report

C. Hydrologic and Hydraulic Report

Appendix A. Pipe Inspection Report

Blood Hound, Inc.
750 Patrick's Place Ste B
Brownsburg, IN. 46112
Tel: 888.858.9830
E-Mail: bhi@bhug.com
Web: http://www.bhug.com

Inspection Report

Date	Section #	Weather	Cleaning	Operator	Certificate #
10/30/2015	**1**	**Dry**	**No Pre-Cleaning**	**Mike Bennett**	**U-313-17480**

Street Name:	**6725 N 500th St.**	Use of Sewer	**Stormwater**	Upstream MH	**Upper Primary**
City	**Newton, ILL**	Pipe Diameter	**30 inch**	Dowstream MH	**Lower Primary**
		Pipe Material	**Corrugated Metal Pipe**	Dir. of Survey	**Downstream**
		Length surveyed	**17.99 ft**	Section Length	**17.99 ft**

Add. Information :

1:56	Position	Observation
Upper Primary		
	0.00	Water Level, 5 %of cross sectional area
	0.00	Special Chamber / Survey Begins @ Upper Primary
	17.99	General Observation / Reached Clients Needed Footage
Lower Primary		

0 FT

17.99 FT

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	**0000**	**0**	**0**	**0**	**0**	**0**	**0**

Blood Hound, Inc.
750 Patrick's Place Ste B
Brownsburg, IN. 46112
Tel: 888.858.9830
Fax: 888.858.9829
E-mail: bhi@bhug.com

Inspection photos

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Newton, ILL	**6725 N 500th St.**			**1**

Photo: 45602-103015-01-AECOM Denver-1-30102015105328_A.JPG
0FT, Special Chamber / Survey Begins @ Upper Primary

Photo: 45602-103015-01-AECOM Denver-1-30102015110025_A.JPG
17.99FT, General Observation / Reached Clients Needed Footage

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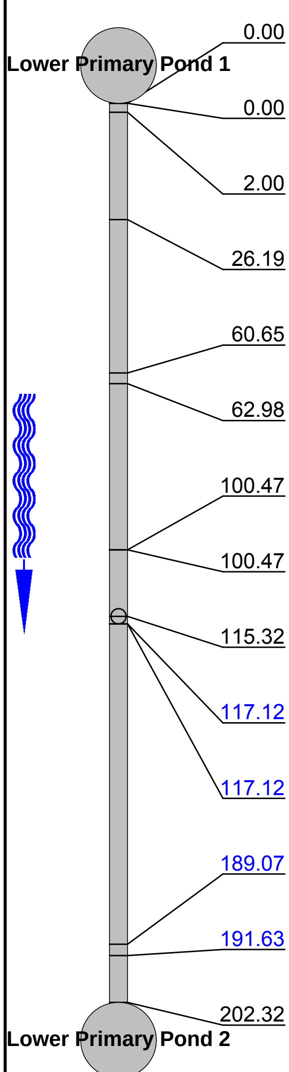
E-Mail: bhi@bhug.com
Web: http://www.bhug.com

Inspection Report

Date	Section #	Weather	Cleaning	Operator	Certificate #
10/30/2015	**3**	**Dry**	**No Pre-Cleaning**	**Mike Bennett**	**U-313-17480**

Street Name:	**6725 N 500th St.**	Use of Sewer	**Stormwater**	Upstream MH	**Lower Primary Pond 1**
City	**Newton, ILL**	Pipe Diameter	**30 inch**	Dowstream MH	**Lower Primary Pond 2**
		Pipe Material	**Corrugated Metal Pipe**	Dir. of Survey	**Downstream**
		Length surveyed	**202.32 ft**	Section Length	**202.32 ft**

Add. Information :



1:518	Position	Observation
Lower Primary Pond 1	0.00	Discharge Point / Survey Begins @ Lower Primary Pond 1
	0.00	Water Level, 5 %of cross sectional area
	2.00	General Observation / Crease
	26.19	General Observation / Air Pocket
	60.65	General Observation / Air Pocket
	62.98	General Observation / Air Pocket
	100.47	General Observation / Not Round
	100.47	Lining Failure Other, at 10 o'clock, within 8 inches of joint: YES / Leak
	115.32	Tap Factory Made, at 12 o'clock, -, within 8 inches of joint: YES, 30" / Upper Primary
	117.12	Infiltration Weeper, from 12 to 03 o'clock, within 8 inches of joint: YES
	117.12	Infiltration Weeper, from 08 to 11 o'clock, within 8 inches of joint: YES
	189.07	Infiltration Weeper, at 09 o'clock, within 8 inches of joint: YES
	191.63	Infiltration Weeper, at 09 o'clock, within 8 inches of joint: YES
Lower Primary Pond 2	202.32	General Observation / Reached Clients Needed Footage, Sediment Was Getting Thick

0 FT

2 FT

26.19 FT

60.65 FT

62.98 FT

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	**2400**	**0**	**8**	**8**	**0**	**2**	**2**

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E-mail: bhi@bhug.com

Inspection photos

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Newton, ILL	**6725 N 500th St.**			**3**

Photo: 45602-103015-01-AECOM Denver-3-30102015144520_A.JPG
0FT, Discharge Point / Survey Begins @ Lower Primary Pond 1

Photo: 45602-103015-01-AECOM Denver-3-30102015152117_A.JPG
2FT, General Observation / Crease

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Inspection photos

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Newton, ILL	**6725 N 500th St.**			**3**

Photo: 45602-103015-01-AECOM Denver-3-30102015151901_A.JPG
26.19FT, General Observation / Air Pocket

Photo: 45602-103015-01-AECOM Denver-3-30102015144916_A.JPG
60.65FT, General Observation / Air Pocket

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Inspection photos

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Newton, ILL	**6725 N 500th St.**			**3**

Photo: 45602-103015-01-AECOM Denver-3-30102015144950_A.JPG
62.98FT, General Observation / Air Pocket

Photo: 45602-103015-01-AECOM Denver-3-30102015145328_A.JPG
100.47FT, General Observation / Not Round

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Inspection photos

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Newton, ILL	**6725 N 500th St.**			**3**

Photo: 45602-103015-01-AECOM Denver-3-30102015145428_A.JPG
100.47FT, Lining Failure Other, at 10 o'clock, within 8 inches of joint: YES / Leak

Photo: 45602-103015-01-AECOM Denver-3-30102015145606_A.JPG
115.32FT, Tap Factory Made, at 12 o'clock, -, within 8 inches of joint: YES, 30" / Upper Primary

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Inspection photos

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Newton, ILL	**6725 N 500th St.**			**3**

Photo: 45602-103015-01-AECOM Denver-3-30102015145614_B.JPG
115.32FT, Tap Factory Made, at 12 o'clock, -, within 8 inches of joint: YES, 30" / Upper Primary

Photo: 45602-103015-01-AECOM Denver-3-30102015145847_A.JPG
117.12FT, Infiltration Weeper, from 12 to 03 o'clock, within 8 inches of joint: YES

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E-mail: bhi@bhug.com

Inspection photos

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Newton, ILL	**6725 N 500th St.**			**3**

Photo: 45602-103015-01-AECOM Denver-3-30102015145940_A.JPG
117.12FT, Infiltration Weeper, from 08 to 11 o'clock, within 8 inches of joint: YES

Photo: 45602-103015-01-AECOM Denver-3-30102015150617_A.JPG
189.07FT, Infiltration Weeper, at 09 o'clock, within 8 inches of joint: YES

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E-mail: bhi@bhug.com

Inspection photos

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Newton, ILL	**6725 N 500th St.**			**3**

Photo: 45602-103015-01-AECOM Denver-3-30102015150655_A.JPG
191.63FT, Infiltration Weeper, at 09 o'clock, within 8 inches of joint: YES

Photo: 45602-103015-01-AECOM Denver-3-30102015150946_A.JPG
202.32FT, General Observation / Reached Clients Needed Footage, Sediment Was Getting Thick

Appendix B. Geotechnical Report

AECOM
1001 Highlands Plaza Drive West
Suite 300
St. Louis, MO 63110-1337
www.aecom.com

314.429.0100 tel
314.429.0462 fax

October 7, 2016

Mr. Matt Ballance, PE
Senior Project Engineer
Dynegy Inc.
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

RE: Geotechnical Report
Newton Power Station
Primary Ash Pond

Dear Mr. Ballance:

AECOM is pleased to provide this Geotechnical Report for the Illinois Power Generating Company (IPGC) Coal Combustion Residuals (CCR) Primary Ash Pond unit at the Newton Power Station located in Newton, Illinois. This Geotechnical Report has been prepared to document the analyses performed to check that the facility meets the geotechnical slope stability requirements, including Factors of Safety, required by 40 CFR § 257.73.

AECOM looks forward to providing continued support to IPGC and working together on this important program. Please do not hesitate to call Ron Hager at 314-429-0100 (office) / 440-591-7868 (mobile), if you have any questions or comments on this Geotechnical Report.

Sincerely,

AECOM

Victor Modeer, PE, D. GE
Site Manager
victor.modeer@aecom.com

Ron Hager
Program Manager
ronald.hager@aecom.com

Attachments:

A. Figures
B. Boring Logs
C. CPT Data Report
D. Lab Test Data
E. Slope Stability Analysis Calculations
F. Probabilistic Seismic Hazard Analysis Report

1. INTRODUCTION

1.1. *Purpose of This Report*

This report presents the results of the geotechnical analysis prepared by AECOM for the Illinois Power Generating Company (IPGC)[1] Coal Combustion Residuals (CCR) Primary Ash Pond at the Newton Power Station, located in Newton, Illinois (see **Figure 1 in Attachment A** for Vicinity Map). The purpose of the geotechnical investigation and analyses performed is to evaluate the design, performance, and condition of the impoundment and associated structures using the data collected from surface and subsurface investigations, available design drawings, construction records, inspection reports, previous engineering investigations, and other pertinent historic documents provided to AECOM by IPGC. This information was then used to evaluate the design and operation of the surface impoundment against the regulatory standards set in 40 CFR § 257.73.

The geotechnical field exploration was conducted between August 3 and August 14, 2015. The field program consisted of solid stem auger (SSA), hollow stem auger (HSA), and mud rotary borings; Standard Penetration Testing (SPT); obtaining undisturbed samples of subsurface soils; piezometer installation; and Cone Penetration Testing (CPT). Laboratory testing was conducted on the materials obtained through various sampling techniques to assist in characterization of the subsurface conditions, especially with respect to defining material parameters for use in stability analyses. Stability analyses were performed by AECOM to evaluate the potential for slope instabilities, in accordance with the Environmental Protection Agency (EPA) regulation 40 CFR § 257.73 (d) and (e).

A summary of the geotechnical field program, laboratory testing program, and stability evaluations are presented herein. Detailed interpretation, calculations, and presentation of analysis results are provided in the Attachments to this report.

1.2. *Description of Impoundments*

The CCR unit at the Newton Power Station consists of the approximately 400-acre Primary Ash Pond which receives CCR materials produced by the Newton Power Station. The Primary Ash Pond discharges into the Secondary Pond, which is a 12-acre non-CCR secondary settling pond located downstream and south-southwest of the Primary Ash Pond.

The crest of the containment dike surrounding the Primary Ash Pond is approximately 3.2 miles long and constructed above natural grade along its entirety. The design elevation of the crest was shown as 555 feet on design drawings (Sargent and Lundy, 1974). Based on field data collected during the summer and fall of 2015, the elevation of the crest varied between 552.7 and 555.1 feet (all elevations listed in this report are in the NAVD88 datum unless otherwise noted). The height of the embankment varies across the natural topography and typically ranges from about 14 to 42 feet in height (excluding Section B, which extends below the Newton Lake normal pool level for a total height of approximately 72 feet). Crest widths vary between approximately 12 and 50 feet, depending on the location. The upstream and downstream slopes are generally 3H:1V (Horizontal:Vertical) but range from about 2.5H:1V to 3.4H:1V.

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[1] Although the Newton Primary Ash Pond is owned by IPGC, Dynegy Administrative Services Company (Dynegy) contracted AECOM develop this geotechnical report on behalf of IPGC. Therefore, “Dynegy” is referenced in materials attached to this geotechnical report.

2. SUMMARY OF FIELD INVESTIGATIONS

A subsurface exploration program was performed at the Primary Ash Pond and Secondary Pond. Although the Secondary Pond is not a CCR Unit, subsurface data collected at the Secondary Pond is discussed in this report due to the similar embankment and foundation conditions relative to the Primary Ash Pond. The subsurface exploration program included 15 soil borings, installation of 14 vibrating-wire piezometers to monitor the phreatic levels, and 19 cone penetration test (CPT) soundings with shear wave velocity measurements and pore pressure dissipation (PPD) testing. The borings were drilled by AECOM's subcontractor Subsurface Exploration Services, LLC (SES) of Green Bay, WI, under the full-time supervision of an AECOM geotechnical engineer or geologist. SES used a Diedrich D-50 Turbo (truck mounted) drill rig and a Diedrich D-120 (all-terrain vehicle mounted) drill rig in conjunction with 4¼-inch inner diameter (8-inch outer diameter) hollow stem augers, 4-inch outer diameter solid stem augers, and $3^7/_8$-inch tricone drill bit for mud-rotary methods to drill the borings. SES typically performed auger drilling above the phreatic surface, switching to cased mud-rotary methods as needed in saturated materials below the phreatic surface. CPT soundings were performed by AECOM's subcontractor ConeTec, Inc., with full-time oversight by an AECOM geotechnical engineer or geologist.

Boring depths varied from 50 to 102 feet below ground surface (bgs) and CPT depths varied from 15 to 68 feet bgs. Boring and CPT sounding locations are shown in **Figure 2 in Attachment A**. Representative soil samples were collected from each of the borings for classification and/or testing. Disturbed soil samples were obtained by Standard Penetration Testing (SPT) with a split-spoon sampler in accordance with ASTM D 1586. Undisturbed samples of fly ash and/or fine-grained soils were obtained using 3-inch outside diameter steel (Shelby) tubes in accordance with ASTM D 6519. **Table 1** provides a summary of field investigation and piezometer locations and a site plan is provided as **Figures 2** and **4** in **Attachment A**. Boring and CPT logs are provided in **Attachments B** and **C**, respectively.

Table 1. Summary of Field Investigations and Piezometers

Investigation ID	Northing (NAD83, feet)	Easting (NAD83, feet)	Surface Elevation (NAVD88, feet)	Depth (ft)	Piezometer ID	Piezometer Depth (ft)
Auger Borings						
NEW-B001	821,500	996,567	554.1	102.0	NEW-P001	65.0
NEW-B003	996,060	821,135	532.5	75.7	NEW-P003	40.2
NEW-B004	822,211	995,358	552.7	45.8	NEW-P004	36.0
NEW-B004A	822,211	995,358	552.7	102.0	-	-
NEW-B005	822,197	995,284	531.2	52.0	NEW-P005	44.8
NEW-B006	823,663	996,123	553.0	79.1	NEW-P006	28.0
NEW-B006A	823,663	996,123	553.0	13.6	-	-
NEW-B007	825,467	999,599	553.7	62.0	NEW-P007	32.0
NEW-B008	824,359	1,001,353	554.4	60.0	NEW-P008	50.0
NEW-B009	823,037	1,001,051	555.1	74.3	NEW-P009	36.0
NEW-B010	821,874	999,530	554.7	82.0	NEW-P010A NEW-P010B	32.0 50.0
NEW-B012	821,534	998,445	554.8	102.0	NEW-P012	77.0
NEW-B014	821,365	998,446	510.0	50.0	NEW-P014	36.0
NEW-B015	823,386	1,001,309	554.6	77.0	NEW-P015	35.0
NEW-B016	823,177	1,001,410	508.8	50.0	NEW-P016	8.0
CPT Soundings						
NEW-SC001	821,369	997,731	554.9	46.3	-	-
NEW-C002	821,493	996,562	554.0	38.5	-	-
NEW-C003	996,054	821,126	528.6	50.0	-	-
NEW-C004	821,842	995,903	553.7	37.7	-	-
NEW-C005	822,208	995,363	553.0	39.9	-	-
NEW-C006	822,963	995,736	553.2	36.4	-	-
NEW-C007	823,688	996,068	534.4	23.6	-	-
NEW-C008	824,245	996,454	553.6	36.1	-	-
NEW-C009	824,840	996,800	554.1	55.0	-	-
NEW-C010	825,208	998,391	554.0	31.7	-	-
NEW-C011	825,463	999,600	554.2	15.4	-	-
NEW-C012	824,996	1,000,730	554.8	37.2	-	-
NEW-C013	824,406	1,001,416	538.3	40.0	-	-
NEW-C014	823,736	1,001,718	554.9	34.9	-	-
NEW-C015	822,987	1,001,190	518.0	36.9	-	-
NEW-C016	822,084	1,000,645	555.0	40.8	-	-
NEW-C017	821,874	999,530	554.7	38.9	-	-
NEW-SC018	821,512	998,443	554.9	68.1	-	-
NEW-SC019	821,757	999,636	512.6	40.4	-	-

3. SUMMARY OF SITE-SPECIFIC SUBSURFACE CONDITIONS

3.1. *Site Stratigraphy*

A summary of selected field data for each soil stratum is presented in **Table 2**. Applicable boring logs are included in **Attachment B**, applicable CPT records are included in **Attachment C**, and pertinent lab test results are included as **Attachment D**. The following are brief explanations of each of the representative material horizons identified at the project site, including the Unified Soil Classification System (USCS) classifications:

Embankment Road: The road located on the top of all embankments typically consisted of a thin layer of gravel; however, at two locations the gravel was underlain by poorly graded sand (SP) and silty sand with gravel (SM). The thickness was approximately 1 foot with a relative density of medium dense based on SPT N-values.

Embankment Fill: The embankment fill for the Primary Ash Pond and Secondary Pond was comprised of soils with the following descriptions: lean clay to lean clay with sand (CL), silty clay (CL-ML), silty clay with sand (CL), sandy lean clay (CL), fat clay (CH), fat clay with gravel and sand (CH), fat clay with sand and silt (CH), fat clay with sand (CH), and clayey silt (ML). The consistencies exhibited variability ranging from soft to very stiff consistency based on SPT N-values and pocket penetrometer estimates.

Upper Clay: The upper clay layer of native soils (weathered loess) present beneath the embankments consisted of lean clay (CL), fat clay (CH), clayey sand (SC), fat clay with sand (CH), lean clay with sand (CL), silty sand (SM), silty clay (CL-ML), silty clay with sand (CL-ML), sandy lean clay (CL). The clayey soils exhibited a stiff to hard consistency based on SPT N-values and pocket penetrometer estimates.

Lower Clay: The lower clay is glacial till consisting of sandy lean clay (CL), silty sand (SM), clayey silt with sand (ML), silty clay with sand (CL-ML), well graded sand with silt (SW-SM), lean clay (CL), fat clay (CH), clayey sand (SC), silty clay (CL-ML), lean clay with sand (CL), clayey sand with silt (SC), and fat clay with sand (CH). The consistencies of the soil were very stiff to hard based on SPT N-values and pocket penetrometer estimates.

Table 2. Summary of Soil Stratum Stiffness/Density Properties

	SPT Blowcount (N-value)			Pocket Penetrometer (ksf)			CPT Tip Resistance (tsf)		
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Embankment Road	11	24	17	N/A	N/A	N/A	9	405	85
Embankment Fill	4	27	14	3	10	6	5	405	34
Upper Clay	9	100	31	2	10	6	0.01	127	54
Lower Clay	3	100	56	2.5	12	9	3	721	90

3.2. *Phreatic Water Conditions*

To help assess the location of the phreatic surface within the embankments, 14 vibrating wire piezometers (VWPs) were installed into the borings around the perimeter of the ponds. SES performed the drilling and installation of the piezometers. Presence of phreatic water was measured in borings NEW-B001, NEW-B003, NEW-B004, NEW-B005, NEW-B007, NEW-B009, NEW-B012, and NEW-B016 at time of drilling as shown in the boring logs. No apparent water was encountered in borings NEW-B006, NEW-B006A, NEW-B008, NEW-B010, NEW-B014, and NEW-B015 at the time of drilling. Measured phreatic water levels referenced for this report are summarized in **Table 3**. This information was used to develop the phreatic surface used for slope stability analyses. Piezometric levels measured by AECOM at the site have been relatively stable, indicating that steady-state seepage conditions have been achieved and the measured phreatic levels are therefore appropriate for use in slope stability analysis.

Table 3. Summary of Measured Phreatic Water Levels

Boring ID	Piezometer ID	Approximate Elevation of Subsurface Water[1] (feet)
NEW-B001	NEW-P001	507.5
NEW-B003	NEW-P003	514.8
NEW-B004	NEW-P004	539.3
NEW-B005	NEW-P005	525.6
NEW-B006	NEW-P006	534.2
NEW-B007	NEW-P007	536.8
NEW-B008	NEW-P008	534.7
NEW-B009	NEW-P009	527.9
NEW-B010[2]	NEW-P010A (32') NEW-P010B (50')	530.9 526.5
NEW-B012	NEW-P012	519.2
NEW-B014	NEW-P014	505.9
NEW-B015	NEW-P015	534.6
NEW-B016	NEW-P016	509.0

Notes:

1. Measured subsurface water elevations obtained on February 12, 2016 were used in the analyses.
2. Nested vibrating-wire piezometers were installed at depths of 32 and 50 feet below ground surface.

4. SUMMARY OF LABORATORY TESTING

4.1. ***Summary of Laboratory Testing Scope***

Laboratory testing was performed by TerraSense, LLC of Totowa, New Jersey in accordance with applicable ASTM standards. Index testing was performed on both disturbed (SPT) and relatively undisturbed (Shelby tube) samples with strength testing limited to the undisturbed samples. The undisturbed samples were carefully collected in the field, sealed (wax and mechanical plugs for Shelby tubes) to preserve moisture contents, and shipped to the TerraSense lab. A summary of the type and number of laboratory tests performed are shown in **Table 4** and **Table 5**.

Table 4. Frequency of Laboratory Index Testing by Stratum

Stratum	Number of Index Tests					
	Moisture Content (%)	Atterberg Limits[1]	Fines Content (%)	Clay Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)
ASTM Std.	D2216	D4318	D422	E100	D7263	D7263
Embankment Fill	73	22	13	5	35	18
Upper Clay	83	29	18	11	42	25
Lower Clay	65	30	24	21	8	5
Totals	221	81	55	37	85	48

Notes: ASTM Std. = ASTM International Standard

1. Atterberg Limits consist of a Liquid limit (LL), Plastic Limit (PL), and Plasticity Index (PI). If the soil is Non-Plastic (NP) it will not have a LL or PI.

Table 5. Frequency of Laboratory Hydraulic Conductivity and Strength Testing by Stratum

Stratum	Hydraulic Conductivity	Number of Strength Tests				
		Consolidated Isotropic Undrained (CIU)	Undrained Unconsolidated (UU)	Direct Shear (DS)	Direct Simple Shear (DSS)	Extension Consolidated Isotropic Undrained (Ext. CIU)
ASTM Std.	D5084	D4767	D2850	D3080	6528	-
Embankment Fill	1	13	3	0	1	0
Upper Clay	4	5	5	11	1	1
Lower Clay	1	1	0	3	0	0
Totals	6	19	7	14	2	1

Notes: ASTM Std. = ASTM International Standard

4.2. ***Summary of Laboratory Testing Results***

A summary of index test results by soil layer is provided in **Table 6**. The results of all the testing performed are provided in **Attachment D**.

Table 6. Summary of Ranges of Index Testing Results

Stratum	Moisture Content (%)	LL (%)	PI (%)	Fines[1] Content (%)	Clay[2] Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)
Embankment Fill	10 to 27	24 to 66	11 to 52	52 to 88	17 to 36	115 to 141	99 to 128
Upper Clay	8 to 29	23 to 57	11 to 44	23 to 88	16 to 36	123 to 149	102 to 130
Lower Clay[3]	9 to 20	22 to 52	8 to 38	11 to 74	2 to 21	107 to 140	114 to 126

Notes: LL = Liquid Limit; PI = Plasticity Index; NP = Nonplastic; pcf = pounds per cubic foot
1. Fines content is defined as the percent, by dry mass, of grainsizes smaller than U.S. No. 200 sieve opening (0.075-mm).
2. Clay content is defined as the percent, by hydrometer analysis, of grainsizes smaller than 0.002 mm (2 μm).
3. One sample within the ML/SM layer in boring NEW-B009 and was excluded from the summary.

Shear strength testing consisted of direct shear (DS), unconsolidated undrained triaxial shear tests (UU), consolidated undrained triaxial shear tests with pore pressure measurements (CIU), extensional consolidated undrained triaxial shear tests with pore pressure measurements, (Ext CIU), and direct simple shear tests (DSS). The strength testing was performed at a variety of confining stresses on the embankment fill, upper clay, and lower clay stratum in accordance with applicable ASTM standards. A summary of strength testing results is provided in **Attachment D**.

Drained shear failure was defined at the point of peak obliquity, which generally exhibited less scatter in the data. However, measured shear strengths at 5 or 10 percent strain may have been supplemented if strain incompatibility or post-peak strength loss was observed for peak obliquity. The shear stress on the failure plane at failure, as estimated using Mohr-Coulomb relationships and the design friction angle for the soil, was selected as the shear strength. For undrained strength parameters, the shear strength was plotted against initial effective normal consolidation pressure. See **Attachment E** for a more detailed explanation of shear strengths selection.

5. SLOPE STABILITY ANALYSES

Slope stability analyses were performed for multiple loading conditions at selected cross sections as described in the subsequent subsections. Soil material properties and seismic analyses are also discussed in the following sub-sections.

5.1. ***Cross Sections for Analysis***

The slope stability analyses were performed for 10 cross sections (labeled A through K on **Figure 3 in Attachment A**) around the Primary Ash Pond[2]. The cross-section locations were selected to consider the presumed maximum section as well as areas with representative subsurface conditions, upstream/downstream slope configurations, and within historic drainages. The embankment geometry used in the slope stability models was derived from cross sections developed using 2015 topographic and bathymetric survey data performed by Weaver Consultants. It should be noted that section K was not within the boundaries of the new data collected in 2015 and is based on the older 2012 data obtained from the Illinois Geospatial Data Clearinghouse [IGDC] (IGDC 2015).

The subsurface profile was developed using CPT tip resistance, sleeve, and PPD data; boring logs from the 2015 AECOM geotechnical investigation; original design drawings (Sargent and Lundy 1974); and engineering judgment. The phreatic surface within and below the embankment was interpreted using estimates from the CPTs and vibrating-wire piezometers installed as part of this investigation. **Figure 3 in Attachment A** shows the locations of the CPTs and borings in relation to the cross sections as summarized below in **Table 7**.

[2] Analysis of Section J at the Secondary Pond is not included in this Geotechnical Report as the Secondary Pond is not a CCR Unit.

Table 7. Investigation Items Associated by Cross Section

Cross Section	Boring	CPT	Piezometer
A[1]	-	NEW-SC001	-
B	NEW-B012, NEW-B014	NEW-SC018	NEW-P012 NEW-P014
C	NEW-B010	NEW-C017, NEW-SC019	NEW-P010 (32′) NEW-P010 (50′)
D	NEW-B009	NEW-CO15	NEW-P009
E	NEW-B008	NEW-C013	NEW-P008
F	NEW-B007	-	NEW-P007
G	NEW-B006	NEW-C007	NEW-P006
H	NEW-B004, NEW-B004A, NEW-B005	NEW-C005	NEW-P004 NEW-P005
I	NEW0B001	NEW-C002	NEW-P001
K	NEW-B015, NEW-B016	-	NEW-P015 NEW-P016

Note:
1 – Boings were previously performed for Section A (Geotechnology, Inc. 2011).

5.2. *Stability Analysis Conditions Considered*

Consistent with the criteria provided in the USEPA CCR Rule § 257.73(e), the stability of each cross section was evaluated for the following load cases:

Static Long-Term Maximum Storage Pool Condition: This case models the conditions under static, long-term conditions, at the normal water level within the impoundment of 534.0 feet, as listed in AECOM's hydrologic and hydraulic report (AECOM, 2016) for the Primary Ash Pond. Drained (effective stress) shear strength parameters were used for all materials and phreatic conditions were estimated based on piezometer data and pore pressure dissipation tests performed in CPT soundings. ***Target Factor of Safety of 1.50.***

Static, Maximum Surcharge or Flood Condition: This case models the conditions under a short-term surcharge pool elevation of 534.9 feet, as listed in AECOM's hydrologic and hydraulic report (AECOM, 2016) for the Primary Ash Pond. Drained (effective stress) shear strength parameters were used for all materials in this analysis. This is because the increase in flood pool is relatively small (1.8 feet) and is not expected to result in the development of undrained conditions in the downstream embankment slope or foundation soils, which is where the critical slip surface from the normal pool condition was found. Therefore, the use of drained soil strengths is appropriate. It was also assumed that the temporary surcharge load was not of sufficient duration to significant alter the phreatic surface (i.e. saturation line within the embankment). Therefore, the phreatic surface was modeled equivalent to the steady state case; however the pool level in the Primary Ash Pond was increased to model the additional surcharge. ***Target Factor of Safety of 1.40.***

Seismic (Pseudo-Static) Condition: These analyses incorporate a horizontal seismic coefficient k_h selected to be representative of expected loading during the design earthquake event (i.e., a "pseudostatic" analysis). The analyses utilized undrained strength parameters in soils that are not considered to be rapidly draining materials, and drained strengths in soils considered to freely drain. Phreatic water and pool level conditions were assumed to be the same as the maximum storage pool condition case. ***Target Factor of Safety of 1.00.***

Post-Liquefaction Analysis: This analysis was not performed because neither the embankment or foundation soils are susceptible to liquefaction or cyclic softening (see **Section 5.3.2.3**).

Sudden Drawdown Analysis: This analysis was performed at cross-sections which were adjacent to Newton Lake and the Secondary Pond (cross-sections B, C, D, I, and K). The case models the embankment under rapid (sudden) drawdown of the downstream pool level in Newton Lake or the Secondary Pond, where the stabilizing force on the downstream pool is removed from the downstream slope, but phreatic conditions in the embankment are equivalent to the static, steady-state, normal pool condition case. This analysis uses a staged approach (Duncan et al., 1990, as described in Duncan and Wright, 2005), with both drained and undrained soil strengths, and two piezometric lines are used. As factor of safety criteria for this analysis case is not included in the USEPA CCR §257.73(e) regulation, a ***Target Factor of Safety of 1.3*** was used, which is listed in United States Army Corps of Engineers (USACE) EM 1110-2-1902 guidance for drawdown from normal pool (maximum storage pool). Phreatic water and pool level conditions within the embankment and upstream Primary Ash Pond were assumed to be the same as the maximum storage pool condition case.

5.3. *Methodology of Analyses*

The slope stability analyses were performed using the software program SLOPE/W 2012 (Version 8.15.4.11512), commercially available through GEO-SLOPE International, Ltd. (GEO-SLOPE International Ltd. 2015). SLOPE/W used circular slip surfaces defined using entry and exit methods, and was allowed to use tension cracks and to optimize failure surfaces to determine the final, noncircular critical slip surface. Spencer’s method was used to calculate slope stability factors of safety which satisfy both force and moment equilibrium. All calculated factors of safety correspond to a global slip surface that intersected the crest and could result in the release of impounded CCR materials.

5.3.1. *Static Analysis Conditions*

Strength parameters were derived from laboratory testing of field samples. A summary of the selected shear strength parameters and unit weights are presented in **Table 8**. See **Attachment E** for a more detailed explanation of shear strength selection.

Table 8. Summary of Material Strength Parameters for Static Cases

Material	Unit Weight (pcf)	Drained Strength	
		Effective Friction Angle ϕ′ (deg)	Effective Cohesion c′ (psf)
Embankment Fill	130	31	0
Upper Clay	130	29	0
Lower Clay[1]	130	33	3,700
Ash	90	30	0

Notes:

1. Shear strength based on correlations with Atterberg tests and SPT N-value blowcounts. This stratum is a very stiff layer through which shear surfaces are not anticipated to pass. Due to the very stiff consistency of the soil, it was not possible to obtain Shelby tubes for shear strength testing.

5.3.2. *Earthquake Analysis Conditions*

The Newton Power Station is located in a region with potential seismic sources, including the New Madrid and Wabash Valley seismic zones, as well as background seismicity. Evaluation of potential hazards from liquefaction and cyclic-softening following a large seismic event were analyzed as described in the subsections below.

5.3.2.1. Probabilistic Seismic Hazard Analysis

AECOM conducted a site-specific probabilistic seismic hazard analysis (PSHA) for the Newton Power Station. The PSHA results were used to compute a 2,500-year return period Uniform Hazard Spectrum (UHS). The PSHA-estimated peak ground acceleration (PGA) was 0.212 g for top of hard rock. The modal magnitude and distance for the 2,500-year return period were 5.1 and 12.5 km, respectively. This corresponds to background seismicity, rather than a larger and more distant event within the New Madrid or Wabash Valley seismic zones.

Parameters were developed including magnitude, distance, style of faulting, response spectra, and Arias Intensity for the current study. Near field and directivity effects were also considered. All seismically capable faults in the project region were considered.

Four sets of time histories were developed for each approved design spectrum. The time histories represent the site-specific ground motions associated with the controlling near-field or far-field earthquake event, and consider the magnitude, distance, and Arias Intensity. Refer to **Attachment F** for the site-specific UHS for hard rock and acceleration time history data.

5.3.2.2. Dynamic Response Analysis

A dynamic response analysis is useful for more precisely estimating the amplification and attenuation characteristics of the embankment structure and local soils to the design rock motions and to estimate the earthquake-induced stresses within the embankment and foundation. A one-dimensional site-response analysis was performed for the Newton Power Station using RASCALS (Silva and Lee 1987), with which the results of the PSHA are used in combination with site-specific soil conditions (layer thicknesses, seismic velocities, density, shear modulus, and damping curves) to propagate hard rock control motions to the ground surface. The site-response analysis yielded a PGA of 0.182 g for the ground surface at the site (base of the embankment or free-field conditions beyond the embankment). Additional discussion of both the PSHA and site-response analysis is included in the PSHA Report in **Appendix F**.

Published correlations between recorded peak crest accelerations and base accelerations for embankments show that ground motions may be significantly higher than accelerations at the base of earth and rock fill dams (Harder et al. 1998) and should be adjusted. Consequently, the crest acceleration was adjusted to account for dynamic effects within the embankment using the estimated upper range curve provided in communication with I.M. Idriss (2015), which is consistent with Harder et al. (1998), and the site-specific surface acceleration (0.182 g) from the site-response analysis. The resulting peak crest acceleration was estimated to be 0.45g (See **Attachment E**).

Furthermore, Makdisi and Seed (1978) suggest that the maximum average acceleration for a potential sliding mass is less than the peak acceleration at the embankment crest (0.45g) when the failure surface is deep enough relative to the height of the embankment. For full embankment height failure surfaces extending from the crest into the native soil, the horizontal seismic coefficient for pseudostatic analyses can be reduced by approximately 66% relative to the peak crest acceleration (See of **Attachment E**). Therefore, the pseudostatic seismic coefficient, k_h, was estimated to be 0.153 g.

5.3.2.3. Liquefaction Triggering Analysis

Liquefaction is used to describe the contraction of loose sands (or sand-like materials) under cyclic loading imposed by earthquake shaking, which can transfer stress from the sand matrix onto the pore water if the soil is saturated and largely unable to drain during the shaking. The result is a reduction in the effective confining stress within the soil and an associated loss of strength (Idriss and Boulanger 2008). Liquefaction only occurs in saturated soils. Liquefaction susceptibility also largely depends on compositional characteristics such as particle size, shape, and gradation; however, laboratory and field observations also indicate that plasticity characteristics influence liquefaction susceptibility (Kramer 1996). Idriss and Boulanger (2008) suggested that soils with a plasticity index (PI) greater than about 7 are not susceptible to liquefaction.

The large majority of soil samples tested had PIs between 8 and 52, which are indicative of a clay-like behavior. Most samples with lower PIs had high blowcounts (greater than 50 bpf), which indicates that these samples are very dense and are typically considered not susceptible to liquefaction. Furthermore, all samples exhibiting non-plastic behavior had high blowcounts (greater than 50 for 12 inches). One sample in NEW-B014 (sample 5) at a depth of approximately 20 feet was indicated to have relatively low plasticity, fines content of about 50%, and an uncorrected blowcount of 20. The sample was unsaturated with blowcounts corrected for hammer energy and fines content $(N_1)_{60cs}$ averaging about 26. Based on correlations provided in Idriss and Boulanger (2008, 2014) and Youd et al. (2001), this represents the approximate upper bound for any case history where liquefaction was identified. Consequently, a formal liquefaction analysis was determined unnecessary as the soils at the site are not susceptible to liquefaction based on their composition, consistency, and index properties.

Due to the typically stiff nature of the embankment fill, upper clay, and lower clay, the soils are not susceptible to cyclic softening. Typically, the effects of cyclic softening are limited to relatively soft to medium stiff clays, which were only found in limited areas at the site. As the clays at the site are overconsolidated and are likely to have dilative behavior during shear, cyclic softening or strength losses following seismic shaking are unlikely to occur by inspection, and post-earthquake slope stability analyses were judged not applicable and were not performed.

5.3.2.4. Seismic Strength Parameter Selection

Strength parameters were derived from laboratory testing of field samples. A summary of the strength parameters used for this analysis is presented in **Table 9**. Shear strengths were selected as previously described in Section 4.2. See **Attachment E** for a more detailed explanation of shear strengths selection.

Table 9. Summary of Material Parameters for Earthquake Cases

Material	Unit Weight (pcf)	Undrained Strength	
		S_u/σ'_c	Minimum Strength (psf)
Embankment Fill	130	0.41 ($s'_c \geq 500$ psf) 1.39 ($s'_c < 500$ psf)	-
Upper Clay	130	0.40 ($s'_c \geq 2{,}000$ psf) 0.63 ($s'_c < 2{,}000$ psf)	-
Lower Clay	130	-	5,000
Ash	90	0.05	-

5.3.3. Sudden Drawdown Analysis Conditions

Soil strengths for drawdown analyses were developed using the Duncan et al. (1990) approach, as described in Duncan and Wright (2005). This approach uses both drained and undrained (R-envelope) soil strengths to evaluate sudden drawdown slope stability. The R-envelope shear strengths represent undrained shear strength on the slip surface as a function of effective stress on the slip surface prior to drawdown. The staged approach first conducts a slope stability analysis using drained soils strengths under pre-drawdown conditions. Effective stresses on the slip surface are calculated for the pre-drawdown conditions, and the lower of the drained and R-envelope strengths corresponding to the effective stress are then used to calculate the post-drawdown factor of safety without the stabilizing effect of the downstream pool. The selected R-envelope strengths are listed in **Table 10**.

Table 10: Summary of Material Parameters for Drawdown Conditions

Material	Unit Weight (pcf)	R-Envelope Strength	
		f_R (deg)	c_R (psf)
Embankment Fill	130	22	500
Upper Clay	130	22	470
Lower Clay	130	Assumed Drained	
Ash	90	Assumed Drained	

The R-envelope strengths were developed by converting the S_u/s'_c peak undrained shear strength ratio, which provides peak undrained shear strength as a ratio of vertical effective stress, to a R-envelope friction angle (f_R) and cohesion (c_R). The conversion involved taking the tangent of the S_u/s'_c ratio to develop f_R, and extrapolating the envelope to a zero effective stress condition to estimate c_R. As the stability analysis software (SLOPE/W) only allows linear drained and R-envelope strengths for drawdown analysis, both of the shear strength envelopes were simplified to a linear envelope by neglecting steeper portions of the undrained shear strength envelope at low consolidation stresses.

It should be noted that the ash and lower clay horizons were assumed to behave in a drained manner during drawdown conditions. This is because the ash is isolated from the downstream pool in Newton Lake or the Secondary Pond by the clay embankment fill, and is not expected to undergo stress changes due to drawdown of the downstream water body. The lower clay material has much higher drained shear strength than the overlying upper clay, and is unlikely to control sudden drawdown slope stability.

6. RESULTS

6.1. ***Results of Static Analyses***

The minimum calculated factors of safety for each of the slope stability analyses performed for the static cases are shown in **Table 11**. Refer to **Attachment E** for associated output figures containing the slip surfaces with the minimum factors of safety.

Table 11. Summary of Slope Stability Results for Static Cases

Loading Condition	Program Criteria	Cross Section									
		A	B	C	D	E	F	G	H	I	K
Long Term (Drained)	FS ≥ 1.50	1.82	1.81	1.67	1.76	2.18	1.99	2.05	1.81	1.66	1.92
Surcharge (Drained)	FS ≥ 1.40	1.82	1.81	1.67	1.76	2.18	1.95	2.04	1.81	1.66	1.91

6.2. *Results of Earthquake Analyses*

6.2.1. *Liquefaction Potential Analysis*

The 2015 AECOM field investigation did not identify any liquefaction or cyclic softening-susceptible soil layers and a liquefaction analysis was not required as described in **Section 5.3.2**. Therefore, liquefaction (post-earthquake) slope stability analyses do not need to be performed as the embankment and foundation soils at the site are not susceptible to earthquake-induced strength losses for the design 2,500-year seismic event.

6.2.2. *Earthquake Analysis Results*

The minimum calculated factors of safety for each of the slope stability analyses performed for the earthquake case are shown in **Table 12**. Refer to **Attachment E** for associated output figures containing the slip surfaces with the minimum factors of safety.

Table 12. Summary of Slope Stability Results for Earthquake Cases

Loading Condition	Program Criteria	Cross Section									
		A	B	C	D	E	F	G	H	I	K
Pseudostatic (Undrained)	FS ≥ 1.00	1.26	1.07	1.11	1.23	1.91	1.50	1.59	1.36	1.42	1.28

6.3. *Results of Sudden Drawdown Stability Analyses*

The minimum sudden drawdown slope stability factor of safety per USACE EM 1110-2-1902 criteria is 1.3. Results for each of the slope stability analyses performed for the sudden drawdown case are shown in **Table 13**. It should be noted that sudden drawdown analyses were only performed for sections where Newton Lake or the Secondary Pond is adjacent to the toe of the embankment. Refer to **Attachment E** for associated output figures containing the slip surfaces with the minimum factors of safety.

Table 13. Summary of Slope Stability Results for Sudden Drawdown Cases

Loading Condition	Program Criteria	Cross Section				
		B	C	D	I	K
Rapid Drawdown	FS ≥ 1.30	1.6	1.7	1.8	1.6	1.9

7. CONCLUSIONS

The calculated factors of safety from the limit equilibrium slope stability analysis satisfy the USEPA CCR Rule § 257.73(e) requirements for all the load cases analyzed for all cross-sections analyzed for each of the embankments that comprise the Primary Ash Pond at Newton Power Station. Load cases analyzed for this study included static (steady-state) normal pool, maximum flood surcharge pool, seismic (pseudo-static), static post-liquefaction, and sudden drawdown.

8. LIMITATIONS

Background information, design basis, and other data have been furnished to AECOM by IPGC, which AECOM has used in preparing this report. AECOM has relied on this information as furnished, and is not responsible for the accuracy of this information. Our recommendations are based on available information from previous and current investigations. These recommendations may be updated as future investigations are performed.

Borings have been spaced as closely as economically feasible, but variations in soil properties between borings, that may become evident at a later date, are possible. The recommendations made in this report are based on the assumption that the subsurface soil, rock, and phreatic water conditions do not deviate appreciably from those disclosed in the site-specific exploratory borings. If any variations or undesirable conditions are encountered in any future exploration, AECOM should be notified so that additional recommendations can be made, if necessary.

The conclusions presented in this report are intended only for the purpose, site location, and project indicated. The recommendations presented in this report should not be used for other projects or purposes. Conclusions or recommendations made from these data by others are their responsibility. The conclusions and recommendations are based on AECOM's understanding of current plant operations, maintenance, stormwater handling, and ash handling procedures at the station, as provided by IPGC. Changes in any of these operations or procedures may invalidate the findings in this report until AECOM has had the opportunity to review the findings, and revise the report if necessary.

This geotechnical investigation was performed in accordance with the standard of care commonly used as state-of-practice in our profession. Specifically, our services have been performed in accordance with accepted principles and practices of the geological and geotechnical engineering profession. The conclusions presented in this report are professional opinions based on the indicated project criteria and data available at the time this report was prepared. Our services were provided in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation is intended.

9. REFERENCES

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Attachment A: Figures

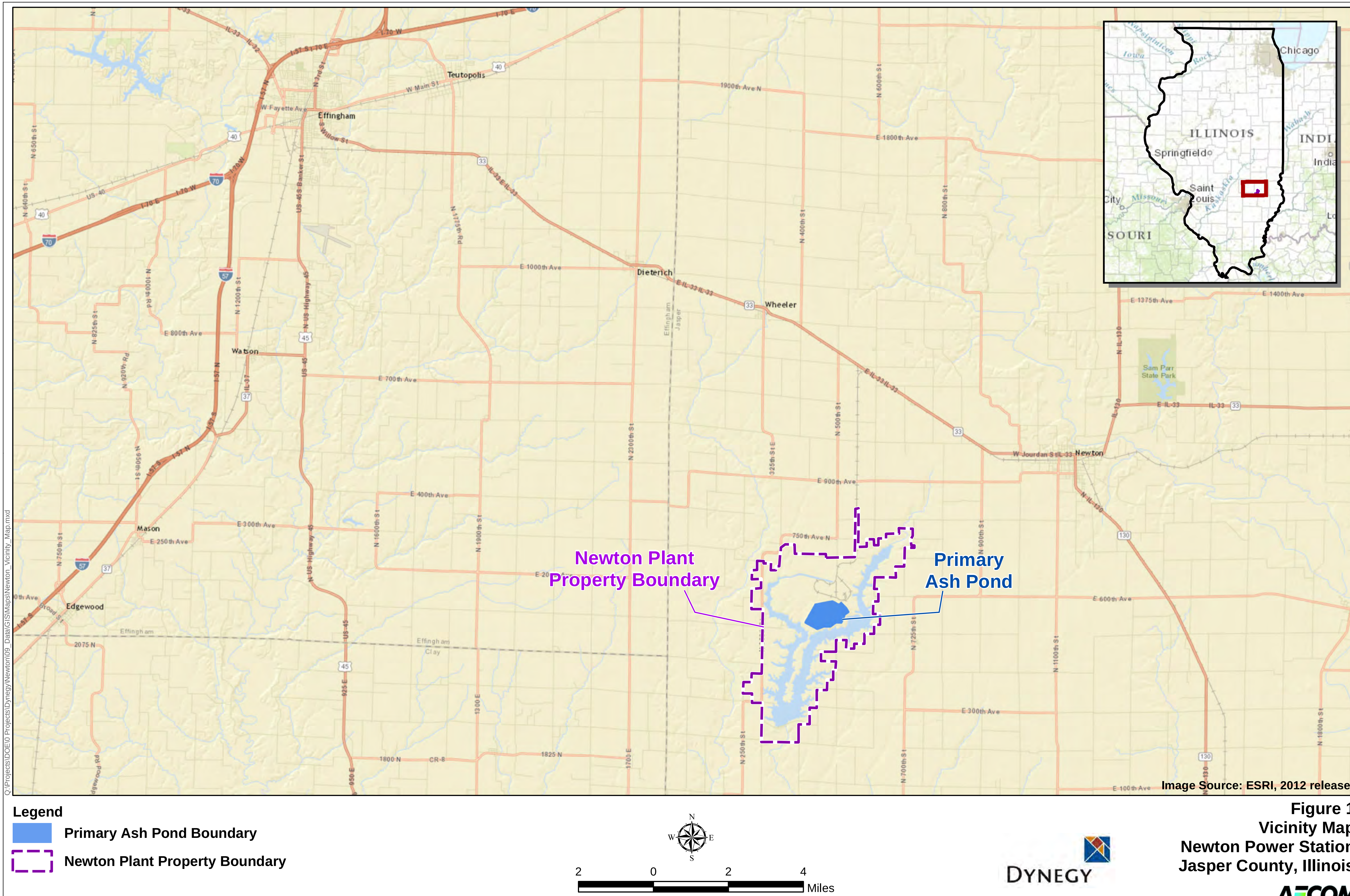

Figure 1
Vicinity Map
Newton Power Station
Jasper County, Illinois

DYNEGY
AECOM

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Legend

AECOM Boring Location

AECOM CPT Location

N W E S

0.1 0 0.1 0.2 Miles

DYNEGY

Figure 2
Exploration Locations
Newton Power Station
Jasper County, Illinois

AECOM

Q:\Projects\DOE\0 Projects\Dynegy\Newton\09_Data\GIS\Maps\Newton_Exporation_Locations_wXS.mxd

Legend

- AECOM Boring Location
- AECOM CPT Location
- Cross Sections

N W E S

0.1 0 0.1 0.2 Miles

DYNEGY

Figure 3

Cross-Section Locations
Newton Power Station
Jasper County, Illinois

AECOM

Q:\Projects\DOE\0 Projects\Dynegy\Newton\09_Data\GIS\Maps\Newton_Piezometer_Locations.mxd

Legend

AECOM Piezometer Locations

N W E S

0.1 0 0.1 0.2 Miles

DYNEGY

Figure 4

Piezometer Locations
Newton Power Station
Jasper County, Illinois

AECOM

Attachment B: Boring Logs

Project:	DYNEGY CCR RULE ASSESSMENT OF PLANTS	Key to Soil Boring Logs
Project Location:	BALDWIN ENERGY COMPLEX BALDWIN, ILLINOIS	Sheet 1 of 1
Project Number:	60428794	

Group	Graphic Symbol	Description	USCS Classification
SAND AND GRAVEL		SAND poorly graded	SP
		SAND well graded	SW
		Silty SAND	SM
		Clayey SAND	SC
		GRAVEL poorly graded	GP
LOW PLASTIC SILTS AND CLAYS		Inorganic low plastic SILT	ML
		Inorganic low plastic CLAY	CL
		Gravelly CLAY	CL
HIGH PLASTIC CLAYS		Organic CLAY	OH
		Inorganic high plastic CLAY	CH
		Sandy Inorganic high plastic CLAY	CH
ROCKS		LIMESTONE	
		SHALE	
SURFACE MATERIALS		Asphalt, Pavement	
		CONCRETE	
		Topsoil	
		Fly Ash	
		Fly Ash/Coal	

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 uncorrected SPT blows per foot.

Descriptive Term	SPT Blows per Foot	Estimated Undrained Shear Strength (ksf)	Hand Test
Very soft	0–2	< 0.25	Extruded between fingers
Soft	2–4	0.25–0.5	Molded by light 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 split spoon test sample

Undisturbed shelby tube sample

PP qu	Pocket penetrometer unconfined compressive strength
NMC	Natural Moisture Content, %
LL	Liquid Limit
PL	Plastic Limit
PI	Plasticity Index
NP	Non–plastic
∇	Depth Groundwater enters at time of drilling.
▼	Groundwater Level at some specified time after drilling
Su	Undrained Shear Strength
TXUU	Triaxial Unconsolidated Undrained
DTW	Depth to water
N/A	Not Applicable

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
WOR	Weight of rods

ABBREVIATIONS USED UNDER "REMARKS"

HSA	Hollow Stem Auger	NoR	No Recovery
ATD	At Time of Drilling	CIU	Isotropically Consolidated Undrained
AD	After Drilling	ST	Shelby Tube
ID	Inside Diameter	SS	Split Spoon
OD	Outside Diameter		
RQD	Rock Quality Designation		
-#200	(% Passing #200 Sieve)		
Sa (%)	Sieve Analysis (% Passing #200)		

AECOM

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B001

Date(s) Drilled	08/07/2015 1:50 PM to 08/08/2015 5:00 PM	Logged By	DP	Checked By	LW
Drilling Method	HSA, Mud rotary	Drill Bit Size/Type	4.25" ID 8" OD HSA, 3.875" tricone	Borehole Depth	102.0 ft
Drill Rig Type	Diedrich D-50 Turbo (Truck Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	554.1 ft NAVD88
Borehole Backfill	Cement-Bentonite grout with VWP at 65'	Sampling Method(s)	Split Spoon, Shelby Tube	Hammer Data	Auto-Hammer, 83% efficiency
Boring Location	N 821500 E 996567 (ft NAD83)	Groundwater Level(s)	36 ft on 8/7/2015		

Elevation (feet)	Depth (feet)	Samples: Type	Samples: Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	Material Description (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	Remarks
554.1	0						554.1 / 0.0								
		Split spoon	S1	7 5 5 10	100		[EMBANKMENT ROAD] 553.1 / 1.0 Poorly Graded SAND (SP), medium dense, dark gray brown to dark brown gray, dry to moist, some gravel								*Began drilling on 8/7/2015*
		Split spoon	S2	8 8 11 11	88		[EMBANKMENT FILL] Lean CLAY to Lean CLAY with Sand (CL), stiff to very stiff, dark brown, dry to wet, trace to some Gravel								
550	5	Split spoon	S3	3 6 8 7	100										
		Split spoon	S4	4 4 8 8	83										
545	10	Shelby tube	S5		67			18.1	125.4	50	36				*P200 = 79.1*
540	15	Split spoon	S6	5 6 10 11	100		Increasing Sand content								
535	20	Shelby tube	S7		83			16.2	130.1	49	36				*P200 = 59.9*
530	25	Split spoon	S8	4 6 8 10	100			17.1							*P200 = 65.3*
525	30														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B001

Elevation (feet)	Depth (feet)	Samples: Type	Samples: Number	Samples: Sampling Resist. OR Core RQD (%)	Samples: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30		S9	4 4 8 9	100		Lean CLAY to Lean CLAY with Sand (CL), stiff to very stiff, dark brown, dry to wet, trace to some Gravel								
															Hard drilling
520															34'-35' soft drilling
	35		S10	3 3 9 28	100			15.8		25	11				P200 = 55.6
517.6	36.5						[NATIVE] Sandy Lean CLAY (CL), hard, brown to dark brown, dry to wet, fine to coarse Sand, trace Gravel								Water encountered at 36' End 8/7/2015 5:05 PM, Start 8/8/2015 7:50 AM with Mud Rotary
515															
	40		S11	33 51/6"	92			14.6		22	9				P200 = 57.0
			S12	19 31 37 46	100		Orange to gray brown								
510															
	45		S13	11 21 31 40	94			11.8							
			S14	11 15 23 28	90		Dark gray brown to very dark brown								
505															
	50		S15	12 25 42 43	98		Gray brown to dark gray brown	12.3		27	9				
500															
	55		S16	10 17 28 37	92			11.5		30	17				P200 = 63.3
495															
	60		S17	11 18 30 39	100										
490															
	65														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B001

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
			S18	12 20 30 42	100	Sandy Lean CLAY (CL), hard, brown to dark brown, dry to wet, fine to coarse Sand, trace Gravel	12.8		33	19				P200 = 64.6 Vibrating wire piezometer installed at 65' on 8/8/2015 (Serial number 1520847)
485														
	70		S19	25 50/5"	100		12.4		24	9				
480														
	75		S20	15 26 37 45	100		13.0							
475														
	80		S21	12 17 22 33	100									
470														
	85		S22	9 15 21 29	100									
465														
	90		S23	10 16 20 28	100		12.8		28	14				
461.6	92.5					Silty SAND (SM), very dense, brown gray fine to coarse, wet, some fine to coarse Gravel								
460														
	95		S24	14 33 32 26	65		11.0							P200 = 13.4 2" piece of Gravel in sampler
455														
	100													

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B001

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
			S24	20 20 28 34	100		Silty SAND (SM), very dense, brown gray fine to coarse, wet, some fine to coarse Gravel								*Sample 25A-Gravel/Sand, 25B-Clay*
452.6	101.5						Lean CLAY (CL), hard, dark brown gray, moist, trace fine Sand								
452.1	102.0						End of Boring at 102 ft								
450															
	105														
445															
	110														
440															
	115														
435															
	120														
430															
	125														
425															
	130														
420															
	135														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B003

Date(s) Drilled	08/06/2015 9:30 AM to 08/06/2015 6:30 PM	Logged By	JKD	Checked By	LW
Drilling Method	HSA, Mud rotary	Drill Bit Size/Type	4" OD SSA, 3.875" tricone	Borehole Depth	75.7 ft
Drill Rig Type	Diedrich D-120 (ATV Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	532.5 ft NAVD88
Borehole Backfill	Cement-Bentonite grout with VWP at 40.2'	Sampling Method(s)	Split Spoon, Shelby Tube	Hammer Data	Auto-Hammer, 68% efficiency
Boring Location	N 996060 E 821135 (ft NAD83)	Groundwater Level(s)	16.5 ft on 8/14/2015		

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
532.5	0.0	Split Spoon	S1	6 10 10 5	75		[EMBANKMENT FILL] Poorly Graded SAND with Silt and Gravel (SP-SM), medium dense, medium gray to orange-brown to brownish gray, moist, angular Gravel, bottom ash								*Began drilling on 8/6/2015*
529.5	3.0						Silty CLAY (CL-ML), stiff, bright yellowish brown, moist, low to high plasticity								
	5	Split Spoon	S2	4 5 6 7	75							3.0			
	10	Split Spoon	S3	5 7 7 7	100		Light gray mottled with bright yellowish brown	16.1				5			
	15	Shelby Tube	ST-1		100			20.9	129.5	59	44	4			*P200 = 77.3*
	21	Split Spoon	S4	4 6 7 10	100			17.7				5			
	23	Shelby Tube	ST-2		100			19.4	130.6	43	26	8.5			*P200 = 82.7*
507.5	25.0	Split Spoon	S5	3 4 7 10	100		[NATIVE] Fat CLAY (CH), stiff, dull yellow-orange, moist, trace coarse Sand, medium plasticity	19.2				2.5-5			
	28	Shelby Tube	ST-3		100			21.1	128.1	55	39				
502.5	30.0														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B003

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30		S6	5 5 6 6	100	Lean CLAY (CL), stiff, dull yellow-orange, moist, trace coarse Sand, medium plasticity	19.6		42	28	4			*P200 = 69.8*
500.0	32.5					Lean CLAY (CL), stiff, bright yellowish brown, moist, none to low plasticity, occasional organics								
	35		S7	5 6 7 9	100		17.0		41	26	3.5			
495.0	37.5					Fat CLAY with Sand (CH), stiff, mottled light gray to bright yellowish brown, moist, fine Sand								
	40		S8	woh 4 7 5	100		22.9		50	32				*P200 = 88.2 Vibrating wire piezometer installed at 40.2' on 8/7/2015 (Serial number 1520853)*
490.0	42.5					Silty CLAY with Sand (CL-ML), soft, light yellow to yellowish gray, moist, fine to coarse Sand, medium plasticity								
	45		S9A& 9B	1 3 12 7	100		11.7				2.5 10.0+			
486.5	46.0					Clayey SILT with Sand (ML), very stiff to hard, gray, moist, angular coarse Sand, trace angular Gravel, low plasticity, occasional organics								*Switched to mud rotary at 47', no groundwater encountered*
	50		S10	18 22 32 45	100						10.0+			*Sample 10 is full of disturbed/mixed material*
480.0	52.5					Silty CLAY with Sand (CL-ML), hard, gray, moist, trace fine angular Gravel, medium plasticity								
	55		S11	19 24 43 50/4"	100						9.0			
475.0	57.5					Lean CLAY (CL), hard, gray, moist, trace coarse Sand, low to medium plasticity								
	60		S12	13 17 30 41	100		13.3		32	17	7.0			
	65													

Elevation scale: 500, 495, 490, 485, 480, 475, 470

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Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

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Log of Boring NEW-B003

Elevation (feet)	Depth (feet)	Type / Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
		S13	12 16 21 29	100		Lean CLAY (CL), hard, gray, moist, trace coarse Sand, low to medium plasticity	12.7				8.0			*P200 = 67.6*
465														
	70	S14	10 15 24 32	100		Occasional organics					9.0+			
460														
	75	S15	36 50/2"	75							9.0+			
456.8	75.7					End of Boring at 75.7 ft								
455														
	80													
450														
	85													
445														
	90													
440														
	95													
435														
	100													

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B004

Date(s) Drilled	08/05/2015 10:30 AM to 08/05/2015 4:00 PM	Logged By	DP	Checked By	LW
Drilling Method	SSA, HSA, Mud rotary	Drill Bit Size/Type	4.25" ID 8" OD HSA, 3.875" tricone	Borehole Depth	45.8 ft
Drill Rig Type	Diedrich D-50 Turbo (Truck Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	552.7 ft NAVD88
Borehole Backfill	Cement-Bentonite grout with VWP at 36'	Sampling Method(s)	Split Spoon, Shelby Tube	Hammer Data	Auto-Hammer, 83% efficiency
Boring Location	N 822211 E 995358 (ft NAD83)	Groundwater Level(s)	37.9 ft on 8/5/2015		

Elevation (feet)	Depth (feet)	Sample Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
552.7	0.0	S1	10 6 4 4	67	[EMBANKMENT FILL] Sandy Lean CLAY (CL), stiff, light gray brown to dark brown gray, dry to moist								*Began drilling on 8/5/2015*
550		S2	4 6 8 7	100									
	5	S3	3 6 9 9	100		13.9							*P200 = 64.2 Switched from solid stem auger to hollow stem auger at 5'*
545													
544.2	8.5	S4		100	Fat CLAY with Sand (CH), stiff, gray brown to orange brown to dark gray, moist to wet	18.5	131.3	50	37				*P200 = 83.9*
	10	S5	4 6 8 8	100		20.0							
540													
	15	S6	3 6 7 8	67		20.3							
535		S7		100		18.3	126.9	52	37				
	20	S8	4 6 7 7	96		20.3							
530					orange brown to gray brown								
	25	S9	4 4 5 7	92		20.7							
525.2	27.5	S10	6 10 14 14	100	[NATIVE] Sandy Lean CLAY (CL), stiff to very stiff, orange to black, moist to wet	17.7		37	23				*P200 = 61.7*
525	30												

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B004

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30		S11	4 10 14 20	100		Sandy Lean CLAY (CL), stiff to very stiff, orange to black, moist to wet								
520															
519.2	33.5		S12		100			9.7	106.5	24	11				
	35		S13	18 24 32 37	100		Sandy Lean CLAY (CL), hard, dark gray brown to dark brown, dry to moist, trace to some Gravel	9.0							*P200 = 52.8*
			S14	12 19 32 50/5"	100		Sand lense at 37'	8.9		26	13				*Vibrating wire piezometer installed at 36' on 8/9/2015 (Serial number 1520849) Water table encountered at 37.9'*
515															
	40		S15	28 51/5.5"	100										*Switched to mud rotary at 3:00 pm on 8/5/15*
510															
	45		n/a	27 50/4"	0										*Split spoon sampler broke off rods at 4:00 pm. Drillers unable to retrieve it, hole abandoned. Drilled NEW-B004A 5' North.*
507.0	45.8						End of Boring at 45.8 ft								
505															
	50														
500															
	55														
495															
	60														
490															
	65														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B004A

Date(s) Drilled	08/06/2015 10:30 AM to 08/07/2015 1:00 PM	Logged By	DP	Checked By	LW
Drilling Method	Mud rotary	Drill Bit Size/Type	3.875" tricone	Borehole Depth	102.0 ft
Drill Rig Type	Diedrich D-50 Turbo (Truck Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	552.7 ft NAVD88
Borehole Backfill	Cement-Bentonite grout	Sampling Method(s)	Split Spoon	Hammer Data	Auto-Hammer, 83% efficiency
Boring Location	N 822211 E 995358 (ft NAD83)	Groundwater Level(s)	14.6 ft on 8/14/2015		

Elevation (feet)	Depth (feet)	SAMPLES: Type Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) 552.7 / Depth (feet) 0.0)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	0													*Began drilling on 8/6/2015. Boring offset 5' North from NEW-B004 when it was abandoned. See NEW-B004 for soil descriptions in the upper 45'.*
550														
	5													
545														
	10													
540														
	15													
535														
	20													
530														
	25													
525														
	30													

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30														
520															
	35														
515															
	40														
510															
	45		S1	40 50/6"	100		507.7 / 45.0 [NATIVE] Sandy Lean CLAY (CL), hard, gray brown to dark gray brown to very dark brown, moist to wet, coarse Sand	10.4							*P200 = 63.2*
505															
	50		S2	13 21 34 49	100			11.3		29	14				
500															
	55		S3	15 24 36 49	100			10.0							
495															
	60		S4	16 26 37 47	100			11.4							*P200 = 68.1*
490															
	65														

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
			S5	14 28 36 49	100		Sandy Lean CLAY (CL), hard, gray brown to dark gray brown to very dark brown, moist to wet, coarse Sand								
485															
	70		S6	13 22 34 44	100		Trace coarse Gravel	16.8		32	18				
480															
	75		S7	13 19 28 36	100										
475															
	80		S8	10 17 26 34	100			12.5		31	17				
							470.2 / 82.5								
470							Well Graded SAND with Silt (SW-SM), medium to very dense, very dark gray, wet, trace to some Gravel								
	85		S9	41 50/3.5"	100										
465															
	90		S10	10 25 37 34	100			10.9							
460															*End 8/6/2015 5:45 PM, Start 8/7/2015 7:50 AM*
	95		S11	25 45 52	100			11.1							*P200 = 11.2*
455															
	100														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B004A

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
			S12	46 40 38 53	85		Well Graded SAND with Silt (SW-SM), medium to very dense, very dark gray, wet, trace to some Gravel 450.7 — 102.0								
450							End of Boring at 102 ft								
	105														
445															
	110														
440															
	115														
435															
	120														
430															
	125														
425															
	130														
420															
	135														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B005

Date(s) Drilled	08/05/2015 11:00 AM to 08/06/2015 4:00 PM	Logged By	JKD	Checked By	LW
Drilling Method	HSA, Mud rotary	Drill Bit Size/Type	4" OD SSA, 3.875" tricone	Borehole Depth	52.0 ft
Drill Rig Type	Diedrich D-120 (ATV Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	531.2 ft NAVD88
Borehole Backfill	Cement-Bentonite grout with VWP at 44.8'	Sampling Method(s)	Split Spoon, Shelby Tube	Hammer Data	Auto-Hammer, 68% efficiency
Boring Location	N 822197 E 995284 (ft NAD83)	Groundwater Level(s)	16.5 ft on 8/5/2015		

Elevation (feet)	Depth (feet)	Samples: Type	Samples: Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
531.2	0.0		S1	4 8 7 7	67		[NATIVE] Sandy SILT with Clay (ML), stiff, light brownish gray, dry, fine Sand, trace organics					10.0			Began drilling on 8/5/2015
529.0	2.3		S2	4 7 6 7	100		Lean CLAY (CL), stiff, yellow, moist to wet, low to medium plasticity					3.5			
			S3	5 7 8 9	100			17.9		47	32	4.0			
			S4A& 4B	5 6 6 6	100							2.5			
522.2	9.0		S5	14 22 28 32	100		Sandy Lean CLAY (CL), stiff to hard, yellow, dry to moist, fine to coarse Sand, non to low plasticity, occasional organics	9.8		24	11	10.0+			
			S6	16 37 50/5"	100		Trace fine Gravel and coarse Sand	9.4		27	15	12.0			P200 = 54.6 Water encountered at 16.5'
			S7	37 50/5"	100		Switched to mud rotary at 20.9'	10.8		26	13	4.0			
			S8	19 53	100			11.6				10.0+			P200 = 54.6
503.7	27.5						Sandy SILT (ML), hard, gray, dry to moist, fine to coarse subangular to subrounded Sand, trace subrounded Gravel, low plasticity								

Elevation scale: 530, 525, 520, 515, 510, 505; Depth scale: 0, 5, 10, 15, 20, 25, 30

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B005

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
500	30		S9	13 27 37 53	100		Sandy SILT (ML), hard, gray, dry to moist, fine to coarse subangular to subrounded Sand, trace subrounded Gravel, low plasticity					10.0+			
495	35		S10	15 23 38 53	100			11.3				10.0+			P200 = 66.4
493.7	37.5						Lean CLAY with Sand (CL), hard, gray, moist, fine to coarse Sand, trace fine angular to subangular Gravel, low to medium plasticity								
490	40		S11	12 21 30 48	100			14.0				10.0+			
485	45		S12	13 20 28 37	100		Subrounded Gravel, occasional organics	13.1		33	18	8.5			P200 = 70.2 Vibrating wire piezometer installed at 44.8' on 8/5/2015 (Serial number 1521534)
483.7	47.5						Silty CLAY with Sand (CL-ML), hard, gray moist, trace subrounded Gravel, low plasticity								
480	50		S13	9 12 21 31	100							10.0+			
479.2	52.0						End of Boring at 52 ft								
475	55														
470	60														
	65														

AECOM

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B006

Date(s) Drilled	08/13/2015 7:30 AM to 08/13/2015 3:20 PM	Logged By	JKD	Checked By	LW
Drilling Method	HSA, Mud rotary	Drill Bit Size/Type	4" OD SSA, 3.875" tricone	Borehole Depth	79.1 ft
Drill Rig Type	Diedrich D-120 (ATV Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	553.0 ft NAVD88
Borehole Backfill	Cement-Bentonite grout with VWP at 28'	Sampling Method(s)	Split Spoon, Shelby Tube	Hammer Data	Auto-Hammer, 68% efficiency
Boring Location	N 823663 E 996123 (ft NAD83)	Groundwater Level(s)	15.7 ft on 8/14/2015		

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
553.0	0.0	Split Spoon	S1	5 6 6 6	63	[EMBANKMENT FILL] Fat CLAY (CH), stiff, light brownish gray to dull orange mottled light gray, moist, medium to high plasticity, numerous organics in top 6"					9.0			*Began drilling on 8/13/2015*
	5	Split Spoon	S2	3 5 5 8	100	Mottled bright yellowish brown to light gray					5.0			
	10	Split Spoon	S3	3 5 6 6	100		21.2		66	52	4.0			*P 200 = 88.2*
541.0	12.0					Sandy Lean CLAY (CL), stiff to very stiff, light gray and orange, moist to wet								
	15	Split Spoon	S4	3 5 6 6	75						4.0			
	20	Shelby Tube	ST-1		100		18.2	128.0	40	23				*P200 = 78.4*
	22	Split Spoon	S5	3 7 9 10	100	Occasional organics					5.5			
529.0	24.0					[NATIVE] Sandy Lean to fat CLAY (CL-CH), stiff to very stiff, light gray and orange, moist to wet								*Switched to mud rotary at 24' P200 = 65.6*
	25	Shelby Tube	ST-2		100		19.7	140.1	44	32				
	27	Split Spoon	S6	3 5 7 8	100		19.4		54	41	5.0			*Vibrating wire piezometer installed at 28' on 8/13/2015 (Serial number*
523.0	30.0													

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30		ST-3		100		Sandy Lean CLAY, stiff, mottled dull and light brownish gray mottled dull brownish gray, moist to wet, trace Gravel	18.3	133.0	37	22				*1520850)* *P200 = 52.1*
520			S7	4 4 8 16	100			17.5				3.0-6.0			
	35		ST-4		100			12.8	148.8	30	17				*P200 = 58.3* *Shelby tube end crushed*
			S8	50/5"	100		517.2 — 35.8 Clayey SAND (SC), very dense, dull orange, moist								
515							515.0 — 38.0 Sandy Lean CLAY (CL), hard, dull brown, coarse Sand, trace fine Gravel								
	40		S9	20 39 36 40	100			13.0				10.0+			
510															
	45		S10	15 21 31 40	100										
505															
	50		S11	14 19 22 36	100										
500															
	55		S12	13 19 26 38	100							10.0+			
495															
	60		S13	10 25 32 41	50		Decreasing Sand content								
490															
	65														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B006

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
			S14	9 16 22 33	100		Sandy Lean CLAY (CL), hard, dull brown, coarse Sand, trace fine Gravel					10.0+			
485															
	70		S15	9 16 21 28	100							9.5			
480															
	75		S16	9 15 20 28	100							7.0			
475			S17	11 19 50/1"	100		473.9 — 79.1					9.0			
							End of Boring at 79.1 ft								
	80														
470															
	85														
465															
	90														
460															
	95														
455															
	100														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B006A

Date(s) Drilled	08/14/2015 7:40 AM to 08/14/2015 10:00 AM	Logged By	JKD	Checked By	LW
Drilling Method	PA (Power Auger)	Drill Bit Size/Type	4" OD SSA	Borehole Depth	13.6 ft
Drill Rig Type	Diedrich D-120 (ATV Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	553.0 ft NAVD88
Borehole Backfill	Cement-Bentonite grout	Sampling Method(s)	Shelby Tube	Hammer Data	Auto-Hammer, 68% efficiency
Boring Location	N 823663 E 996123 (ft NAD83)	Groundwater Level(s)	ft on		

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
553.0	0.0														Began drilling on 8/14/2015.,Advanced SSA to a depth of 10' to recover two shelby tubes. See NEW-B006,NEW-C006,a NEW-B004 for approximate soil characterizations.
543.0	10.0						[EMBANKMENT FILL] Fat CLAY (CH), stiff, light brownish gray to dull orange mottled light gray, moist, medium to high plasticity, numerous organics								
		Shelby Tube	ST-1		100			25.2	115.2	54	38				
		Shelby Tube	ST-2		100			18.9	121.4	53	39				
539.4	13.6						End of Boring at 13.6 ft								

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B007

Date(s) Drilled	08/13/2015 1:30 PM to 08/13/2015 7:22 PM	Logged By	LW	Checked By	LW
Drilling Method	HSA, Mud rotary	Drill Bit Size/Type	4.25" ID 8" OD HSA, 3.875" tricone	Borehole Depth	62.0 ft
Drill Rig Type	Diedrich D-50 Turbo (Truck Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	553.7 ft NAVD88
Borehole Backfill	Cement-Bentonite grout with VWP at 32'	Sampling Method(s)	Split Spoon, Shelby Tube	Hammer Data	Auto-Hammer, 83% efficiency
Boring Location	N 825467 E 999599 (ft NAD83)	Groundwater Level(s)	29 ft on 8/13/2015		

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
553.7	0		S1	15 9 5 5	56		553.7 / 0.0 [EMBANKMENT ROAD]								*Began drilling on 8/13/2015.*
552.7	1.0						Silty SAND with Gravel (SM), medium dense, dry, fine to coarse Sand, fine to coarse angular to subangular Gravel								
551.5	2.3		S2	2 3 4 5	75		[EMBANKMENT FILL] Fat CLAY with Gravel and Sand, stiff, gray brown, moist to dry, fine to coarse Sand, fine to coarse subrounded to angular Gravel								
550							Fat CLAY (CH), medium stiff, dark gray brown, moist, trace fine to coarse Sand, trace fine to coarse Gravel								
	5		S3	2 3 4 7	85		Mottled medium brown and black, increasing Sand content, may be Sandy Fat Clay								
546.5	7.3		S4	3 5 6 7	100		Silty CLAY with Sand (CL-ML), stiff, brown gray to medium brown mottled brown and black, dry, fine to coarse Sand	13.2							
545	10		ST-1		100			15.4	131.6	38	24				
540	15		S5	4 4 6 8	71		Trace subrounded to subangular fine to coarse Gravel, increasing Sand content								
535.2	18.5						[NATIVE] Lean CLAY with Sand (CL), stiff, medium brown, dry to moist, some to trace fine to coarse Sand								
535	20		ST-2		83			12.1	143.6	30	17				*P200 = 52.3*
530	25		S6	4 6 8 10	100		Mottled dark brown to very dark brown, orange brown, increasing Silt content	16.3							
525															*Water encountered at 29'*
523.7	30						523.7 / 30.0								

Elevation (feet)	Depth (feet)	Samples: Type	Samples: Number	Samples: Sampling Resist. OR Core RQD (%)	Samples: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30	ST	ST-3		100		Fat CLAY with Sand, stiff, medium brown, dry to moist, some to trace fine to coarse Sand	21.5	131.1	52	40				*P200 = 71.5*
															Vibrating wire piezometer installed at 32' on 8/14/2015 (Serial number 1520855) Switched to mud rotary at 32'
520.2	33.5						Silty CLAY with Sand (CL-ML), very stiff, medium brown to brown gray, dry to moist, fine to coarse Sand, trace fine subangular Gravel								
	35	SS	S7	7 8 10 14	69			14.8							
515.2	38.5						Fat CLAY with Silt and Sand (CH), stiff, medium brown mottled medium brown gray, dry to moist, fine to coarse Sand								
	40	ST	ST-4		100			17.5	129.9	57	44				
	45	SS	S8	5 6 10 12	100										
	50	ST	ST-5		100			13.9	131.5	32	16				
501.2	52.5						Fat CLAY (CH), hard, medium brown, moist, trace fine to coarse Sand, trace fine subrounded Gravel								
	55	SS	S9	10 21 29 38	100										
	60	SS	S10	14 20 32 39	100		Occasional medium brown gray mottling								
491.7	62.0						End of Boring at 62 ft								

Elevation scale: 520, 515, 510, 505, 500, 495, 490. Depth scale: 30, 35, 40, 45, 50, 55, 60, 65.

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B008

Date(s) Drilled	08/12/2015 11:20 AM to 08/12/2015 4:00 PM	Logged By	JKD	Checked By	LW
Drilling Method	HSA, Mud rotary	Drill Bit Size/Type	4" OD SSA, 3.875" tricone	Borehole Depth	60.0 ft
Drill Rig Type	Diedrich D-120 (ATV Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	554.4 ft NAVD88
Borehole Backfill	Cement-Bentonite grout with VWP at 50'	Sampling Method(s)	Split Spoon, Shelby Tube	Hammer Data	Auto-Hammer, 68% efficiency
Boring Location	N 824359 E 1001353 (ft NAD83)	Groundwater Level(s)	18.2 ft on 8/14/2015		

Elevation (feet)	Depth (feet)	Type / Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
554.4	0.0	S1	6 4 5 5	100	[EMBANKMENT FILL] Silty CLAY (CL-ML), stiff, dull orange, dry to moist, trace coarse Sand and fine angular Gravel, (top 6" Gravel and Bottom Ash), medium plasticity, occasional organics					6.5			*Began drilling on 8/12/2015*
550	5	S2	3 6 7 11	100	Mottled dull yellow orange and brown gray					5.5			
545	10	S3	3 5 7 8	100						5.0			
540	15	ST-1		100		16.7	132.9	50	37				*P200 = 74.4*
535	20	S4	5 5 6 6	100		20.1				6.5			
531.9	22.5	S5	3 4 6 8	100	[NATIVE] Silty CLAY (CL-ML), stiff to hard, light gray moist, medium plasticity	22.6				5.0			*Switched to mud rotary at 22'*
530	25	S6	5 7 9 11	100		23.2				5.0			
525		ST-2		100		14.4	130.3	49	35				
	30												

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B008

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Material Description	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	Remarks
	30					[NATIVE] Silty CLAY (CL-ML), stiff to hard, light gray moist, medium plasticity								
522.9	31.5					Silty CLAY (CL-ML), stiff, bright yellow brown, moist, trace fine rounded Gravel, medium plasticity								
520	35		S7	9 15 29 37	100		13.8				6.0			
516.9	37.5					Clayey SAND (SC), very dense, mottled dull yellow to bright yellowish brown, moist, fine to medium Sand, occasional organics								
515	40		S8	31 35 50/5"	100		14.6				10.0+			*P200 = 46.9*
510.4	44.0					Silty CLAY (CL-ML), hard, dull orange, dry to moist, trace Sand, medium to high plasticity, occasional organics								
510	45		S9	7 12 16 19	100									*Sample S9 was highly disturbed*
505.9	48.5					Lean CLAY (CL), hard, bright yellow brown, dry to moist, trace fine subrounded Gravel, medium plasticity, occasional organics								
505	50		S10	18 33 50/6"	100		15.4		32	16	10.0+			*P200 = 65.4 Vibrating wire piezometer installed at 50' on 8/12/2015 (Serial number 1520857)*
500	55		S11	18 35 50/4"	100	Dull orange, trace Sand					10.0+			
497.4	57.0					Silty CLAY with Sand (CL-ML), hard, bright yellow brown, moist, medium plasticity								
495			S12	18 30 40 50/6"	100						9.0			
494.4	60.0					End of Boring at 60 ft								
490	65													

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Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B009

Date(s) Drilled	08/11/2015 9:00 AM to 08/11/2015 5:40 PM	Logged By	JKD	Checked By	LW
Drilling Method	HSA, Mud rotary	Drill Bit Size/Type	4" OD SSA, 3.875" tricone	Borehole Depth	74.3 ft
Drill Rig Type	Diedrich D-120 (ATV Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	555.1 ft NAVD88
Borehole Backfill	Cement-Bentonite grout with VWP at 36'	Sampling Method(s)	Split Spoon, Shelby Tube	Hammer Data	Auto-Hammer, 68% efficiency
Boring Location	N 823037 E 1001051 (ft NAD83)	Groundwater Level(s)	34.5 ft on 8/11/2015		

Elevation (feet)	Depth (feet)	Samples: Type	Samples: Number	Samples: Sampling Resist. OR Core RQD (%)	Samples: Recovery (%)	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
555	0					555.1 / 0.0								*Began drilling on 8/11/2015*
		Split Spoon	S1	2 5 5 5	83	[EMBANKMENT FILL] Silty CLAY with Sand (CL-ML), stiff to hard, dull yellow orange, dry to moist, coarse Sand, low to medium plasticity, occasional organics					10.0+			
550	5	Split Spoon	S2	4 4 6 6	100	Mottled dull orange and light brown gray, decreasing Sand content					6.0			
545	10	Shelby Tube	ST-1		100		19.0	131.1	47	32				
540	15	Split Spoon	S3	4 8 7 9	100	Trace rounded coarse Sand, fine gray Sand	15.3				6.0			
535	20	Split Spoon	S4	5 9 9 11	100		18.3				5.5			
						532.6 / 22.5								
						Silty CLAY with Sand (CL-ML), very stiff, dull yellow orange coarse, dry to moist, coarse Sand, low to medium plasticity, occasional organics								
530	25	Split Spoon	S5	5 8 9 13	100						7.0			
						527.6 / 27.5								
						Lean CLAY with Sand (CL), very dense, bright yellow brown, moist								
		Shelby Tube	ST-2		100		16.7	128.8	31	17	2.0			
	30													

Elevation (feet)	Depth (feet)	Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
525	30	ST-2		100	Lean CLAY with Sand (CL), very dense, bright yellow brown, moist	16.7	128.8	31	17	2.0			
520	35	S6	21 37 50/6"	100	Rounded coarse Sand	8.6		24	12				P200 = 51.6 Water encountered at 34.5' Switched to mud rotary at 35.5' Vibrating wire piezometer installed at 36' on 8/12/2015 (Serial number 1520852)
519.1	36.0				[NATIVE] Clayey SILT with Sand (ML), hard, mottled light brownish gray to dull orange, moist, low plasticity								
		S7	57/6"	100		16.9			NP				
516.1	39.0				Lean CLAY with Sand (CL), very stiff to hard, dull orange, moist, trace rounded Gravel, medium plasticity								
515	40	S8	32 40 57/6"	100						10.0+			
		S9	9 12 17 21	100	Brownish gray, decreasing Sand content	15.0							
510	45												
505	50	S10	9 18 27 39	100	Olive brown, coarse rounded Sand	13.7				9.0			P200 = 74.0
500	55	S11	14 22 35 47	100	Mottled dull orange, decreasing Sand content, trace fine angular Gravel	14.6				10.0+			
495	60	S12	26 36 39 48	100	Light gray, increasing Sand content	13.5		24	8	10.0+			P200 = 66.4
	65												

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B009

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
490			S13	10 20 27 41	100		Lean CLAY with Sand (CL), very stiff to hard, dull orange, moist, trace rounded Gravel, medium plasticity					10.0			
485	70		S14	10 44 50/5"	100		Dull yellow orange, increasing Sand content	12.2							*P200 = 51.5*
483.1	72.0						Clayey SAND with Silt (SC), very dense, light gray, moist, trace rounded Gravel								
			S15	38 45 50/3"	100							10.0+			
480.8	74.3						End of Boring at 74.3 ft								
480	75														
475	80														
470	85														
465	90														
460	95														
	100														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B010

Date(s) Drilled	08/11/2015 8:25 AM to 08/11/2015 6:00 PM	Logged By	AA, LW	Checked By	LW
Drilling Method	HSA, Mud rotary	Drill Bit Size/Type	4.25" ID 8" OD HSA, 3.875" tricone	Borehole Depth	82.0 ft
Drill Rig Type	Diedrich D-50 Turbo (Truck Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	554.7 ft NAVD88
Borehole Backfill	Cement-Bentonite grout with VWPs at 32' and 50'	Sampling Method(s)	Split Spoon, Shelby Tube	Hammer Data	Auto-Hammer, 83% efficiency
Boring Location	N 821874 E 999530 (ft NAD83)	Groundwater Level(s)	24.7 ft on 8/14/2015		

Elevation (feet)	Depth (feet)	Samples: Type	Samples: Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
554.7	0	Split Spoon	S1	7 8 8 8	71		554.7 / 0.0 [EMBANKMENT FILL] Lean CLAY (CL), soft to stiff, brown yellow, moist to wet, some fine to coarse Sand, trace fine Gravel	10.2	137.3	24	11				*Began drilling on 8/11/2015*
		Split Spoon	S2	4 4 9 11	77										
550	5	Shelby Tube	ST-1		100										
		Split Spoon	S3	3 4 10 6	100										
545	10	Split Spoon	S4	1 2 2 3	65			13.7							
540	15	Shelby Tube	ST-2		100			13.8	137.9	33	20				
535	20	Split Spoon	S5	3 6 8 13	100		Mottled gray	16.1							
530	25	Split Spoon	S6	5 6 8 9	100		529.7 / 25.0 [NATIVE] Lean CLAY (CL), stiff to very stiff, brown yellow, moist, some to trace fine to coarse Sand, trace fine Gravel	19.1							
525	30														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B010

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30		S7	6 8 10 10	100		Lean CLAY (CL), stiff to very stiff, brown yellow, moist, some to trace fine to coarse Sand, trace fine Gravel	21.0		49	33				P200 = 62.3
															Vibrating wire piezometer installed at 32' on 8/12/2015 (Serial number 1520856)
520	35		S8	12 23 35 48	100		518.7 / 36.0 Lean CLAY (CL), hard, gray mottled, dry to moist	8.5		23	11				
															Switched to mud rotary at 37'
515	40		S9& 9A	30 50/5"	100		Some Silt								
							514.0 / 40.8 Fat CLAY with Sand (CH), very dense, brown yellow, moist, medium to coarse subrounded to subangular Sand, some silt and organics								
			S10	18 34 50/5"	100										
510	45		S11	23 42 50/4"	94										
							508.4 / 46.3 Clayey SAND (SC), very dense, brown yellow to yellow red, moist to wet, fine to coarse subrounded to subangular Poorly Graded Sand								
			S12	40 50/2"	100			13.5							
505	50		S13	40 50/4"	100		Mottled gray, increasing Silt content, organics	10.1							P200 = 22.3 Vibrating wire piezometer installed at 50' on 8/12/2015 (Serial number 1520851)
							502.2 / 52.5 Lean CLAY (CL), very stiff to hard, gray, moist, some Silt, some fine to coarse Sand, some to trace fine to coarse Gravel, organics								
500	55		S14	11 19 33 47	100										
							498.5 / 56.3 Silty SAND (SM), very dense, brown gray, moist, medium plasticity								
							496.7 / 58.0 Fat CLAY with Sand (CH), hard, dark brown, moist, fine to coarse Sand, trace fine Gravel, some organics								
495	60		S15	8 14 18 23	100										
490	65						489.7 / 65.0								

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
			S16	8 15 22 30	100		Lean CLAY with Sand (CL), hard, dark brown, moist, fine to coarse Sand, trace fine Gravel, some organics	15.0							*P200 = 70.6*
485	70		S17	8 15 23 27	100										
480	75		S18	12 15 22 31	100			14.5		28	13				
475	80		S19	7 12 18 20	100		Silt and Clay appears to be interbedded	14.7		25	10				
472.7	82.0						End of Boring at 82 ft								
470	85														
465	90														
460	95														
455	100														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B012

Date(s) Drilled	08/09/2015 10:50 AM to 08/10/2015 2:00 PM	Logged By	AA	Checked By	LW
Drilling Method	HSA, Mud rotary	Drill Bit Size/Type	4.25" ID 8" OD HSA, 3.875" tricone	Borehole Depth	102.0 ft
Drill Rig Type	Diedrich D-50 Turbo (Truck Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	554.8 ft NAVD88
Borehole Backfill	Cement-Bentonite grout with VWP at 77'	Sampling Method(s)	Split Spoon, Shelby Tube	Hammer Data	Auto-Hammer, 83% efficiency
Boring Location	N 821534 E 998445 (ft NAD83)	Groundwater Level(s)	45.5 ft on 8/9/2015		

Elevation (feet)	Depth (feet)	SAMPLES: Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
554.8	0 / 0.0		S1	5 5 10 9	67		[EMBANKMENT FILL] Lean CLAY with Sand (CL), stiff to very stiff, brown yellow mottled gray, moist, fine to coarse Sand, trace fine Gravel								*Began drilling on 8/9/2015*
			S2	4 5 7 9	100										
550	5		S3	5 5 6 8	67										
			ST-4		100			12.6	134.0	34	21				
545	10		S5	4 4 5 7	92										
540	15		S6	8 9 12 14	90										
535	20		ST-7		100			13.3	135.0	35	22				*P200 = 52.1*
532.8	22.0						Lean CLAY (CL), stiff to very stiff, brown yellow, moist, trace fine to coarse Sand, trace fine gravel, trace organics								
530	25		S8	5 6 9 9	96			15.2		36	23				
525	30														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B012

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30		S9	5 7 9 10	100		Lean CLAY (CL), stiff to very stiff, brown yellow, moist, trace fine to coarse Sand, trace fine gravel, trace organics	12.9							
520	35		S10	4 5 9 12	100			16.8		40	25				
515	40		S11	7 11 16 20	100		513.5 — 41.3	9.9							P200 = 55.9 0.75"-1.25" sized Gravel in SS
							Gravelly Lean CLAY with Sand (CL), very stiff, brown to brown yellow, moist, some fine to coarse Sand, trace fine to coarse Gravel								
							511.4 — 43.4								
							Lean CLAY (CL), stiff to very stiff, brown yellow, moist, trace fine to coarse Sand, trace fine gravels, trace organics								
510	45		ST-12		100			17.5	131.7	43	29				P200 = 62.1 Shelby tube is wet 45.45'
505	50		S13	5 9 9 9	100			20.0							More moist than above samples
500	55		S14	5 8 11 14	100		Mottled gray	15.8		41	28				Less moist than above
495	60		ST-15		100			12.8	136.2	42	28				
490	65														

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
			S16	7 9 13 16	100		Lean CLAY (CL), stiff to very stiff, brown yellow, moist, trace fine to coarse Sand, trace fine gravels, trace organics								*Stopped drilling on 8/9/2015 at 72'; Resumed drilling on 8/10/2015*
485	70		S17	6 10 13 13	100			10.9							
480	75		S18	6 8 12 13	100			11.8		29	16				*P200 = 53.3*
477.3	77.5						[NATIVE] Clayey SAND (SC), medium dense, gray mottled brown red, moist, fine to coarse Sand, some organics								*Vibrating wire piezometer installed at 77' on 8/10/2015 (Serial number 1520848)*
475	80		ST-19		100		Mottled brown red	11.2	139.7	25	11				
472.3	82.5						Lean CLAY (CL), very stiff to hard, gray, moist, some fine to coarse Sand, trace 0.75" Gravel, trace organics								*Switched to mud rotary at 82'*
470	85		S20	10 15 20 25	100			16.2		34	20				
465	90		S21	10 12 19 20	0										
460	95		S22& 22A	13 10 9 8	100		Sample 22: Top 19" (same as Sample 20)	15.7							*Sample 22A: Bottom 5" is a tree root*
455	100														

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
			S23	8 11 11 9	100		Lean CLAY (CL), very stiff to hard, gray, moist, some fine to coarse Sand, trace 0.75" Gravel, trace organics								
							452.8 — 102.0								
							End of Boring at 102 ft								
450	105														
445	110														
440	115														
435	120														
430	125														
425	130														
420	135														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B014

Date(s) Drilled	08/08/2015 10:20 PM to 08/08/2015 4:20 PM	Logged By	JKD	Checked By	LW
Drilling Method	HSA, Mud rotary	Drill Bit Size/Type	4" OD SSA, 3.875" tricone	Borehole Depth	50.0 ft
Drill Rig Type	Diedrich D-120 (ATV Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	510.0 ft NAVD88
Borehole Backfill	Cement-Bentonite grout with VWP at 36'	Sampling Method(s)	Split Spoon, Shelby Tube	Hammer Data	Auto-Hammer, 68% efficiency
Boring Location	N 821365 E 998446 (ft NAD83)	Groundwater Level(s)	37 ft on 8/8/2015		

Elevation (feet)	Depth (feet)	SAMPLES: Type	SAMPLES: Number	SAMPLES: Sampling Resist. OR Core RQD (%)	SAMPLES: Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
510	0	Split Spoon	S1	3 5 4 5	83	CL	Elevation 510.0, Depth 0.0 [NATIVE] Lean CLAY with Sand (CL), stiff to very stiff, bright yellow brown, dry to moist, trace Gravel, occasional organics					10.0+			*Began drilling on 8/8/2015*
		Shelby Tube	ST-1		100	CL		9.5	140.5	28	15	10.0+			*P200 = 46.2*
505	5	Split Spoon	S2	3 6 7 8	100	CL						8.5			
		Split Spoon	S3	5 5 7 9	100	CL	Mottled gray yellow brown, decreasing Sand content	13.7		41	27	6.0			
500	10	Split Spoon	S4	3 5 7 9	100	CL	Yellow orange	18.7		42	27	5.5			
495	15	Shelby Tube	ST-2		100	CL		12.2	133.8	31	17				
492.5	17.5					SM	Silty SAND (SM), medium dense, dull yellow orange, moist, trace Gravel								
490	20	Split Spoon	S5	5 10 11 13	100	SM		9.6				9.0			*P200 = 49.8*
486.5	23.5					CL	Lean CLAY with Sand (CL), stiff to very stiff, yellow brown, moist to wet, low to medium plasticity, some organics								
485	25	Split Spoon	S6	4 6 9 11	100	CL		16.1		40	25				*P200 = 59.0*
480	30														

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
480	30		S7& 7A	4 5 7 8	100		Lean CLAY with Sand (CL), stiff to very stiff, yellow brown, moist to wet, low to medium plasticity, some organics	16.7 17.5							*P200 = 60.4 (S7A)*
															Switched to mud rotary at 32'
475	35		ST-3		100		Gray, fine Sand to coarse Gravel	16.3	135.0	38	25				*P200 = 13.5* *Vibrating wire piezometer installed at 36' on 8/9/2015 (Serial number 1521533)*
470	40		S8	5 11 15 20	90			16.2		39	25				
465	45		S9	5 11 17 17	75										
			S10	6 7 10 12	100			17.5							*1" thick SILTY CLAY layer at 48' sample*
460	50						460.0 50.0 End of Boring at 50 ft								
455	55														
450	60														
445	65														

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B015

Date(s) Drilled	08/12/2015 1:15 PM to 08/13/2015 10:45 AM	Logged By	LW	Checked By	LW
Drilling Method	HSA, Mud rotary	Drill Bit Size/Type	4.25" ID 8" OD HSA, 3.875" tricone	Borehole Depth	77.0 ft
Drill Rig Type	Diedrich D-50 Turbo (Truck Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	554.6 ft NAVD88
Borehole Backfill	Cement-Bentonite grout with VWP at 35'	Sampling Method(s)	Split Spoon, Shelby Tube	Hammer Data	Auto-Hammer, 83% efficiency
Boring Location	N 823386 E 1001309 (ft NAD83)	Groundwater Level(s)	12.5 ft on 8/14/2015		

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
554.6	0.0	Split spoon	S1	4 7 6 6	100		[EMBANKMENT FILL]								*Began drilling on 8/12/2015*
553.6	1.0						Fat CLAY with Sand and Silt (CH), stiff, gray brown mottled brown, dry, fine to coarse Sand, organics								
		Split spoon	S2	2 5 4 6	88		Lean CLAY (CL), stiff, CL, Gray brown, moist, trace fine to medium Sand, trace fine to coarse Gravel, organics Dark brown								
	5	Split spoon	S3	2 5 6 7	100		Mottled gray								
		Split spoon	S4	3 4 7 8	83										
546.5	8.1						Clayey SILT (ML), stiff, medium brown gray to brown gray, dry, trace fine to medium Sand								
543.6	11.0	Shelby tube	ST-1		81		Fat CLAY with Sand (CH), stiff, brown mottled gray, moist, fine to coarse Sand, trace fine subrounded to subangular Gravel, trace black organics	23.0	130.3	59	44				
	15	Split spoon	S5	4 5 7 9	92			18.4							
	20	Split spoon	S6	4 6 6 8	81			18.2							
	25	Shelby tube	ST-2		75			19.5	130.2	52	37				
							Sand content increasing								
524.6	30.0														

Elevation scale: 550, 545, 540, 535, 530, 525

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30		S7	3 4 6 7	100		Lean CLAY with Sand (CL), stiff, brown mottled gray, moist, fine to coarse Sand, trace fine subrounded to subangular Gravel, trace black organics	16.3		37	24				
521.1	33.5						Lean CLAY (CL), stiff, medium brown mottled gray and black, moist, some Silt, trace fine Sand, trace organics								
520	35		S8	5 6 8 10	100			21.5		46	32				*P200 = 84.5 Vibrating wire piezometer installed at 35' on 8/13/2015 (Serial number 1520854)*
516.1	38.5						Silty CLAY with Sand and Gravel (CL-ML), hard, brown gray to brown mottled brown and orange brown, dry, some fine to coarse Sand, some fine to coarse subrounded to subangular Gravel								
515	40		S9	19 31 37 53	100			8.1							*Switched to mud rotary at 42'*
511.1	43.5						Fat CLAY (CH), very stiff, medium brown to brown gray, moist, trace fine to coarse Sand, trace fine subrounded to rounded Gravel								
510	45		S10	7 10 15 25	100										
506.1	48.5						Fat CLAY with Sand (CH), hard, gray brown mottled very light gray, dry to moist, fine to coarse subangular to subrounded Sand, trace subangular to rounded Gravel								
505	50		S11	12 27 37 53	100			14.1							*Paused drilling on 8/12/2015,Resumed at 50' on 8/13/2015*
500	55		S12	14 21 35 45	100										
495	60		ST-3		100			11.9	140.2	30	15				
490	65														

Elevation (feet)	Depth (feet)	Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	Elevation (feet)	MATERIAL DESCRIPTION	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
			S13	13 26 39 52	100			Fat CLAY with Sand (CH), hard, gray brown mottled very light gray, dry to moist, fine to coarse subangular to subrounded Sand, trace subangular to rounded Gravel									
485	70		ST-4		100												
							482.1	Silty CLAY with Sand (CL-ML), hard, brown gray mottled with gray brown, dry, fine to coarse Sand, trace fine rounded to subrounded Gravel	72.5								
480	75		S14	12 17 25 31	100												
							477.6	End of Boring at 77 ft	77.0								
475	80																
470	85																
465	90																
460	95																
455	100																

Project: Dynegy

Project Location: Newton Power Plant, Jasper County, IL

Project Number: 60428794

Log of Boring NEW-B016

Date(s) Drilled	08/07/2015 12:00 PM to 08/07/2015 5:00 PM	Logged By	JKD	Checked By	LW
Drilling Method	HSA, Mud rotary	Drill Bit Size/Type	4" OD SSA, 3.875" tricone	Borehole Depth	50.0 ft
Drill Rig Type	Diedrich D-120 (ATV Mounted)	Drilling Contractor	Subsurface Exploration Services	Surface Elevation	508.8 ft NAVD88
Borehole Backfill	Cement-Bentonite grout with VWP at 8'	Sampling Method(s)	Split Spoon, Shelby Tube	Hammer Data	Auto-Hammer, 68% efficiency
Boring Location	N 823177 E 1001410 (ft NAD83)	Groundwater Level(s)	6.5 ft on 8/7/2015		

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
508.8	0.0		S1	2 2 1 2	100		[NATIVE] Lean CLAY (CL), soft to medium stiff, bright yellow brown, moist, trace coarse Sand to fine Gravel, scattered organics (roots)					3.0			*Began drilling on 8/7/2015*
505			S2	2 3 3 3	92							3.0			
	5		S3A& 3B	2 3 5 7	92		Sample 3B is Silty SAND (SM)	16.4		35	22				*P200 = 13.2 (S3B)* *Water table at 6.5' at time of driling*
501.3	7.5		S4A& 4B& 4C	4 16 42 42	100		Poorly Graded SAND (SP), medium dense to dense, yellow brown, moist, fine Sand, no plasticity	11.3							*Vibrating wire piezometer installed at 8' on 8/8/2015 (Serial number 1521535)*
500.3	8.5						Sandy SILT with Clay (ML), hard, yellow brown, dry to moist, coarse Sand, trace to some subangular to subrounded fine Gravel								
500	10		S5	15 26 29 35	100		Yellow gray	12.1				10.0+			*Switched to mud rotary at 9.5'* *P200 = 62.6*
496.3	12.5						Fat CLAY (CH), hard, dull orange to gray brown, moist, trace fine angular Gravel								
495	15		S6	12 16 28 26	100			11.1		52	38	10.0+			*P200 = 73.0*
490	20		S7	10 16 24 34	100		Bright yellow brown	14.5				10.0+			
485	25		S8	11 19 27 39	100		Dull yellow orange, occasional organics					10.0+			
481.3	27.5						Lean CLAY with Sand (CL), hard, dull yellow, dry to moist, coarse Sand, trace to some subangular to subrounded fine Gravel, occasional organics								
480	30														

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU (ksf)	REMARKS
	30		S9	12 24 41 43	100		Lean CLAY with Sand (CL), hard, dull yellow, dry to moist, coarse Sand, trace to some subangular to subrounded fine Gravel, occasional organics	11.6		29	14	10.0+			
475															
	35		S10	14 29 36 51	100		Bright yellow brown	13.2				10.0+			
470															
468.8	40.0		S11A& 11B	24 44 64	100		A-Gravelly SILT (ML) B-Poorly Graded SAND (SP)					8.5			
466.3	42.5						Silty SAND (SM), dense, yellow gray, moist to wet, some Gravel and Clay								
465															
	45		S12A& 12B	21 33 42 50/5"	100							10.0+			
462.8	46.0						Clayey SILT with Sand (ML), hard, yellow gray, moist to wet, some Gravel								
461.3	47.5		S13A& 13B	20 42 41 42	100		Clayey SILT with Sand (ML), hard, yellow gray to light gray, moist					7.0 4.5			
460															
458.8	50.0						End of Boring at 50 ft								
455	55														
450	60														
445	65														

Attachment C: CPT Data Report

PRESENTATION OF SITE INVESTIGATION RESULTS

Dynegy Newton Power Station

Prepared for:

AECOM

ConeTec Job No: 15-54068

Project Start Date: 03-AUG-2015
Project End Date: 11-AUG-2015
Report Date: 01-OCT-2015

Prepared by:

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CONETEC

Introduction

This report presents the results of the site investigation program conducted by ConeTec, Inc. for AECOM at the Dynegy Newton Power Station in Newton, IL. The program consisted of cone penetration tests and seismic cone penetration tests at locations around the existing ash storage basin.

Project Information

Project	
Client	AECOM
Project	Dynegy Newton Power Station
ConeTec project number	15-54068

A map from Google earth including the CPT test locations is presented below.

Rig Description	Deployment System	Test Type
15 Ton Track CPT	Integrated Ramset	CPTu, SCPTu

Coordinates		
Test Type	Collection Method	EPSG Number
CPTu, SCPTu	Client supplied	4326

Cone Penetration Test (CPT)	
Depth reference	Depths are referenced to the existing ground surface at the time of each test.
Tip and sleeve data offset	0.1 meter This has been accounted for in the CPT data files.
Additional plots	Shear wave velocity profiles provided
Additional comments	Phreatic surface depths used in empirical correlations based on limited pore pressure dissipation testing and client provided piezometer readings. These values should be considered as a first order estimation.

Cone Penetrometers Used for this Project						
Cone Description	Cone Number	Cross Sectional Area (cm^2)	Sleeve Area (cm^2)	Tip Capacity (bar)	Sleeve Capacity (bar)	Pore Pressure Capacity (psi)
392:T1500F15U500	AD392	15	225	1500	15	500
Cone AD392 was used for all CPT soundings.						

Interpretation Tables	
Additional information	The Soil Behaviour Type (SBT) classification chart (Robertson et al., 1986 presented by Lunne, Robertson and Powell, 1997) was used to classify the soil for this project.

Limitations

This report has been prepared for the exclusive use of AECOM (Client) for the project titled “Dynegy Newton Power Station”. The report’s contents may not be relied upon by any other party without the express written permission of ConeTec, Inc. (ConeTec). ConeTec has provided site investigation services, prepared the factual data reporting, and provided geotechnical parameter calculations consistent with current best practices. No other warranty, expressed or implied, is made.

The information presented in the report document and the accompanying data set pertain to the specific project, site conditions and objectives described to ConeTec by the Client. In order to properly understand the factual data, assumptions and calculations, reference must be made to the documents provided and their accompanying data sets, in their entirety.

The cone penetration tests (CPTu) are conducted using an integrated electronic piezocone penetrometer and data acquisition system manufactured by Adara Systems Ltd. of Richmond, British Columbia, Canada.

ConeTec's piezocone penetrometers are compression type designs in which the tip and friction sleeve load cells are independent and have separate load capacities. The piezocones use strain gauged load cells for tip and sleeve friction and a strain gauged diaphragm type transducer for recording pore pressure. The piezocones also have a platinum resistive temperature device (RTD) for monitoring the temperature of the sensors, an accelerometer type dual axis inclinometer and a geophone sensor for recording seismic signals. All signals are amplified down hole within the cone body and the analog signals are sent to the surface through a shielded cable.

ConeTec penetrometers are manufactured with various tip, friction and pore pressure capacities in both 10 cm^2 and 15 cm^2 tip base area configurations in order to maximize signal resolution for various soil conditions. The specific piezocone used for each test is described in the CPT summary table presented in the first Appendix. The 15 cm^2 penetrometers do not require friction reducers as they have a diameter larger than the deployment rods. The 10 cm^2 piezocones use a friction reducer consisting of a rod adapter extension behind the main cone body with an enlarged cross sectional area (typically 44 mm diameter over a length of 32 mm with tapered leading and trailing edges) located at a distance of 585 mm above the cone tip.

The penetrometers are designed with equal end area friction sleeves, a net end area ratio of 0.8 and cone tips with a 60 degree apex angle.

All ConeTec piezocones can record pore pressure at various locations. Unless otherwise noted, the pore pressure filter is located directly behind the cone tip in the "u_2" position (ASTM Type 2). The filter is 6 mm thick, made of porous plastic (polyethylene) having an average pore size of 125 microns (90-160 microns). The function of the filter is to allow rapid movements of extremely small volumes of water needed to activate the pressure transducer while preventing soil ingress or blockage.

The piezocone penetrometers are manufactured with dimensions, tolerances and sensor characteristics that are in general accordance with the current ASTM D5778 standard. ConeTec's calibration criteria also meet or exceed those of the current ASTM D5778 standard. An illustration of the piezocone penetrometer is presented in Figure CPTu.

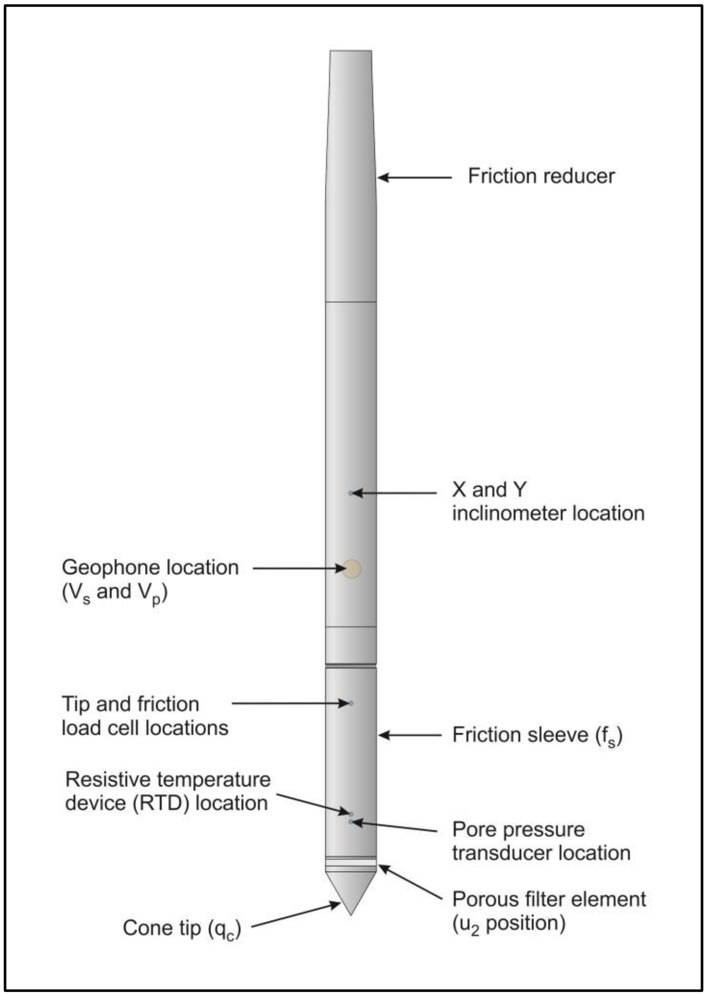

Figure CPTu. Piezocone Penetrometer (15 cm^2)

The ConeTec data acquisition systems consist of a Windows based computer and a signal conditioner and power supply interface box with a 16 bit (or greater) analog to digital (A/D) converter. The data is recorded at fixed depth increments using a depth wheel attached to the push cylinders or by using a spring loaded rubber depth wheel that is held against the cone rods. The typical recording intervals are either 2.5 cm or 5.0 cm depending on project requirements; custom recording intervals are possible. The system displays the CPTu data in real time and records the following parameters to a storage media during penetration:

- Depth
- Uncorrected tip resistance (q_c)
- Sleeve friction (f_s)
- Dynamic pore pressure (u)
- Additional sensors such as resistivity, passive gamma, ultra violet induced fluorescence, if applicable

All testing is performed in accordance to ConeTec's CPT operating procedures which are in general accordance with the current ASTM D5778 standard.

Prior to the start of a CPTu sounding a suitable cone is selected, the cone and data acquisition system are powered on, the pore pressure system is saturated with either glycerin or silicone oil and the baseline readings are recorded with the cone hanging freely in a vertical position.

The CPTu is conducted at a steady rate of 2 cm/s, within acceptable tolerances. Typically one meter length rods with an outer diameter of 1.5 inches are added to advance the cone to the sounding termination depth. After cone retraction final baselines are recorded.

Additional information pertaining to ConeTec's cone penetration testing procedures:

- Each filter is saturated in silicone oil or glycerin under vacuum pressure prior to use
- Recorded baselines are checked with an independent multi-meter
- Baseline readings are compared to previous readings
- Soundings are terminated at the client's target depth or at a depth where an obstruction is encountered, excessive rod flex occurs, excessive inclination occurs, equipment damage is likely to take place, or a dangerous working environment arises
- Differences between initial and final baselines are calculated to ensure zero load offsets have not occurred and to ensure compliance with ASTM standards

The interpretation of piezocone data for this report is based on the corrected tip resistance (q_t), sleeve friction (f_s) and pore water pressure (u). The interpretation of soil type is based on the correlations developed by Robertson (1990) and Robertson (2009). It should be noted that it is not always possible to accurately identify a soil type based on these parameters. In these situations, experience, judgment and an assessment of other parameters may be used to infer soil behavior type.

The recorded tip resistance (q_c) is the total force acting on the piezocone tip divided by its base area. The tip resistance is corrected for pore pressure effects and termed corrected tip resistance (q_t) according to the following expression presented in Robertson et al, 1986:

$$q_t = q_c + (1\text{-}a) \bullet u_2$$

where: q_t is the corrected tip resistance
q_c is the recorded tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the piezocone (0.8 for ConeTec probes)

The sleeve friction (f_s) is the frictional force on the sleeve divided by its surface area. As all ConeTec piezocones have equal end area friction sleeves, pore pressure corrections to the sleeve data are not required.

The dynamic pore pressure (u) is a measure of the pore pressures generated during cone penetration. To record equilibrium pore pressure, the penetration must be stopped to allow the dynamic pore pressures to stabilize. The rate at which this occurs is predominantly a function of the permeability of the soil and the diameter of the cone.

The friction ratio (Rf) is a calculated parameter. It is defined as the ratio of sleeve friction to the tip resistance expressed as a percentage. Generally, saturated cohesive soils have low tip resistance, high friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

A summary of the CPTu soundings along with test details and individual plots are provided in the appendices. A set of interpretation files were generated for each sounding based on published correlations and are provided in Excel format in the data release folder. Information regarding the interpretation methods used is also included in the data release folder.

For additional information on CPTu interpretations, refer to Robertson et al. (1986), Lunne et al. (1997), Robertson (2009), Mayne (2013, 2014) and Mayne and Peuchen (2012).

Shear wave velocity testing is performed in conjunction with the piezocone penetration test (SCPTu) in order to collect interval velocities. For some projects seismic compression wave (Vp) velocity is also determined.

ConeTec's piezocone penetrometers are manufactured with a horizontally active geophone (28 hertz) that is rigidly mounted in the body of the cone penetrometer, 0.2 meters behind the cone tip.

Shear waves are typically generated by using an impact hammer horizontally striking a beam that is held in place by a normal load. In some instances an auger source or an imbedded impulsive source maybe used for both shear waves and compression waves. The hammer and beam act as a contact trigger that triggers the recording of the seismic wave traces. For impulsive devices an accelerometer trigger may be used. The traces are recorded using an up-hole integrated digital oscilloscope which is part of the SCPTu data acquisition system. An illustration of the shear wave testing configuration is presented in Figure SCPTu-1.

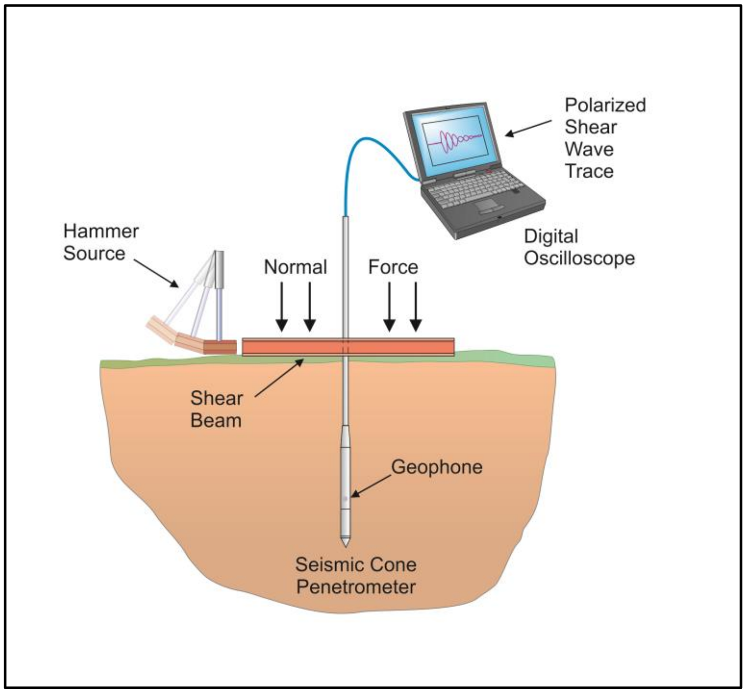

Figure SCPTu-1. Illustration of the SCPTu system

All testing is performed in accordance to ConeTec's SCPTu operating procedures.

Prior to the start of a SCPTu sounding, the procedures described in the Cone Penetration Test section are followed. In addition, the active axis of the geophone is aligned parallel to the beam (or source) and the horizontal offset between the cone and the source is measured and recorded.

Prior to recording seismic waves at each test depth, cone penetration is stopped and the rods are decoupled from the rig to avoid transmission of rig energy down the rods. Multiple wave traces are recorded for quality control purposes. After reviewing wave traces for consistency the cone is pushed to the next test depth (typically one meter intervals or as requested by the client). Figure SCPTu-2 presents an illustration of a SCPTu test.

For additional information on seismic cone penetration testing refer to Robertson et.al. (1986).

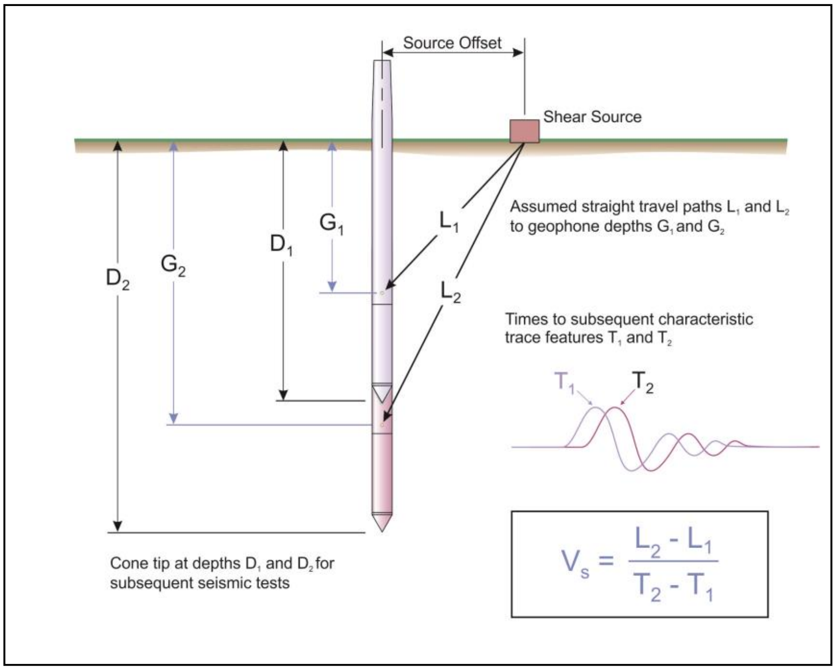

Figure SCPTu-2. Illustration of a seismic cone penetration test

Calculation of the interval velocities are performed by visually picking a common feature (e.g. the first characteristic peak, trough, or crossover) on all of the recorded wave sets and taking the difference in ray path divided by the time difference between subsequent features. Ray path is defined as the straight line distance from the seismic source to the geophone, accounting for beam offset, source depth and geophone offset from the cone tip.

The average shear wave velocity to a depth of 100 feet (30 meters) ($\bar{v}_s$) has been calculated and provided for all applicable soundings using the following equation presented in ASCE, 2010.

$$\bar{v}_s = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{v_{si}}}$$

where: $\bar{v}_s$ = average shear wave velocity ft/s (m/s)
d_i = the thickness of any layer between 0 and 100 ft (30 m)
v_{si} = the shear wave velocity in ft/s (m/s)
$\sum_{i=1}^{n} d_i$ = 100 ft (30 m)

Average shear wave velocity, $\bar{v}_s$ is also referenced to V_{s100} or V_{s30}.

The layer travel times refers to the travel times propagating in the vertical direction, not the measured travel times from an offset source.

Tabular results and SCPTu plots are presented in the relevant appendix.

The cone penetration test is halted at specific depths to carry out pore pressure dissipation (PPD) tests, shown in Figure PPD-1. For each dissipation test the cone and rods are decoupled from the rig and the data acquisition system measures and records the variation of the pore pressure (u) with time (t).

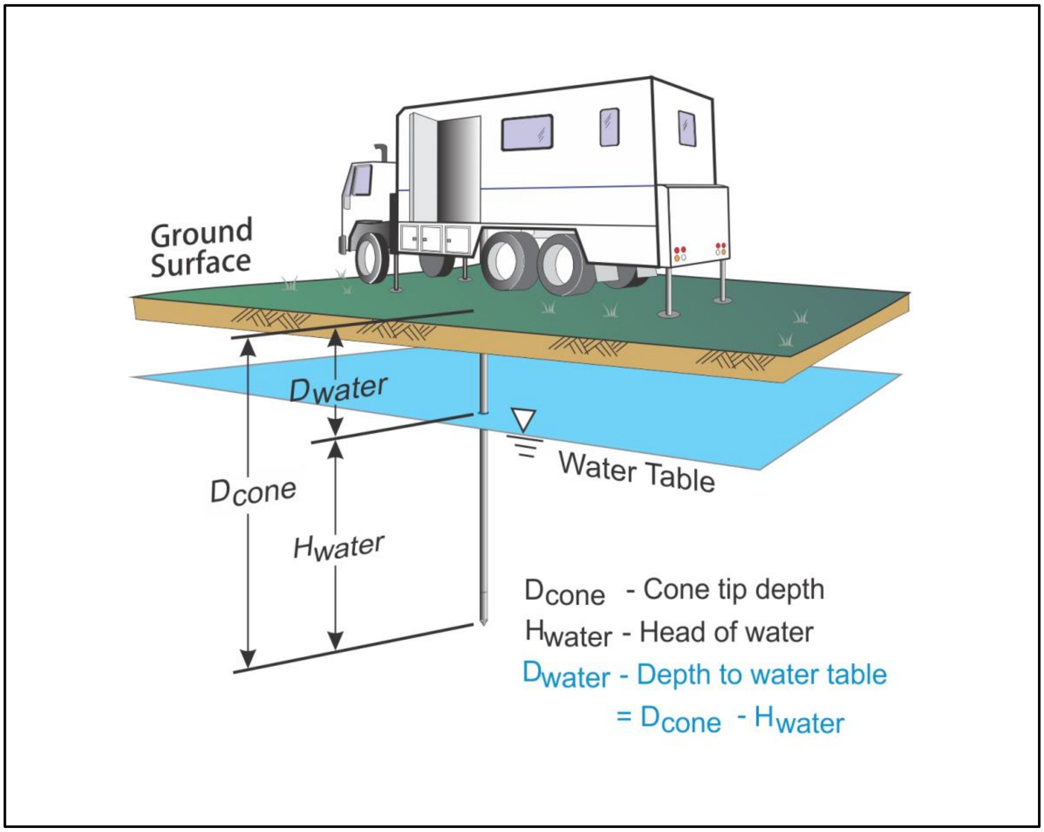

Figure PPD-1. Pore pressure dissipation test setup

Pore pressure dissipation data can be interpreted to provide estimates of ground water conditions, permeability, consolidation characteristics and soil behavior.

The typical shapes of dissipation curves shown in Figure PPD-2 are very useful in assessing soil type, drainage, in situ pore pressure and soil properties. A flat curve that stabilizes quickly is typical of a freely draining sand. Undrained soils such as clays will typically show positive excess pore pressure and have long dissipation times. Dilative soils will often exhibit dynamic pore pressures below equilibrium that then rise over time. Overconsolidated fine-grained soils will often exhibit an initial dilatory response where there is an initial rise in pore pressure before reaching a peak and dissipating.

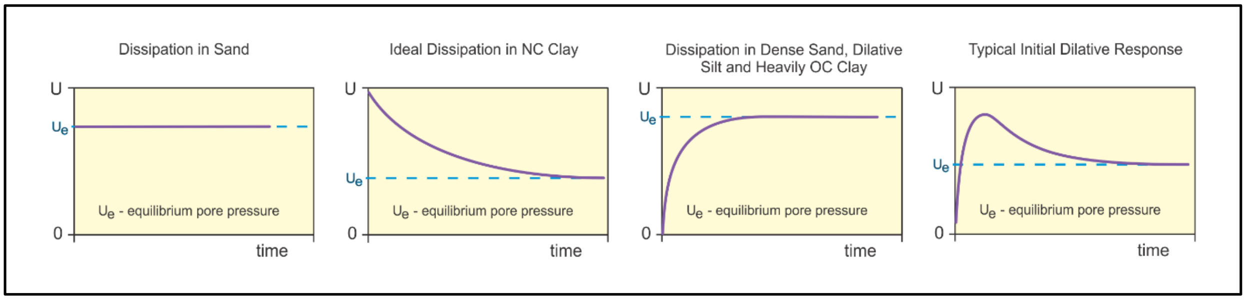

Figure PPD-2. Pore pressure dissipation curve examples

In order to interpret the equilibrium pore pressure (u_{eq}) and the apparent phreatic surface, the pore pressure should be monitored until such time as there is no variation in pore pressure with time as shown for each curve of Figure PPD-2.

In fine grained deposits the point at which 100% of the excess pore pressure has dissipated is known as t_{100}. In some cases this can take an excessive amount of time and it may be impractical to take the dissipation to t_{100}. A theoretical analysis of pore pressure dissipations by Teh and Houlsby (1991) showed that a single curve relating degree of dissipation versus theoretical time factor (T*) may be used to calculate the coefficient of consolidation (c_h) at various degrees of dissipation resulting in the expression for c_h shown below.

$$c_h = \frac{T^* \cdot a^2 \cdot \sqrt{I_r}}{t}$$

Where:
T* is the dimensionless time factor (Table Time Factor)
a is the radius of the cone
I_r is the rigidity index
t is the time at the degree of consolidation

Table Time Factor. T* versus degree of dissipation (Teh and Houlsby, 1991)

Degree of Dissipation (%)	20	30	40	50	60	70	80
T* (u_2)	0.038	0.078	0.142	0.245	0.439	0.804	1.60

The coefficient of consolidation is typically analyzed using the time (t_{50}) corresponding to a degree of dissipation of 50% (u_{50}). In order to determine t_{50}, dissipation tests must be taken to a pressure less than u_{50}. The u_{50} value is half way between the initial maximum pore pressure and the equilibrium pore pressure value, known as u_{100}. To estimate u_{50}, both the initial maximum pore pressure and u_{100} must be known or estimated. Other degrees of dissipations may be considered, particularly for extremely long dissipations.

At any specific degree of dissipation the equilibrium pore pressure (u at t_{100}) must be estimated at the depth of interest. The equilibrium value may be determined from one or more sources such as measuring the value directly (u_{100}), estimating it from other dissipations in the same profile, estimating the phreatic surface and assuming hydrostatic conditions, from nearby soundings, from client provided information, from site observations and/or past experience, or from other site instrumentation.

For calculations of c_h (Teh and Houlsby, 1991), t_{50} values are estimated from the corresponding pore pressure dissipation curve and a rigidity index (I_r) is assumed. For curves having an initial dilatory response in which an initial rise in pore pressure occurs before reaching a peak, the relative time from the peak value is used in determining t_{50}. In cases where the time to peak is excessive, t_{50} values are not calculated.

Due to possible inherent uncertainties in estimating I_r, the equilibrium pore pressure and the effect of an initial dilatory response on calculating t_{50}, other methods should be applied to confirm the results for c_h.

Additional published methods for estimating the coefficient of consolidation from a piezocone test are described in Burns and Mayne (1998, 2002), Jones and Van Zyl (1981), Robertson et al. (1992) and Sully et al. (1999).

A summary of the pore pressure dissipation tests and dissipation plots are presented in the relevant appendix.

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Sully, J.P., Robertson, P.K., Campanella, R.G. and Woeller, D.J., 1999, “An approach to evaluation of field CPTU dissipation data in overconsolidated fine-grained soils”, Canadian Geotechnical Journal, 36(2): 369-381.

Teh, C.I., and Houlsby, G.T., 1991, "An analytical study of the cone penetration test in clay", Geotechnique, 41(1): 17-34.

The appendices listed below are included in the report:

- Cone Penetration Test Summary and Standard Cone Penetration Test Plots
- Seismic Cone Penetration Test Plots
- Seismic Cone Penetration Test Tabular Results
- Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots

Cone Penetration Test Summary and

Standard Cone Penetration Test Plots

ConeTec

Job No: 15-54068
Client: AECOM
Project: Dynegy- Newton Power Station
Start Date: 03-Aug-2015
End Date: 11-Aug-2015

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Assumed Phreatic Surface[1] (ft)	Final Depth (ft)	Shear Wave Velocity Tests	Latitude[2] (degrees)	Longitude (degrees)	Refer to Notation Number
SCPT-SC001	15-54068_SP001	08/10/15	392:T1500F15U500	22	46.3	14	38.92228	-88.28597	4
CPT-C002	15-54068_CP002	08/09/15	392:T1500F15U500	23	38.5		38.92266	-88.29011	4
CPT-C003	15-54068_CP003	08/04/15	392:T1500F15U500	5	50.0		38.92149	-88.29198	3
CPT-C004	15-54068_CP004	08/10/15	392:T1500F15U500	24	37.7		38.92364	-88.29238	3
CPT-C005	15-54068_CP005	08/03/15	392:T1500F15U500	17	39.9		38.92465	-88.29428	4
CPT-C006	15-54068_CP006	08/10/15	392:T1500F15U500	26	36.4		38.92672	-88.29300	3
CPT-C007	15-54068_CP007	08/06/15	392:T1500F15U500	6	23.6		38.92860	-88.29175	3
CPT-C008	15-54068_CP008	08/07/15	392:T1500F15U500	22	36.1		38.93022	-88.29048	4
CPT-C009	15-54068_CP009	08/07/15	392:T1500F15U500	44	55.0		38.93186	-88.28920	4
CPT-C010	15-54068_CP010 - COMB	08/07/15	392:T1500F15U500	11	31.7		38.93279	-88.28371	4
CPT-C011	15-54068_CP011	08/04/15	392:T1500F15U500	6	15.4		38.92677	-88.29320	3
CPT-C012	15-54068_CP012	08/08/15	392:T1500F15U500	20	37.2		38.93229	-88.27540	4
CPT-C013	15-54068_CP013	08/05/15	392:T1500F15U500	12	40.0		38.93065	-88.27307	4
CPT-C014	15-54068_CP014	08/08/15	392:T1500F15U500	22	34.9		38.92879	-88.27195	4
CPT-C015	15-54068_CP015 - COMB	08/06/15	392:T1500F15U500	4	36.9		38.92682	-88.27391	4
CPT-C016	15-54068_CP016	08/08/15	392:T1500F15U500	37	40.8		38.92424	-88.27573	3
CPT-C017	15-54068_CP017	08/09/15	392:T1500F15U500	28	38.9		38.92363	-88.27960	4
SCPT-SC018	15-54068_SP018	08/11/15	392:T1500F15U500	36	68.1	21	38.92269	-88.28347	4
SCPT-SC019	15-54068_SP019	08/11/15	392:T1500F15U500	5	40.4	12	38.92337	-88.27924	4
Totals	19 soundings				747.86	47			

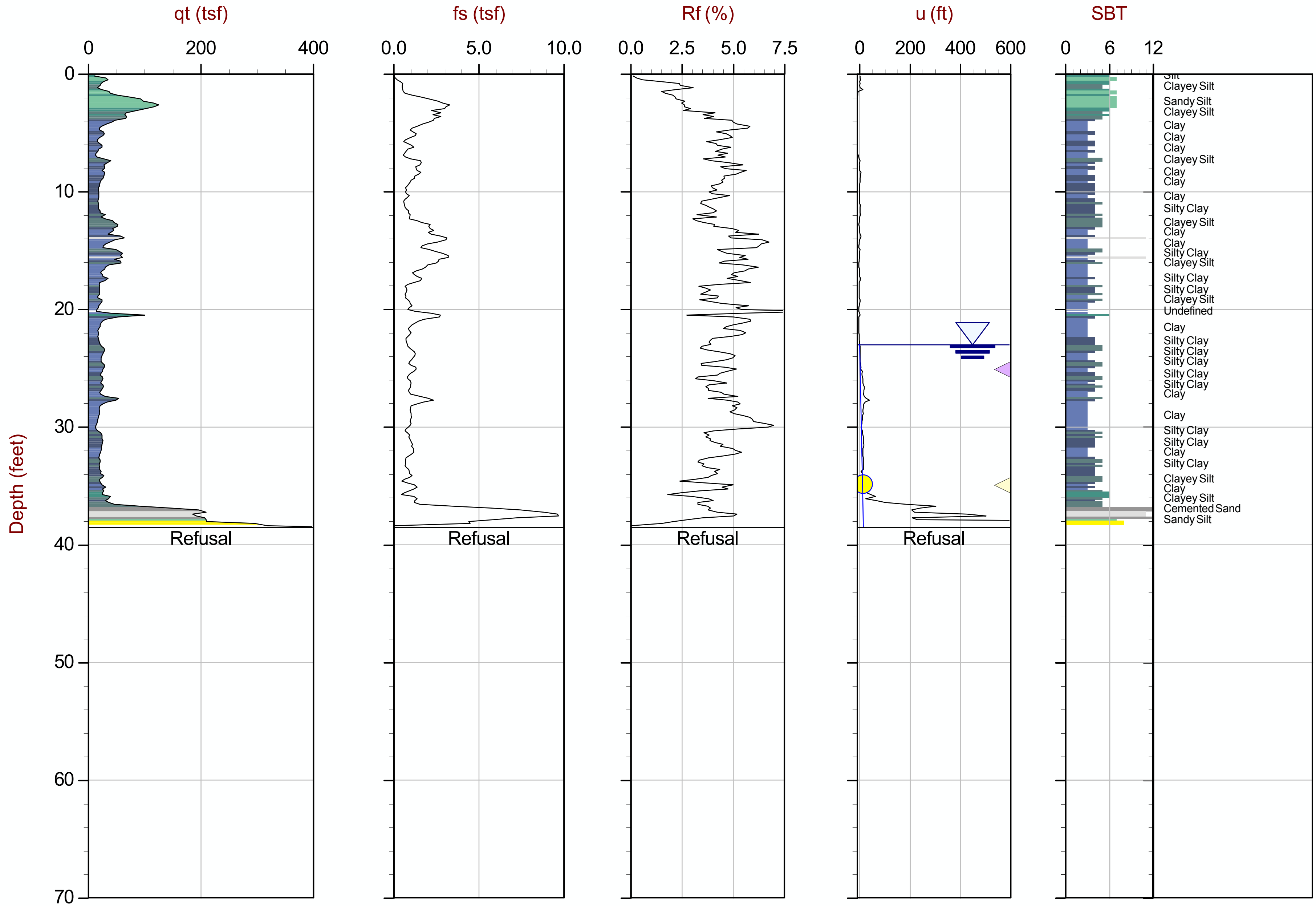
1.Interpretation tables assume hydrostatically increasing pore pressure with depth.
2. WGS 84 Lat/ Long. Coordinates provided by client.
3. Assumed phreatic surface depth based on pore pressure dissipation testing
4. Assumed phreatic surface depth based on piezometer readings.

CONETEC

AECOM

Job No: 15-54068
Date: 08:09:15 13:22
Site: Dynegy - Newton Plant

Sounding: CPT-C002
Cone: 392:T1500F15U500



Max Depth: 11.750 m / 38.55 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP002.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92266 E: -88.29011

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

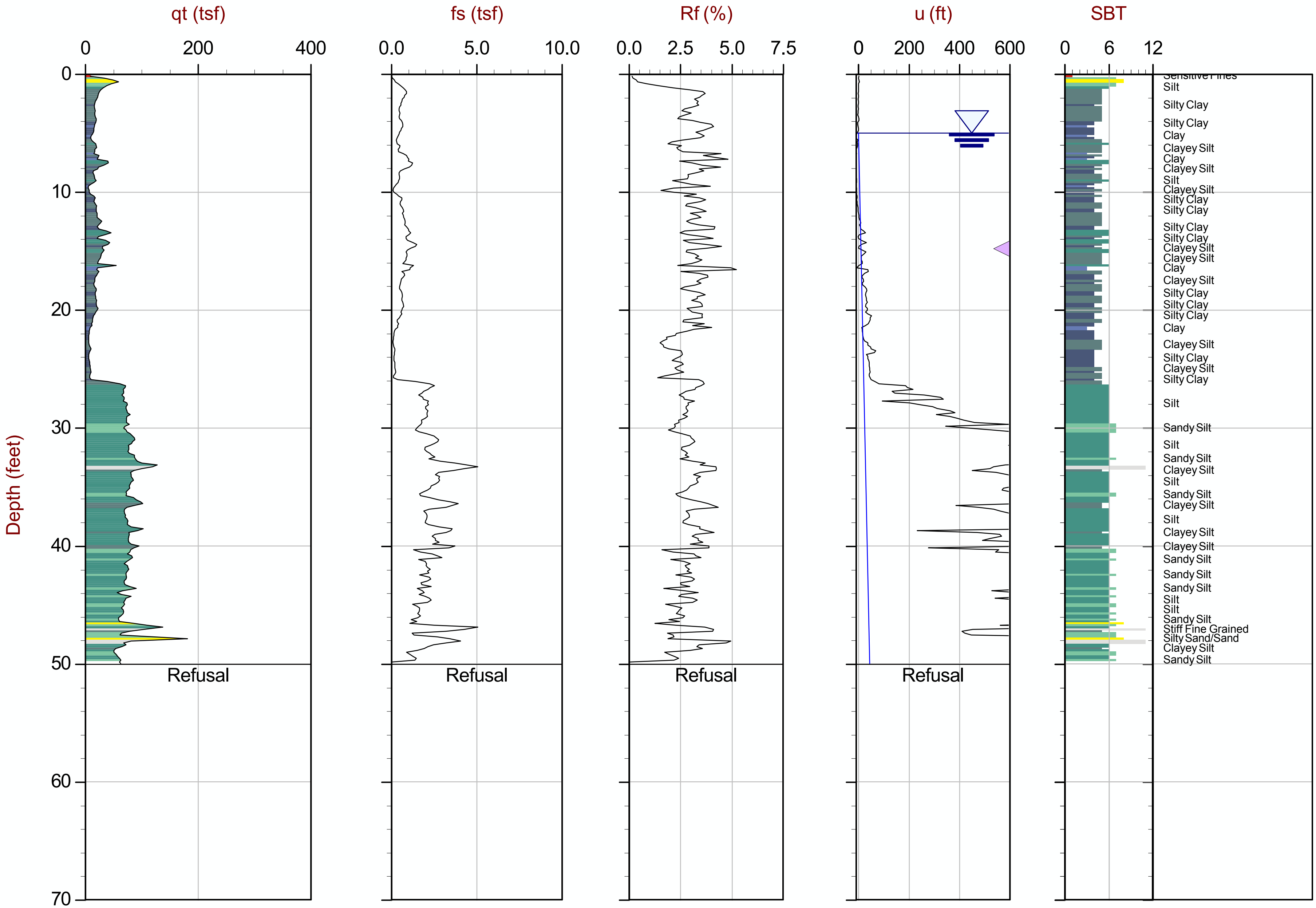
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:04:15 17:13
Site: Dynegy - Newton Plant

Sounding: CPT-C003
Cone: 392:T1500F15U500



Max Depth: 15.250 m / 50.03 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP003.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92149 E: -88.29198

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

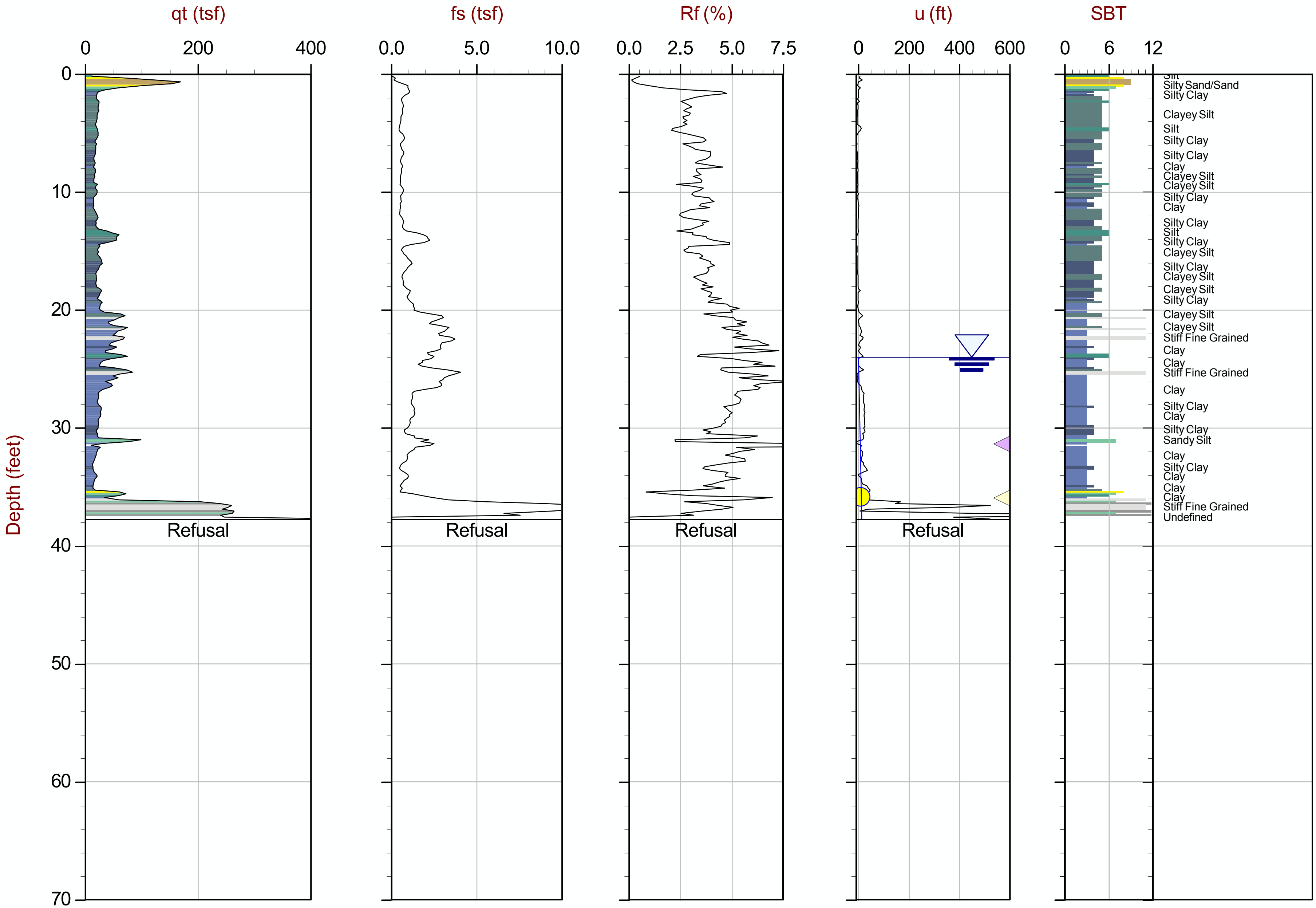
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:10:15 08:25
Site: Dynegy - Newton Plant

Sounding: CPT-C004
Cone: 392:T1500F15U500



Max Depth: 11.500 m / 37.73 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP004.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92364 E: -88.29238

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

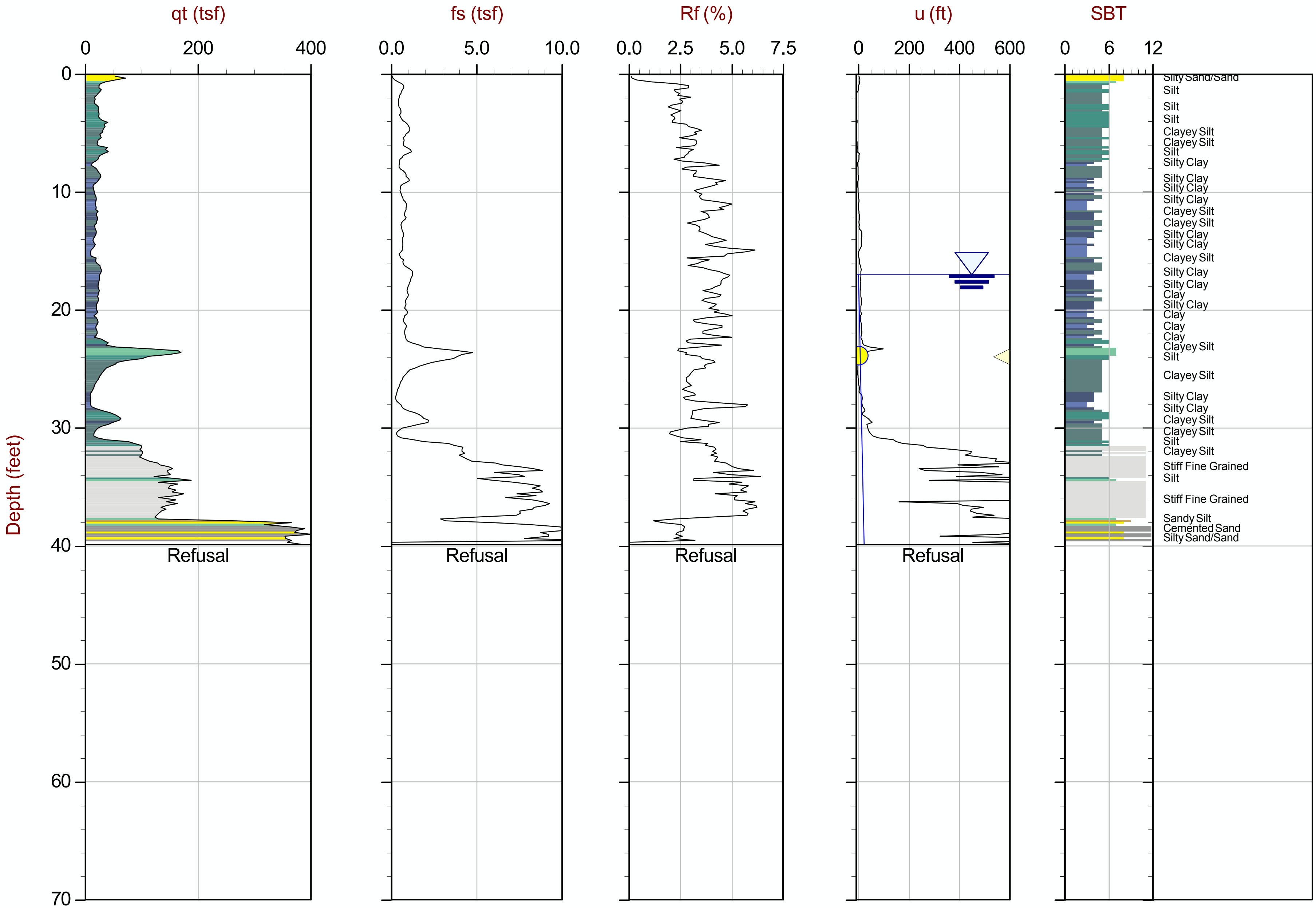
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:03:15 15:44
Site: Dynegy - Newton Plant

Sounding: CPT-C005
Cone: 392:T1500F15U500



Max Depth: 12.150 m / 39.86 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP005.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92465 E: -88.29428

△ Dissipation with estimated Ueq value
△ Dissipation, equilibrium not achieved

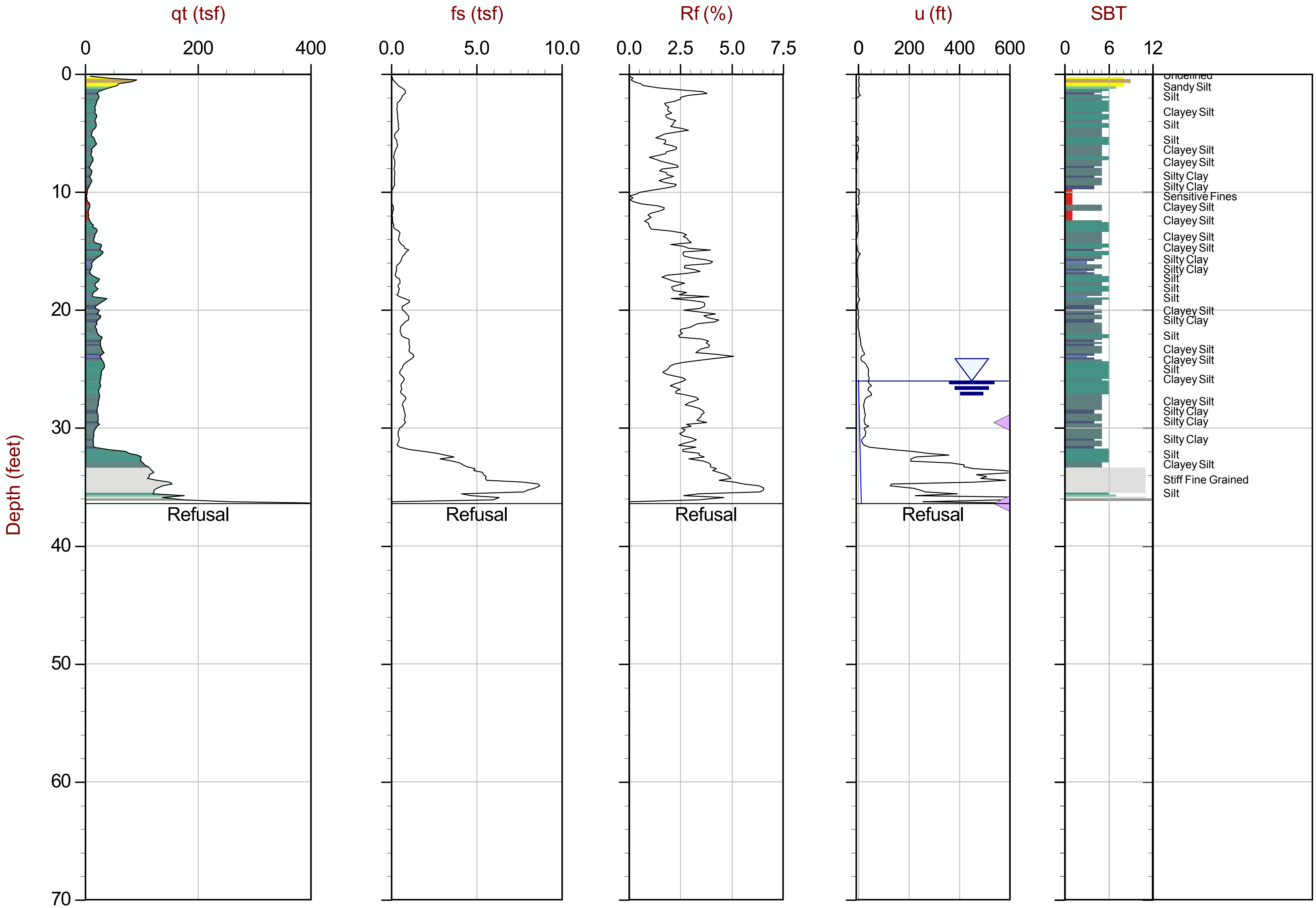
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:10:15 09:53
Site: Dynegy - Newton Plant

Sounding: CPT-C006
Cone: 392:T1500F15U500



Max Depth: 11.100 m / 36.42 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP006.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92672 E: -88.29300

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

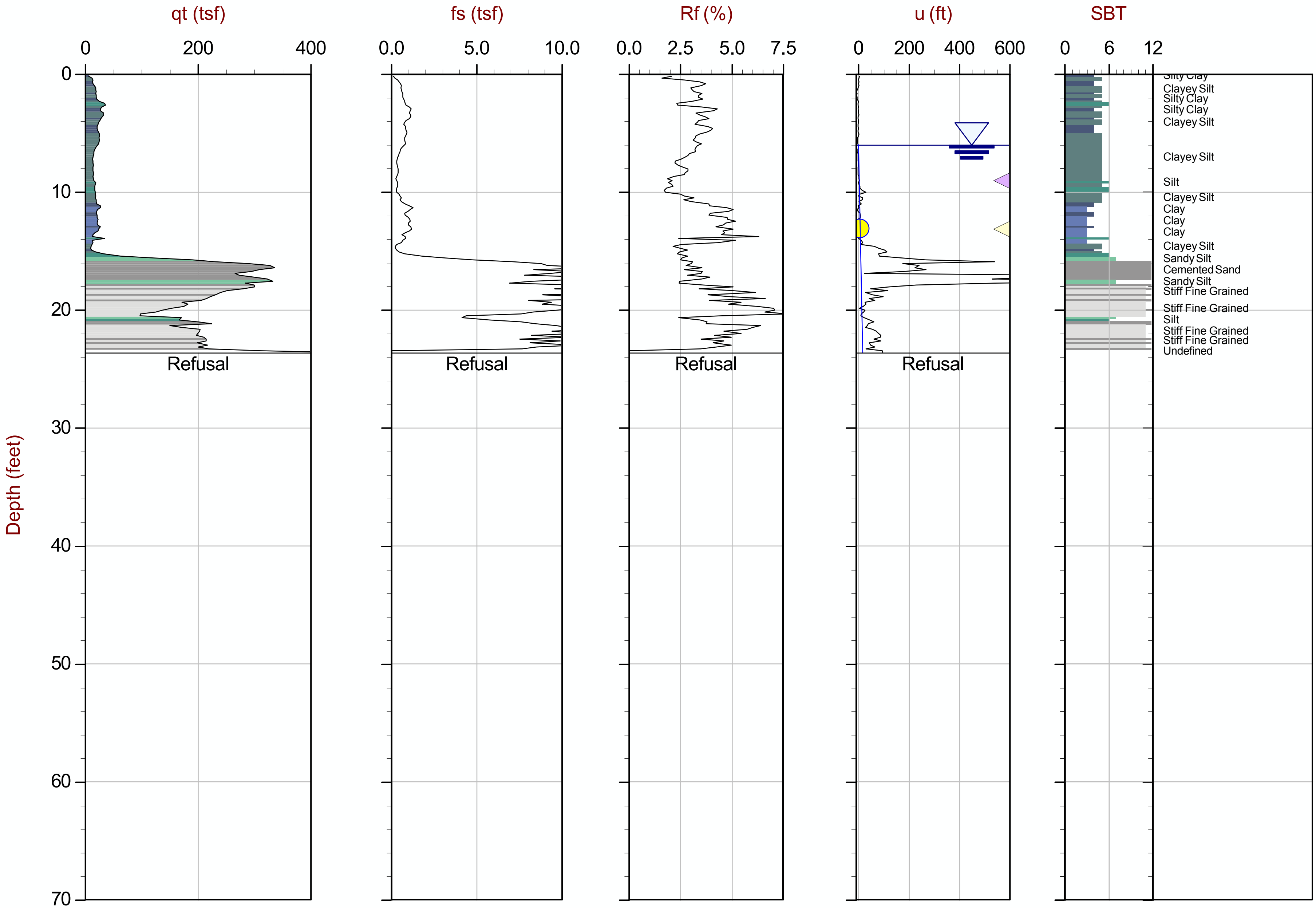
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:06:15 15:43
Site: Dynegy - Newton Plant

Sounding: CPT-C007
Cone: 392:T1500F15U500



Max Depth: 7.200 m / 23.62 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP007.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92860 E: -88.29175

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

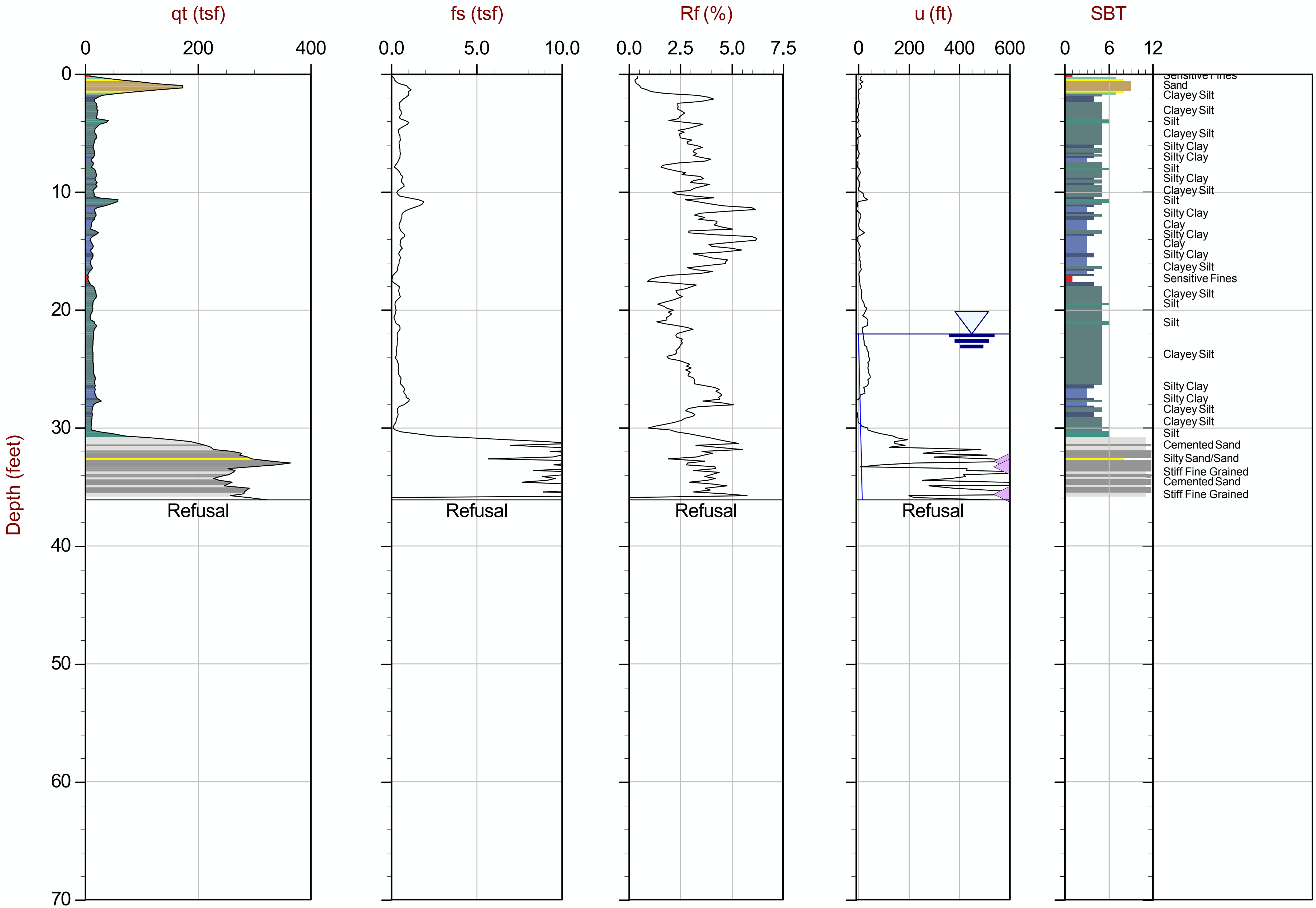
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:07:15 09:28
Site: Dynegy - Newton Plant

Sounding: CPT-C008
Cone: 392:T1500F15U500



Max Depth: 11.000 m / 36.09 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP008.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.93022 E: -88.29048

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

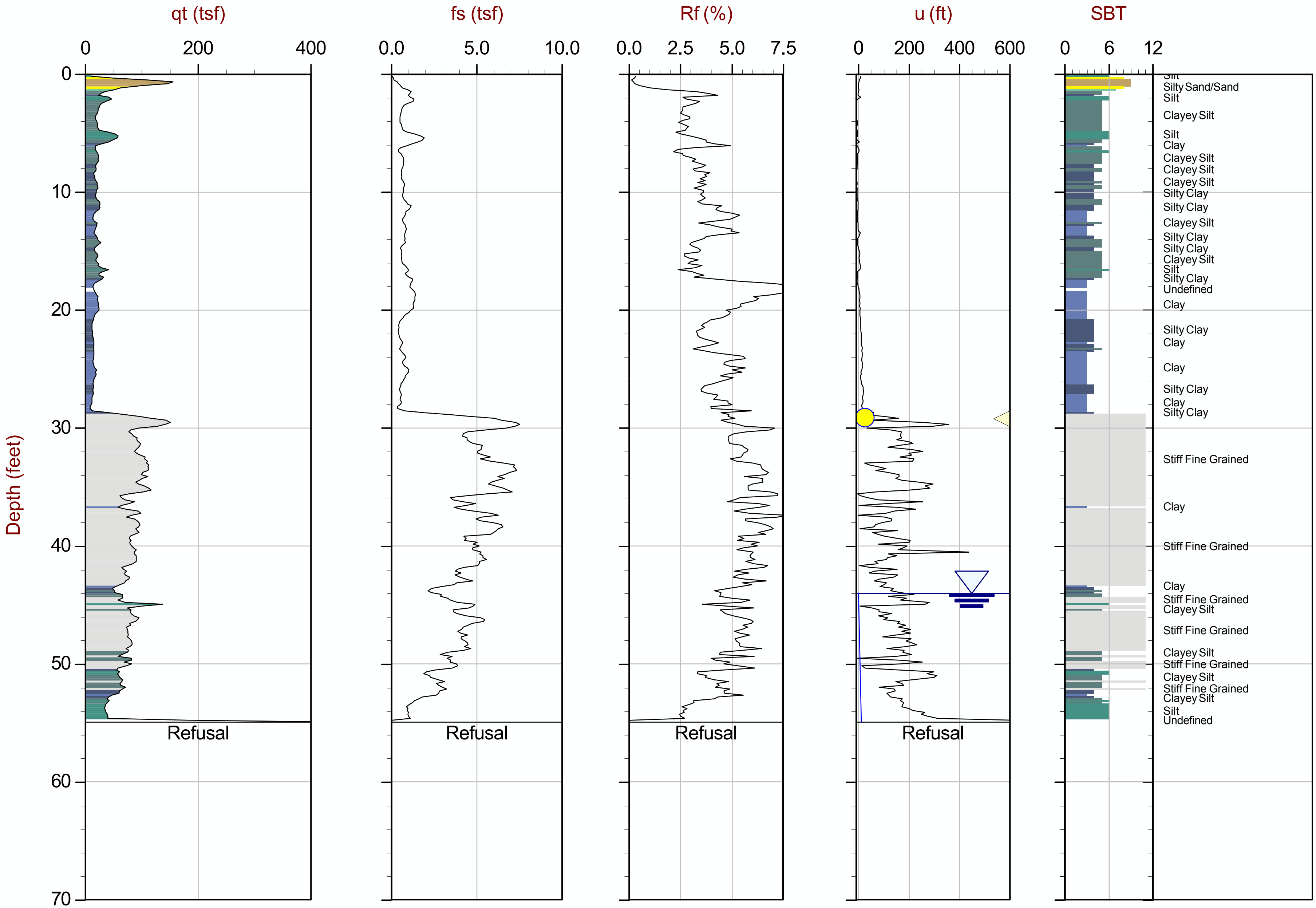
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

ConeTec

AECOM

Job No: 15-54068
Date: 08:07:15 11:49
Site: Dynegy - Newton Plant

Sounding: CPT-C009
Cone: 392:T1500F15U500



Max Depth: 16.750 m / 54.95 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP009.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.93186 E: -88.28920

△ Dissipation with estimated Ueq value
△ Dissipation, equilibrium not achieved

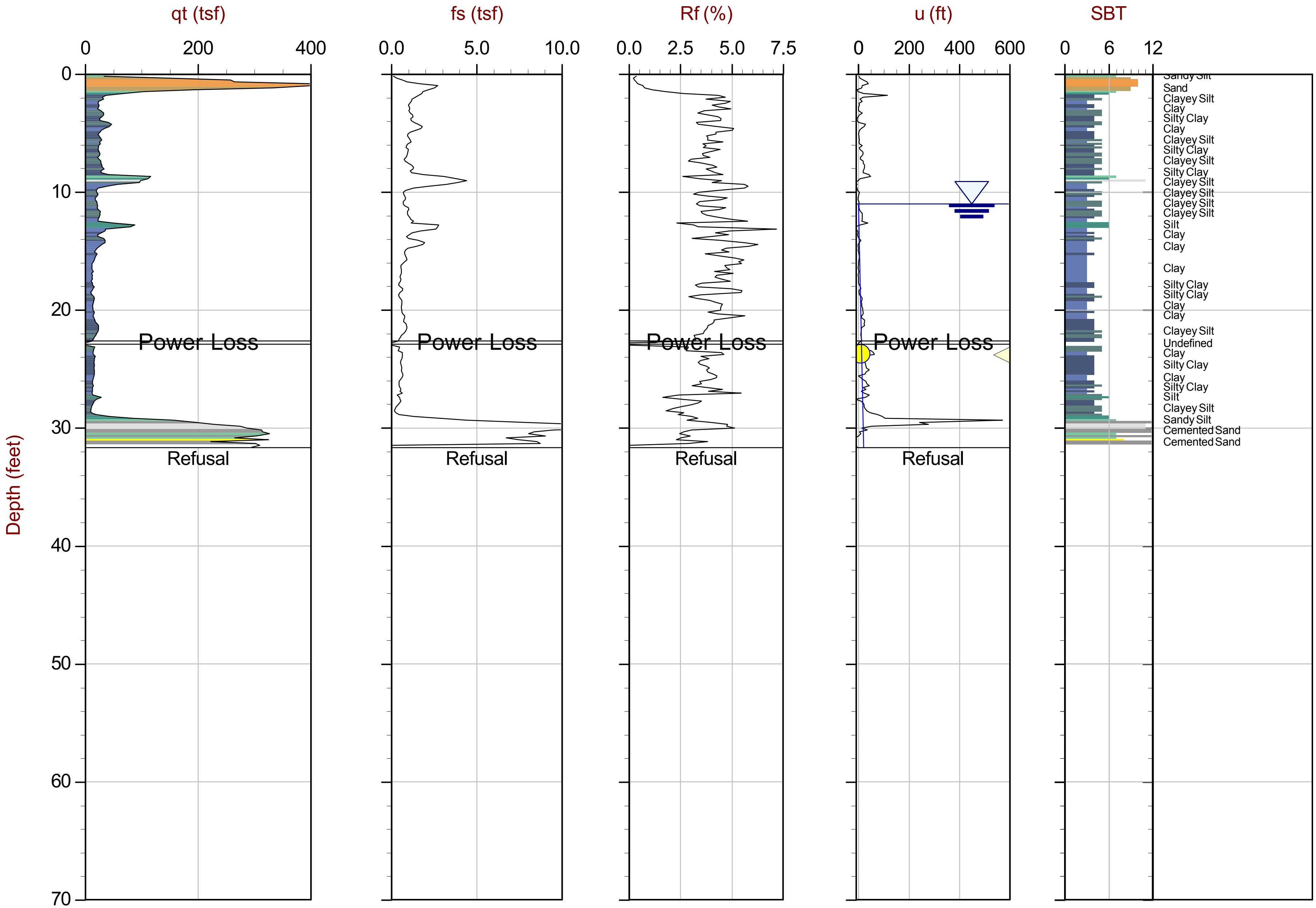
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:07:15 16:09
Site: Dynegy - Newton Plant

Sounding: CPT-C010
Cone: 392:T1500F15U500



Max Depth: 9.650 m / 31.66 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP010-COMB.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.93279 E: -88.28371

△ Dissipation with estimated Ueq value
△ Dissipation, equilibrium not achieved

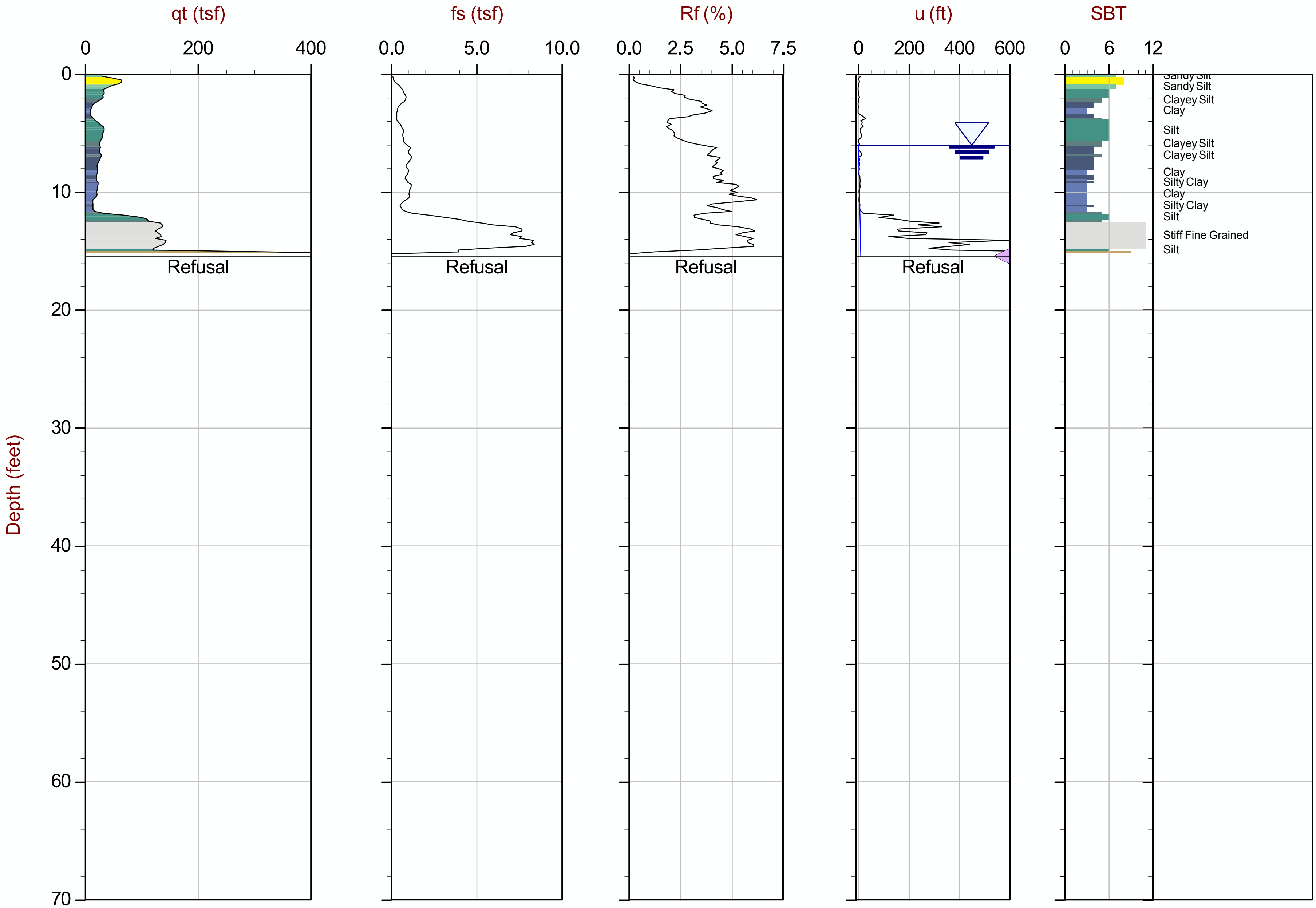
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:04:15 10:29
Site: Dynegy - Newton Plant

Sounding: CPT-C011
Cone: 392:T1500F15U500



Max Depth: 4.700 m / 15.42 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP011.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92677 E: -88.29320

△ Dissipation with estimated Ueq value
△ Dissipation, equilibrium not achieved

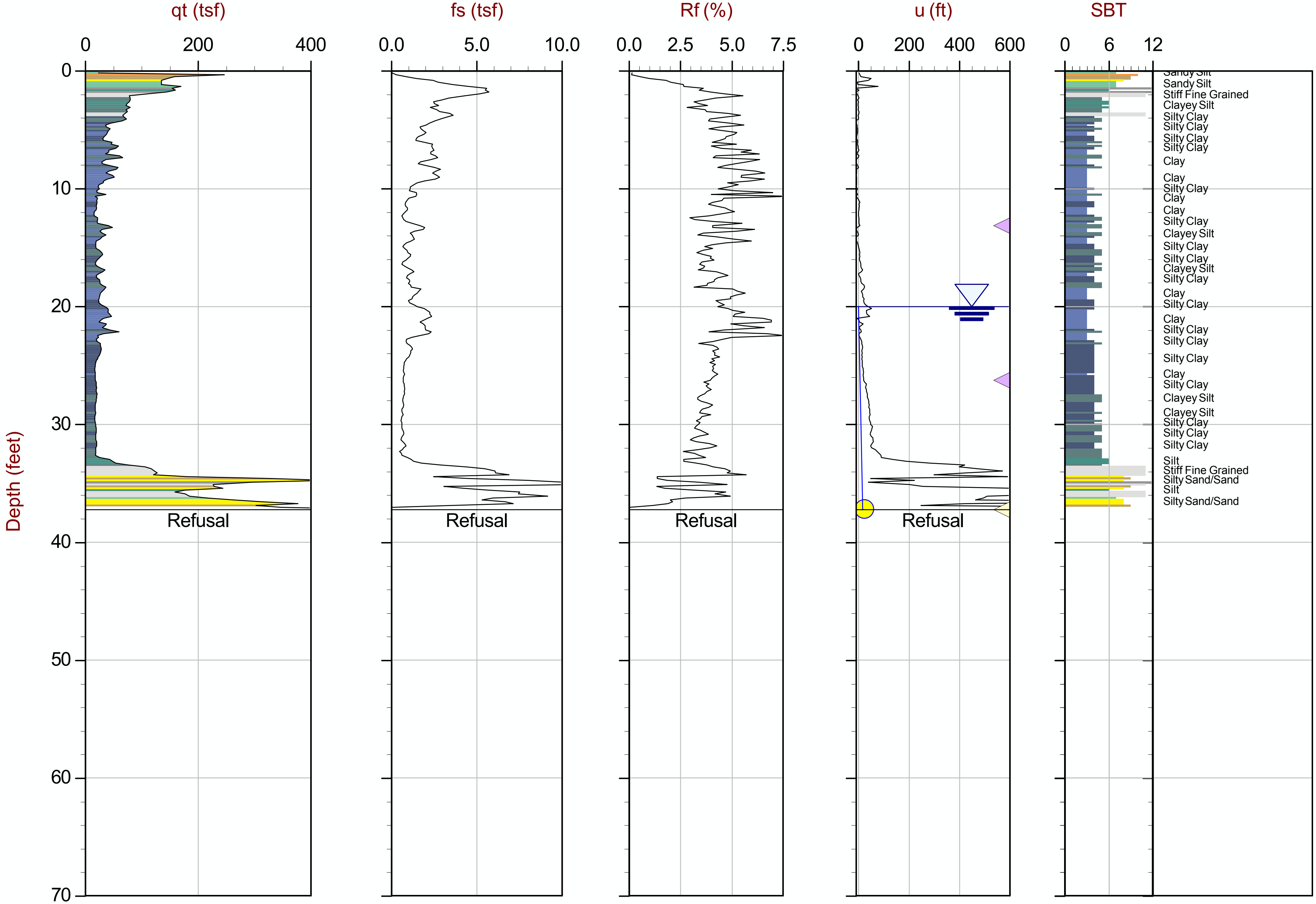
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:08:15 09:40
Site: Dynegy - Newton Plant

Sounding: CPT-C012
Cone: 392:T1500F15U500



Max Depth: 11.350 m / 37.24 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP012.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.93229 E: -88.27540

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

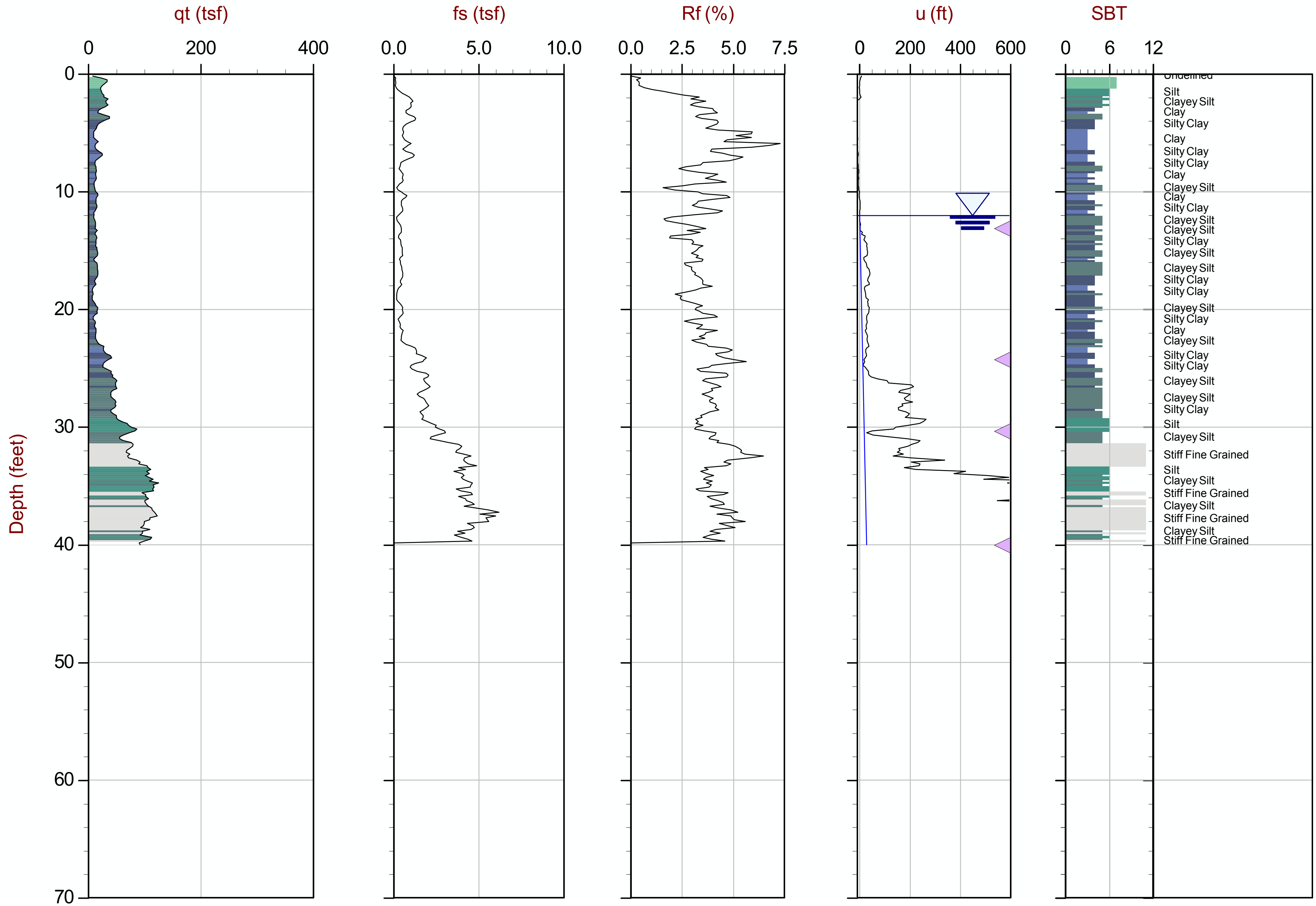
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:05:15 12:59
Site: Dynegy - Newton Plant

Sounding: CPT-C013
Cone: 392:T1500F15U500



Max Depth: 12.200 m / 40.03 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP013.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.93065 E: -88.27307

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

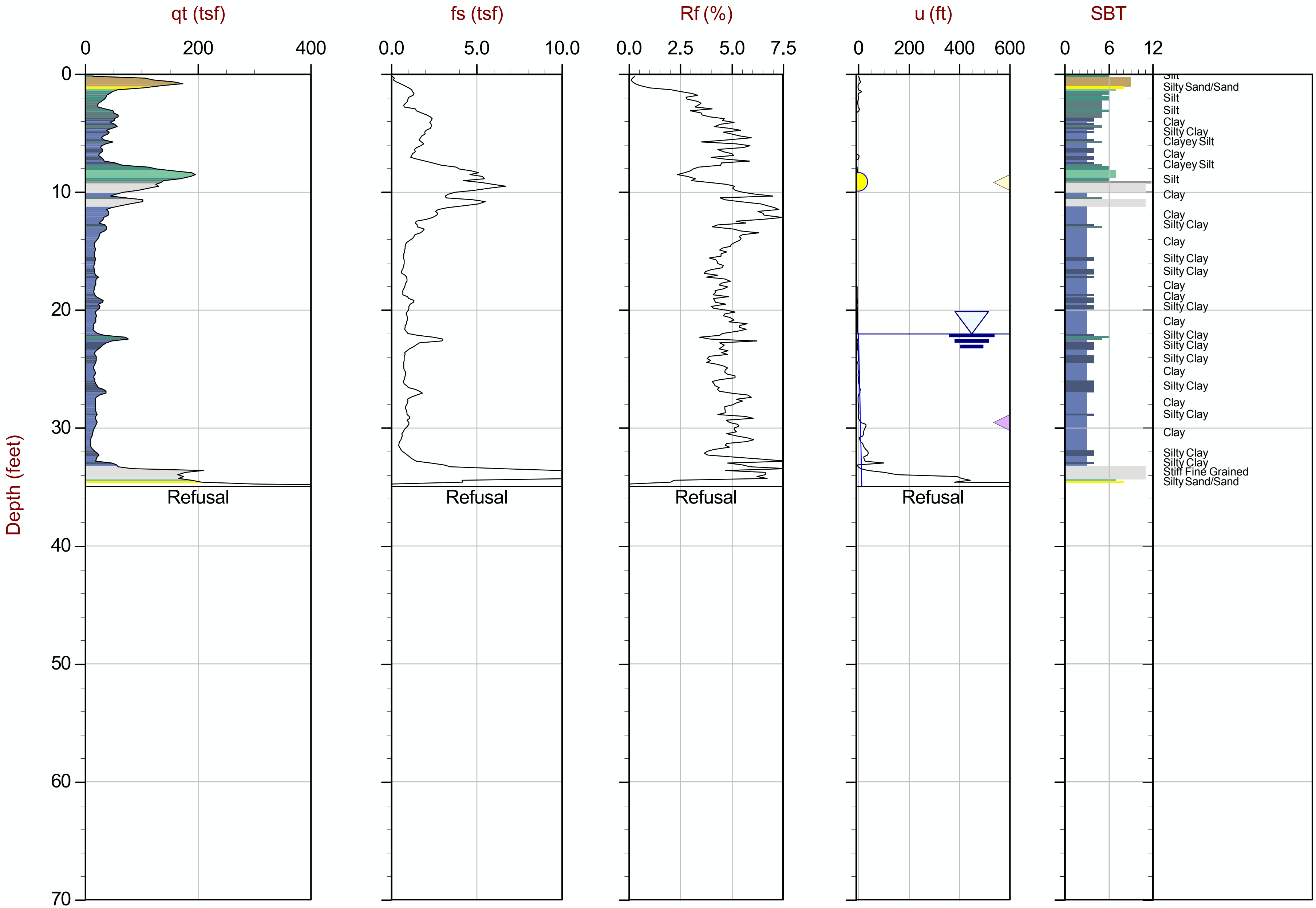
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

ConeTec

AECOM

Job No: 15-54068
Date: 08:08:15 12:00
Site: Dynegy - Newton Plant

Sounding: CPT-C014
Cone: 392:T1500F15U500



Max Depth: 10.650 m / 34.94 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP014.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92879 E: -88.27195

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

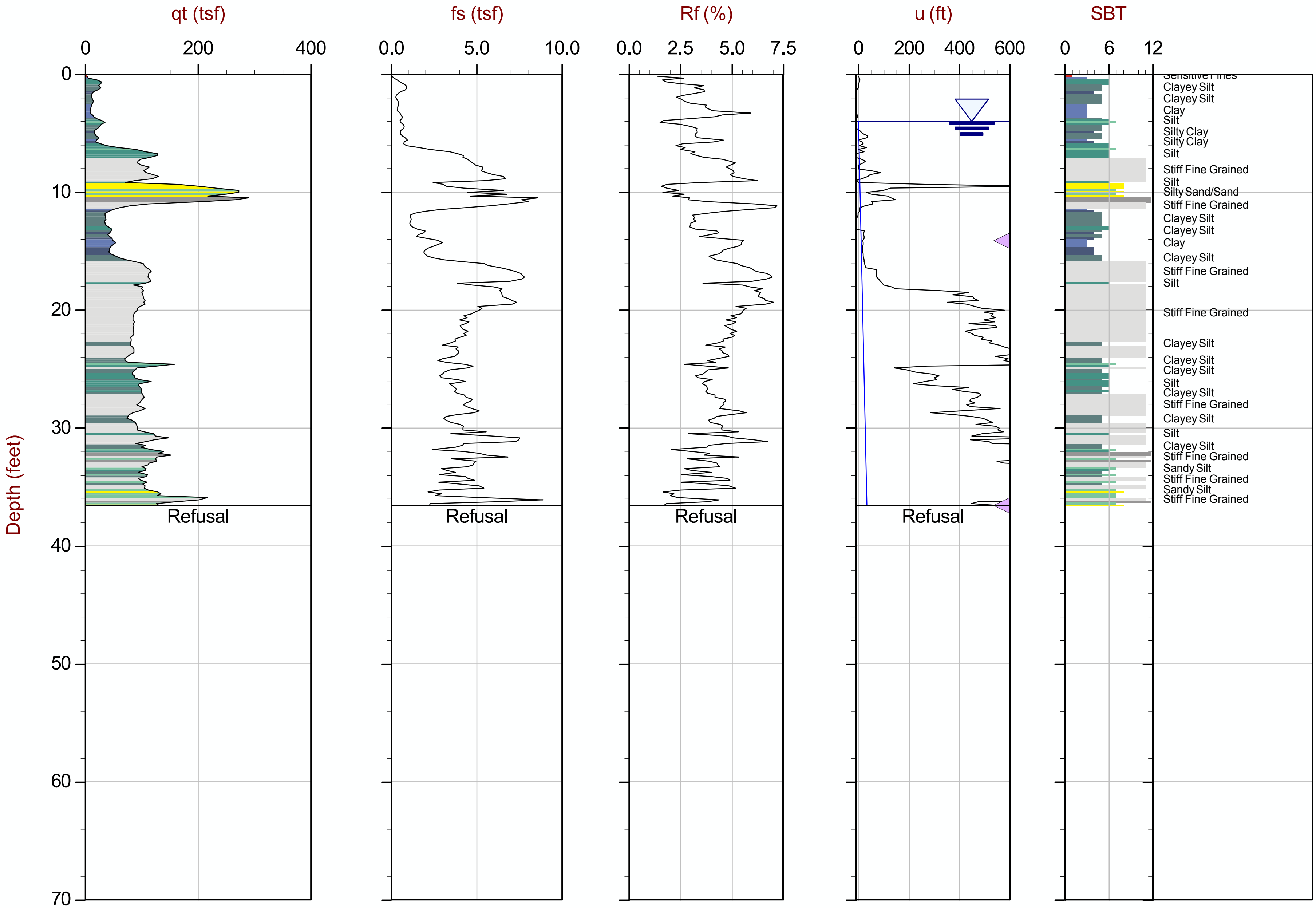
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:06:15 11:31
Site: Dynegy - Newton Plant

Sounding: CPT-C015
Cone: 392:T1500F15U500



Max Depth: 11.150 m / 36.58 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP015.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92682 E: -88.27391

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

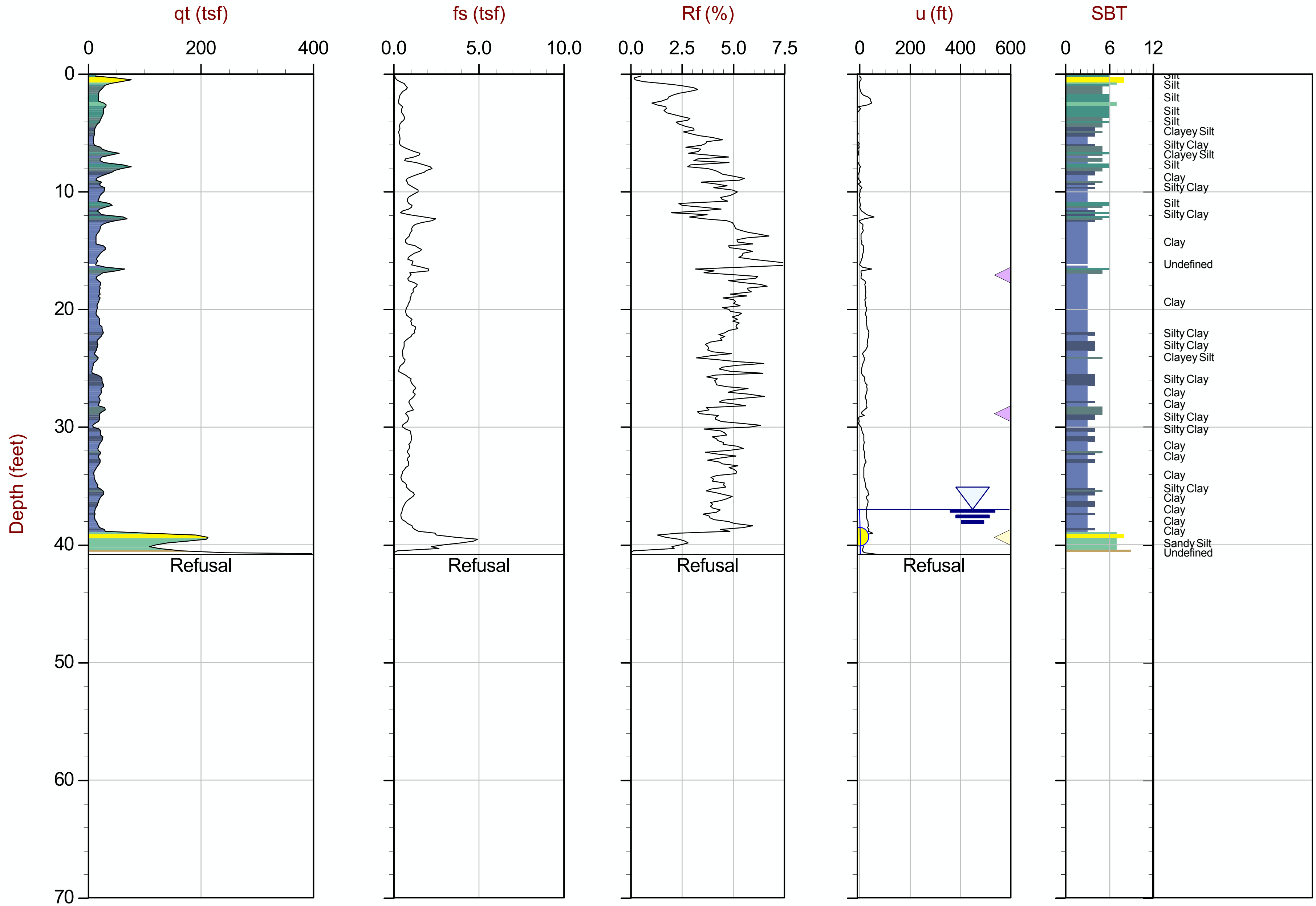
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:08:15 14:33
Site: Dynegy - Newton Plant

Sounding: CPT-C016
Cone: 392:T1500F15U500



Max Depth: 12.450 m / 40.85 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP016.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92424 E: -88.27573

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

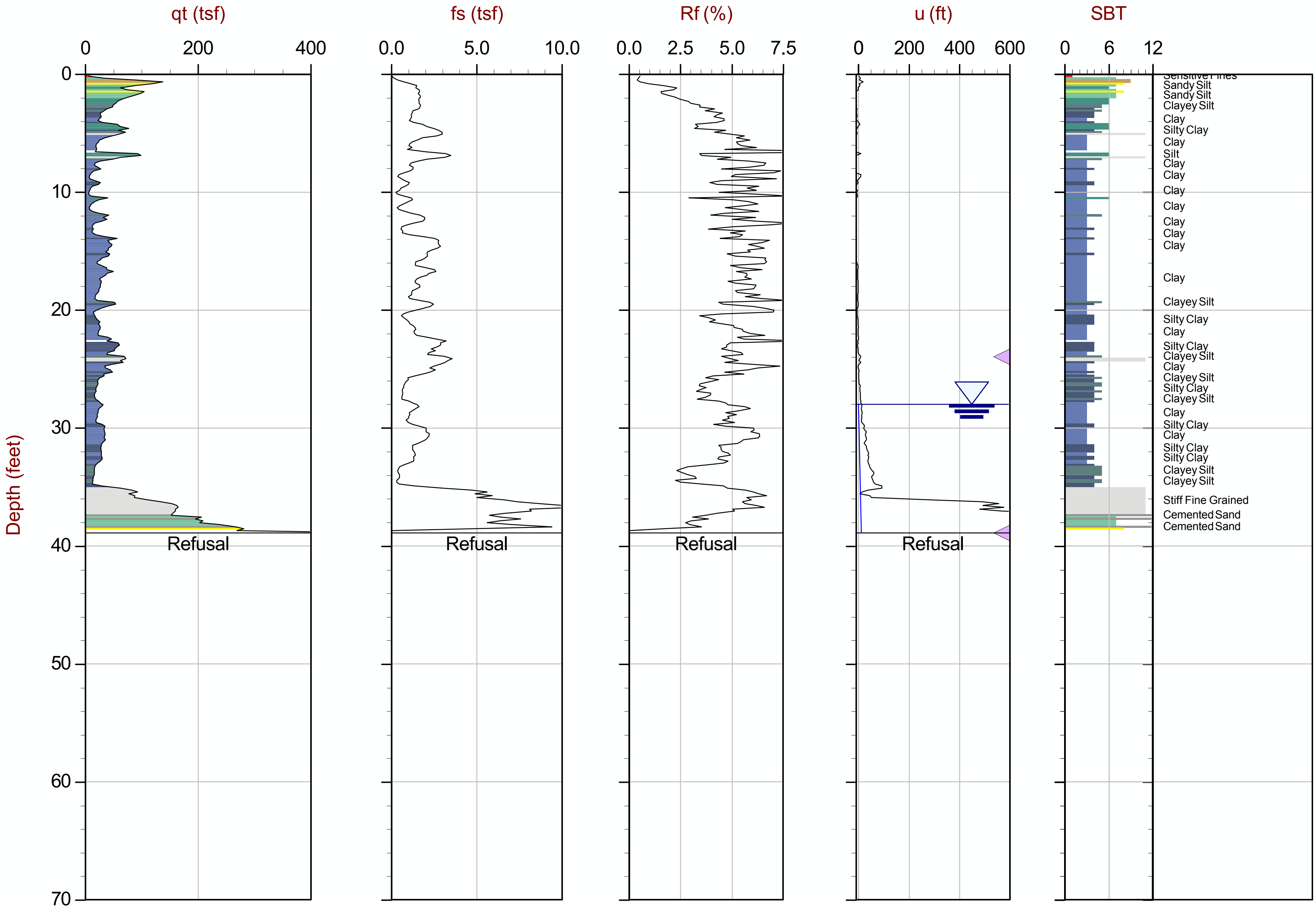
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

ConeTec

AECOM

Job No: 15-54068
Date: 08:09:15 08:34
Site: Dynegy - Newton Plant

Sounding: CPT-C017
Cone: 392:T1500F15U500



Max Depth: 11.850 m / 38.88 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_CP017.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92363 E: -88.27960

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

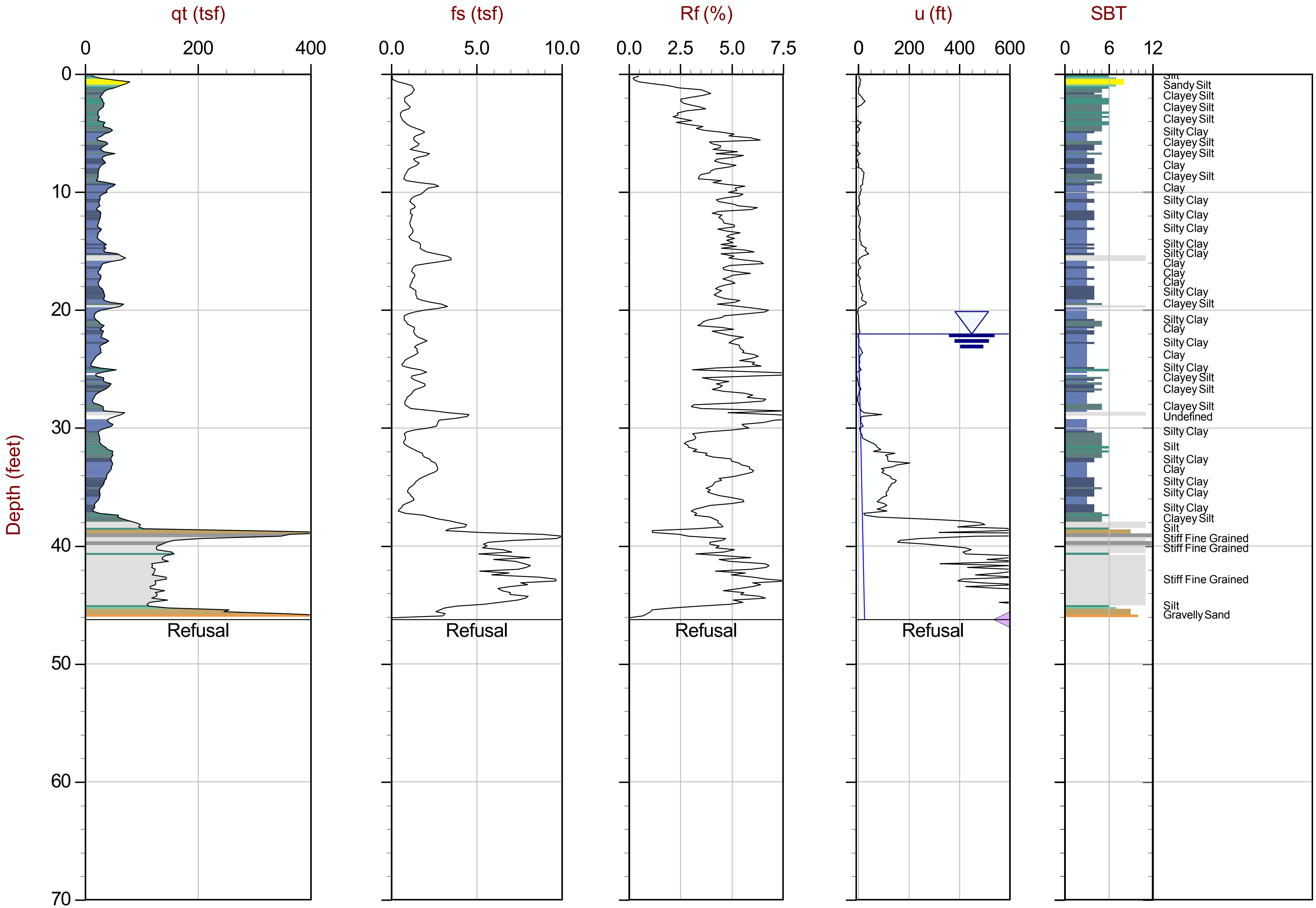
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:10:15 13:33
Site: Dynegy - Newton Plant

Sounding: SCPT-SC001
Cone: 392:T1500F15U500



Max Depth: 14.100 m / 46.26 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_SP001.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92228 E: -88.28597

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

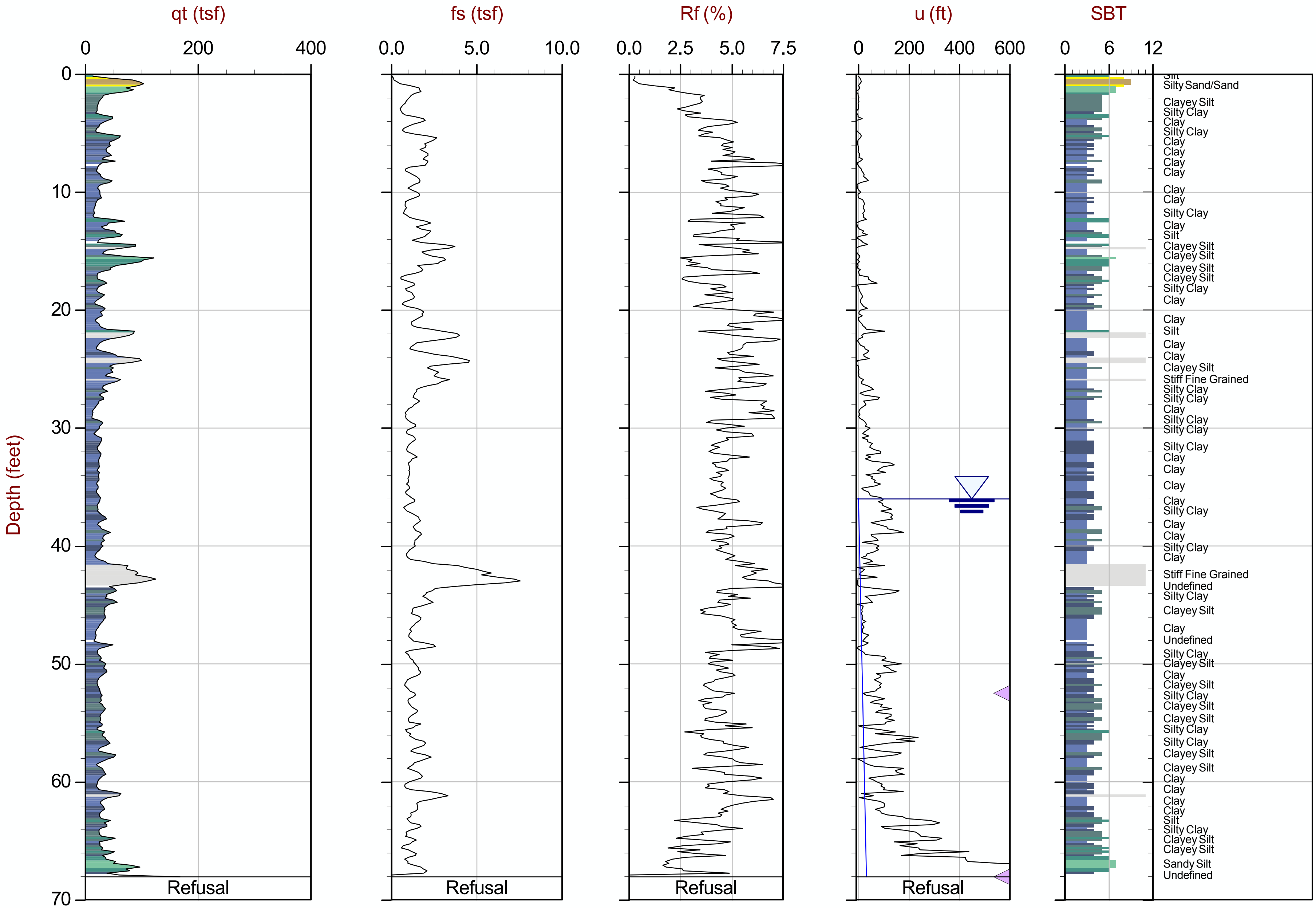
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:11:15 08:32
Site: Dynegy - Newton Plant

Sounding: SCPT-SC018
Cone: 392:T1500F15U500



Max Depth: 20.750 m / 68.08 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_SP018.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92269 E: -88.28347

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

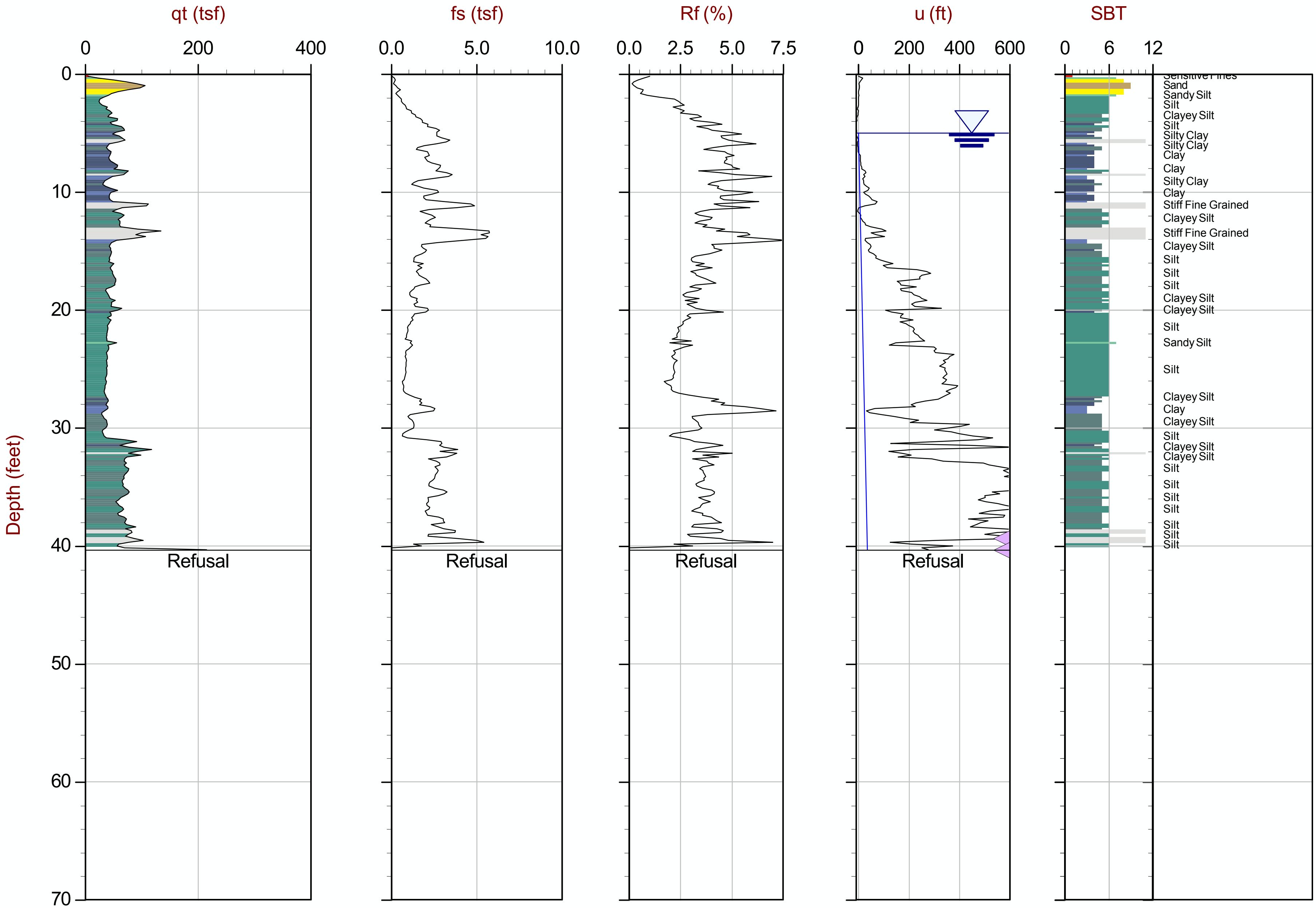
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

ConeTec

AECOM

Job No: 15-54068
Date: 08:11:15 12:05
Site: Dynegy - Newton Plant

Sounding: SCPT-SC019
Cone: 392:T1500F15U500



Max Depth: 12.300 m / 40.35 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_SP019.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92337 E: -88.27924

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

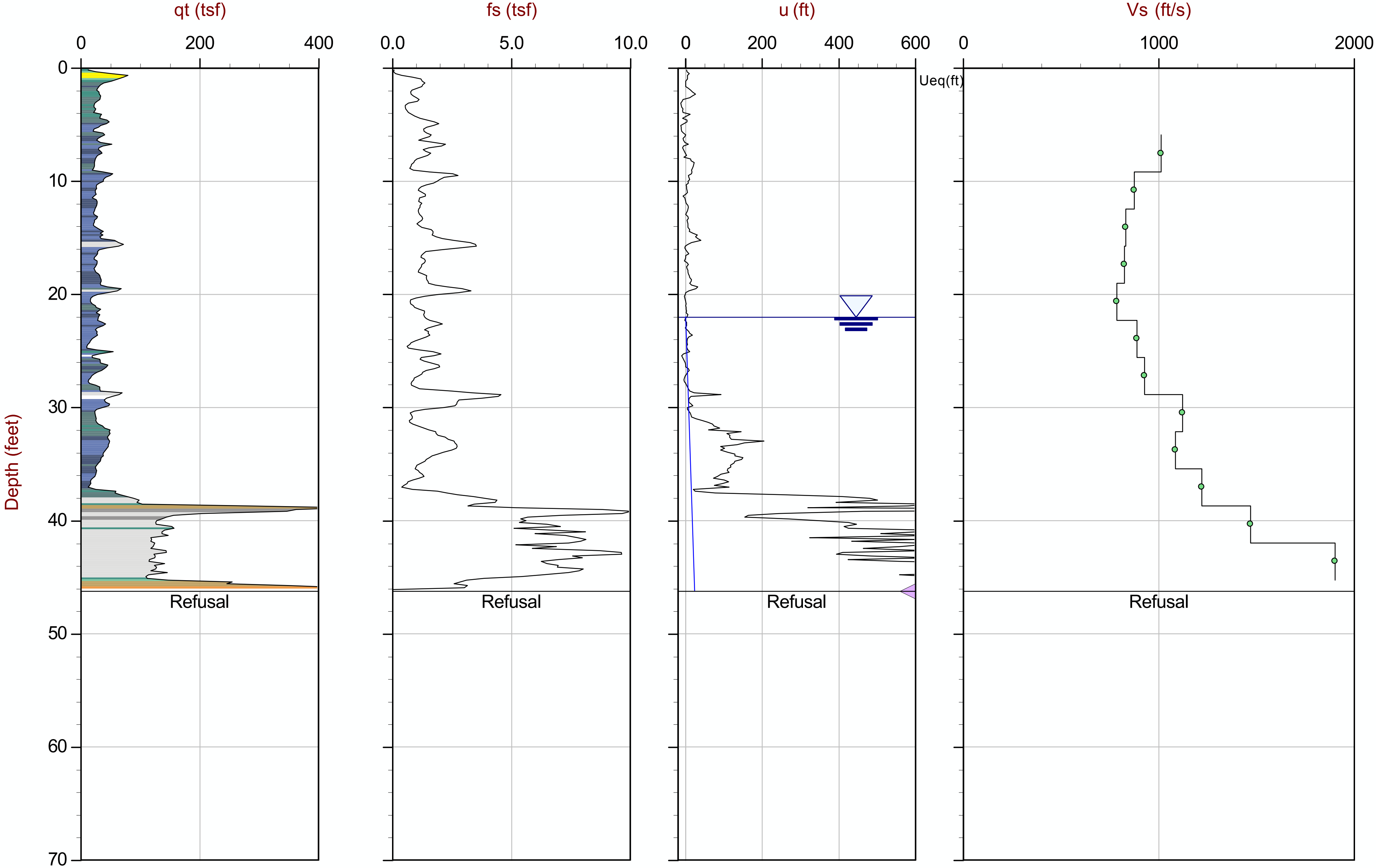
Seismic Cone Penetration Test Plots

CONETEC

AECOM

Job No: 15-54068
Date: 08:10:15 13:33
Site: Dynegy - Newton Plant

Sounding: SCPT-SC001
Cone: 392:T1500F15U500



Max Depth: 14.100 m / 46.26 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_SP001.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92228 E: -88.28597

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

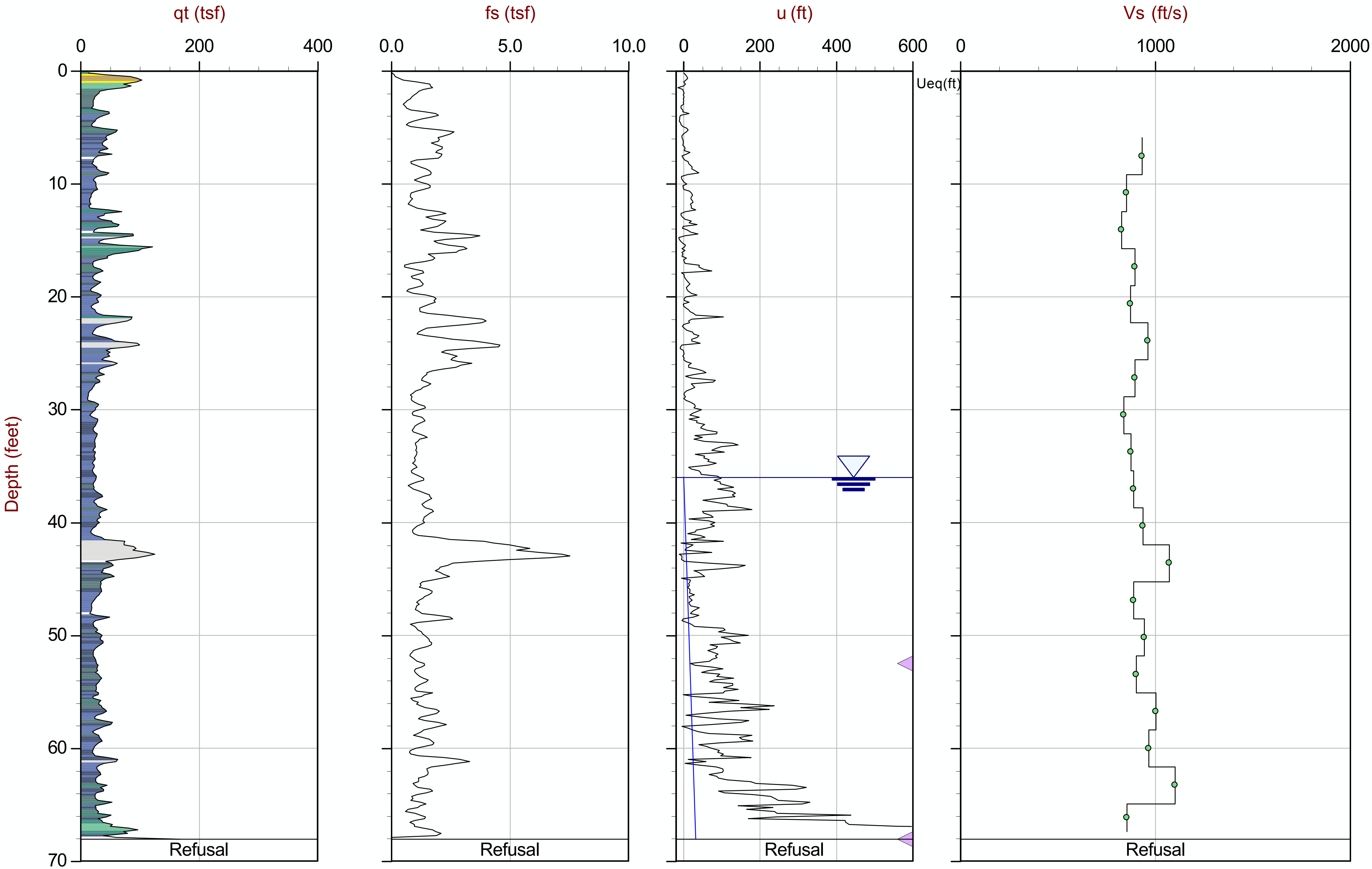
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

ConeTec

AECOM

Job No: 15-54068
Date: 08:11:15 08:32
Site: Dynegy - Newton Plant

Sounding: SCPT-SC018
Cone: 392:T1500F15U500



Max Depth: 20.750 m / 68.08 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_SP018.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92269 E: -88.28347

△ Dissipation with estimated Ueq value
△ Dissipation, equilibrium not achieved

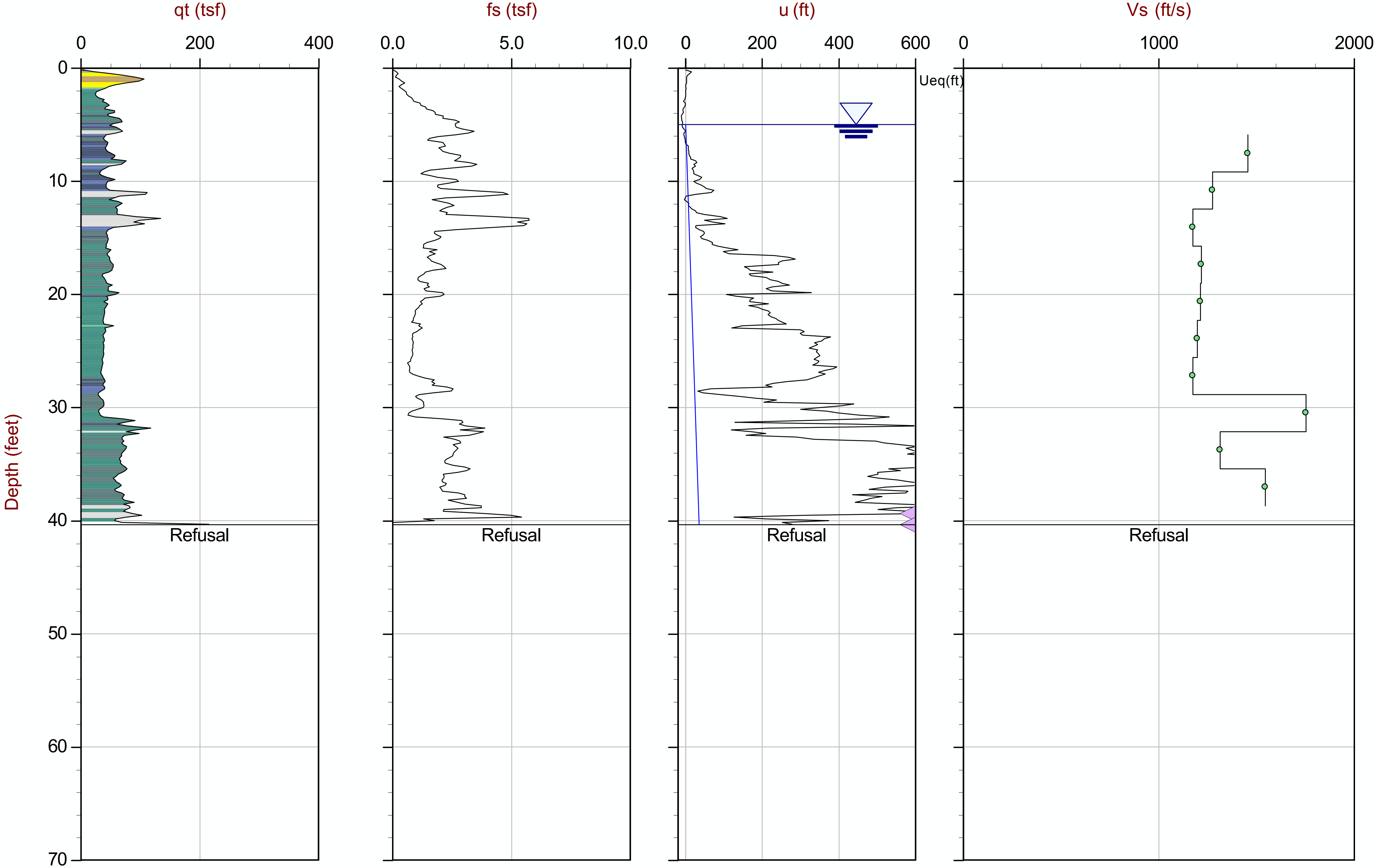
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-54068
Date: 08:11:15 12:05
Site: Dynegy - Newton Plant

Sounding: SCPT-SC019
Cone: 392:T1500F15U500



Max Depth: 12.300 m / 40.35 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-54068_SP019.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: N: 38.92337 E: -88.27924

△ Dissipation with estimated Ueq value

△ Dissipation, equilibrium not achieved

The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Seismic Cone Penetration Test Tabular Results

Job No: 15-54068
Client: AECOM
Project: Dynegy Newton
Sounding ID: SCPT-C001
Date: 10-Aug-2015

Seismic Source: Beam
Source Offset (ft): 7.05
Source Depth (ft): 0.00
Geophone Offset (ft): 0.66

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Ray Path Difference (ft)	Travel Time Interval (ms)	Interval Velocity (ft/s)
6.56	5.91	9.20			
9.84	9.19	11.58	2.38	2.35	1013
13.12	12.47	14.32	2.74	3.13	875
16.40	15.75	17.25	2.93	3.52	832
19.69	19.03	20.29	3.04	3.68	826
22.97	22.31	23.40	3.10	3.95	786
26.25	25.59	26.54	3.15	3.54	888
29.53	28.87	29.72	3.18	3.42	927
32.81	32.15	32.92	3.20	2.85	1123
36.09	35.43	36.13	3.21	2.96	1085
39.37	38.71	39.35	3.22	2.64	1221
42.65	41.99	42.58	3.23	2.20	1470
45.93	45.28	45.82	3.24	1.70	1902

Job No:	15-54068	
Client:	AECOM	
Project:	Dynegy Newton	
Sounding ID:	SCPT-C018	
Date:	11-Aug-2015	

Seismic Source:	Beam
Source Offset (ft):	7.05
Source Depth (ft):	0.00
Geophone Offset (ft):	0.66

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Ray Path Difference (ft)	Travel Time Interval (ms)	Interval Velocity (ft/s)
6.56	5.91	9.20			
9.84	9.19	11.58	2.38	2.56	932
13.12	12.47	14.32	2.74	3.22	852
16.40	15.75	17.25	2.93	3.54	828
19.69	19.03	20.29	3.04	3.39	897
22.97	22.31	23.40	3.10	3.56	872
26.25	25.59	26.54	3.15	3.27	962
29.53	28.87	29.72	3.18	3.54	897
32.81	32.15	32.92	3.20	3.81	839
36.09	35.43	36.13	3.21	3.66	876
39.37	38.71	39.35	3.22	3.62	889
42.65	41.99	42.58	3.23	3.45	938
45.93	45.28	45.82	3.24	3.02	1071
49.21	48.56	49.07	3.24	3.65	890
52.49	51.84	52.31	3.25	3.44	944
55.77	55.12	55.57	3.25	3.61	902
59.06	58.40	58.82	3.26	3.24	1004
62.34	61.68	62.08	3.26	3.37	967
65.62	64.96	65.34	3.26	2.96	1101
68.08	67.42	67.79	2.45	2.87	854

Job No: 15-54068
Client: AECOM
Project: Dynegy Newton
Sounding ID: SCPT-C019
Date: 11-Aug-2015

Seismic Source: Beam
Source Offset (ft): 7.05
Source Depth (ft): 0.00
Geophone Offset (ft): 0.66

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Ray Path Difference (ft)	Travel Time Interval (ms)	Interval Velocity (ft/s)
6.56	5.91	9.20			
9.84	9.19	11.58	2.38	1.64	1456
13.12	12.47	14.32	2.74	2.15	1276
16.40	15.75	17.25	2.93	2.49	1176
19.69	19.03	20.29	3.04	2.49	1219
22.97	22.31	23.40	3.10	2.56	1213
26.25	25.59	26.54	3.15	2.62	1199
29.53	28.87	29.72	3.18	2.71	1174
32.81	32.15	32.92	3.20	1.82	1755
36.09	35.43	36.13	3.21	2.44	1314
39.37	38.71	39.35	3.22	2.08	1546

Pore Pressure Dissipation Summary and

Pore Pressure Dissipation Plots

Job No: 15-54068
Client: AECOM
Project: Dynegy- Newton Power Station
Start Date: 03-Aug-2015
End Date: 11-Aug-2015

CPTu PORE PRESSURE DISSIPATION SUMMARY

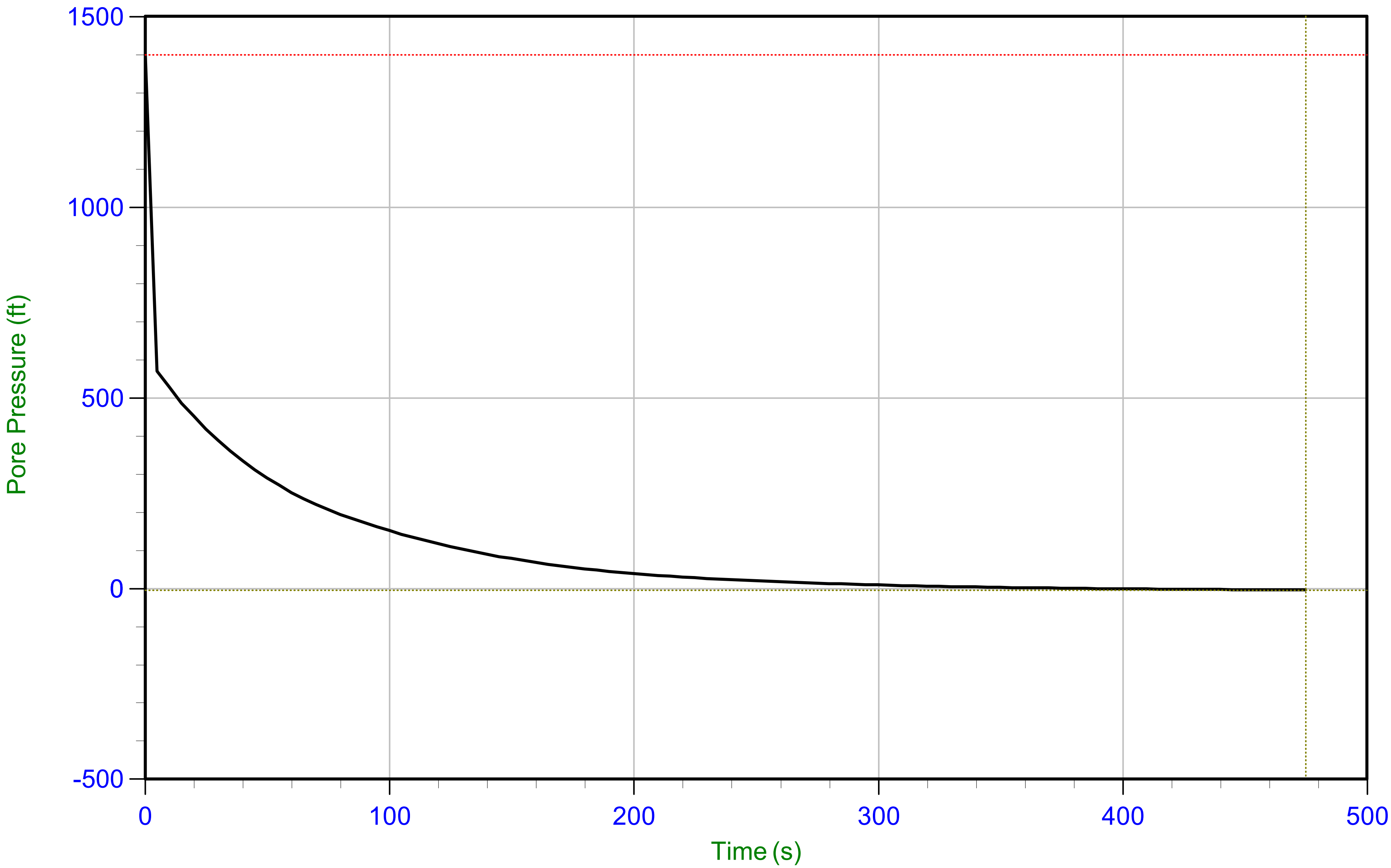
Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (ft)	Estimated Equilibrium Pore Pressure U_{eq} (ft)	Calculated Phreatic Surface (ft)
SCPT-C001	15-54068_SP001	15	475	46.3		
CPT-C002	15-54068_CP002	15	605	25.1		
CPT-C002	15-54068_CP002	15	4430	34.9	16.1	18.8
CPT-C003	15-54068_CP003	15	260	14.8		
CPT-C004	15-54068_CP004	15	390	31.3		
CPT-C004	15-54068_CP004	15	265	35.9	11.7	24.2
CPT-C005	15-54068_CP005	15	2295	23.9	4.3	19.7
CPT-C006	15-54068_CP006	15	320	29.5		
CPT-C006	15-54068_CP006	15	5395	36.4		
CPT-C007	15-54068_CP007	15	425	9.0		
CPT-C007	15-54068_CP007	15	3450	13.1	6.8	6.3
CPT-C008	15-54068_CP008	15	915	32.8		
CPT-C008	15-54068_CP008	15	390	33.3		
CPT-C008	15-54068_CP008	15	235	35.6		
CPT-C009	15-54068_CP009	15	7950	29.2	27.1	2.1
CPT-C010	15-54068_CP010 - comb	15	12720	23.8	11.6	12.2
CPT-C011	15-54068_CP011	15	7930	15.4		
CPT-C012	15-54068_CP012	15	5015	13.1		
CPT-C012	15-54068_CP012	15	480	26.2		
CPT-C012	15-54068_CP012	15	1190	37.2	25.2	12.1
CPT-C013	15-54068_CP013	15	69975	13.1		
CPT-C013	15-54068_CP013	15	135	24.3		
CPT-C013	15-54068_CP013	15	520	30.3		
CPT-C013	15-54068_CP013	15	300	40.0		
CPT-C014	15-54068_CP014	15	490	9.2	2.5	6.7
CPT-C014	15-54068_CP014	15	900	29.5		
CPT-C015	15-54068_CP015	15	300	14.1		
CPT-C015	15-54068_CP015	15	900	36.6		
CPT-C016	15-54068_CP016	15	2010	17.1		
CPT-C016	15-54068_CP016	15	345	28.9		
CPT-C016	15-54068_CP016	15	540	39.4	1.9	37.5
CPT-C017	15-54068_CP017	15	495	23.9		
CPT-C017	15-54068_CP017	15	6735	38.9		
SCPT-SC018	15-54068_SP018	15	680	52.5		
SCPT-SC018	15-54068_SP018	15	2825	68.1		
SCPT-SC019	15-54068_SP019	15	1015	39.4		
SCPT-SC019	15-54068_SP019	15	6025	40.4		
Totals			2488.8 min			

CONETEC

AECOM

Job No: 15-54068
Date: 08/10/2015 13:33
Site: Dynegy - Newton Plant

Sounding: SCPT-C001
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_SP001.PPD
Depth: 14.100 m / 46.259 ft
Duration: 475.0 s

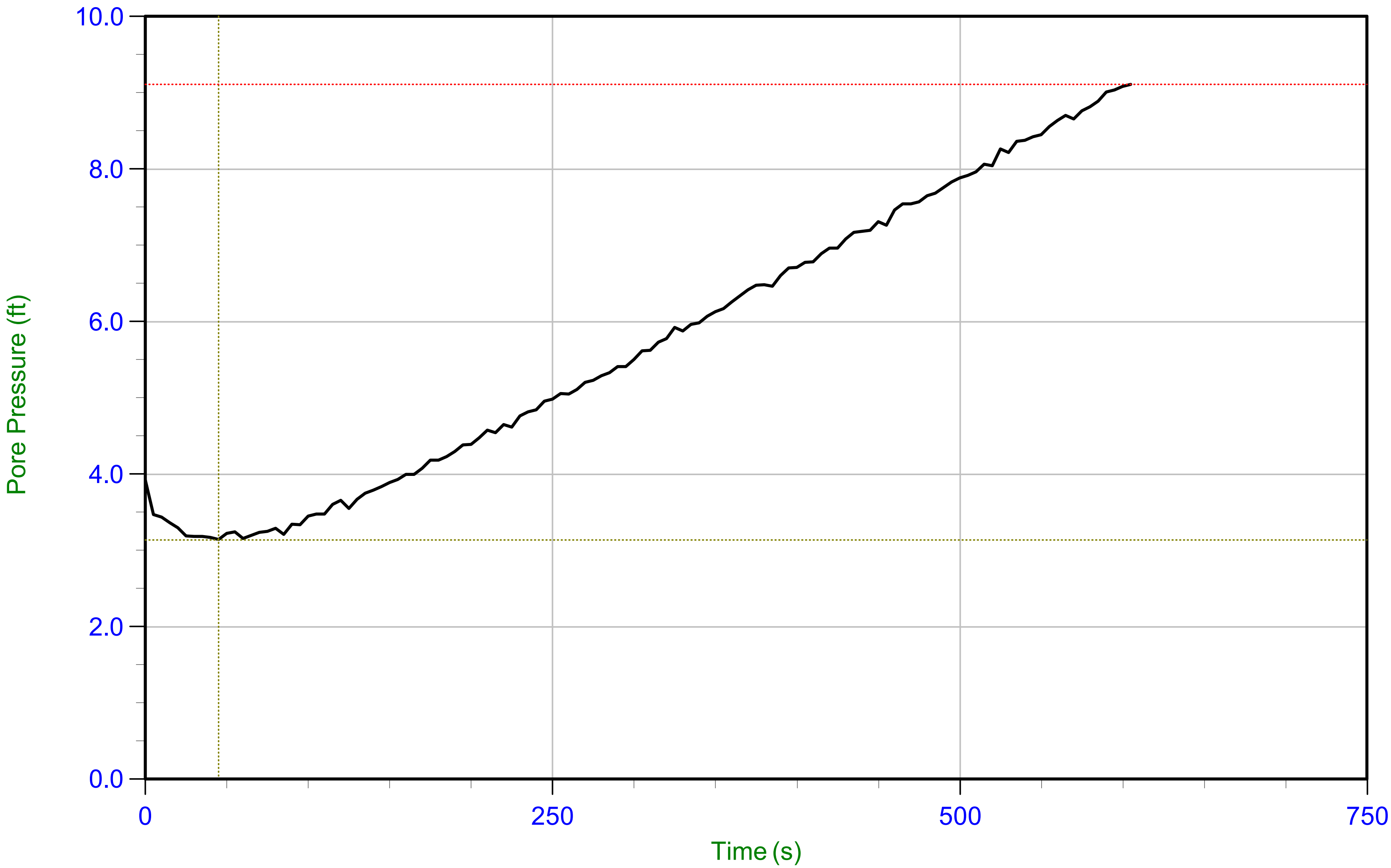
U Min: -3.8 ft
U Max: 1400.4 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/09/2015 13:22
Site: Dynegy - Newton Plant

Sounding: CPT-C002
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP002.PPD
Depth: 7.650 m / 25.098 ft
Duration: 605.0 s

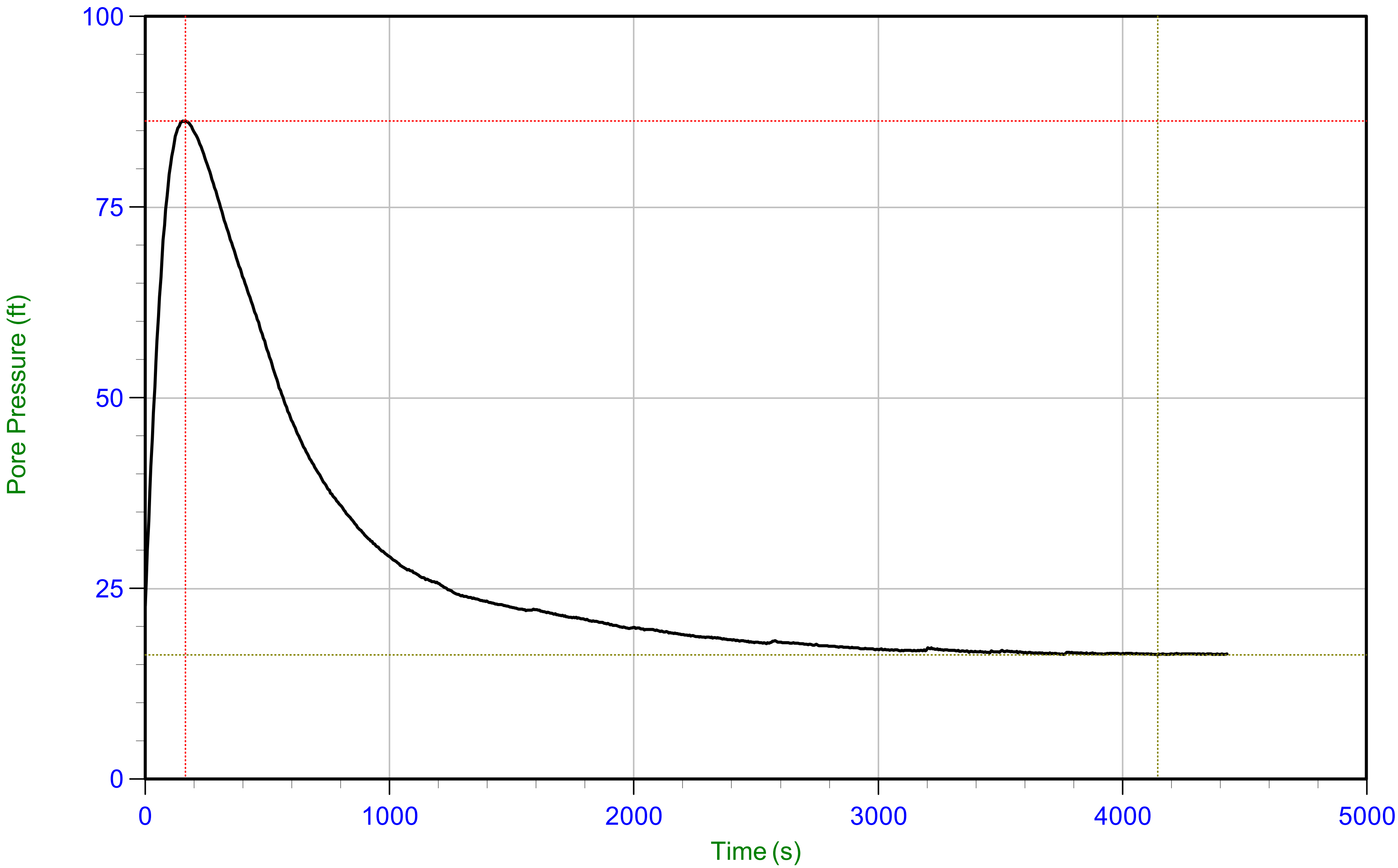
U Min: 3.1 ft
U Max: 9.1 ft

ConeTec

AECOM

Job No: 15-54068
Date: 08/09/2015 13:22
Site: Dynegy - Newton Plant

Sounding: CPT-C002
Cone: 392:T1500F15U500
Cone Area: 15 sq cm

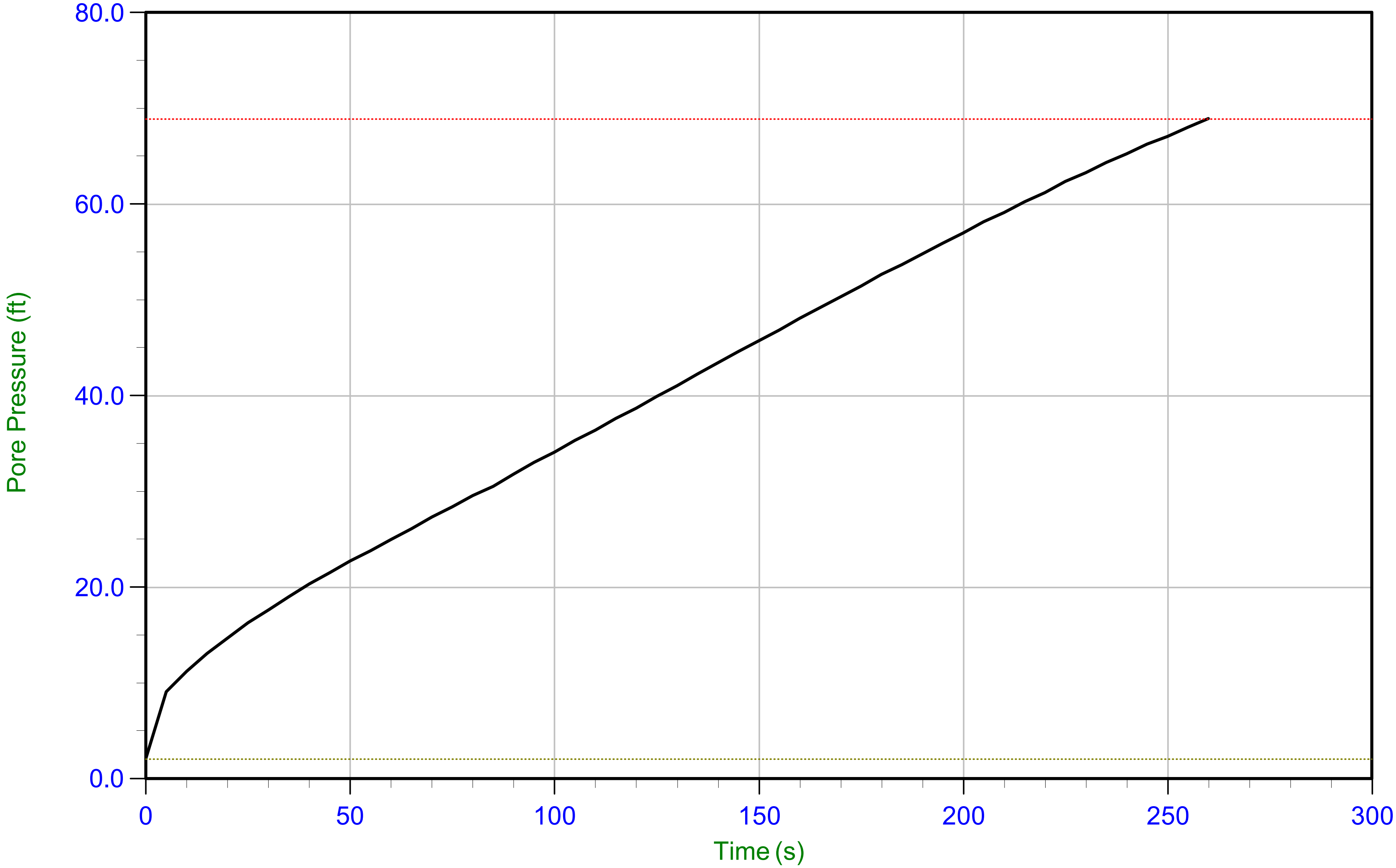


Trace Summary:

Filename: 15-54068_CP002.PPD
Depth: 10.650 m / 34.941 ft
Duration: 4430.0 s

U Min: 16.3 ft
U Max: 86.3 ft

AECOM	Job No: 15-54068 Date: 08/04/2015 17:13 Site: Dynegy - Newton Plant	Sounding: CPT-C003 Cone: 392:T1500F15U500 Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP003.PPD
Depth: 4.500 m / 14.764 ft
Duration: 260.0 s

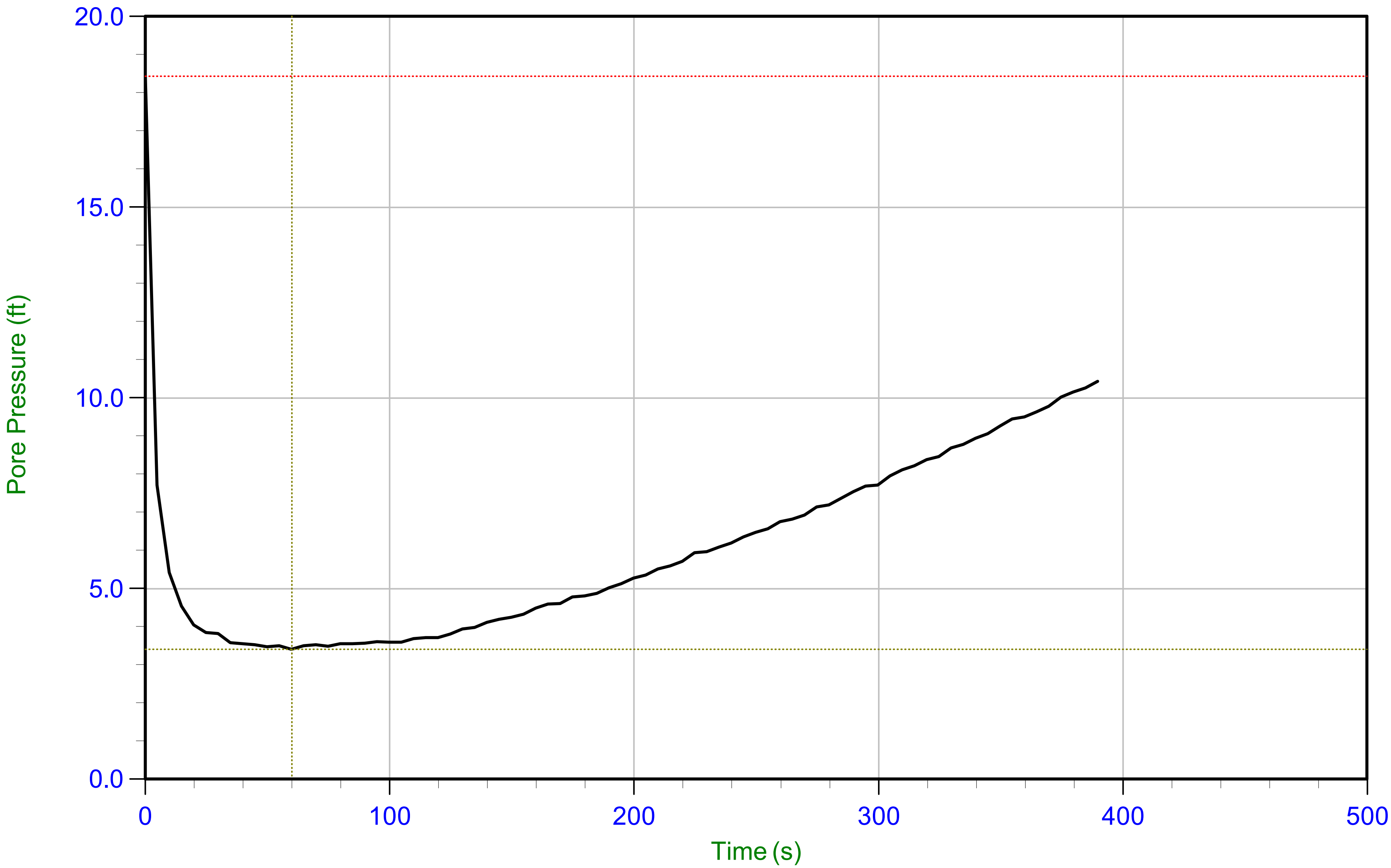
U Min: 2.1 ft
U Max: 68.9 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/10/2015 08:25
Site: Dynegy - Newton Plant

Sounding: CPT-C004
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP004.PPD
Depth: 9.550 m / 31.332 ft
Duration: 390.0 s

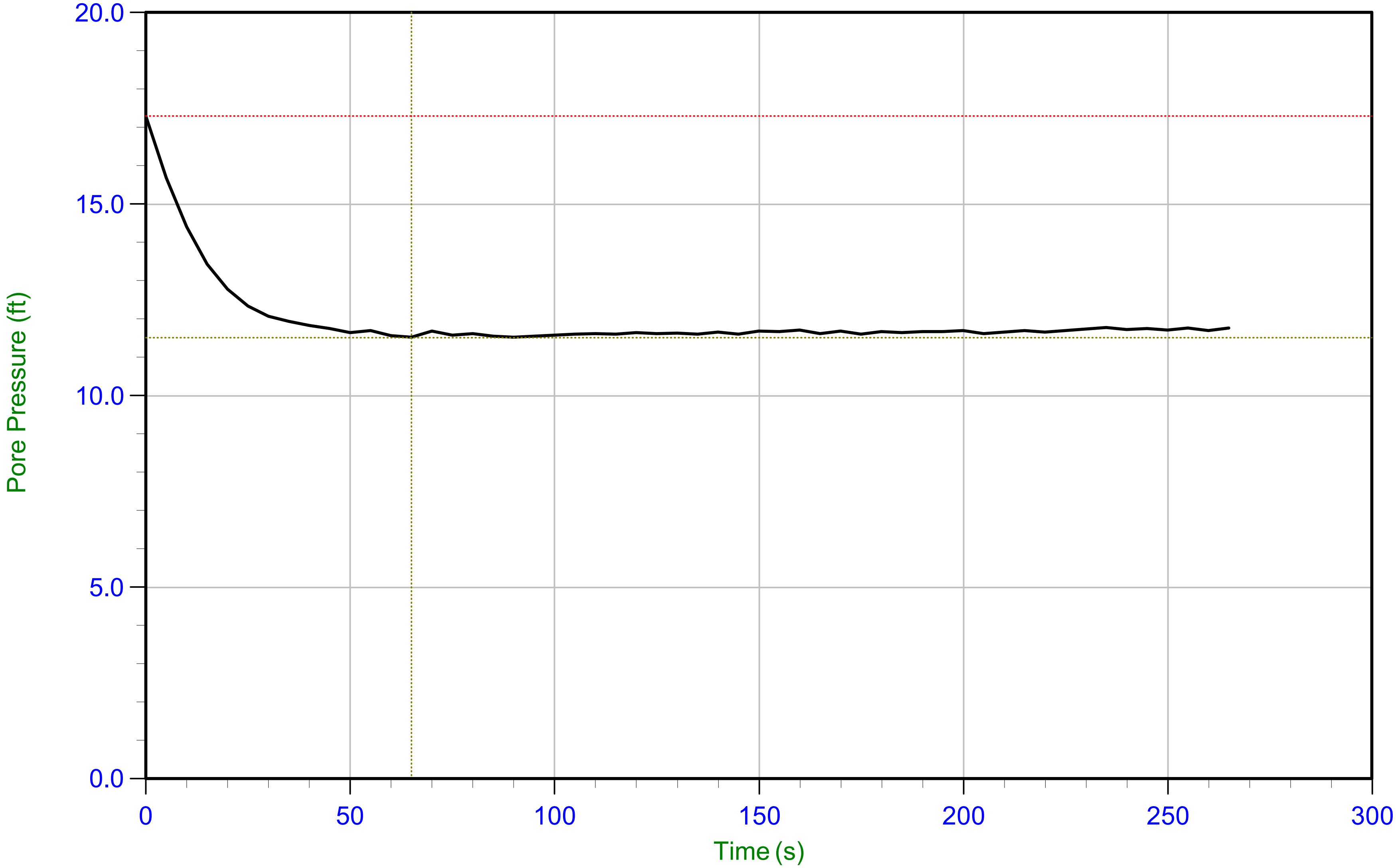
U Min: 3.4 ft
U Max: 18.4 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/10/2015 08:25
Site: Dynegy - Newton Plant

Sounding: CPT-C004
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP004.PPD
Depth: 10.950 m / 35.925 ft
Duration: 265.0 s

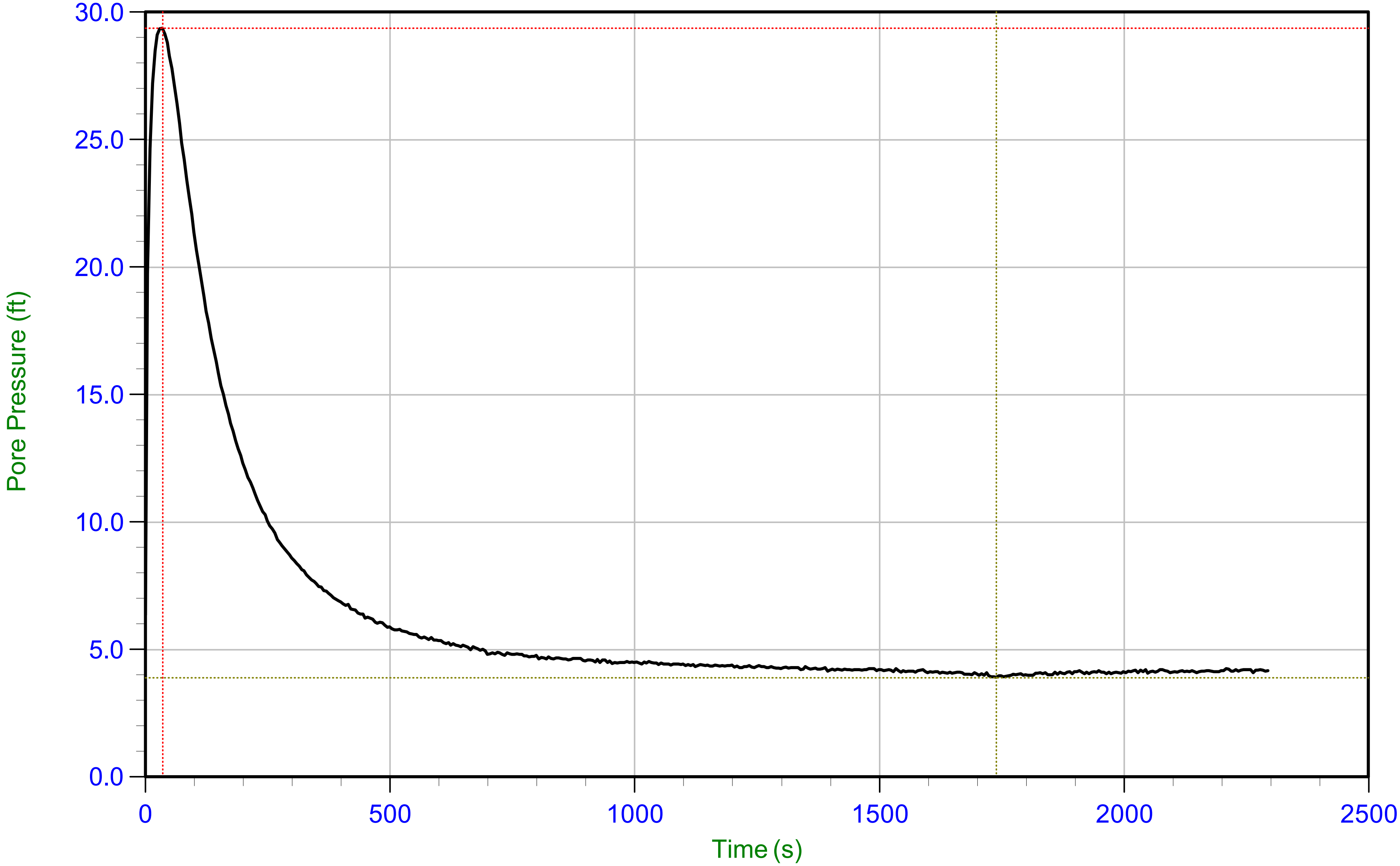
U Min: 11.5 ft
U Max: 17.3 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/03/2015 15:44
Site: Dynegy - Newton Plant

Sounding: CPT-C005
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP005.PPD
Depth: 7.300 m / 23.950 ft
Duration: 2295.0 s

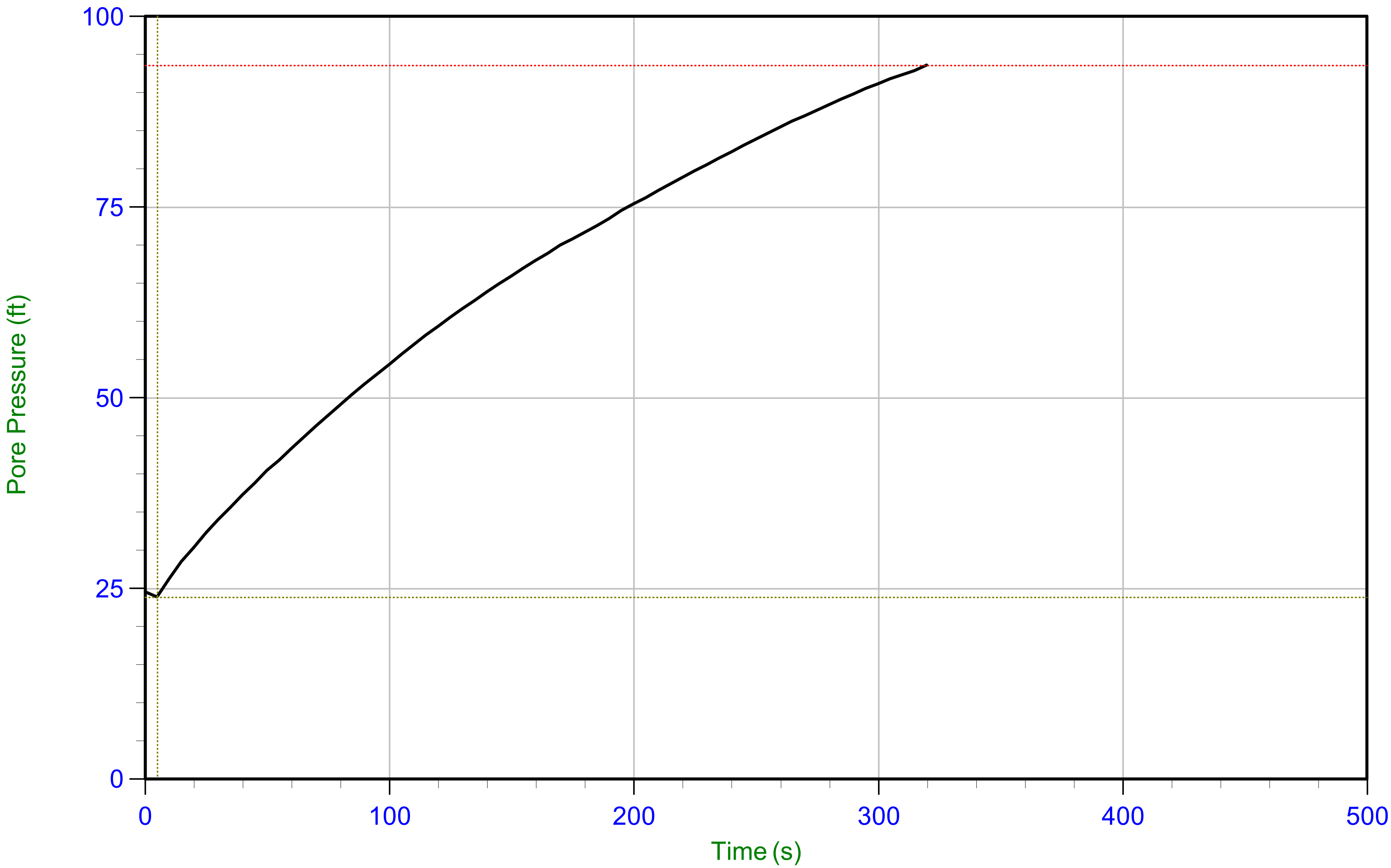
U Min: 3.9 ft
U Max: 29.4 ft

ConeTec

AECOM

Job No: 15-54068
Date: 08/10/2015 09:53
Site: Dynegy - Newton Plant

Sounding: CPT-C006
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP006.PPD
Depth: 9.000 m / 29.527 ft
Duration: 320.0 s

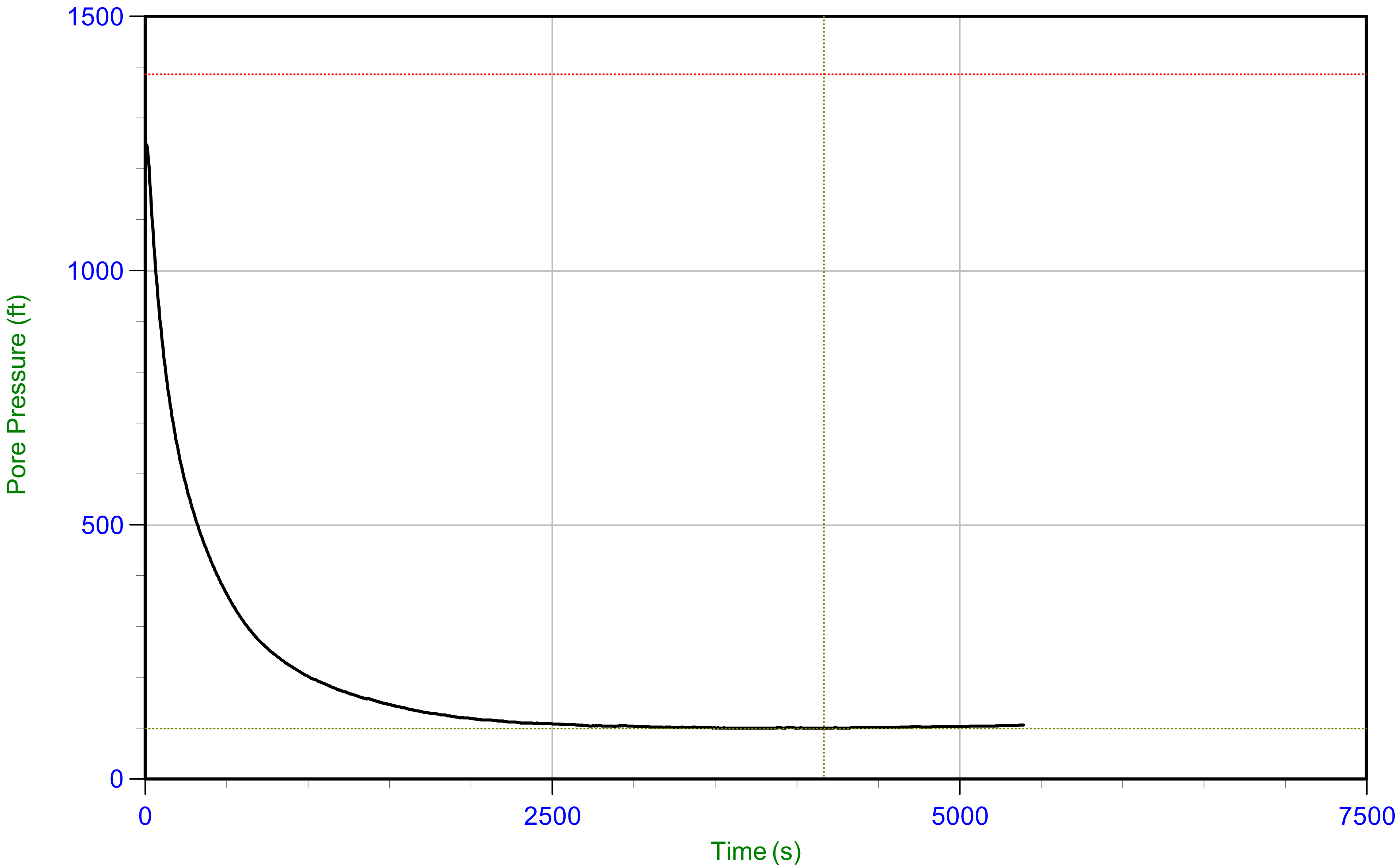
U Min: 23.9 ft
U Max: 93.6 ft

ConeTec

AECOM

Job No: 15-54068
Date: 08/10/2015 09:53
Site: Dynegy - Newton Plant

Sounding: CPT-C006
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP006.PPD
Depth: 11.100 m / 36.417 ft
Duration: 5395.0 s

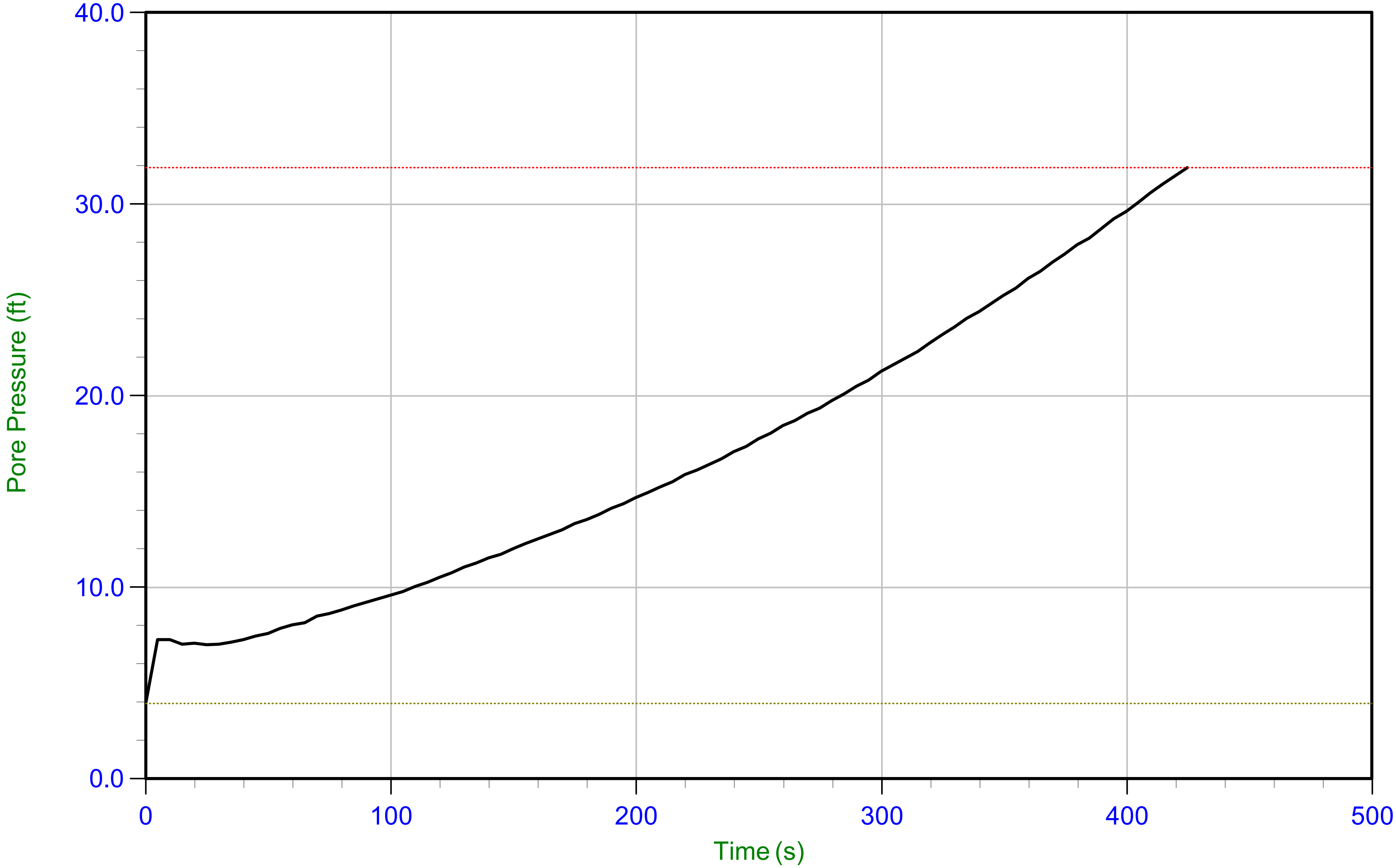
U Min: 100.0 ft
U Max: 1387.4 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/06/2015 15:43
Site: Dynegy - Newton Plant

Sounding: CPT-C007
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP007.PPD
Depth: 2.750 m / 9.022 ft
Duration: 425.0 s

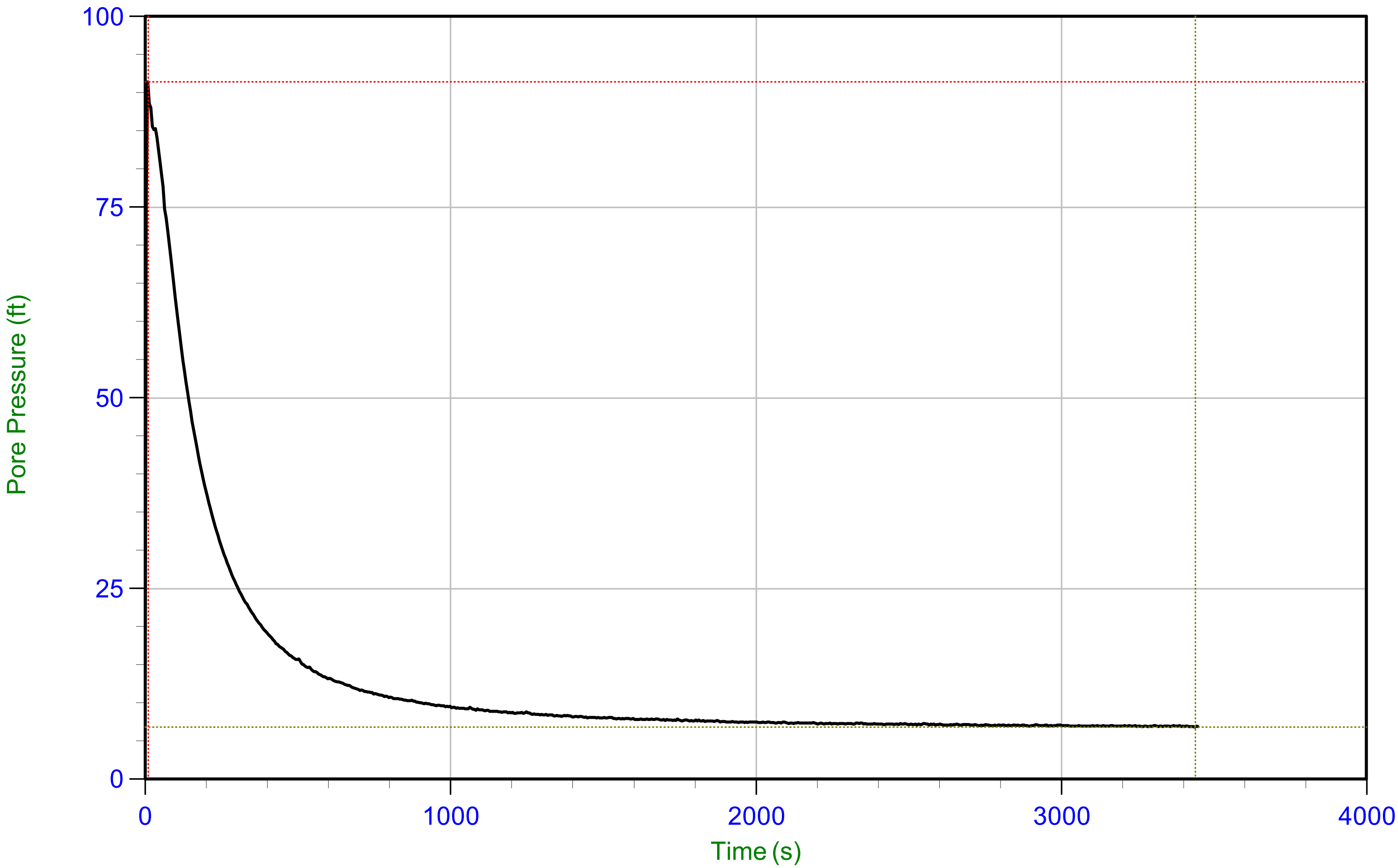
U Min: 4.0 ft
U Max: 31.9 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/06/2015 15:43
Site: Dynegy - Newton Plant

Sounding: CPT-C007
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP007.PPD
Depth: 4.000 m / 13.123 ft
Duration: 3450.0 s

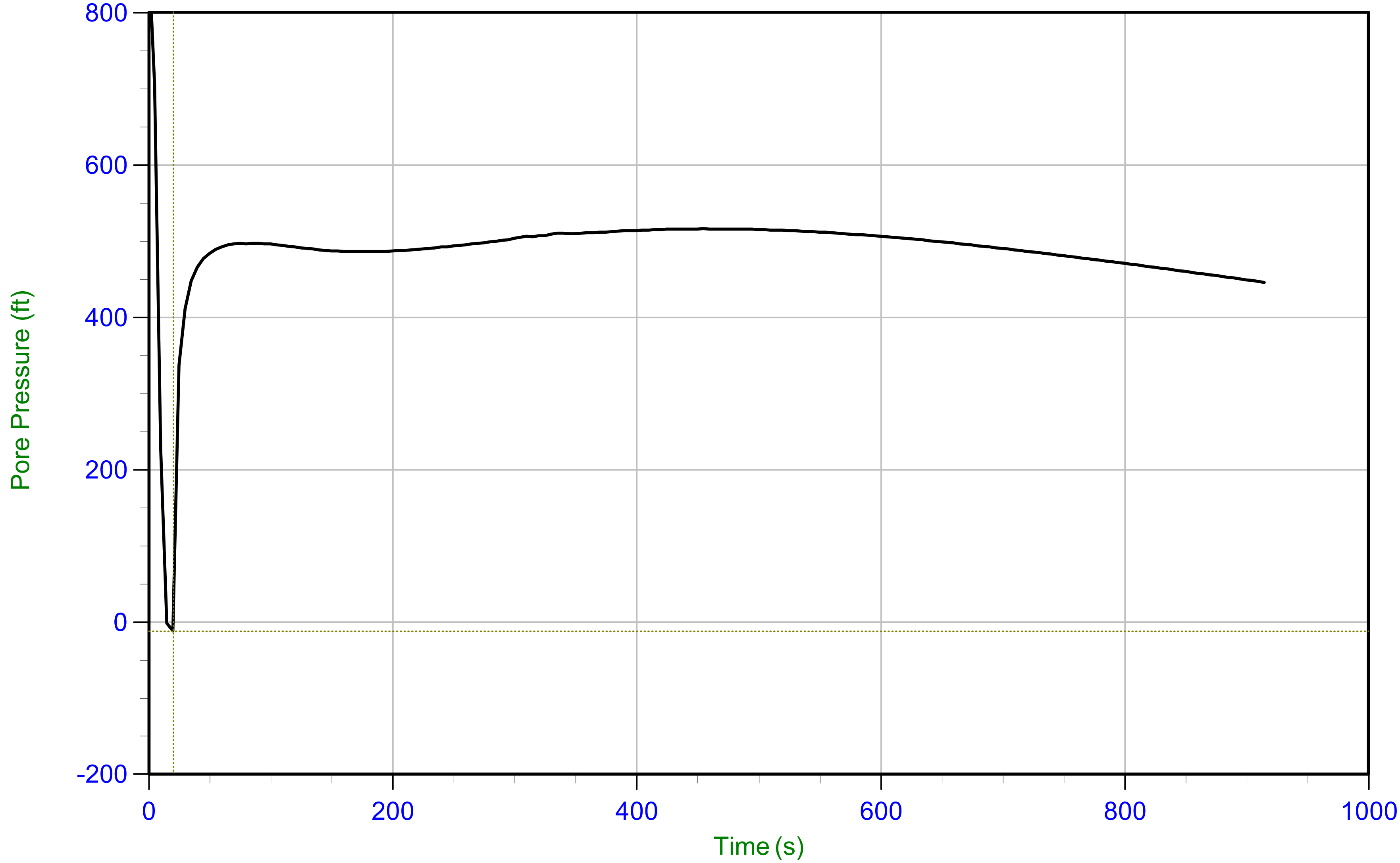
U Min: 6.9 ft
U Max: 91.5 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/07/2015 09:28
Site: Dynegy - Newton Plant

Sounding: CPT-C008
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP008.PPD
Depth: 10.000 m / 32.808 ft
Duration: 915.0 s

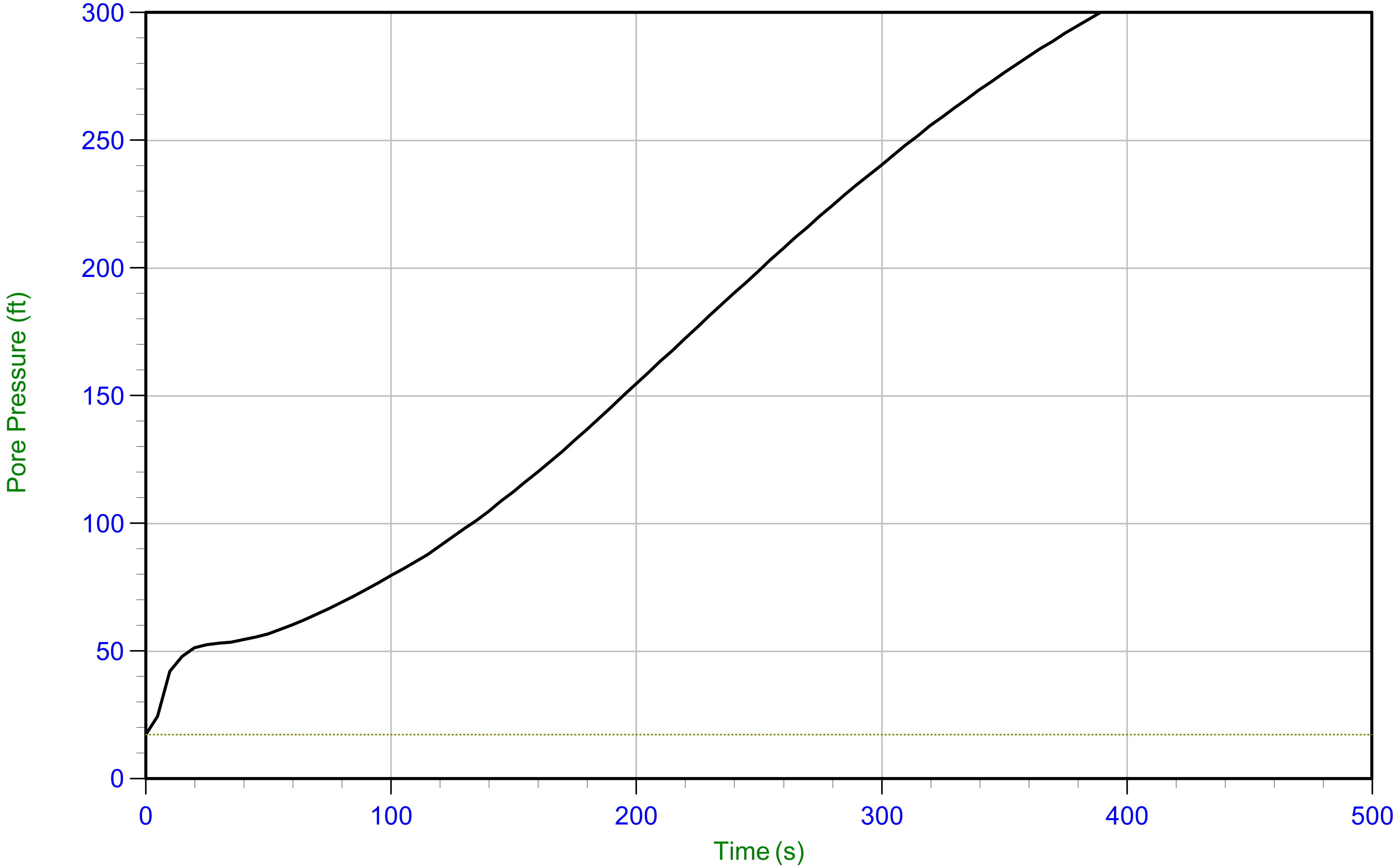
U Min: -11.9 ft
U Max: 869.8 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/07/2015 09:28
Site: Dynegy - Newton Plant

Sounding: CPT-C008
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP008.PPD
Depth: 10.150 m / 33.300 ft
Duration: 390.0 s

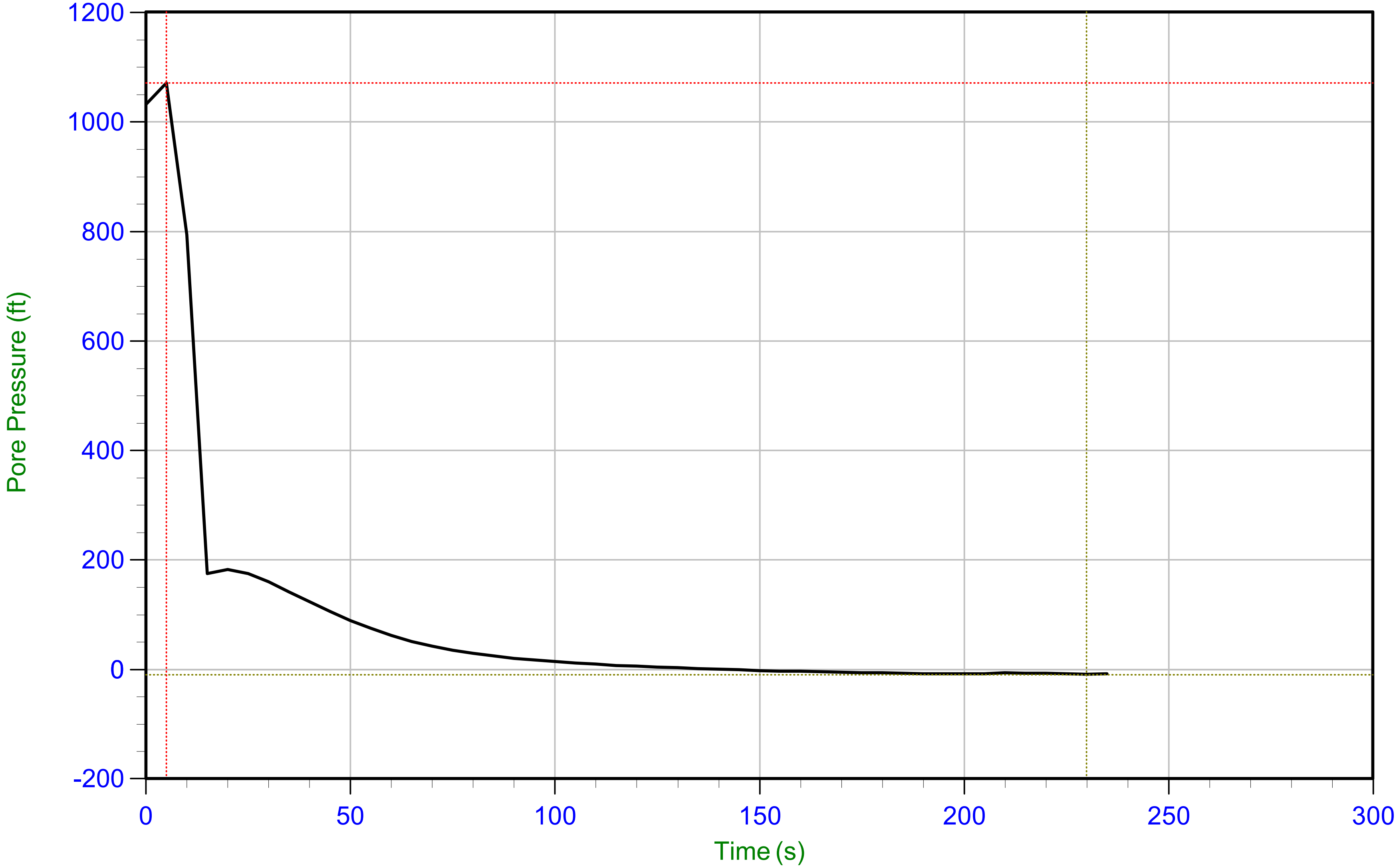
U Min: 17.4 ft
U Max: 300.3 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/07/2015 09:28
Site: Dynegy - Newton Plant

Sounding: CPT-C008
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP008.PPD
Depth: 10.850 m / 35.597 ft
Duration: 235.0 s

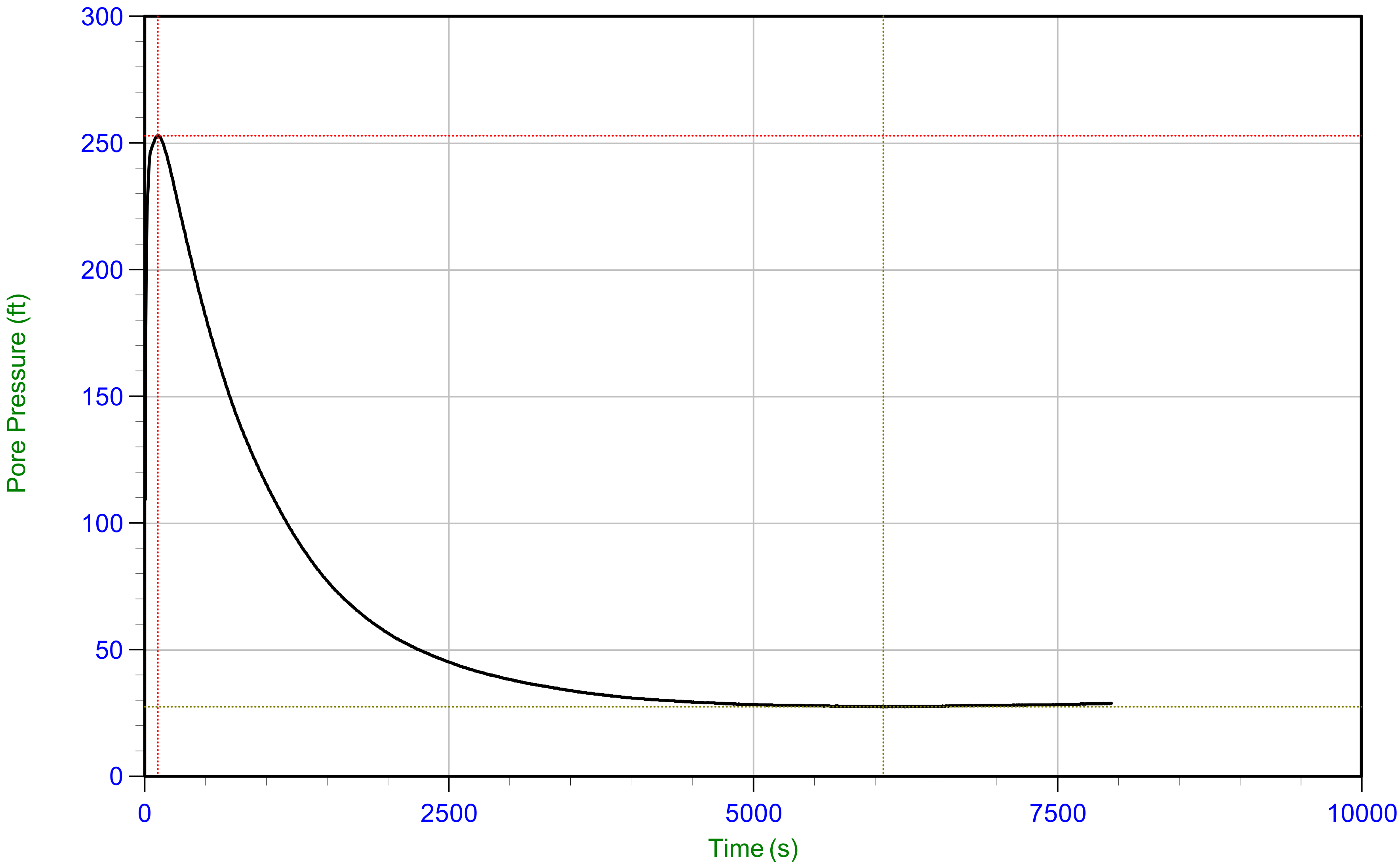
U Min: -9.2 ft
U Max: 1070.8 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/07/2015 11:49
Site: Dynegy - Newton Plant

Sounding: CPT-C009
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP009.PPD
Depth: 8.900 m / 29.199 ft
Duration: 7950.0 s

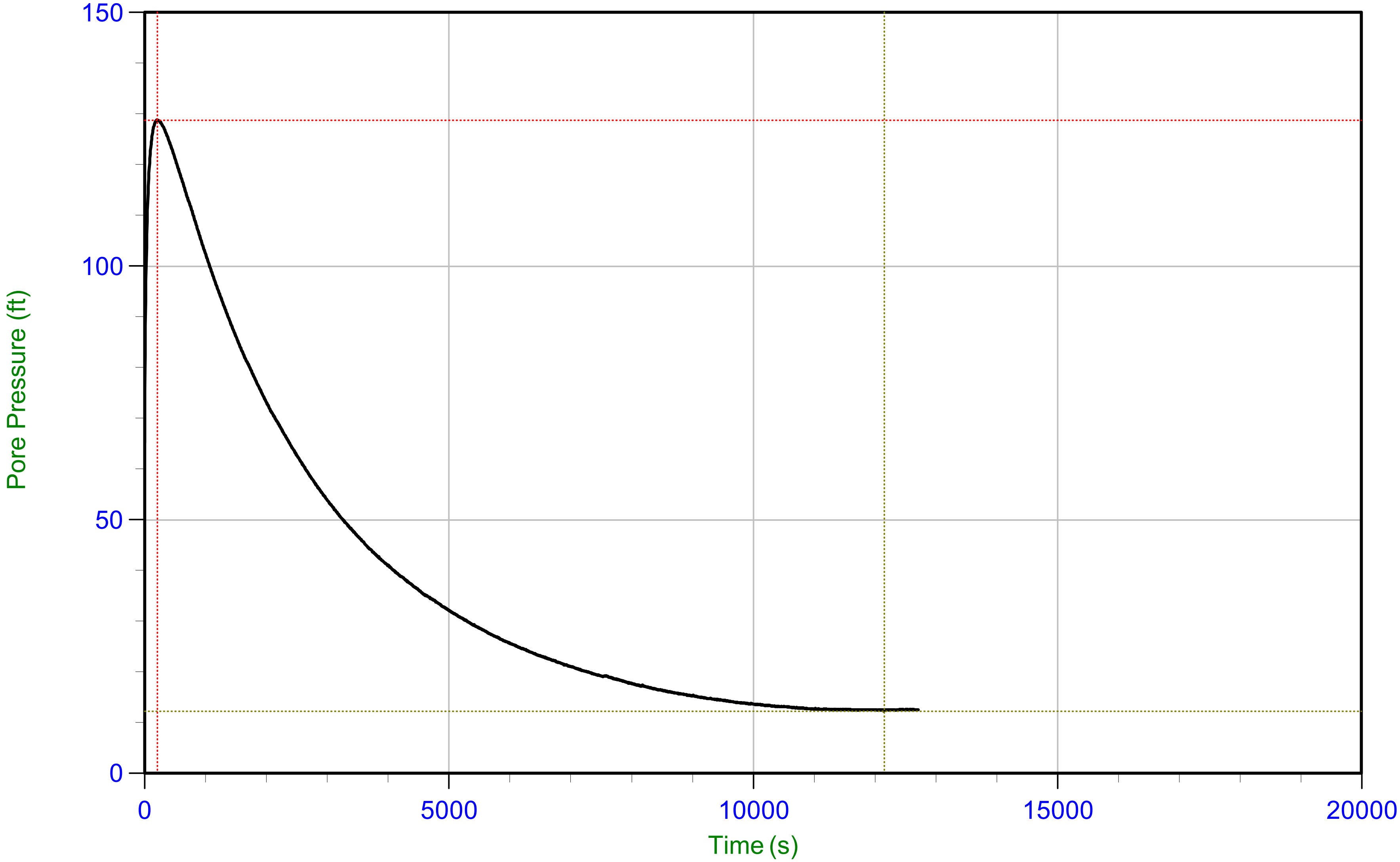
U Min: 27.5 ft
U Max: 253.0 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/07/2015 16:09
Site: Dynegy - Newton Plant

Sounding: CPT-C010
Cone: 392:T1500F15U500
Cone Area: 15 sq cm

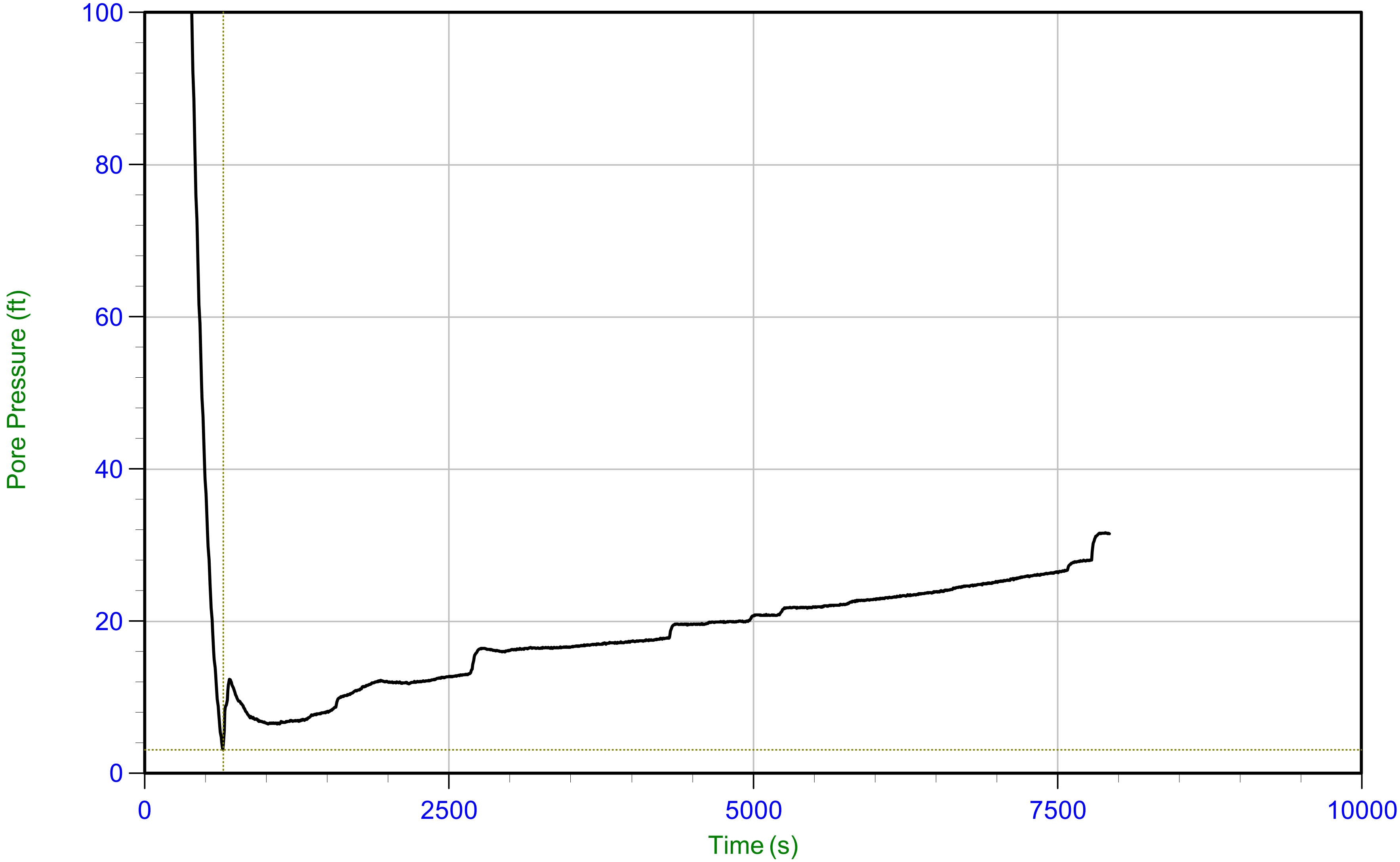


Trace Summary:

Filename: 15-54068_CP010-comb.PPD
Depth: 7.250 m / 23.786 ft
Duration: 12720.0 s

U Min: 12.3 ft
U Max: 128.8 ft

ConeTec	AECOM	Job No: 15-54068 Date: 08/04/2015 10:29 Site: Dynegy - Newton Plant	Sounding: CPT-C011 Cone: 392:T1500F15U500 Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP011.PPD
Depth: 4.700 m / 15.420 ft
Duration: 7930.0 s

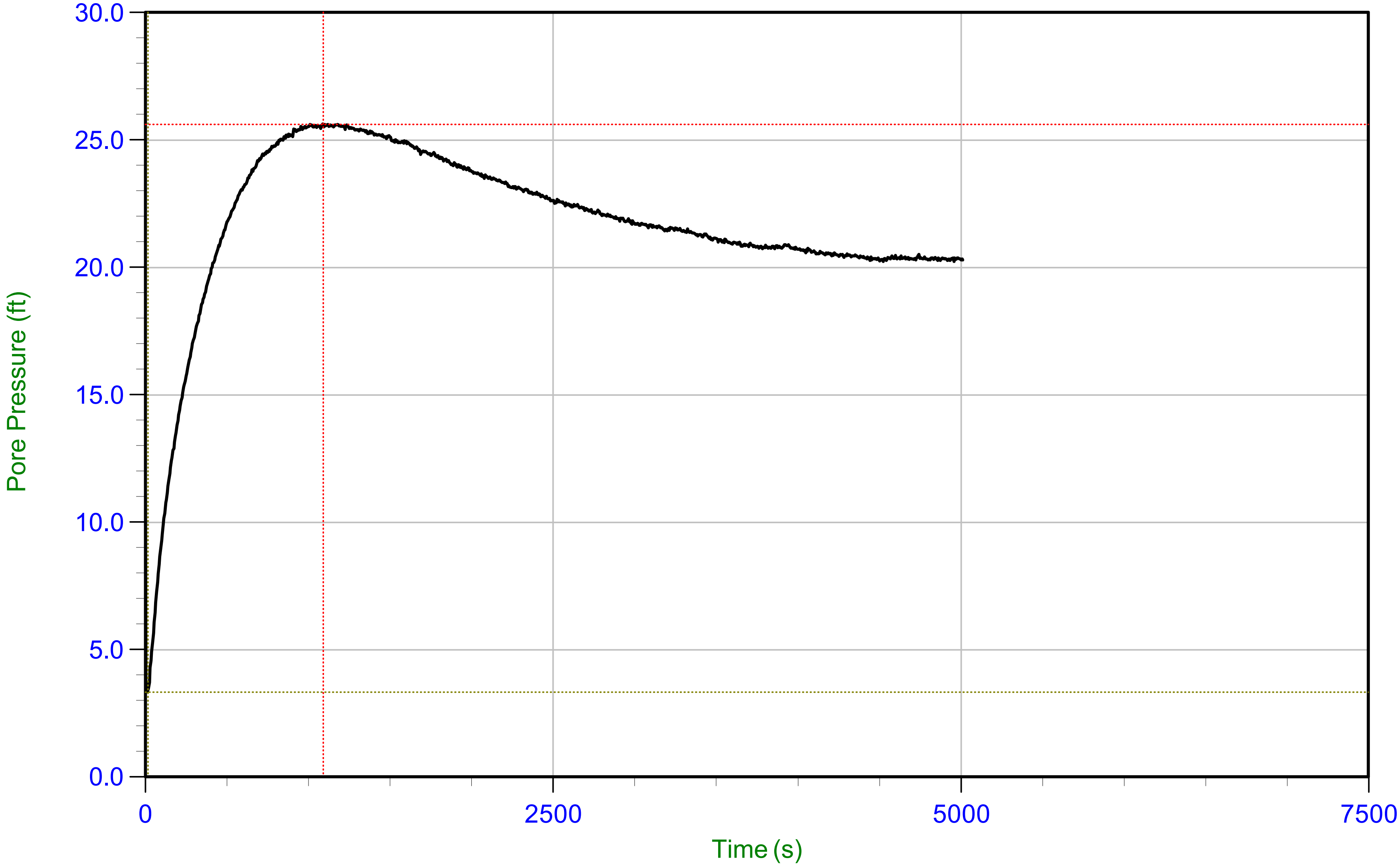
U Min: 3.1 ft
U Max: 1512.2 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/08/2015 09:40
Site: Dynegy - Newton Plant

Sounding: CPT-C012
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP012.PPD
Depth: 4.000 m / 13.123 ft
Duration: 5015.0 s

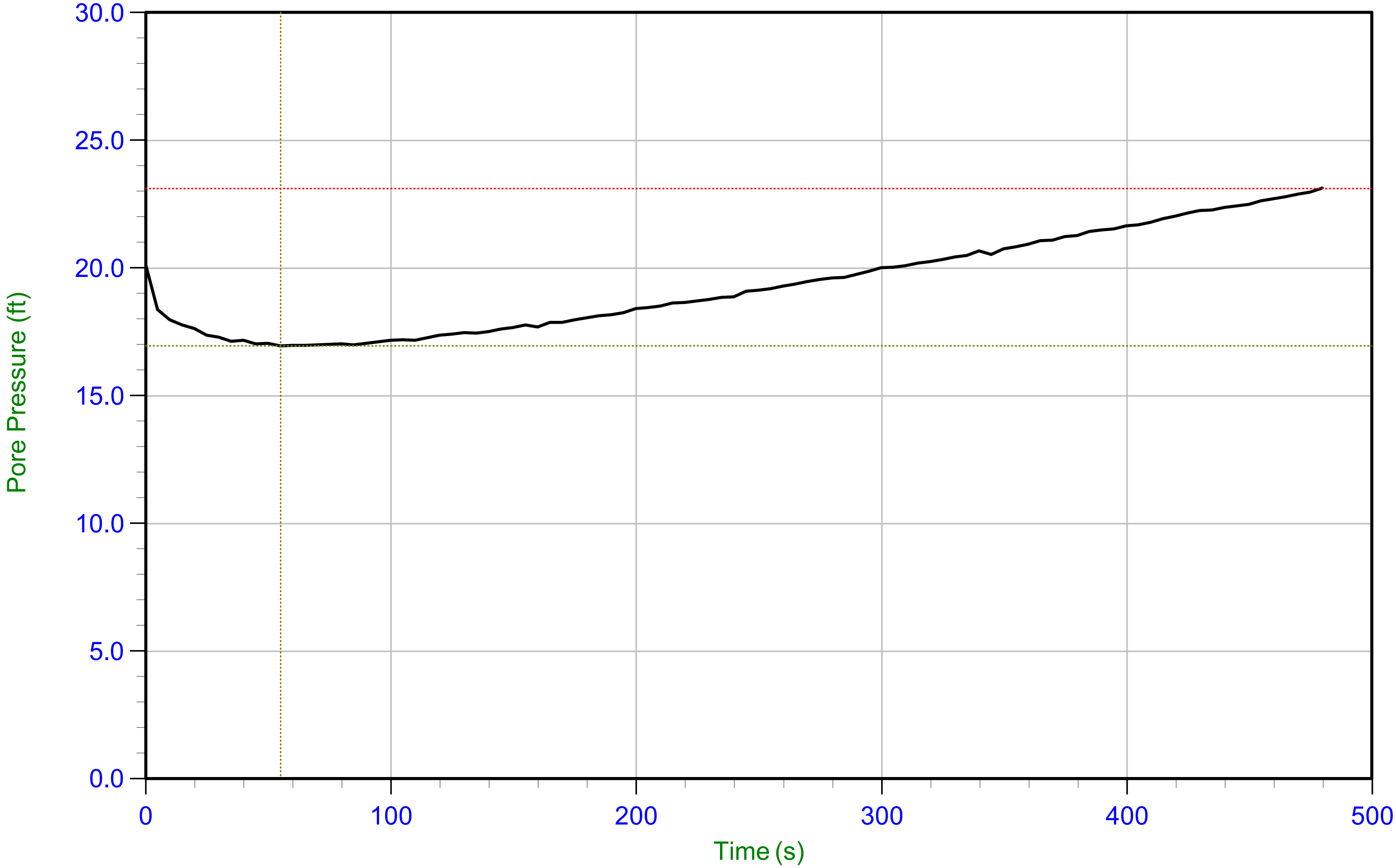
U Min: 3.3 ft
U Max: 25.6 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/08/2015 09:40
Site: Dynegy - Newton Plant

Sounding: CPT-C012
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP012.PPD
Depth: 8.000 m / 26.246 ft
Duration: 480.0 s

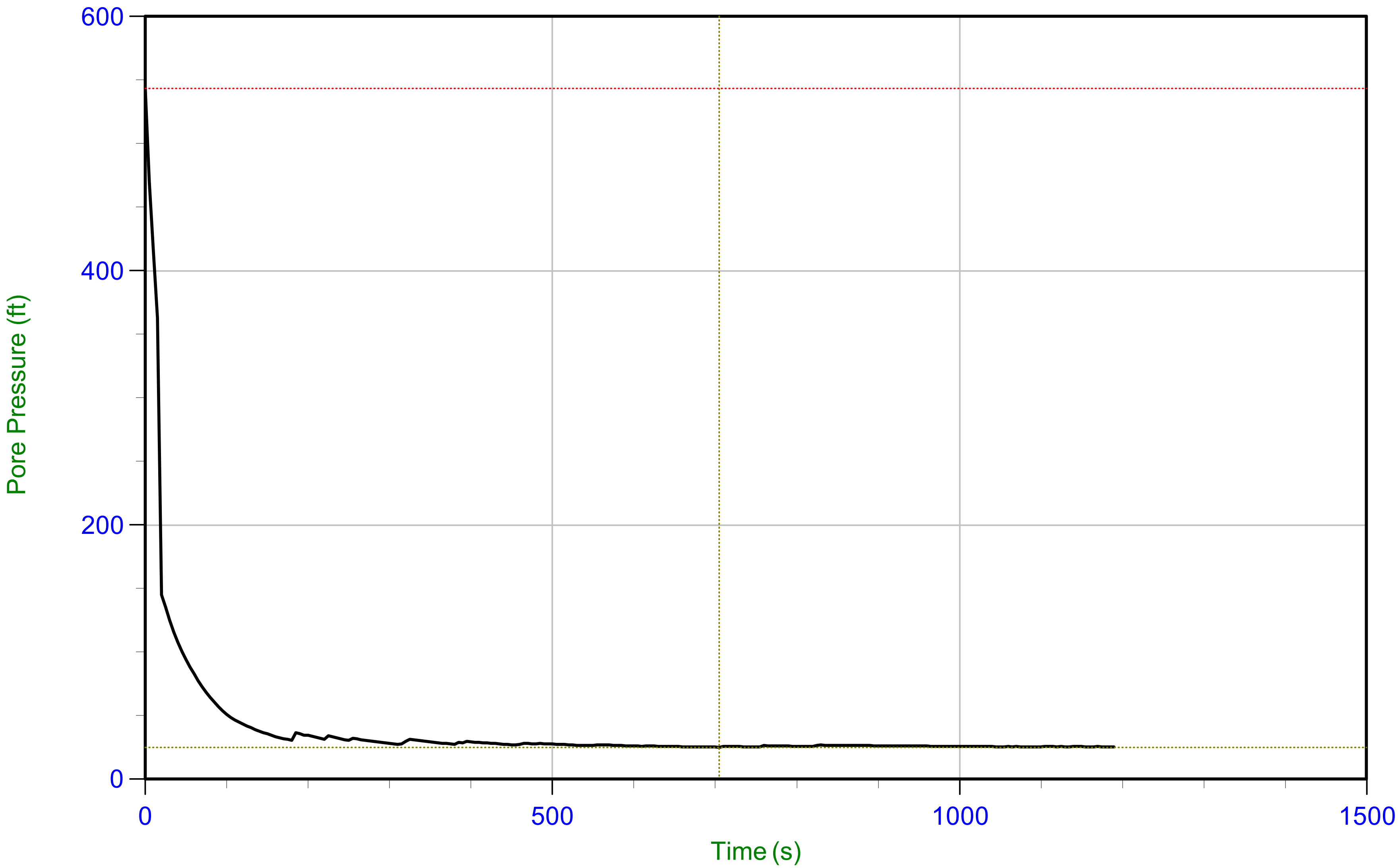
U Min: 17.0 ft
U Max: 23.1 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/08/2015 09:40
Site: Dynegy - Newton Plant

Sounding: CPT-C012
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP012.PPD
Depth: 11.350 m / 37.237 ft
Duration: 1190.0 s

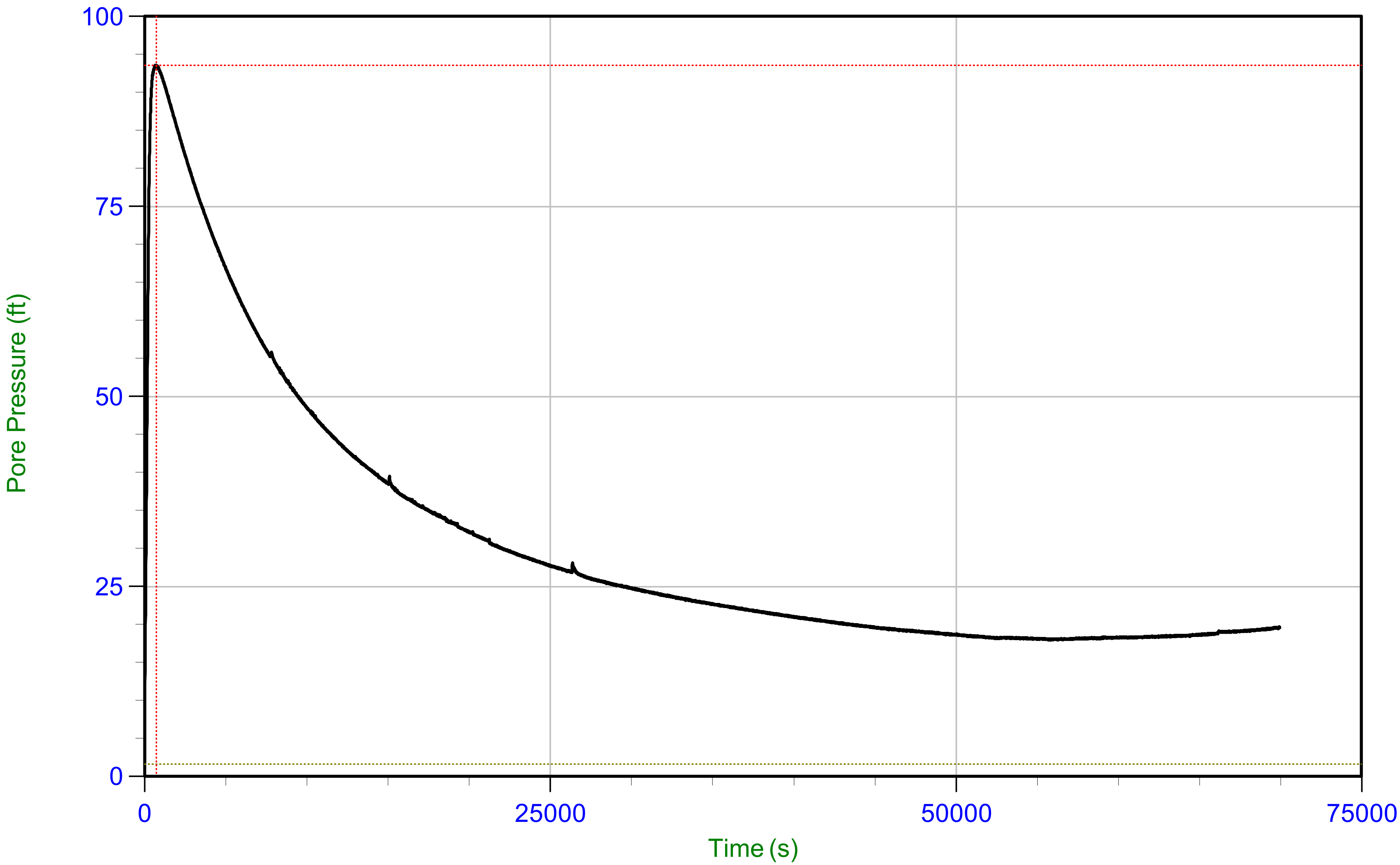
U Min: 25.1 ft
U Max: 543.6 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/05/2015 12:59
Site: Dynegy - Newton Plant

Sounding: CPT-C013
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP013.PPD
Depth: 4.000 m / 13.123 ft
Duration: 69975.0 s

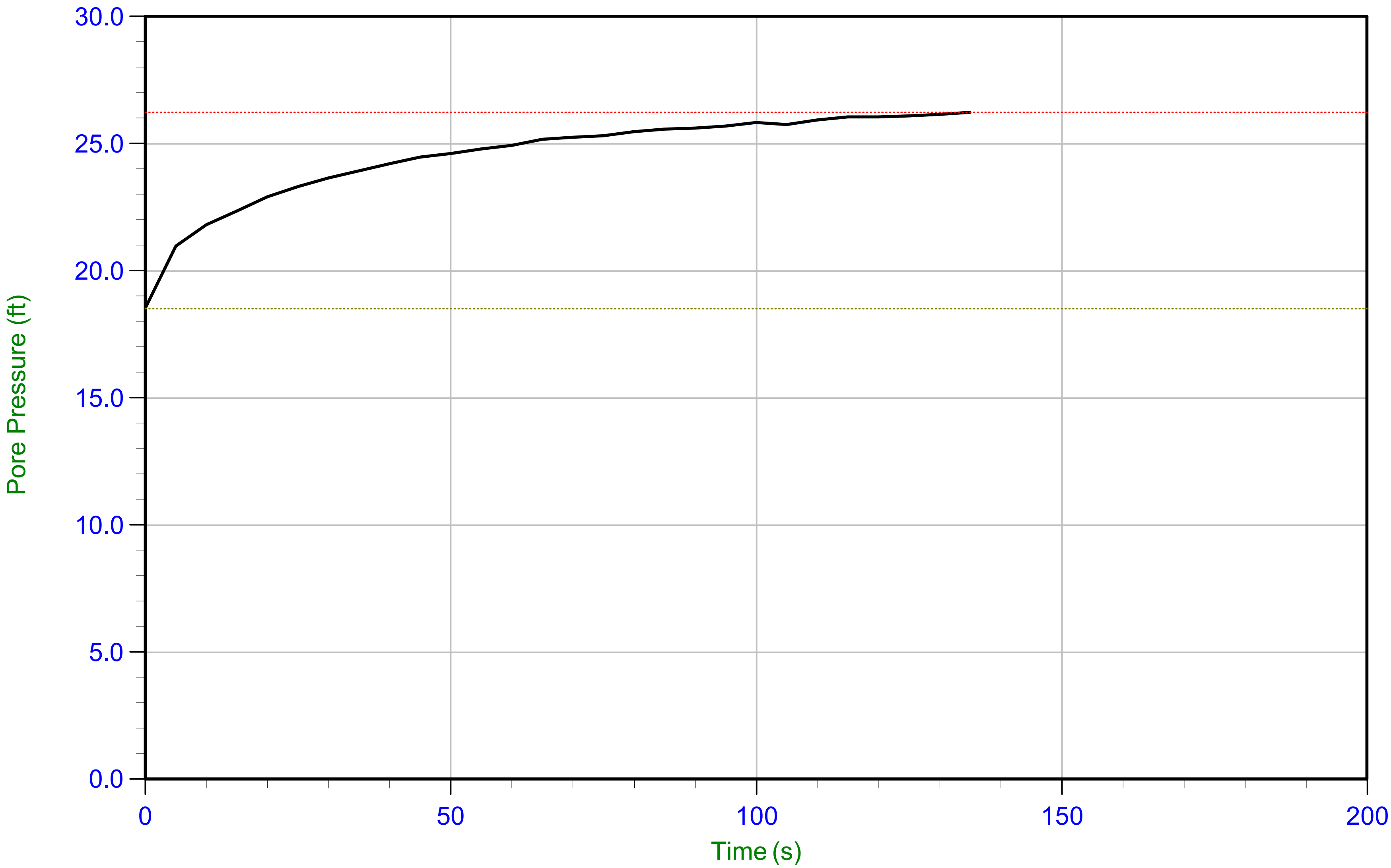
U Min: 1.7 ft
U Max: 93.6 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/05/2015 12:59
Site: Dynegy - Newton Plant

Sounding: CPT-C013
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP013.PPD
Depth: 7.400 m / 24.278 ft
Duration: 135.0 s

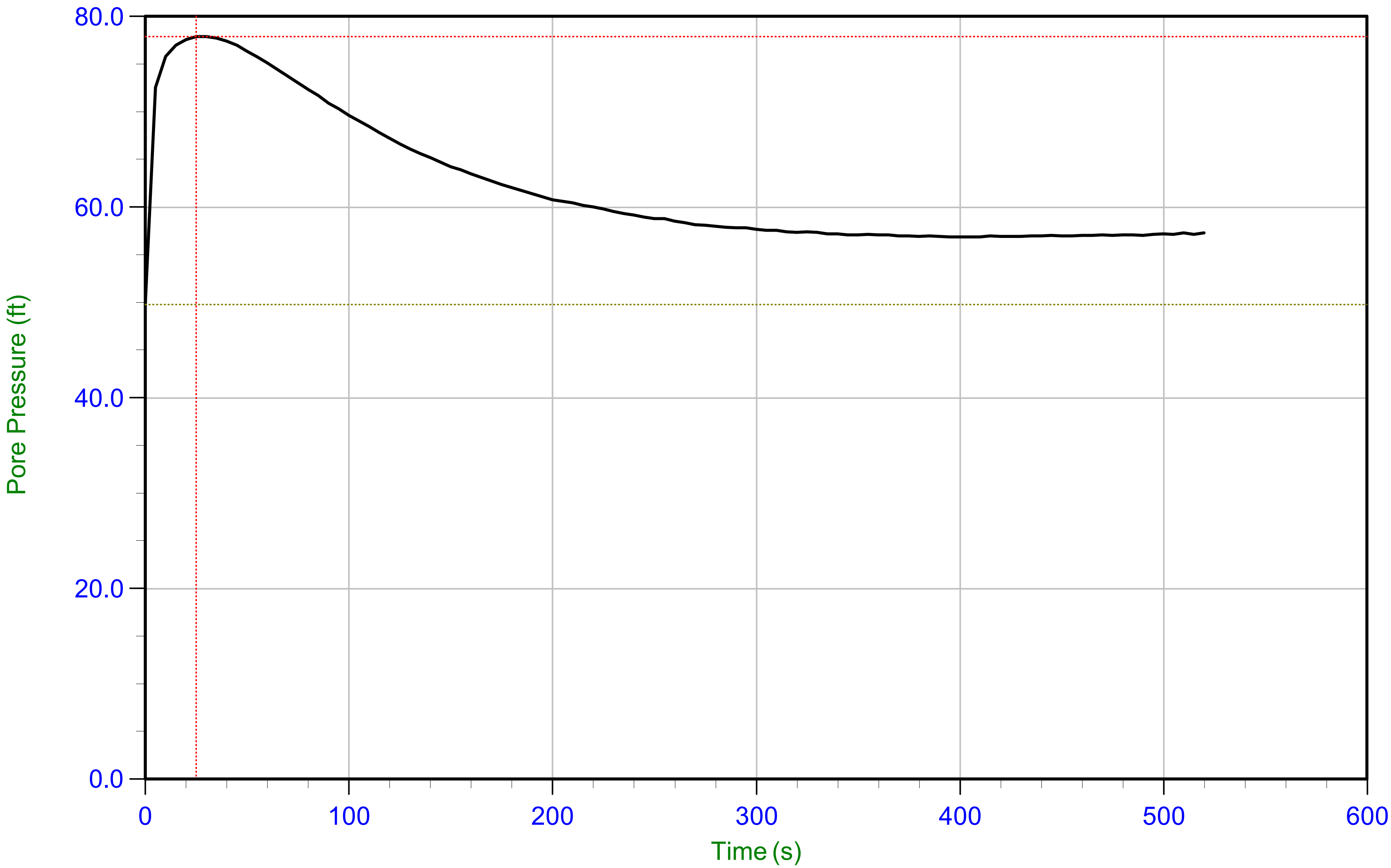
U Min: 18.5 ft
U Max: 26.2 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/05/2015 12:59
Site: Dynegy - Newton Plant

Sounding: CPT-C013
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP013.PPD
Depth: 9.250 m / 30.347 ft
Duration: 520.0 s

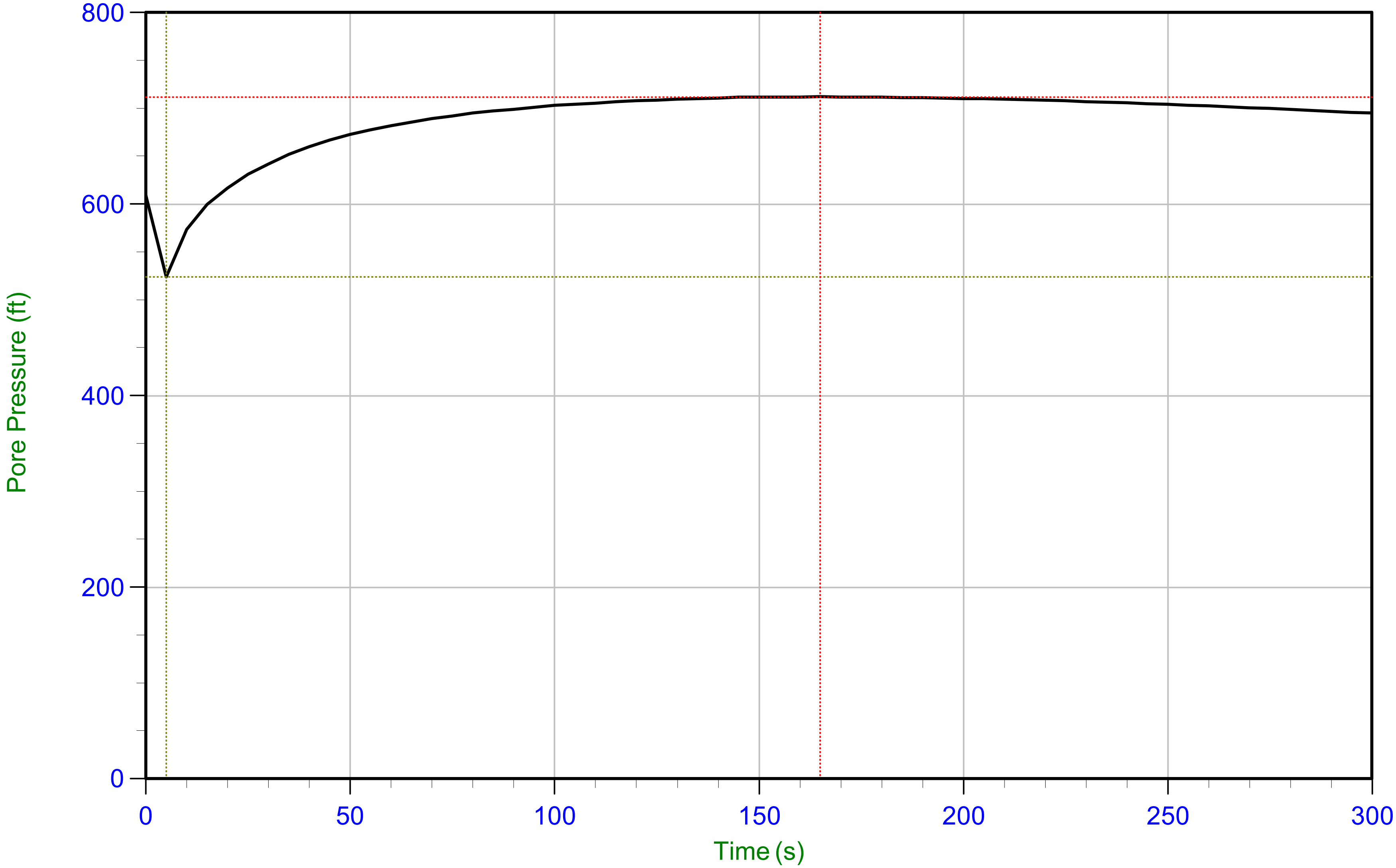
U Min: 49.8 ft
U Max: 77.9 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/05/2015 12:59
Site: Dynegy - Newton Plant

Sounding: CPT-C013
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP013.PPD
Depth: 12.200 m / 40.026 ft
Duration: 300.0 s

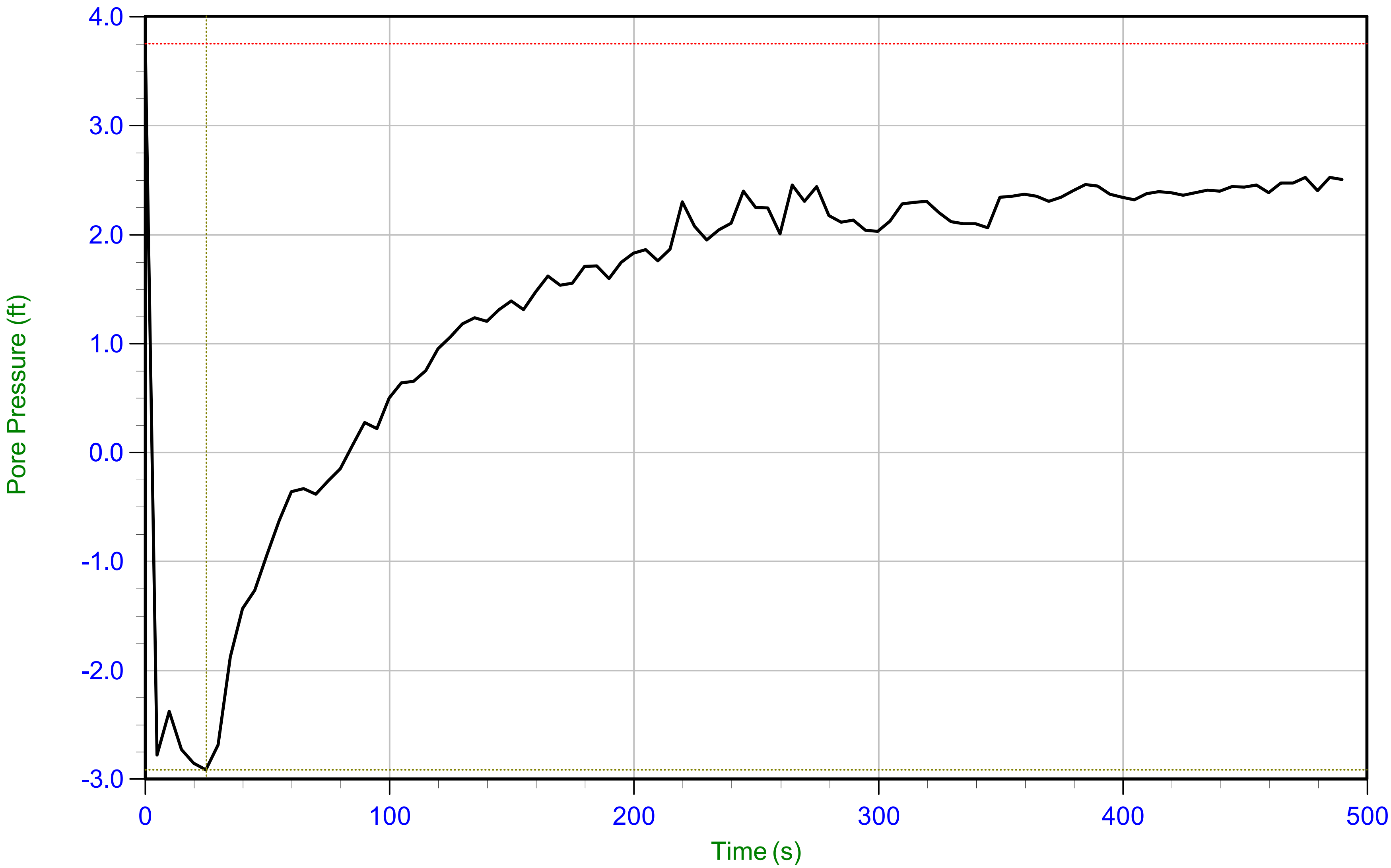
U Min: 524.1 ft
U Max: 712.2 ft

ConeTec

AECOM

Job No: 15-54068
Date: 08/08/2015 12:00
Site: Dynegy - Newton Plant

Sounding: CPT-C014
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP014.PPD
Depth: 2.800 m / 9.186 ft
Duration: 490.0 s

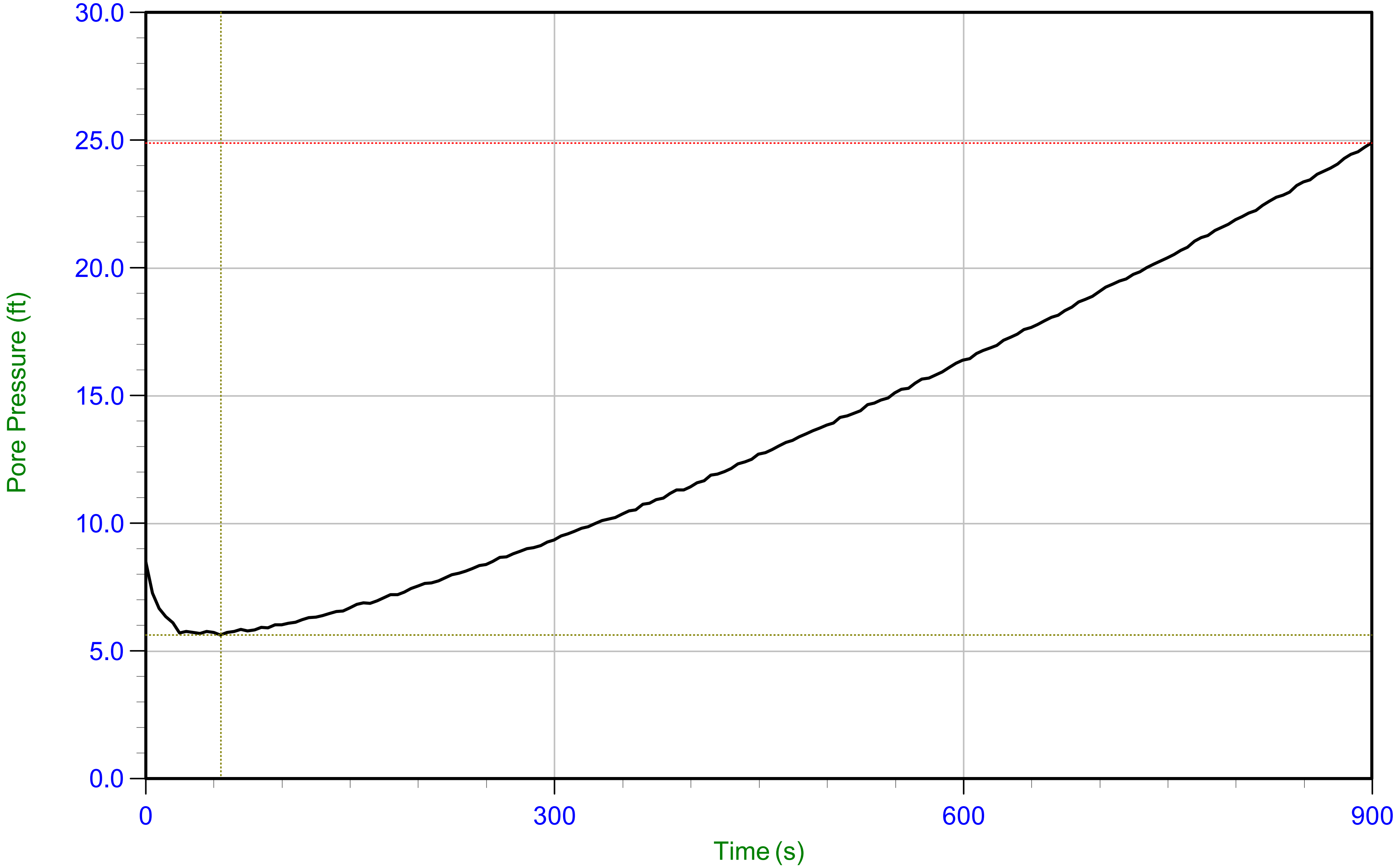
U Min: -2.9 ft
U Max: 3.8 ft

ConeTec

AECOM

Job No: 15-54068
Date: 08/08/2015 12:00
Site: Dynegy - Newton Plant

Sounding: CPT-C014
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP014.PPD
Depth: 9.000 m / 29.527 ft
Duration: 900.0 s

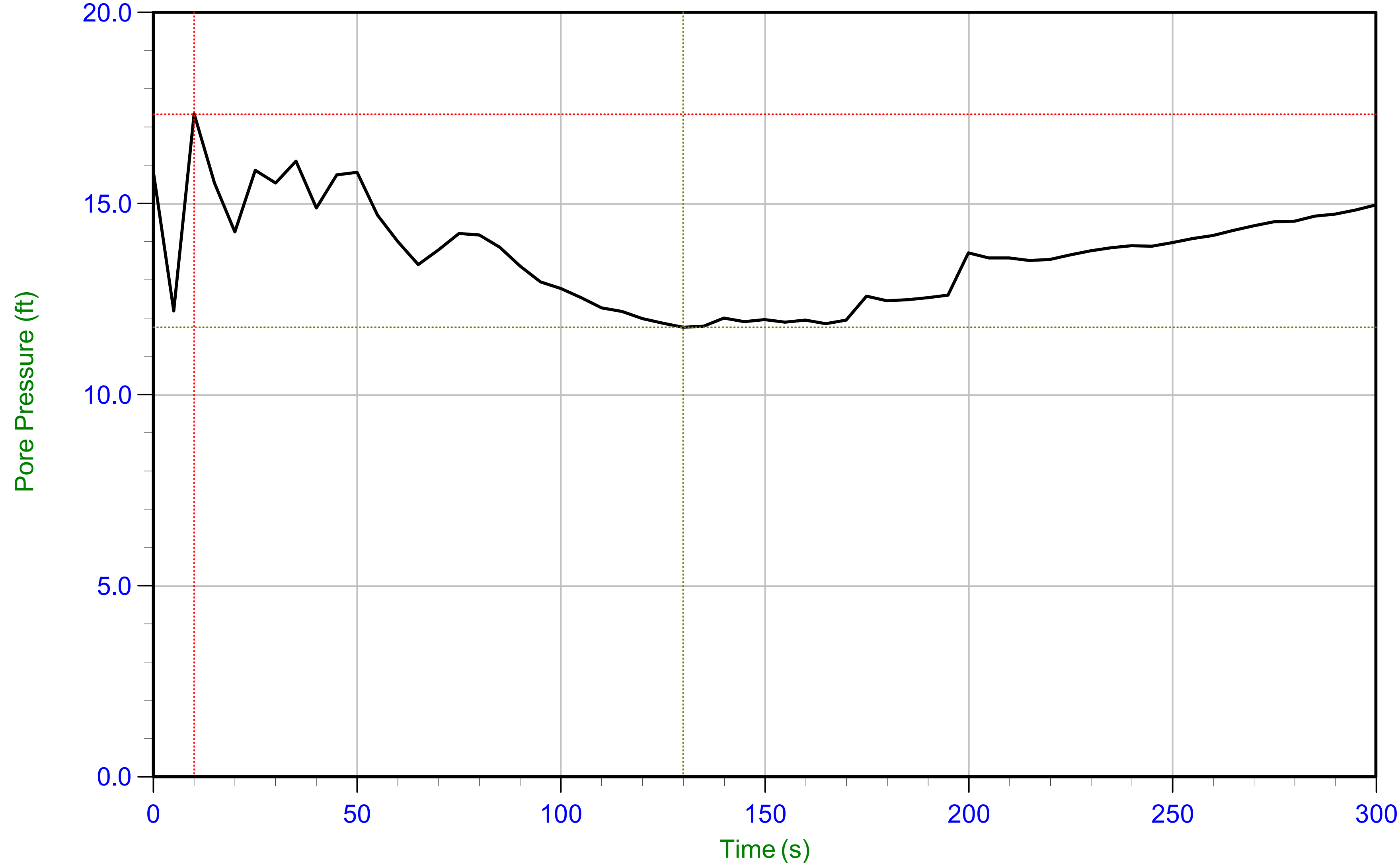
U Min: 5.6 ft
U Max: 24.9 ft

ConeTec

AECOM

Job No: 15-54068
Date: 08/06/2015 11:31
Site: Dynegy - Newton Plant

Sounding: CPT-C015
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP015.PPD
Depth: 4.300 m / 14.107 ft
Duration: 300.0 s

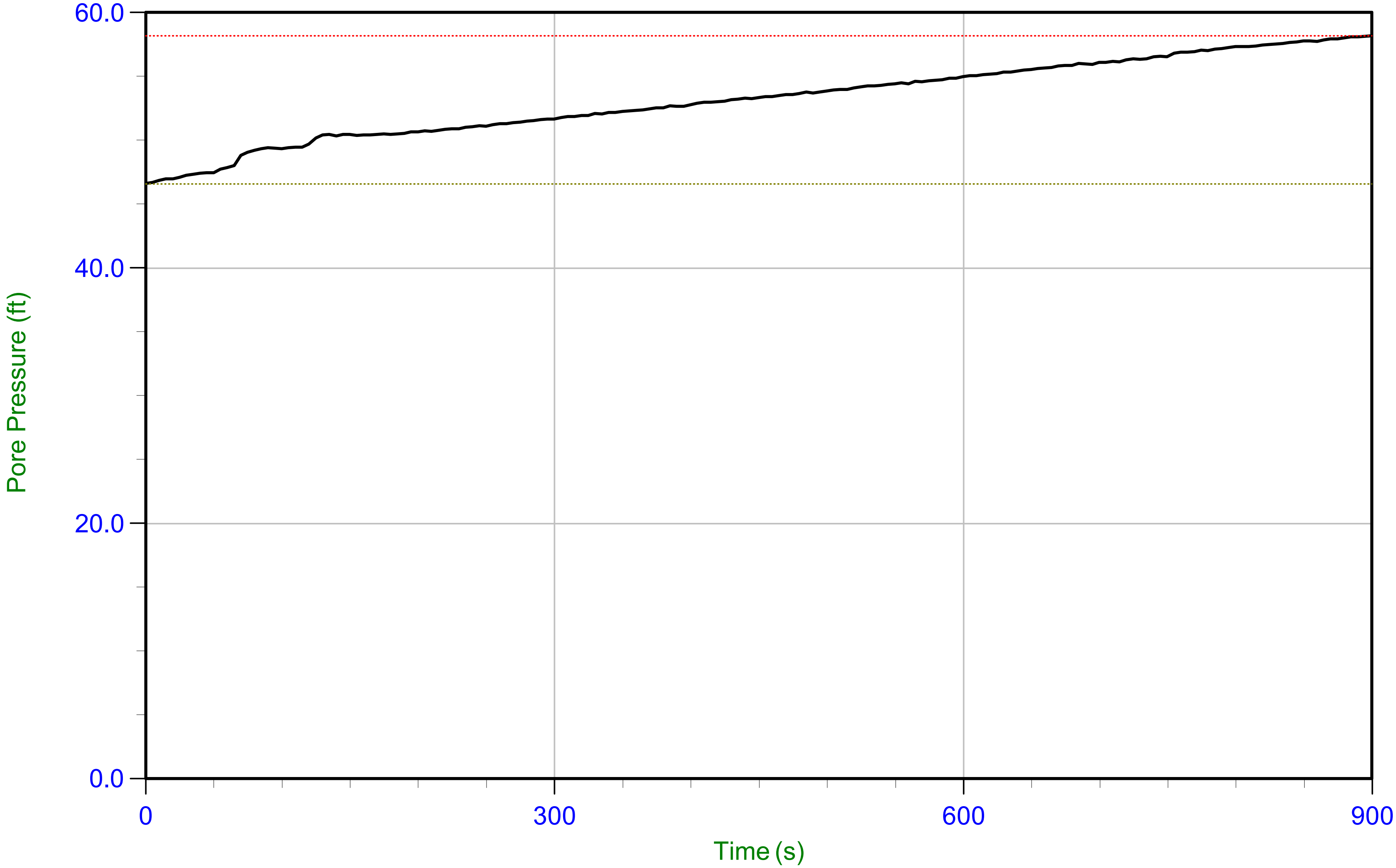
U Min: 11.8 ft
U Max: 17.3 ft

ConeTec

AECOM

Job No: 15-54068
Date: 08/06/2015 11:31
Site: Dynegy - Newton Plant

Sounding: CPT-C015
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP015.PPD
Depth: 11.150 m / 36.581 ft
Duration: 900.0 s

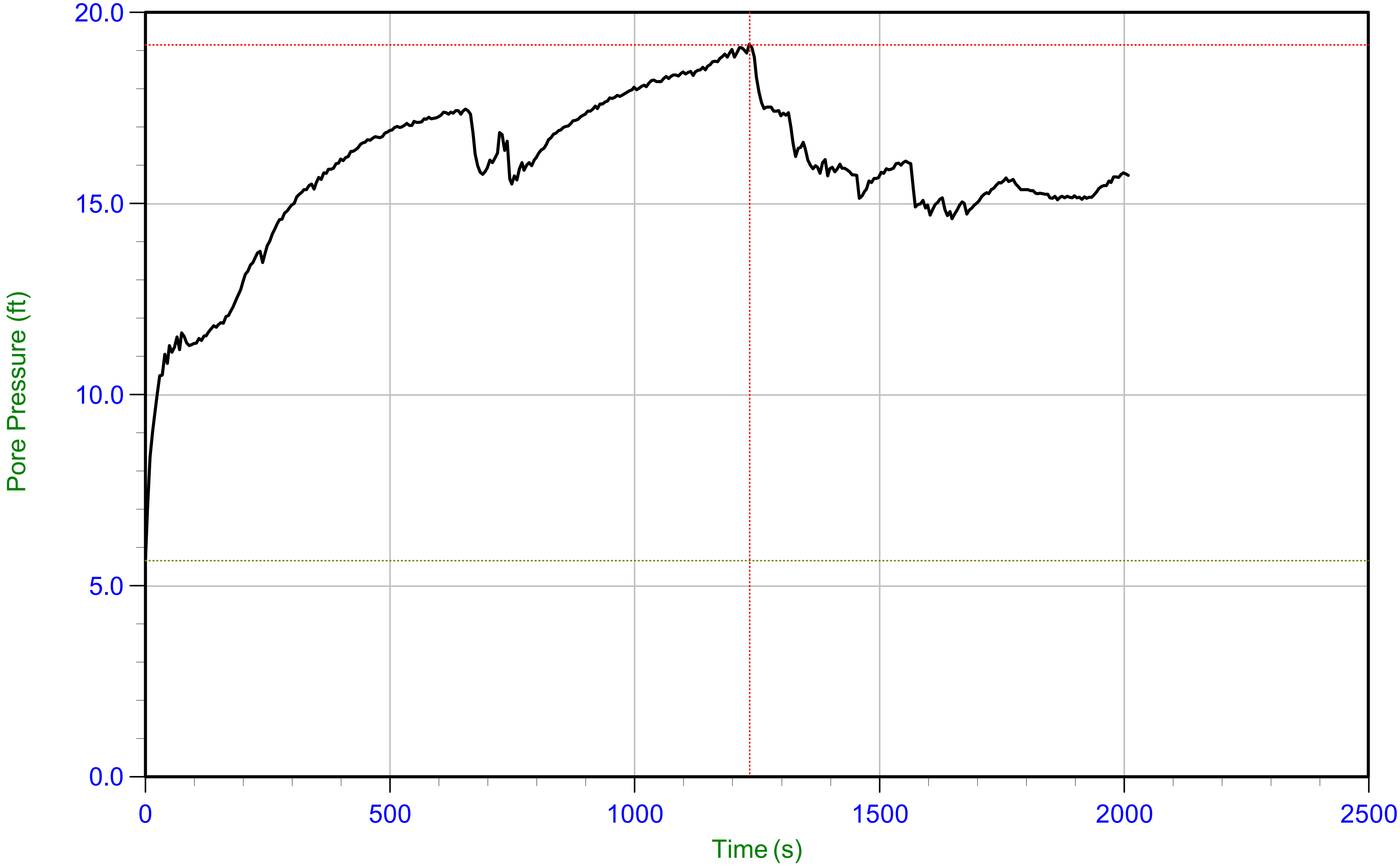
U Min: 46.6 ft
U Max: 58.2 ft

ConeTec

AECOM

Job No: 15-54068
Date: 08/08/2015 14:33
Site: Dynegy - Newton Plant

Sounding: CPT-C016
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP016.PPD
Depth: 5.200 m / 17.060 ft
Duration: 2010.0 s

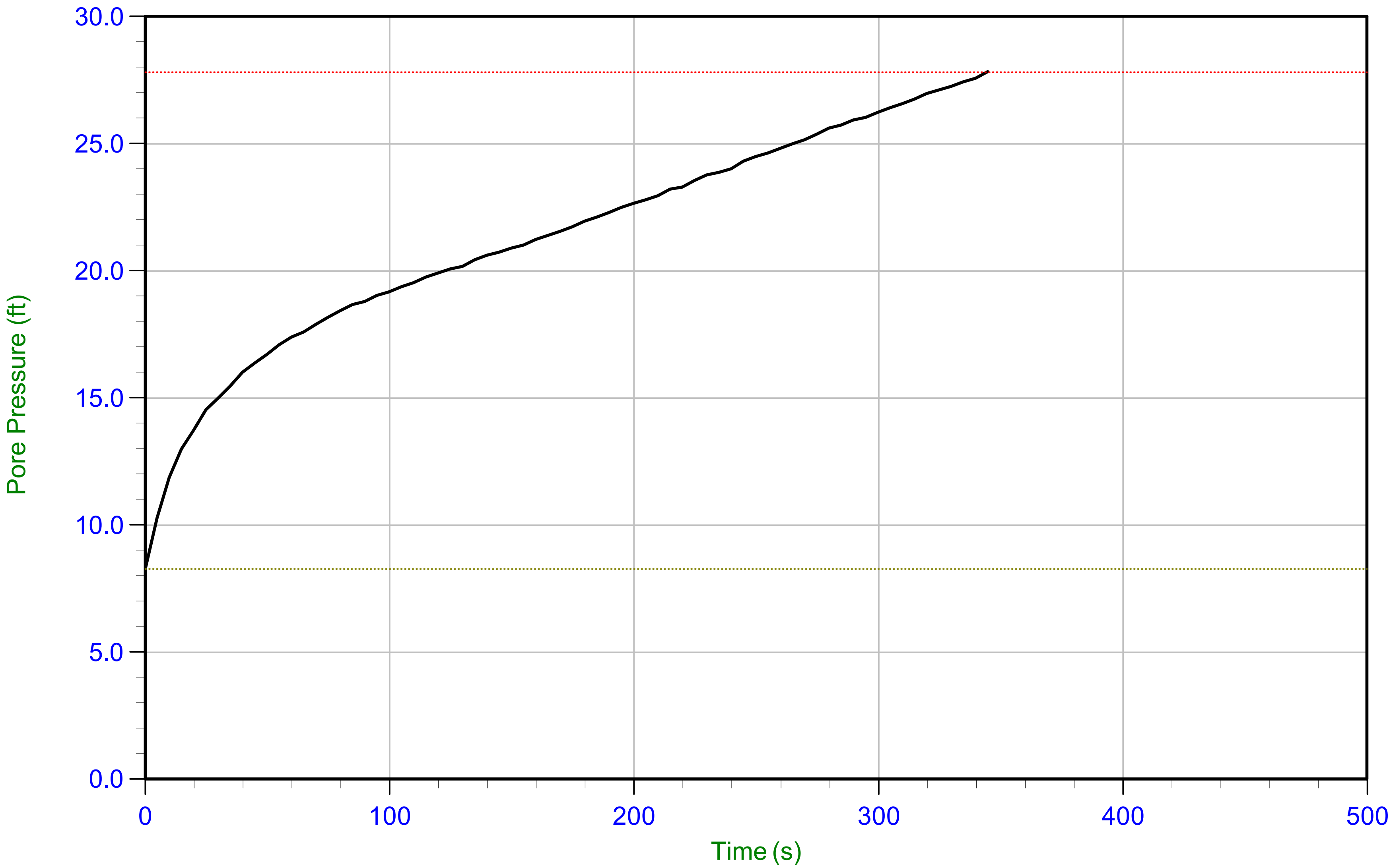
U Min: 5.7 ft
U Max: 19.2 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/08/2015 14:33
Site: Dynegy - Newton Plant

Sounding: CPT-C016
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP016.PPD
Depth: 8.800 m / 28.871 ft
Duration: 345.0 s

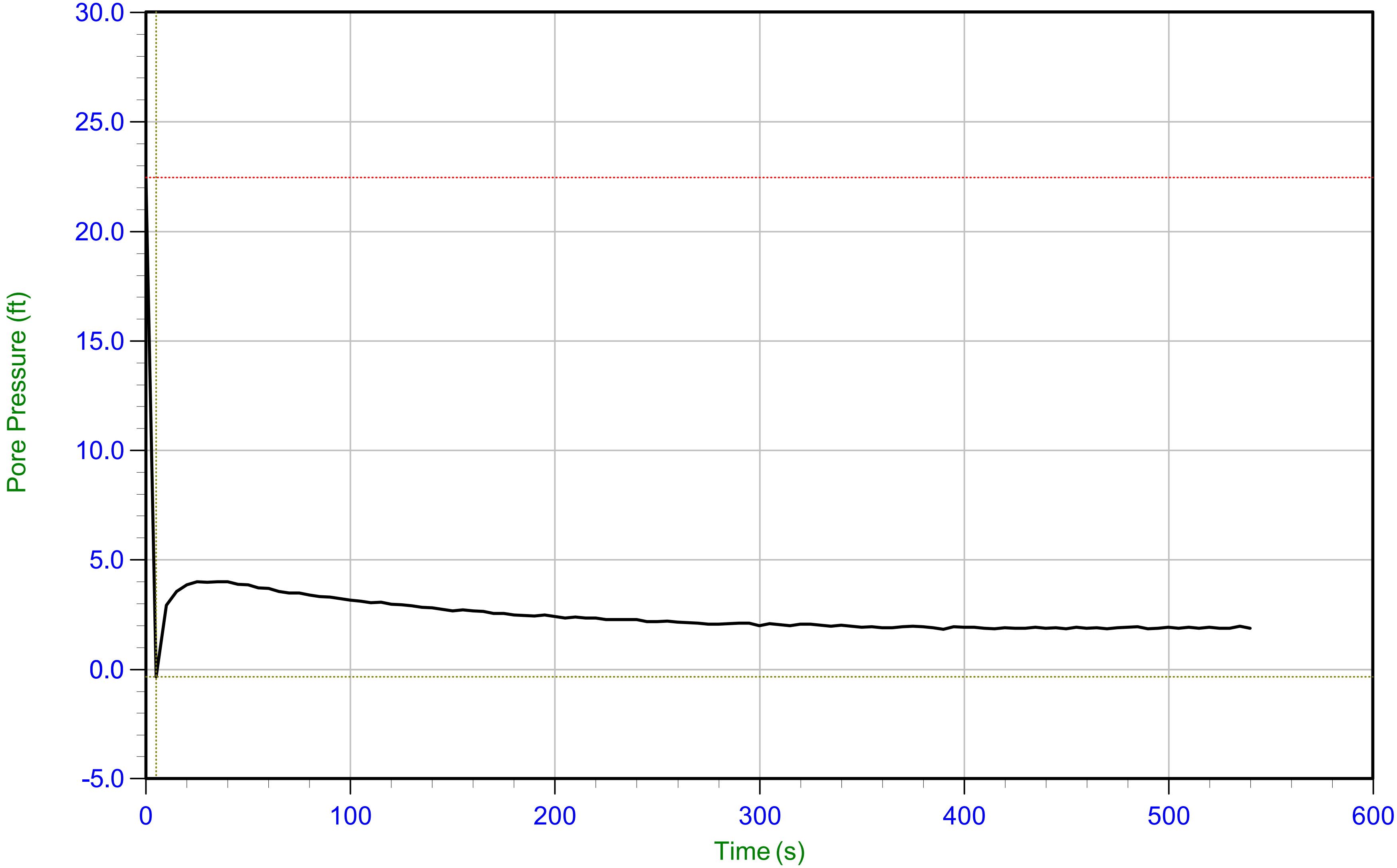
U Min: 8.3 ft
U Max: 27.8 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/08/2015 14:33
Site: Dynegy - Newton Plant

Sounding: CPT-C016
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP016.PPD
Depth: 12.000 m / 39.370 ft
Duration: 540.0 s

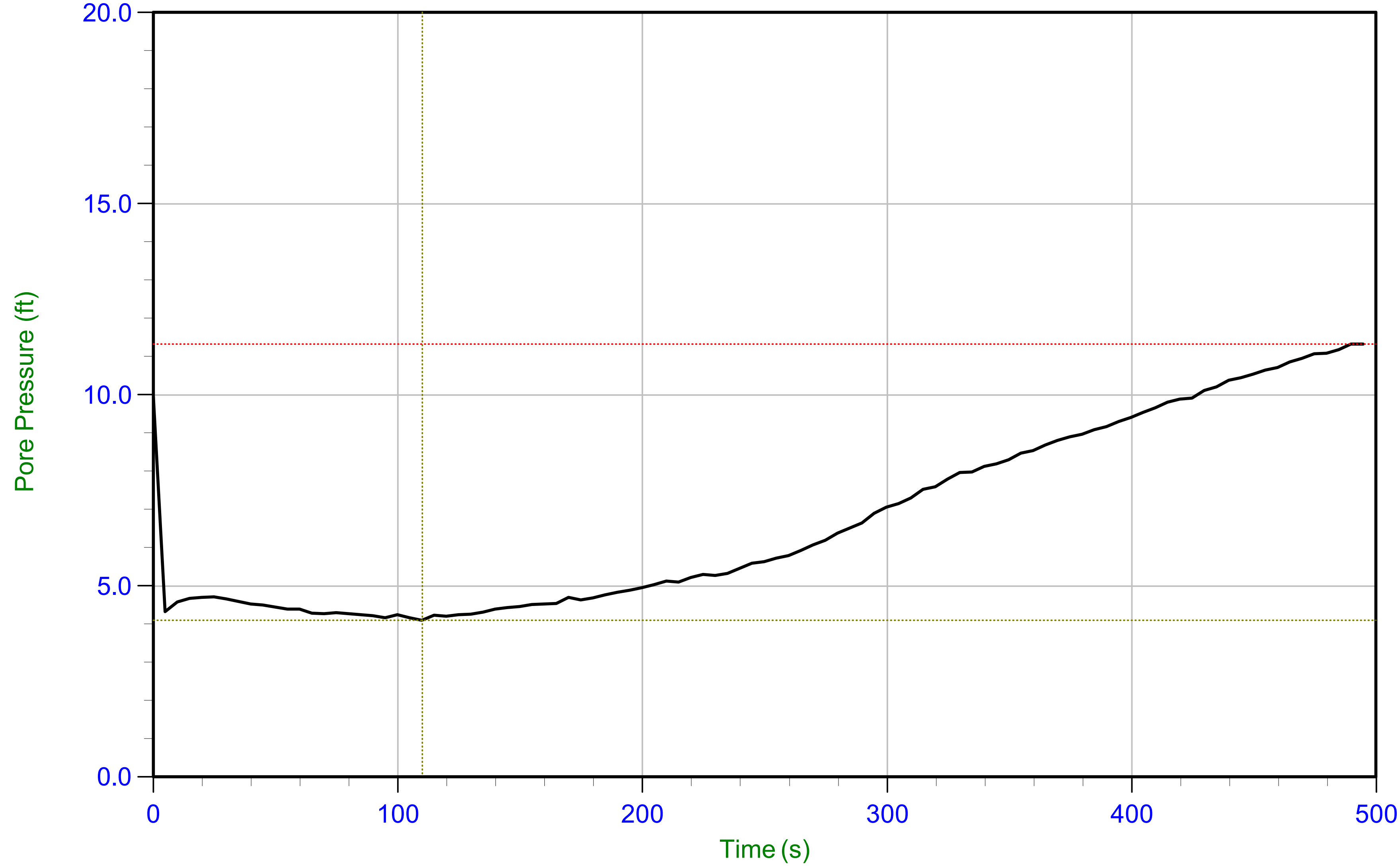
U Min: -0.3 ft
U Max: 22.5 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/09/2015 08:34
Site: Dynegy - Newton Plant

Sounding: CPT-C017
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP017.PPD
Depth: 7.300 m / 23.950 ft
Duration: 495.0 s

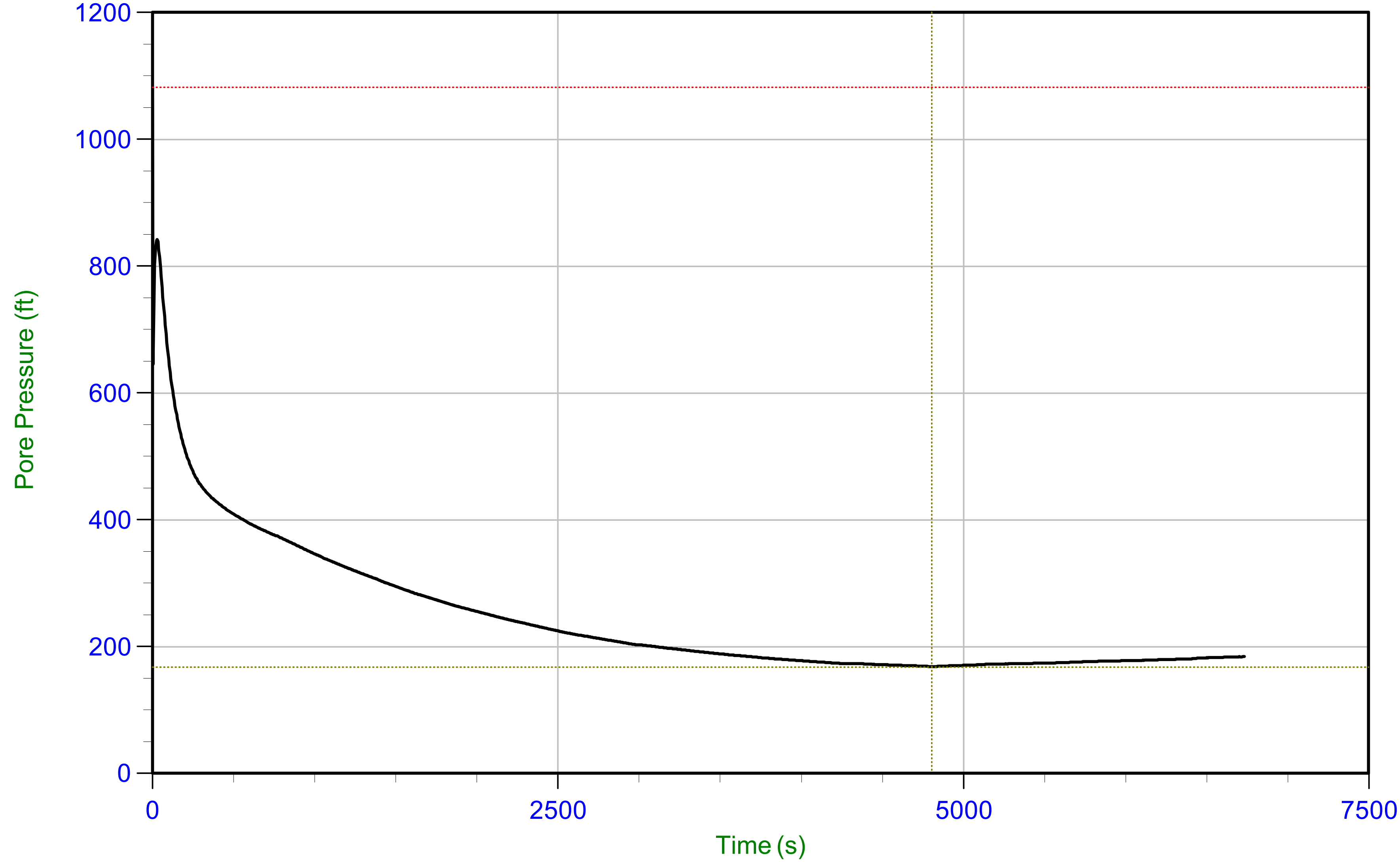
U Min: 4.1 ft
U Max: 11.3 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/09/2015 08:34
Site: Dynegy - Newton Plant

Sounding: CPT-C017
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_CP017.PPD
Depth: 11.850 m / 38.877 ft
Duration: 6735.0 s

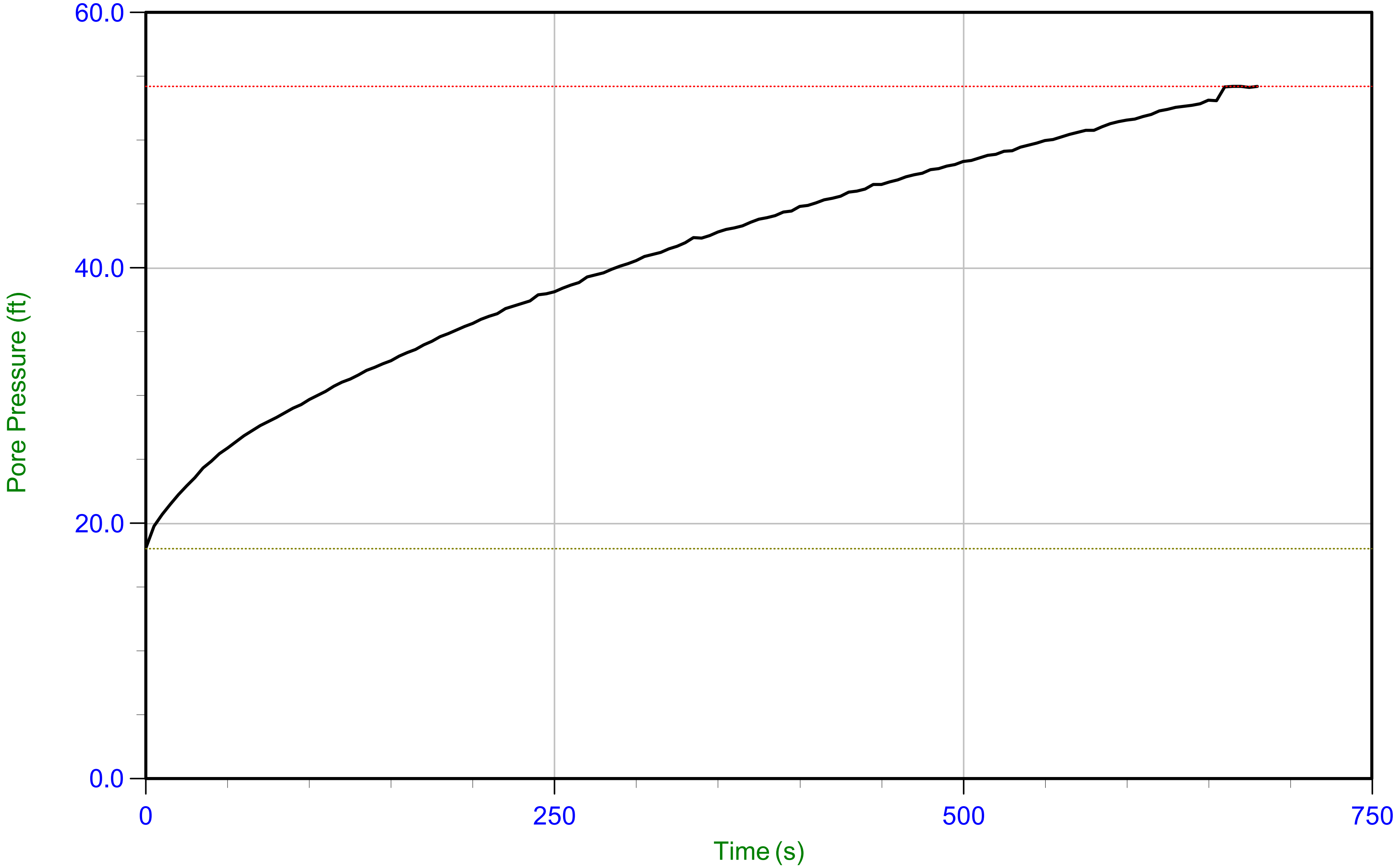
U Min: 168.3 ft
U Max: 1082.2 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/11/2015 08:32
Site: Dynegy - Newton Plant

Sounding: SCPT-SC018
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_SP018.PPD
Depth: 16.000 m / 52.493 ft
Duration: 680.0 s

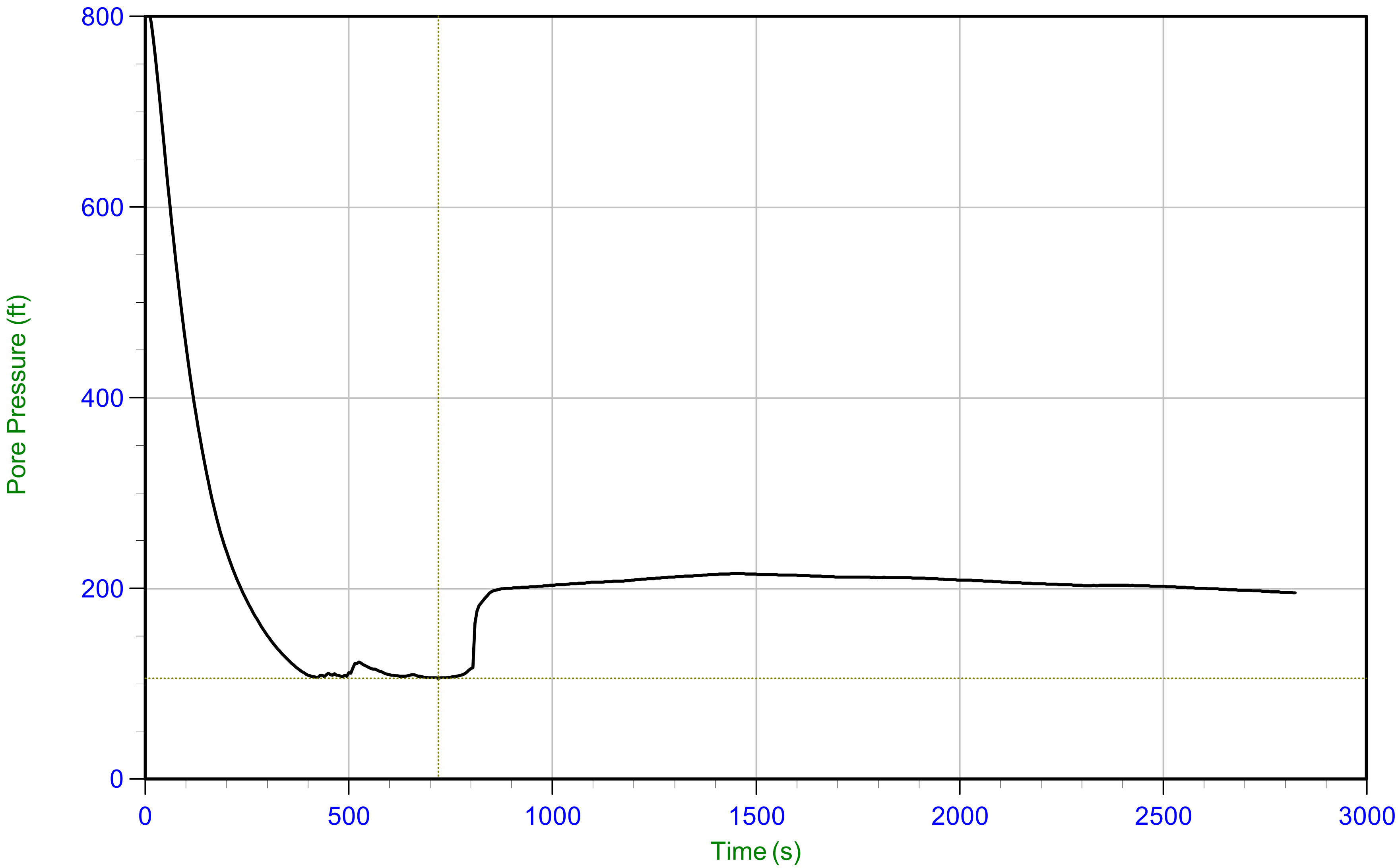
U Min: 18.0 ft
U Max: 54.2 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/11/2015 08:32
Site: Dynegy - Newton Plant

Sounding: SCPT-SC018
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_SP018.PPD
Depth: 20.750 m / 68.077 ft
Duration: 2825.0 s

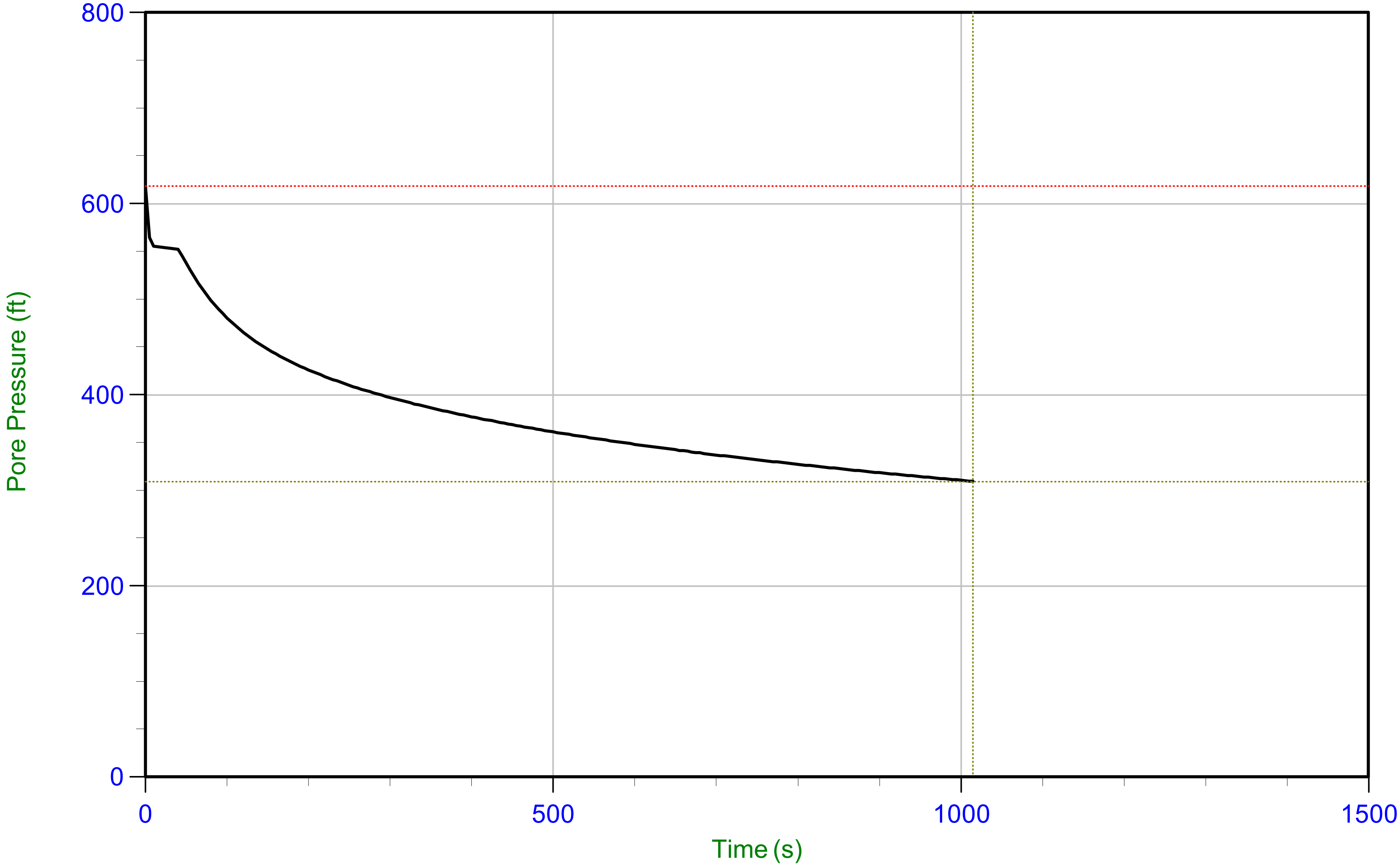
U Min: 106.1 ft
U Max: 869.6 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/11/2015 12:05
Site: Dynegy - Newton Plant

Sounding: SCPT-SC019
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_SP019.PPD
Depth: 12.000 m / 39.370 ft
Duration: 1015.0 s

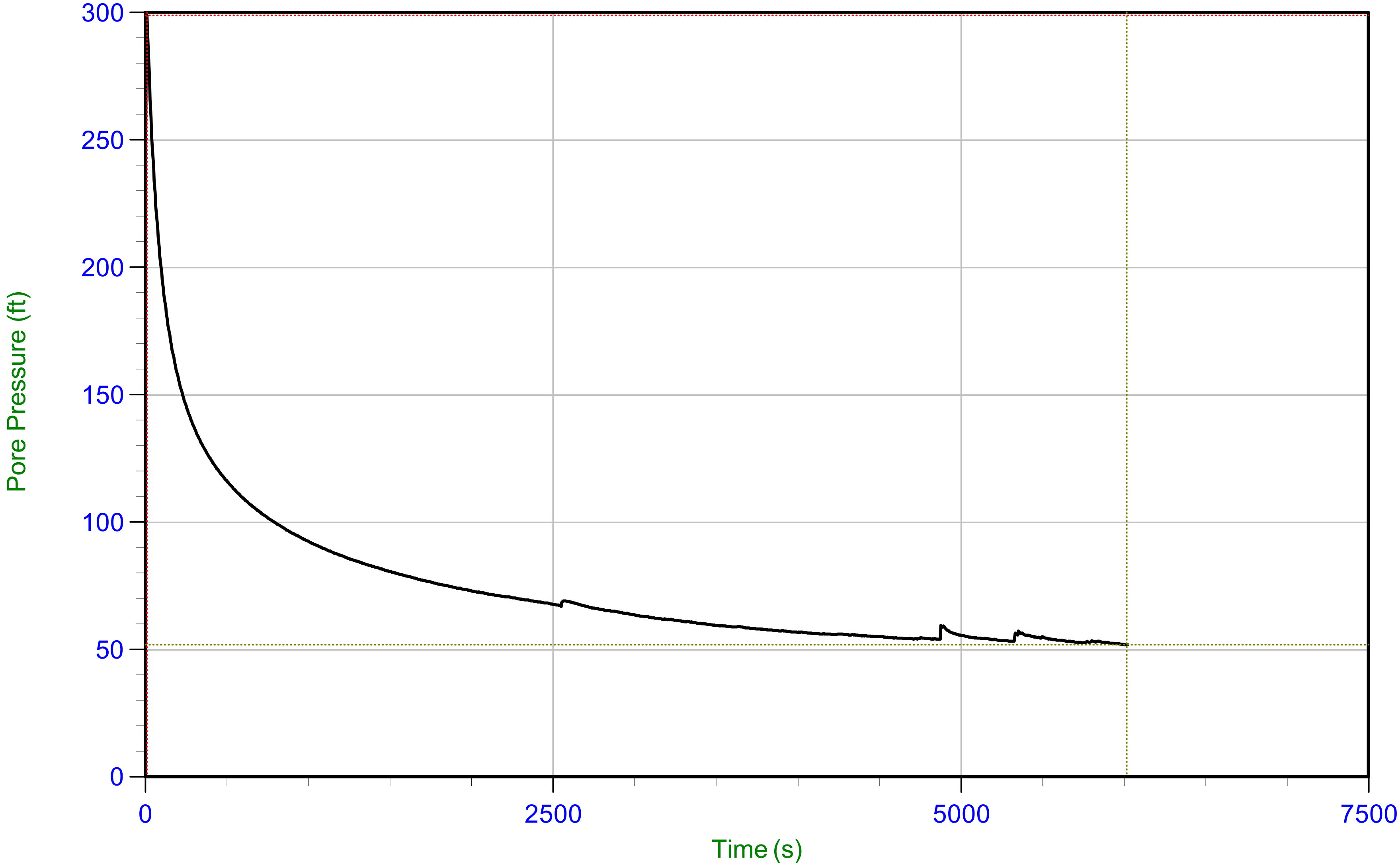
U Min: 309.4 ft
U Max: 618.5 ft

CONETEC

AECOM

Job No: 15-54068
Date: 08/11/2015 12:05
Site: Dynegy - Newton Plant

Sounding: SCPT-SC019
Cone: 392:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-54068_SP019.PPD
Depth: 12.300 m / 40.354 ft
Duration: 6025.0 s

U Min: 51.9 ft
U Max: 298.9 ft

Attachment D: Lab Test Data

AECOM #60428794-108
Dynegy CCR - Newton
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)	PERMEABILITY (cm/sec)	STRENGTH: TEST TYPE @STRESS (ksf)	PEAK SHEAR STRESS (ksf)	STRAIN @ PEAK STRESS (%)	CONSOLIDATION INITIAL CONDITIONS: VOID RATIO (-)	SATUR-ATION (%)	REMARKS
NEW-B001	ST-5	10-12								125.4								
NEW-B001	ST-5	10.55	19.3															
NEW-B001	ST-5B	10.75	18.1	50	14	36	CH	79.1		132.6	112.3		CIU@1.5	2.3	21.3			T3937
NEW-B001	ST-7	20-22								130.1								
NEW-B001	ST-7	20.3	22.8															
NEW-B001	ST-7	20.85	18.4															
NEW-B001	ST-7B	21.1	16.2	49	13	36	CL	59.9		134.5	115.7		CIU@3.0	2.6	20.6			T3939
NEW-B001	S-8	25-27	17.1				CL	65.3										
NEW-B001	S-10	35-37	15.8	25	14	11	CL	55.6	17									
NEW-B001	S-11	40-41	14.6	22	13	9	CL	57.0	11									
NEW-B001	S-13	45-47	11.8															
NEW-B001	S-15	50-52	12.3	27	18	9	CL											
NEW-B001	S-16	55-57	11.5	30	13	17	CL	63.3	16									
NEW-B001	S-18	65-67	12.8	33	14	19	CL	64.6	18									
NEW-B001	S-19	70-70.92	12.4	24	15	9	CL											
NEW-B001	S-20	75-77	13.0															
NEW-B001	S-23	90-92	12.8	28	14	14	CL											
NEW-B001	S-24	95-97	11.0				SM	13.4	2									
NEW-B003	S-3	9-11	16.1															
NEW-B003	ST-1	14-15.9								129.5								
NEW-B003	ST-1	14.55	16.3															
NEW-B003	ST-1	15.1	23.7															
NEW-B003	ST-1C	15.35	20.9	59	15	44	CH	77.3		129.5	107.1		CIU@2.5	1.7	15.7			T3940
NEW-B003	S-4	20-22	17.7															
NEW-B003	ST-2	23-24.6								130.6								
NEW-B003	ST-2	23.35	16.6															
NEW-B003	ST-2	23.9	19.5															
NEW-B003	ST-2B	24.15	19.4	43	17	26	CL	82.7		130.9	109.7		UU@4	2.5	15.0			UU296a
NEW-B003	S-5	25-27	19.2															
NEW-B003	ST-3	27.5-29.5								128.1								
NEW-B003	ST-3	28.05	19.7															
NEW-B003	ST-3B	28.3	21.2				CH			126.4	104.3	9.6E-8						P10611
NEW-B003	ST-3	28.6	22.8															
NEW-B003	ST-3C	28.8	21.1	55	16	39	CH			129.2	106.7		UU@3	3.0	15.0			UU296b

Prepared by: YC
Reviewed by: GET
Date: 11/17/2015

TerraSense, LLC
45H Commerce Way
Totowa, NJ 07512

AECOM #60428794-108
Dynegy CCR - Newton
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)	PERMEABILITY (cm/sec)	STRENGTH: TEST TYPE @STRESS (ksf)	PEAK SHEAR STRESS (ksf)	STRAIN @ PEAK STRESS (%)	CONSOLIDATION INITIAL CONDITIONS: VOID RATIO (-)	SATUR-ATION (%)	REMARKS
NEW-B003	S-6	30-32	19.6	42	14	28	CL	69.8	23									
NEW-B003	S-7	35-37	17.0	41	15	26	CL											
NEW-B003	S-8	40-42	22.9	50	18	32	CH	88.2	25									
NEW-B003	S-9B	46-47	11.7															
NEW-B003	S-12	60-62	13.3	32	35	17	CL											
NEW-B003	S-13	65-67	12.7				CL	67.6	19									
NEW-B004	S-3	5-7	13.9				CL	64.2										
NEW-B004	ST-4	8-10								132.3								
NEW-B004	ST-4	8.15	16.1															
NEW-B004	ST-4	8.7	18.5															
NEW-B004	ST-4	9.25	17.9															
NEW-B004	ST-4C	9.5	18.5	50	13	37	CH	83.9	28	131.3	110.9		CIU@0.5	1.4	17.9			T3936
NEW-B004	S-5	10-12	20.0															
NEW-B004	S-6	15-17	20.3				CL	79.3										
NEW-B004	ST-7	18-20								126.9								
NEW-B004	ST-7	18.55	18.1															
NEW-B004	ST-7	19.1	16.7															
NEW-B004	ST-7C	19.35	18.3	52	15	37	CH			128.5	108.7		CIU@3.0	2.4	20.5			T3941
NEW-B004	S-8	20-22	20.3															
NEW-B004	S-9	25-27	20.7															
NEW-B004	S-10	27.5-29.5	17.7	37	14	23	CL	61.7	25									
NEW-B004	ST-12	33-33.5								106.5								
NEW-B004	ST-12A	33.2	9.7	24	13	11	CL			136.2	124.2	6.4E-6						P10610
NEW-B004	ST-12	33.5	10.2															
NEW-B004	S-13	33.5-35.5	9.0				CL	52.8	16									
NEW-B004	S-14	36-37.92	8.9	26	13	13	CL											
NEW-B004A	S-1	45-46	10.4				CL	63.2	13									
NEW-B004A	S-2	50-52	11.3	29	15	14	CL											
NEW-B004A	S-3	55-57	10.0															
NEW-B004A	S-4	60-62	11.4				CL	68.1										
NEW-B004A	S-6	70-72	16.8	32	14	18	CL											
NEW-B004A	S-8	80-82	12.5	31	14	17	CL											
NEW-B004A	S-10	90-92	10.9															
NEW-B004A	S-11	95-97	11.1				SW-SM	11.2	3									

AECOM #60428794-108
Dynegy CCR - Newton
LABORATORY TESTING DATA SUMMARY

BORING	SAMPLE	DEPTH	IDENTIFICATION TESTS									PERMEABILITY	STRENGTH			CONSOLIDATION		REMARKS
			WATER	LIQUID	PLASTIC	PLAS.	USCS	SIEVE	HYDRO.	TOTAL	DRY		TEST	PEAK	STRAIN	INITIAL CONDITIONS		
NO.	NO.		CONTENT	LIMIT	LIMIT	INDEX	SYMB.	MINUS	% MINUS	UNIT	UNIT		TYPE	SHEAR	@ PEAK	VOID	SATUR-	
							(1)	NO. 200	2 µm	WEIGHT	WEIGHT		@STRESS	STRESS	STRESS	RATIO	ATION	
		(ft)	(%)	(-)	(-)	(-)		(%)	(%)	(pcf)	(pcf)	(cm/sec)	(ksf)	(ksf)	(%)	(-)	(%)	
NEW-B005	S-3	5-7	17.9	47	15	32	CL											
NEW-B005	S-5	10-12	9.8	24	13	11	CL											
NEW-B005	S-6	15-16.5	9.4	27	12	15	CL	54.6	16									
NEW-B005	S-7	20-20.92	10.8	26	13	13	CL											
NEW-B005	S-8	25-26	11.6				CL	54.6	18									
NEW-B005	S-10	35-37	11.3				ML	66.4										
NEW-B005	S-11	40-42	14.0															
NEW-B005	S-12	45-47	13.1	33	15	18	CL	70.2	19									
NEW-B006	S-3	10-12	21.2	66	14	52	CH	88.2	36									
NEW-B006	ST-1	20-22								128.0								
NEW-B006	ST-1	20.4	21.6															
NEW-B006	ST-1	20.95	16.4															
NEW-B006	ST-1B	21.2	18.2	40	17	23	CL	78.4	22	130.8	110.6		UU@3.5	2.3	8.7			UU301f
NEW-B006	ST-2	25-27								140.1								
NEW-B006	ST-2	25.4	17.9															
NEW-B006	ST-2	25.95	18.2															
NEW-B006	ST-2	26.5	18.6															
NEW-B006	ST-2C	26.75	19.7	44	12	32	CL	65.6	28	128.8	107.6		CIU@7.5	3.0	12.8			T3945
NEW-B006	S-6	27-29	19.4	54	13	41	CH											
NEW-B006	ST-3	30-32								133.0								
NEW-B006	ST-3	30.45	29.1															
NEW-B006	ST-3	31.0	20.4															
NEW-B006	ST-3B	31.25	20.7				CL			130.6	108.1	1.6E-7						P10597
NEW-B006	ST-3	31.55	18.5															
NEW-B006	ST-3C	31.8	18.3	37	15	22	CL	52.1	21	133.3	112.8		CIU@7.2	4.0	14.8			T3915
NEW-B006	S-7	32-34	17.5															
NEW-B006	ST-4	35-35.8		30	13	17	CL	58.3	20	148.8								
NEW-B006	ST-4	35.4	11.1				CL			140.2	126.2		DS@9	6.6				DS1619
NEW-B006	ST-4	35.6	15.8				CL			147.4	127.2		DS@18	11.5				DS1617
NEW-B006	ST-4	35.7	11.2															
NEW-B006	S-9	40-42	13.0															
NEW-C006	ST-1	10-12								115.2								
NEW-C006	ST-1	10.5	26.7															
NEW-C006	ST-1	11.05	27.1															

Prepared by: YC
Reviewed by: GET
Date: 11/17/2015

TerraSense, LLC
45H Commerce Way
Totowa, NJ 07512

Project No.: T60428794
File: Indx1.xls

AECOM #60428794-108
Dynegy CCR - Newton
LABORATORY TESTING DATA SUMMARY

BORING	SAMPLE	DEPTH	IDENTIFICATION TESTS									PERMEABILITY	STRENGTH			CONSOLIDATION		REMARKS
			WATER	LIQUID	PLASTIC	PLAS.	USCS	SIEVE	HYDRO.	TOTAL	DRY		TEST	PEAK	STRAIN	INITIAL CONDITIONS		
NO.	NO.		CONTENT	LIMIT	LIMIT	INDEX	SYMB.	MINUS	% MINUS	UNIT	UNIT		TYPE	SHEAR	@ PEAK	VOID	SATUR-	
							(1)	NO. 200	2 μm	WEIGHT	WEIGHT		@STRESS	STRESS	STRESS	RATIO	ATION	
		(ft)	(%)	(-)	(-)	(-)		(%)	(%)	(pcf)	(pcf)	(cm/sec)	(ksf)	(ksf)	(%)	(-)	(%)	
NEW-C006	ST-1B	11.3	25.2	54	16	38	CH			124.1	99.2		CIU@1.5	1.2	13.7			T3916
NEW-C006	ST-2	12-14								121.4								
NEW-C006	ST-2	12.75	19.3															
NEW-C006	ST-2B	13.0	18.9	53	14	39	CH			131.5	110.6		CIU@2.0	2.4	16.7			T3917
NEW-B007	S-4	7.5-9.5	13.2															
NEW-B007	ST-1	10-12								131.6								
NEW-B007	ST-1	10.75	16.5															
NEW-B007	ST-1	11.3	17.3															
NEW-B007	ST-1C	11.55	15.4	38	14	24	CL			135.1	117.1		CIU@1.0	2.3	21.5			T3933
NEW-B007	ST-2	20-22								143.6								
NEW-B007	ST-2	20.25	10.1															
NEW-B007	ST-2	20.8	12.7															
NEW-B007	ST-2B	21.0	12.1	30	13	17	CL	52.3		140.5	125.4		CIU@2.5	3.7	21.1			T3934
NEW-B007	S-6	25-27	16.3															
NEW-B007	ST-3	30-32								131.1								
NEW-B007	ST-3	30.35	17.8															
NEW-B007	ST-3	30.9	20.1															
NEW-B007	ST-3	31.45	19.2															
NEW-B007	ST-3C	31.7	21.5	52	12	40	CH	71.5	29	132.0	108.6		UU@6.0	2.6	11.7			UU288d
NEW-B007	S-7	35-37	14.8															
NEW-B007	ST-4	40-42																
NEW-B007	ST-4	40.85	25.1															
NEW-B007	ST-4B	41.0	17.5	57	13	44	CH			129.9	110.5		DS@5	2.7				DS1620
NEW-B007	ST-4C	41.3	14.7				CH			128.7	112.2		DS@10	5.4				DS1621
NEW-B007	ST-4B	41.5	16.1				CH			132.6	114.2		DS@15	7.6				DS1622
NEW-B007	ST-5	50-51.5								131.5								
NEW-B007	ST-5A	50.3	16.3				CH			137.1	117.9	5.1E-9						P10598
NEW-B007	ST-5	50.8	14.0															
NEW-B007	ST-5B	51.05	13.9	32	16	16	CL			136.1	119.5		DSS@7.6	3.5	5.6			DSS855
NEW-B008	ST-1	15-17								132.9								
NEW-B008	ST-1	15.85	11.1															
NEW-B008	ST-1	16.4	16.9															
NEW-B008	ST-1C	16.65	16.7	50	13	37	CH	74.4		136.3	116.8		UU@2.5	3.1	15.0			UU288e
NEW-B008	S-4	20-22	20.1															

AECOM #60428794-108
Dynegy CCR - Newton
LABORATORY TESTING DATA SUMMARY

BORING	SAMPLE	DEPTH	IDENTIFICATION TESTS									PERMEABILITY	STRENGTH			CONSOLIDATION		REMARKS
			WATER	LIQUID	PLASTIC	PLAS.	USCS	SIEVE	HYDRO.	TOTAL	DRY		TEST	PEAK	STRAIN	INITIAL CONDITIONS		
NO.	NO.		CONTENT	LIMIT	LIMIT	INDEX	SYMB.	MINUS	% MINUS	UNIT	UNIT		TYPE	SHEAR	@ PEAK	VOID	SATUR-	
							(1)	NO. 200	2 μm	WEIGHT	WEIGHT		@STRESS	STRESS	STRESS	RATIO	ATION	
		(ft)	(%)	(-)	(-)	(-)		(%)	(%)	(pcf)	(pcf)	(cm/sec)	(ksf)	(ksf)	(%)	(-)	(%)	
NEW-B008	S-5	22.5-24.5	22.6															
NEW-B008	S-6	25-27	23.2															
NEW-B008	ST-2	27.5-28.75								130.3								
NEW-B008	ST-2A	27.7	20.3				CL			122.5	101.8		DS@2	1.2				DS1624
NEW-B008	ST-2B	28	14.4	49	14	35	CL			133.8	117.0		DS@4	2.9				DS1626
NEW-B008	ST-2C	28.4	16.4				CL			133.2	114.5		DS@8	4.4				DS1628
NEW-B008	S-7	35-37	13.8															
NEW-B008	S-8	40-42	14.6				SC	46.9	9									
NEW-B008	S-10	50-51.5	15.4	32	16	16	CL	65.4	20									
NEW-B009	ST-1	9-11								131.1								
NEW-B009	ST-1	9.5	20.0															
NEW-B009	ST-1B	9.75	19.0	47	15	32	CL			132.3	111.2		UU@2.0	2.5	15.0			UU288f
NEW-B009	S-3	14-16	15.3															
NEW-B009	S-4	19-21	18.3															
NEW-B009	ST-2	29-31.3								128.8								
NEW-B009	ST-2B	30.0	16.7	31	14	17	CL			132.6	113.6		CIU@4.0	2.9	10.5			T3942
NEW-B009	ST-2	30.35	19.5															
NEW-B009	S-6	34-35.5	8.6	24	12	12	CL	51.6										
NEW-B009	S-7	37.5-38	16.9		19	NP	ML											
NEW-B009	S-9	42.5-44.5	15.0															
NEW-B009	S-10	50-52	13.7				CL	74.0	21									
NEW-B009	S-11	55-57	14.6															
NEW-B009	S-12	60-62	13.5	24	16	8	CL	66.4	18									
NEW-B009	S-14	70-71.42	12.2				CL	51.5	12									
NEW-B010	ST-1	5-7								137.3								
NEW-B010	ST-1	5.55	10.9															
NEW-B010	ST-1	6.1	15.8															
NEW-B010	ST-1C	6.3	10.2	24	13	11	CL			140.5	127.5		CIU@1.0	4.4	21.3			T3943
NEW-B010	S-4	10-12	13.7															
NEW-B010	ST-2	15-17								137.9								
NEW-B010	ST-2	15.7	13.9															
NEW-B010	ST-2	16.25	12.7															
NEW-B010	ST-2C	16.5	13.8	33	13	20	CL			137.3	120.6		CIU@2	3.5	20.9			T3944
NEW-B010	S-5	20-22	16.1															

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Dynegy CCR - Newton
LABORATORY TESTING DATA SUMMARY

BORING	SAMPLE	DEPTH	IDENTIFICATION TESTS									PERMEABILITY	STRENGTH			CONSOLIDATION		REMARKS
			WATER	LIQUID	PLASTIC	PLAS.	USCS	SIEVE	HYDRO.	TOTAL	DRY		TEST	PEAK	STRAIN	INITIAL CONDITIONS		
NO.	NO.		CONTENT	LIMIT	LIMIT	INDEX	SYMB.	MINUS	% MINUS	UNIT	UNIT		TYPE	SHEAR	@ PEAK	VOID	SATUR-	
							(1)	NO. 200	2 µm	WEIGHT	WEIGHT		@STRESS	STRESS	STRESS	RATIO	ATION	
		(ft)	(%)	(-)	(-)	(-)		(%)	(%)	(pcf)	(pcf)	(cm/sec)	(ksf)	(ksf)	(%)	(-)	(%)	
NEW-B010	S-6	25-27	19.1															
NEW-B010	S-7	30-32	21.0	49	16	33	CL	62.3	24									
NEW-B010	S-8	35-37	8.5	23	12	11	CL											
NEW-B010	S-12	47.5-48.2	13.5															
NEW-B010	S-13	50-50.8	10.1				SC	22.3	6									
NEW-B010	S-16	65-67	15.0				CL	70.6										
NEW-B010	S-18	75-77	14.5	28	15	13	CL											
NEW-B010	S-19	80-82	14.7	25	15	10	CL											
NEW-B012	ST-4	8-10								134.0								
NEW-B012	ST-4	8.65	15.5															
NEW-B012	ST-4	9.2	14.9															
NEW-B012	ST-4C	9.45	12.6	34	13	21	CL			139.6	123.9		UU@1.5	4.1	15.0			UU296d
NEW-B012	ST-7	20-21.7								135.0								
NEW-B012	ST-7	20.35	14.8															
NEW-B012	ST-7A	20.6	13.3				CL			137.1	121.0	7.8E-9						P10609
NEW-B012	ST-7	20.9	16.7															
NEW-B012	ST-7B	21.15	13.3	35	13	22	CL	52.1		138.4	122.1		CIU@2.5	3.2	21.8			T3938
NEW-B012	S-8	25-27	15.2	36	13	23	CL											
NEW-B012	S-9	30-32	12.9															
NEW-B012	S-10	35-37	16.8	40	15	25	CL											
NEW-B012	S-11	40-42	9.9				CL	55.9	17									
NEW-B012	ST-12	45-47								131.7								
NEW-B012	ST-12	45.55	19.8															
NEW-B012	ST-12	46.15	14.3															
NEW-B012	ST-12C	46.4	17.5	43	14	29	CL	62.1	30	133.6	113.8		CIU@6	3.4	23.3			T3883
NEW-B012	S-13	50-52	20.0															
NEW-B012	S-14	55-57	15.8	41	13	28	CL											
NEW-B012	ST-15	60-62								136.2								
NEW-B012	ST-15	60.65	18.7															
NEW-B012	ST-15	61.2	14.1															
NEW-B012	ST-15C	61.45	12.8	42	14	28	CL			132.5	117.6		DSS@7.2	2.8	7.1			DSS849
NEW-B012	S-17	70-72	10.9															
NEW-B012	S-18	75-77	11.8	29	13	16	CL	53.3	17									
NEW-B012	ST-19	80-82								139.7								

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Dynegy CCR - Newton
LABORATORY TESTING DATA SUMMARY

BORING	SAMPLE	DEPTH	IDENTIFICATION TESTS									PERMEABILITY	STRENGTH			CONSOLIDATION		REMARKS
																INITIAL CONDITIONS		
NO.	NO.	(ft)	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)	(cm/sec)	TEST TYPE @STRESS (ksf)	PEAK SHEAR STRESS (ksf)	STRAIN @ PEAK STRESS (%)	VOID RATIO (-)	SATUR-ATION (%)	
NEW-B012	ST-19	80.85	12.2															
NEW-B012	ST-19	80.95	11.7															
NEW-B012	ST-19	81.1	11.2	25	14	11	SC			136.8	122.9		DS@6	4.2				DS1611
NEW-B012	ST-19	81.5	10.5				SC			139.2	126.0		DS@24	15.1				DS1612
NEW-B012	ST-19	81.8	16.9				SC			130.5	111.7		DS@12	7.2				DS1613
NEW-B012	S-20	85-87	16.2	34	14	20	CL											
NEW-B012	S-22	95-97	15.7															
NEW-B014	ST-1	2.5-4.1								140.5								
NEW-B014	ST-1A	2.95																
NEW-B014	ST-1	3.25	13.5															
NEW-B014	ST-1B	3.5	9.5	28	13	15	SC	46.2	16	142.7	130.3		UU@0.5	5.8	8.4			UU260f
NEW-B014	S-3	7.5-9.5	13.7	41	14	27	CL											
NEW-B014	S-4	10-12	18.7	42	15	27	CL											
NEW-B014	ST-2	15-16.9								133.8								
NEW-B014	ST-2	15.6	11.6															
NEW-B014	ST-2B	15.85	12.2	31	14	17	CL			139.2	124.1		EXT CIU	-1.6	-8.4			TE15001
NEW-B014	ST-2	16.15	10.2															
NEW-B014	S-5	20-22	9.6				SC	49.8										
NEW-B014	S-6	25-27	16.1	40	15	25	CL	59.0										
NEW-B014	S-7	30-31.33	16.7															
NEW-B014	S-7A	31.33-32	17.5				CL	60.4										
NEW-B014	ST-3	35-37								135.0								
NEW-B014	ST-3	35.3	19.7															
NEW-B014	ST-3	35.85	15.9															
NEW-B014	ST-3	36.4	12.6															
NEW-B014	ST-3C	36.65	16.3	38	13	25	SC	13.5	4	132.6	114.0		CIU@3	4.2	12.9			T3884
NEW-B014	S-8	40-42	16.2	39	14	25	CL											
NEW-B014	S-10	48-50	17.5															
NEW-B015	ST-1	10-12								130.3								
NEW-B015	ST-1A	10.4																
NEW-B015	ST-1	10.7	20.7															
NEW-B015	ST-1B	10.95	23.0	59	15	44	CH			126.0	102.5		CIU@1.5	1.3	18.0			T3885
NEW-B015	S-5	15-17	18.4															
NEW-B015	S-6	20-22	18.2															

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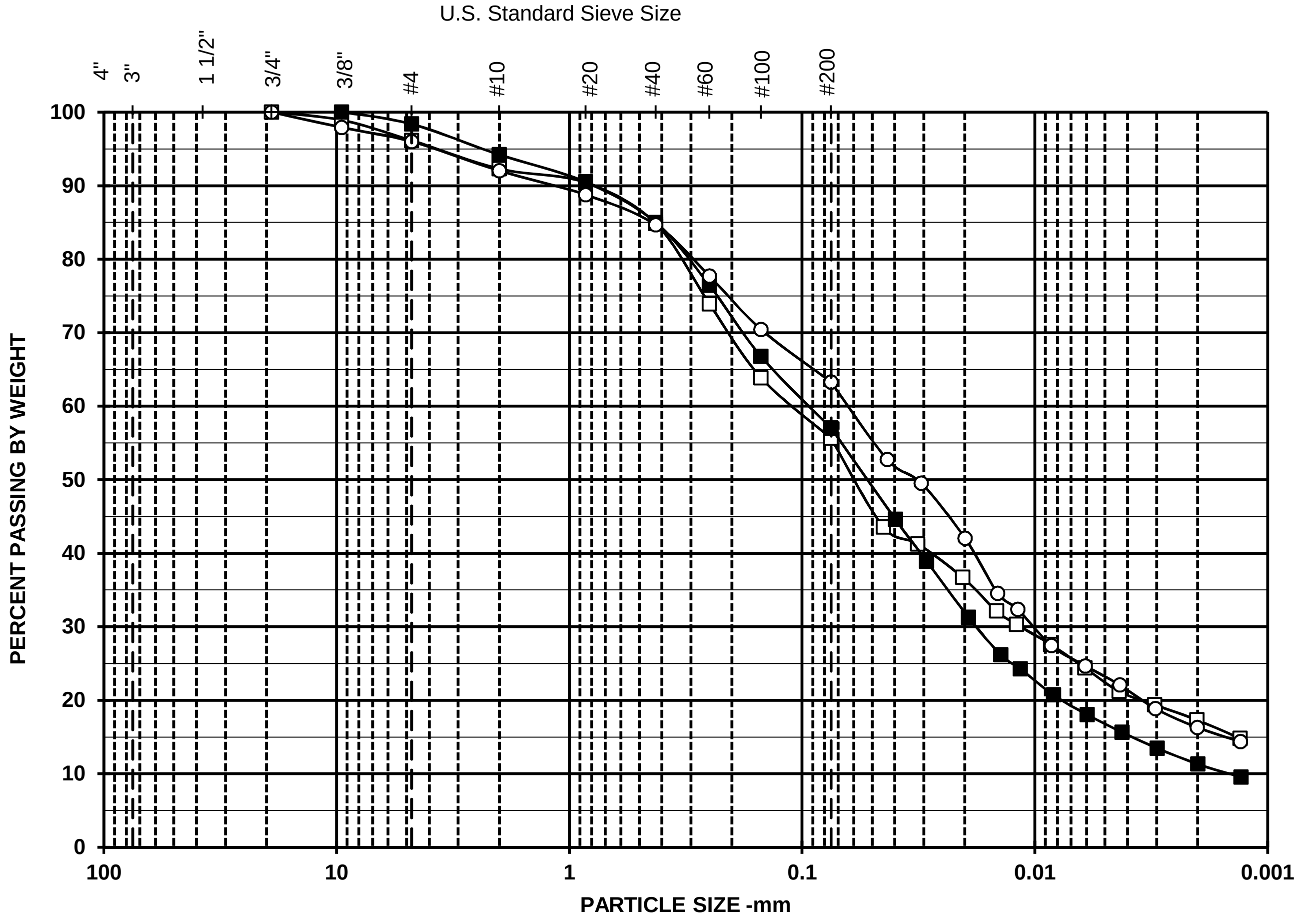
Dynegy CCR - Newton
LABORATORY TESTING DATA SUMMARY

BORING	SAMPLE	DEPTH	IDENTIFICATION TESTS									PERMEABILITY	STRENGTH			CONSOLIDATION		REMARKS
			WATER	LIQUID	PLASTIC	PLAS.	USCS	SIEVE	HYDRO.	TOTAL	DRY		TEST	PEAK	STRAIN	INITIAL CONDITIONS		
NO.	NO.		CONTENT	LIMIT	LIMIT	INDEX	SYMB.	MINUS	% MINUS	UNIT	UNIT		TYPE	SHEAR	@ PEAK	VOID	SATUR-	
							(1)	NO. 200	2 µm	WEIGHT	WEIGHT		@STRESS	STRESS	STRESS	RATIO	ATION	
		(ft)	(%)	(-)	(-)	(-)		(%)	(%)	(pcf)	(pcf)	(cm/sec)	(ksf)	(ksf)	(%)	(-)	(%)	
NEW-B015	ST-2	25-27								130.2								
NEW-B015	ST-2	25.2	15.6															
NEW-B015	ST-2A	25.45	24.0				CH			126.1	101.7	1.8E-9						P10608
NEW-B015	ST-2	25.75	24.7															
NEW-B015	ST-2B	26.0	19.5	52	15	37	CH			131.4	110.0		CIU@5	3.1	13.2			T3935
NEW-B015	S-7	30-32	16.3	37	13	24	CL											
NEW-B015	S-8	35-37	21.5	46	14	32	CL	84.5	36									
NEW-B015	S-9	40-42	8.1															
NEW-B015	S-11	50-52	14.1															
NEW-B015	ST-3	60-61.3								137.7								
NEW-B015	ST-3	60.15	11.7															
NEW-B015	ST-3	60.35	11.2				CL			139.6	125.5		DS@3.75	3.2				DS1623
NEW-B015	ST-3	60.75	11.9	30	15	15	CL			140.2	125.3		DS@7.5	5.4				DS1625
NEW-B015	ST-3	61.05	12.7				CL			139.8	124.1		DS@15	9.1				DS1627
NEW-B015	ST-4	70-70.3																no tests
NEW-B016	S-3A	5-6	16.4	35	13	22	CL											
NEW-B016	S-3B	6.5-7					SM	13.2	7									
NEW-B016	S-4B	8-9	11.3															
NEW-B016	S-5	10-12	12.1				ML	62.6										
NEW-B016	S-6	15-17	11.1	52	14	38	CH	73.0	20									
NEW-B016	S-7	20-22	14.5															
NEW-B016	S-9	30-32	11.6	29	15	14	CL											
NEW-B016	S-10	35-37	13.2															

Note: (1) USCS symbol based on visual observation and Sieve and Atterberg limits reported.

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	15.8	25	14	11	CL	Brown, Sandy lean clay	9/2/2015
■	14.6	22	13	9	CL	Brown, Sandy lean clay	9/2/2015
○	11.5	30	13	17	CL	Dark brown, Sandy lean clay	9/2/2015

Symbol	□	■	○
Boring	NEW-B001	NEW-B001	NEW-B001
Sample	S-10	S-11	S-16
Depth	35-37	40-41	55-57
% +3"	0.0	0.0	0.0
% Gravel	3.9	1.6	4.0
% SAND	40.5	41.4	32.7
%C SAND	3.9	4.2	4.0
%M SAND	7.5	9.2	7.4
%F SAND	29.2	28.0	21.4
% FINES	55.6	57.0	63.3
% -2μ	17	11	16
D_{100} (mm)	19.00	9.50	19.00
D_{60} (mm)	0.11	0.10	0.07
D_{30} (mm)	0.01	0.02	0.01
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	PERCENT FINER ■	PERCENT FINER ○
4"			
3"			
1 1/2"			
3/4"	100.0		100.0
3/8"	98.9	100.0	97.9
4	96.1	98.4	96.0
10	92.3	94.2	92.0
20	90.4	90.5	88.8
40	84.8	85.0	84.7
60	73.9	76.4	77.7
100	63.9	66.8	70.4
200	55.6	57.0	63.3

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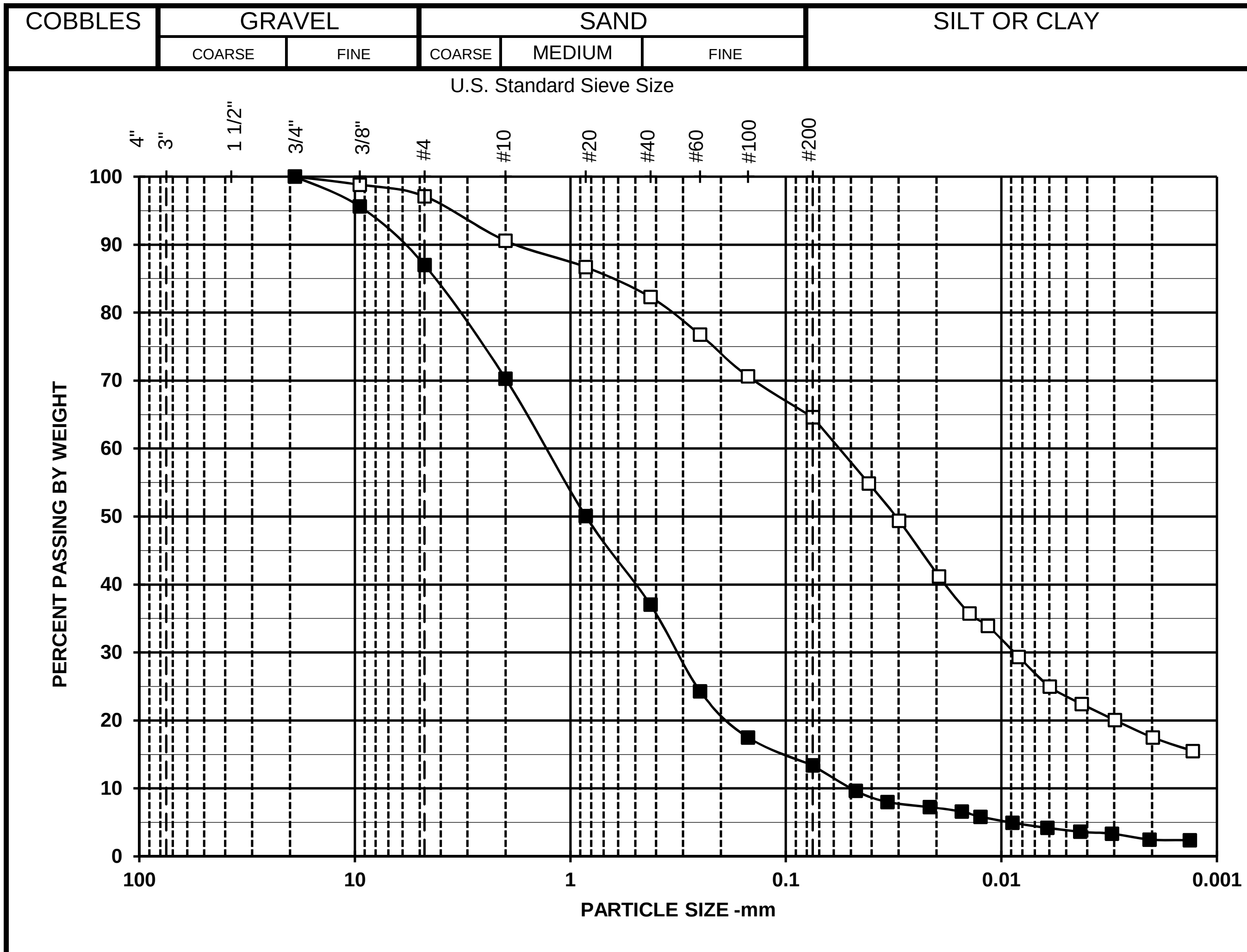

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	12.8	33	14	19	CL	Dark brown, Sandy lean clay	9/2/2015
■	11.0				SM	Brown, Silty sand	9/2/2015
○							

Symbol	□	■	○
Boring	NEW-B001	NEW-B001	
Sample	S-18	S-24	
Depth	65-67	95-97	
% +3"	0.0	0.0	
% Gravel	2.9	13.0	
% SAND	32.5	73.6	
%C SAND	6.6	16.7	
%M SAND	8.3	33.3	
%F SAND	17.7	23.6	
% FINES	64.6	13.4	
% -2μ	18	2	
D_{100} (mm)	19.00	19.00	
D_{60} (mm)	0.06	1.41	
D_{30} (mm)	0.01	0.33	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"	100.0	100.0	
3/8"	98.8	95.6	
4	97.1	87.0	
10	90.6	70.3	
20	86.7	50.1	
40	82.3	37.0	
60	76.7	24.3	
100	70.6	17.5	
200	64.6	13.4	

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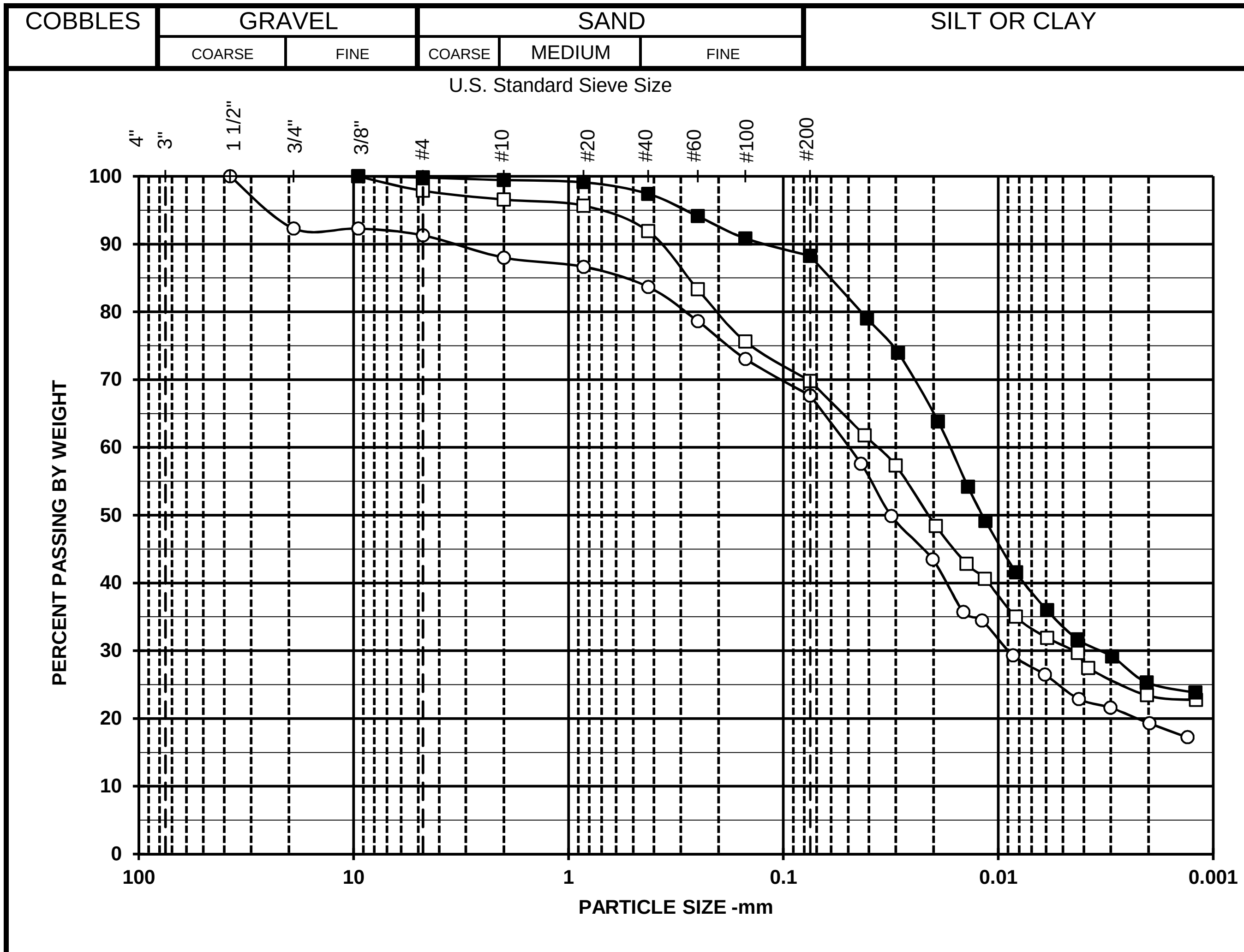

Symbol	□	■	○
Boring	NEW-B003	NEW-B003	NEW-B003
Sample	S-6	S-8	S-13
Depth	30-32	40-42	65-67
% +3"	0.0	0.0	0.0
% Gravel	2.1	0.2	8.7
% SAND	28.1	11.6	23.7
%C SAND	1.3	0.4	3.3
%M SAND	4.7	2.0	4.3
%F SAND	22.1	9.2	16.0
% FINES	69.8	88.2	67.6
% -2µ	23	25	19
D_{100} (mm)	9.50	9.50	37.50
D_{60} (mm)	0.04	0.02	0.05
D_{30} (mm)	0.00	0.00	0.01
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			100.0
3/4"			92.3
3/8"	100.0	100.0	92.3
4	97.9	99.8	91.3
10	96.6	99.4	88.0
20	95.7	99.1	86.6
40	91.9	97.4	83.7
60	83.3	94.1	78.6
100	75.6	90.8	73.0
200	69.8	88.2	67.6

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	19.6	42	14	28	CL	Brown , Sandy lean clay	9/3/2015
■	22.9	50	18	32	CH	Brown, Fat clay	9/3/2015
○	12.7				CL	Brown, Sandy lean clay	8/31/2015

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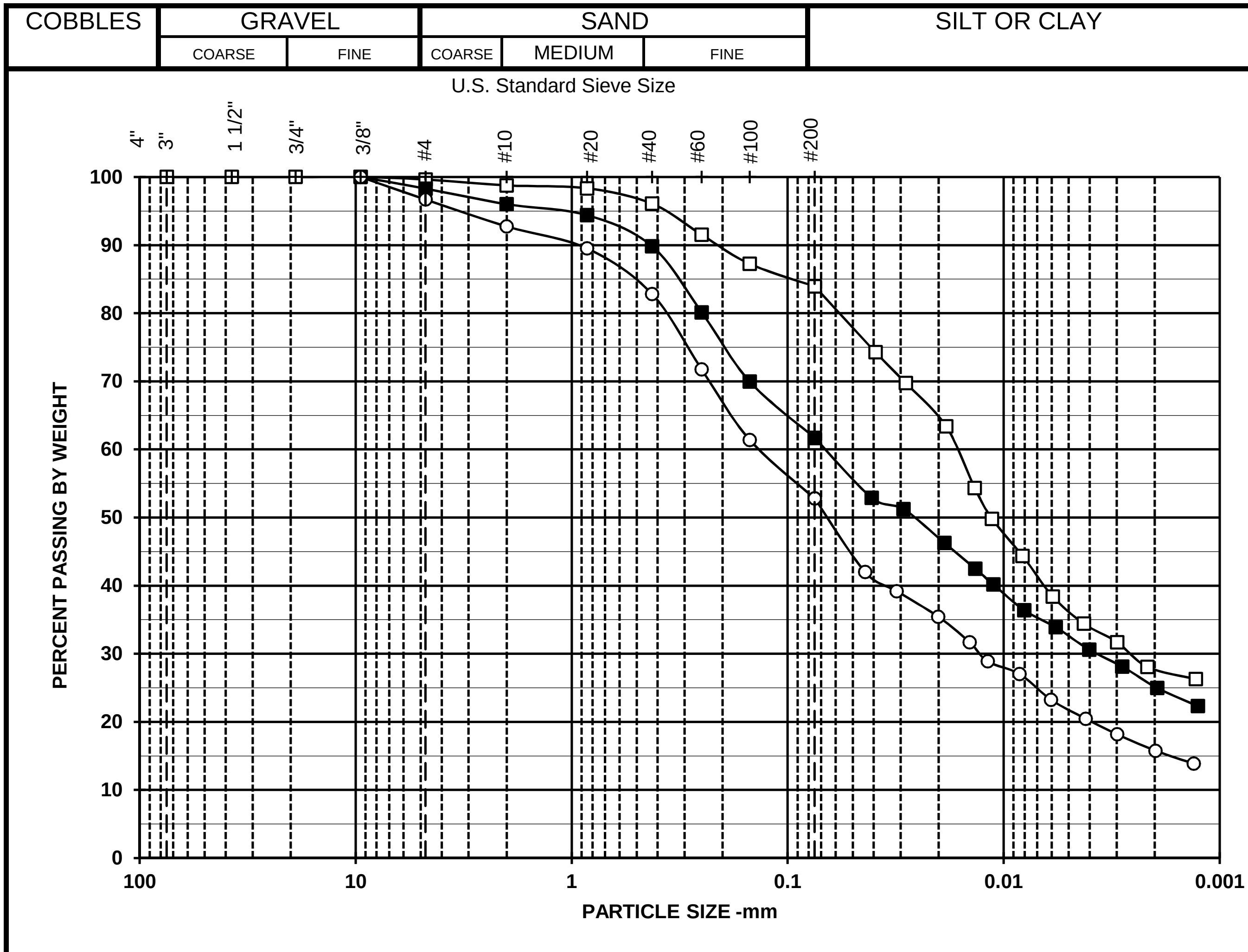

Symbol	□	■	○
Boring	NEW-B004	NEW-B004	NEW-B004
Sample	ST-4C	S-10	S-13
Depth	9.5	27.5-29.5	33.5-35.5
% +3"	0.0	0.0	0.0
% Gravel	0.4	1.7	3.3
% SAND	15.7	36.6	43.9
%C SAND	0.9	2.3	4.0
%M SAND	2.7	6.2	9.9
%F SAND	12.1	28.1	30.0
% FINES	83.9	61.7	52.8
% -2μ	28	25	16
D_{100} (mm)	9.50	9.50	9.50
D_{60} (mm)	0.02	0.07	0.14
D_{30} (mm)	0.00	0.00	0.01
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"	100.0		
3"	100.0		
1 1/2"	100.0		
3/4"	100.0		
3/8"	100.0	100.0	100.0
4	99.6	98.3	96.7
10	98.8	96.0	92.7
20	98.3	94.4	89.5
40	96.1	89.8	82.8
60	91.5	80.1	71.7
100	87.2	70.0	61.4
200	83.9	61.7	52.8

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□		50	13	37	CH	Gray brown , Fat clay with sand	10/27/2015
■	17.7	37	14	23	CL	Brown, Sandy lean clay	9/2/2015
○	9.0				CL	Light brown, Sandy lean clay	8/31/2015

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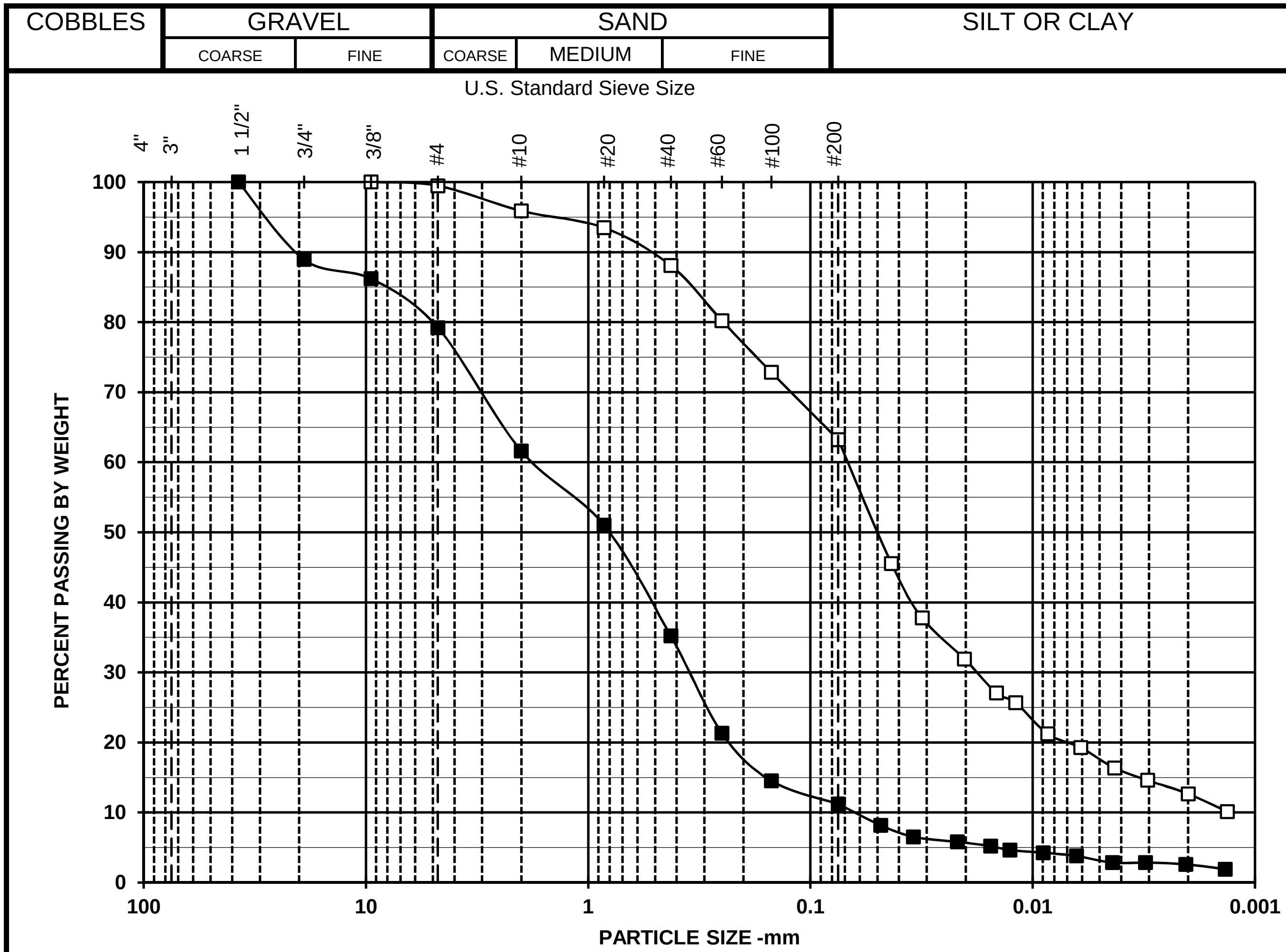

Symbol	□	■	○
Boring	NEW-B004A	NEW-B004A	
Sample	S-1	S-11	
Depth	45-46	95-96.5	
% +3"	0.0	0.0	
% Gravel	0.5	20.8	
% SAND	36.3	68.0	
%C SAND	3.6	17.6	
%M SAND	7.8	26.4	
%F SAND	24.9	24.0	
% FINES	63.2	11.2	
% -2μ	13	3	
D_{100} (mm)	9.50	37.50	
D_{60} (mm)	0.07	1.82	
D_{30} (mm)	0.02	0.36	
D_{10} (mm)		0.06	
Cc		1.1	
Cu		28.4	

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"		100.0	
3/4"		88.9	
3/8"	100.0	86.2	
4	99.5	79.2	
10	95.9	61.6	
20	93.5	51.0	
40	88.1	35.2	
60	80.2	21.3	
100	72.8	14.5	
200	63.2	11.2	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	10.4				CL	Brown, Sandy lean clay	8/31/2015
■	11.1				SW-SM	Brown, Well-graded sand with silt and gravel	8/31/2015
○							

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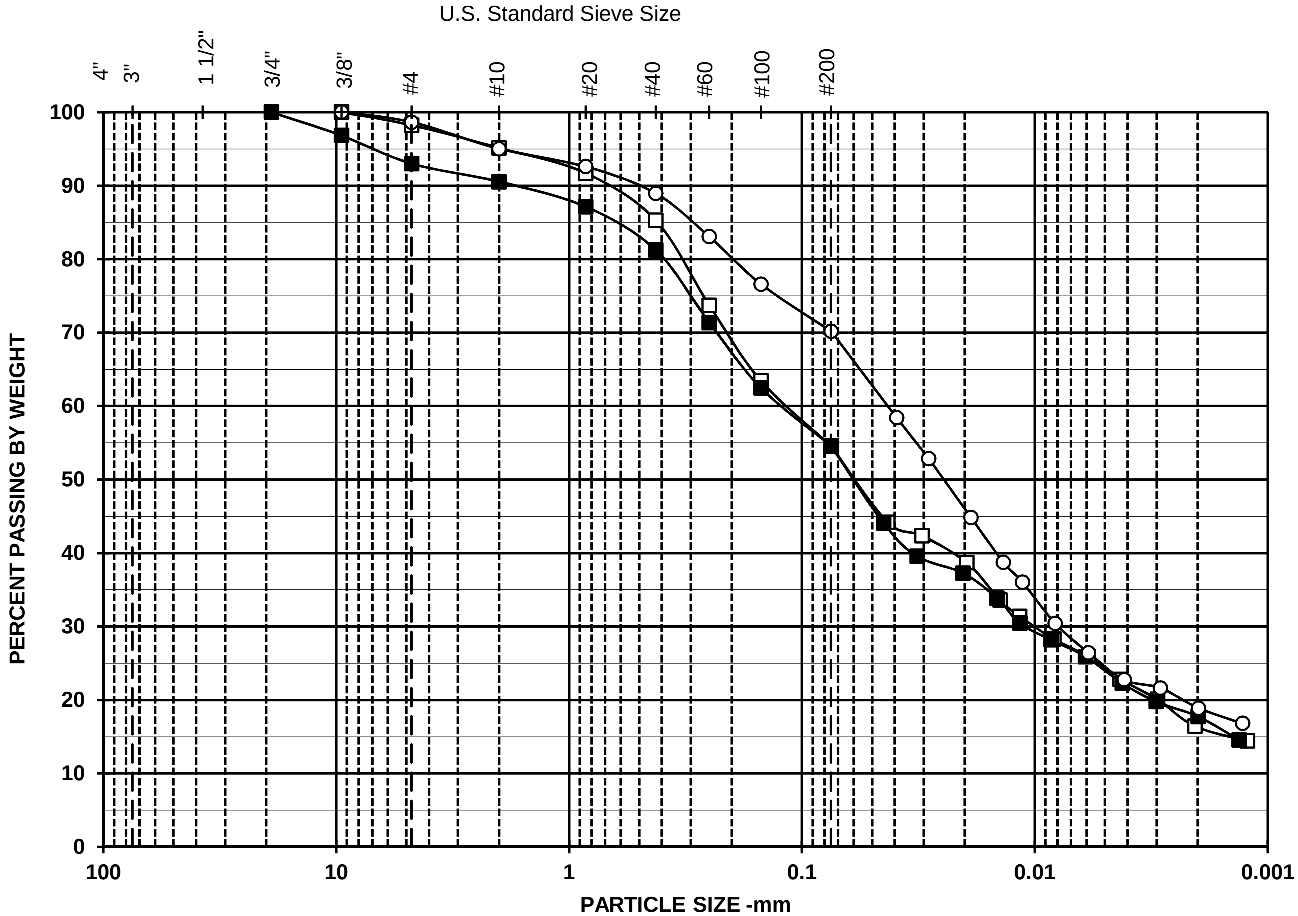
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	NEW-B005	NEW-B005	NEW-B005
Sample	S-6	S-8	S-12
Depth	15-16.5	25-26	45-47
% +3"	0.0	0.0	0.0
% Gravel	1.8	7.0	1.4
% SAND	43.6	38.4	28.4
%C SAND	3.1	2.5	3.6
%M SAND	9.8	9.3	6.1
%F SAND	30.7	26.7	18.8
% FINES	54.6	54.6	70.2
% -2µ	16	18	19
D_{100} (mm)	9.50	19.00	9.50
D_{60} (mm)	0.12	0.13	0.04
D_{30} (mm)	0.01	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"	100.0	96.8	100.0
4	98.2	93.0	98.6
10	95.1	90.5	95.0
20	91.7	87.1	92.6
40	85.3	81.2	89.0
60	73.7	71.4	83.1
100	63.4	62.5	76.6
200	54.6	54.6	70.2

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	9.4	27	12	15	CL	Brown, Sandy lean clay	9/3/2015
■	11.6				CL	Brown, Sandy lean clay	8/31/2015
○	13.1	33	15	18	CL	Dark brown, Lean clay with sand	9/2/2015

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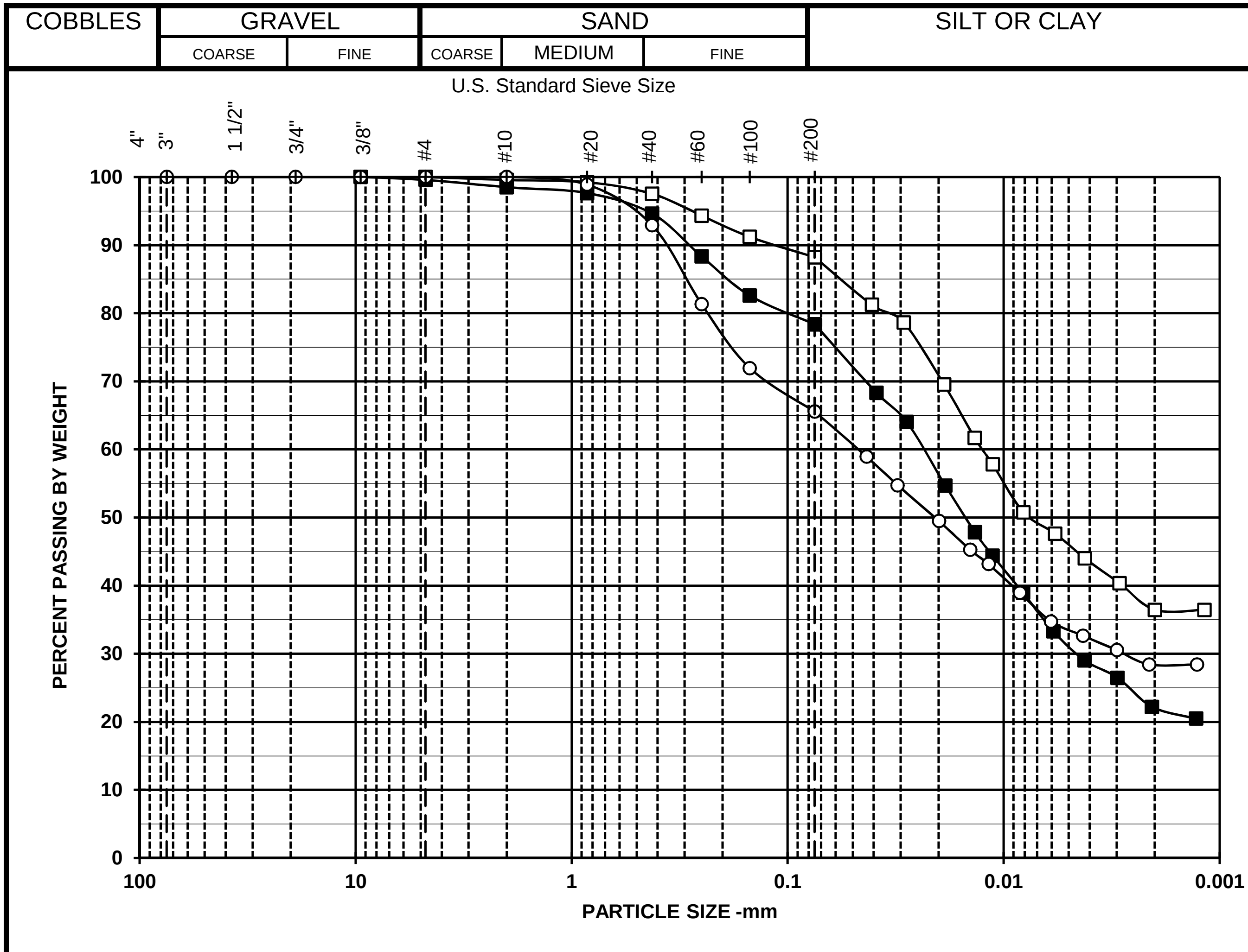

Symbol	□	■	○
Boring	NEW-B006	NEW-B006	NEW-B006
Sample	S-3	ST-1B	ST-2
Depth	10-12	21.20	26.75
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.4	0.0
% SAND	11.8	21.2	34.4
%C SAND	0.4	1.1	0.0
%M SAND	2.0	3.9	7.1
%F SAND	9.3	16.3	27.4
% FINES	88.2	78.4	65.6
% -2μ	36	22	28
D_{100} (mm)	4.75	9.50	2.00
D_{60} (mm)	0.01	0.02	0.05
D_{30} (mm)	0.00	0.00	0.00
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			100.0
3"			100.0
1 1/2"			100.0
3/4"			100.0
3/8"		100.0	100.0
4	100.0	99.6	100.0
10	99.6	98.5	100.0
20	99.2	97.6	98.9
40	97.5	94.6	92.9
60	94.3	88.3	81.3
100	91.2	82.6	71.9
200	88.2	78.4	65.6

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	21.2	66	14	52	CH	Brown, Fat clay	9/3/2015
■	18.2	40	17	23	CL	Brown, Lean clay with sand	10/29/2015
○		44	12	32	CL	Brown, Sandy lean clay	11/5/2015

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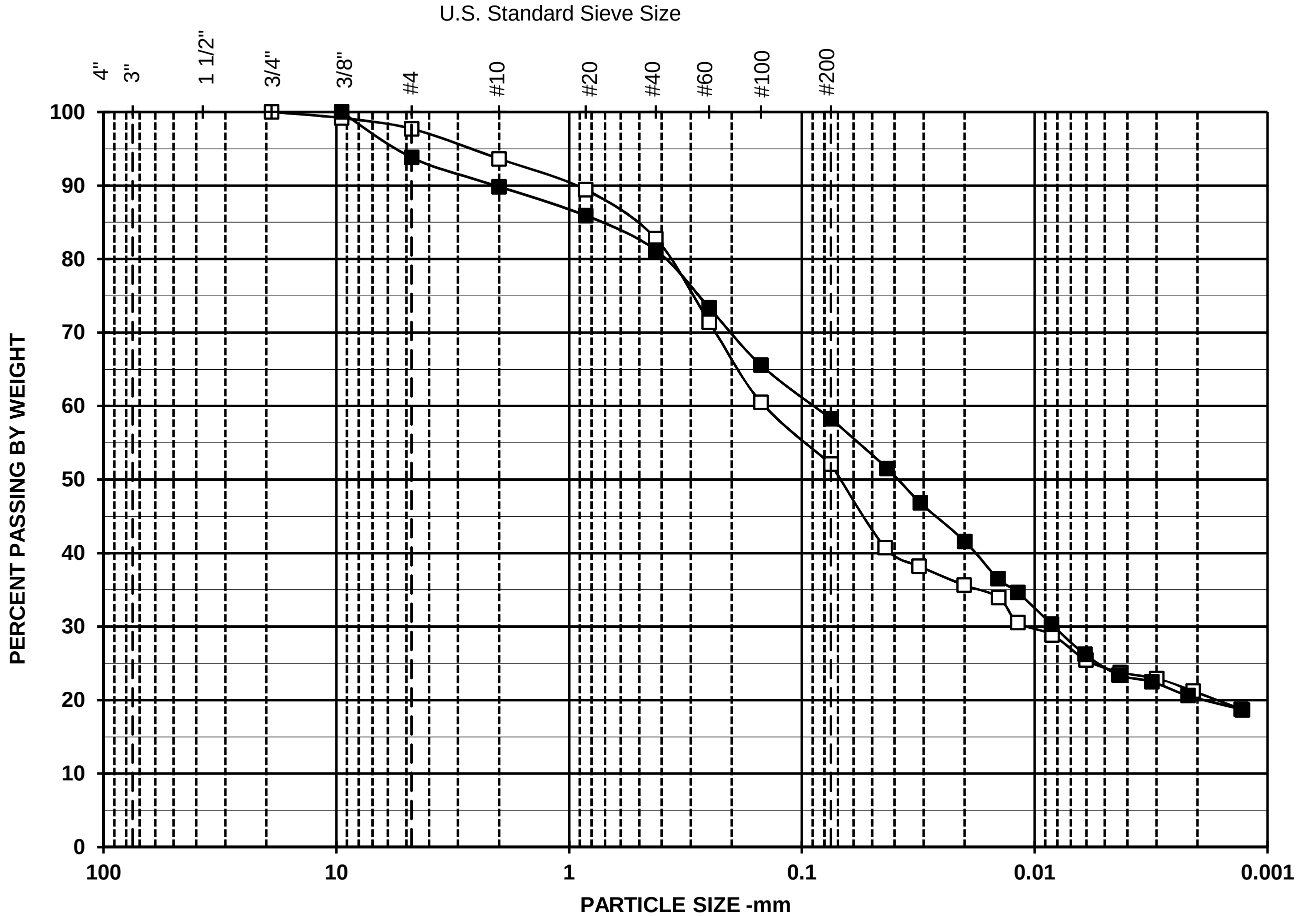
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	NEW-B006	NEW-B006	
Sample	ST-3C	ST-4	
Depth	31.8	35-35.8	
% +3"	0.0	0.0	
% Gravel	2.3	6.2	
% SAND	45.6	35.5	
%C SAND	4.1	4.0	
%M SAND	10.8	8.6	
%F SAND	30.7	22.9	
% FINES	52.1	58.3	
% -2µ	21	20	
D_{100} (mm)	19.00	9.50	
D_{60} (mm)	0.15	0.09	
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"	99.2	100.0	
4	97.7	93.8	
10	93.6	89.8	
20	89.4	85.9	
40	82.8	81.2	
60	71.4	73.4	
100	60.5	65.6	
200	52.1	58.3	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□		37	15	22	CL	Dark brown, Sandy lean clay	10/13/2015
■		30	13	17	CL	Light brown, Sandy lean clay	9/28/2015
○							

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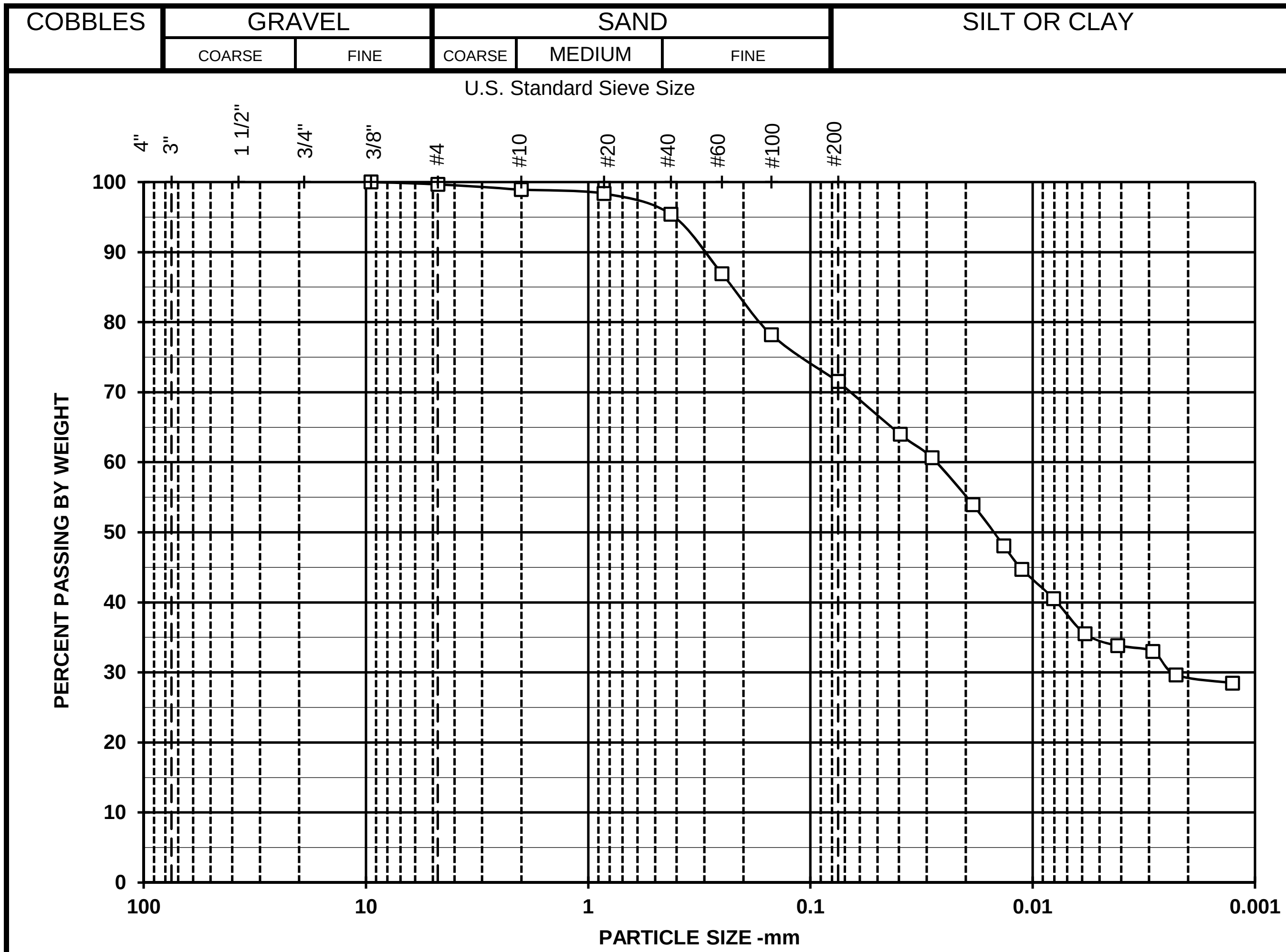

Symbol	□	■	○
Boring	NEW-B007		
Sample	ST-3C		
Depth	31.7		
% +3"	0.0		
% Gravel	0.3		
% SAND	28.2		
%C SAND	0.7		
%M SAND	3.5		
%F SAND	23.9		
% FINES	71.5		
% -2µ	29		
D_{100} (mm)	9.50		
D_{60} (mm)	0.03		
D_{30} (mm)	0.00		
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"	100.0		
4	99.7		
10	98.9		
20	98.4		
40	95.4		
60	86.9		
100	78.2		
200	71.5		

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	21.5	52	12	40	CH	Brown , Fat clay with sand	10/19/2015
■							
○							

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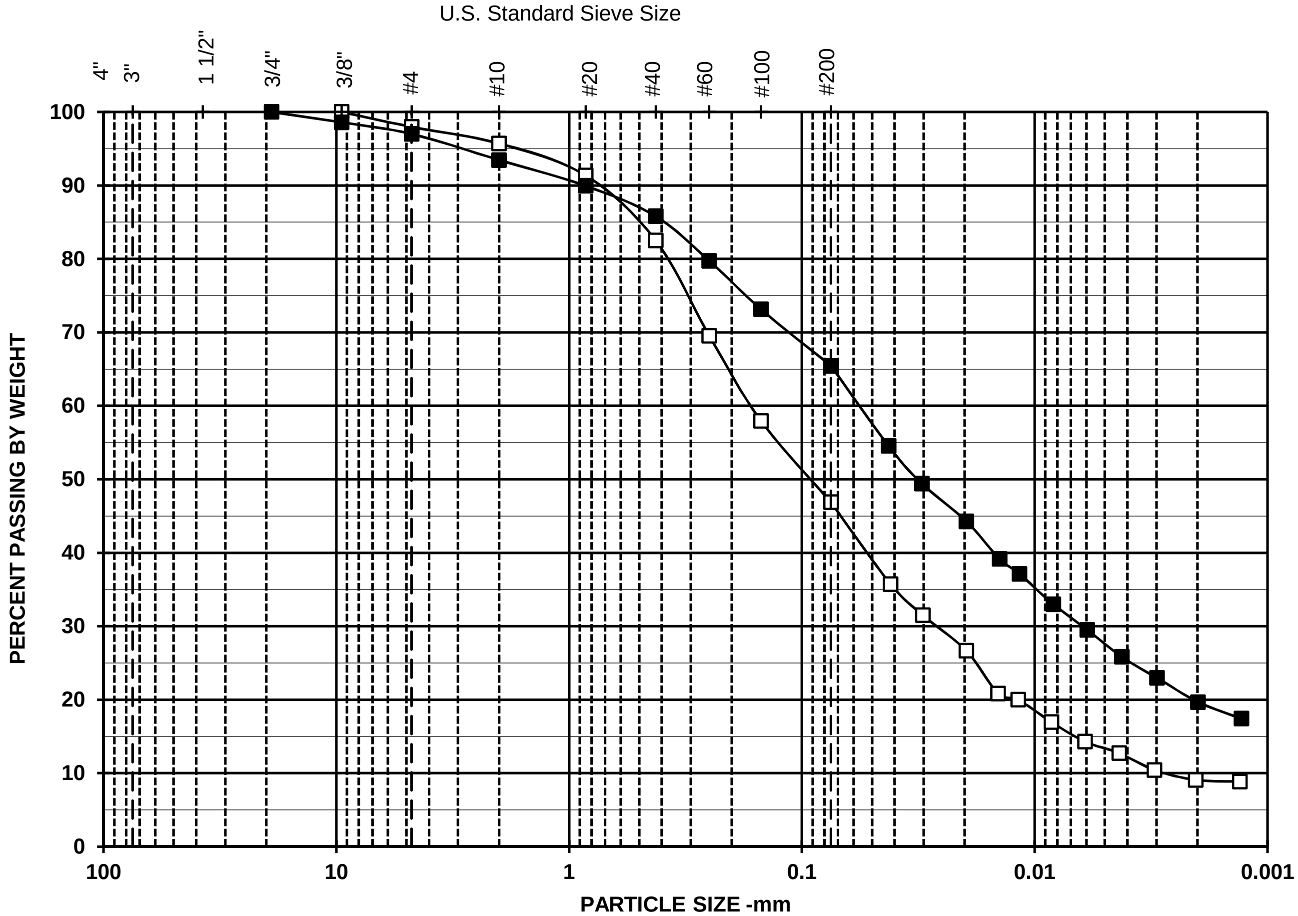
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	NEW-B008	NEW-B008	
Sample	S-8	S-10	
Depth	40-42	50-51.5	
% +3"	0.0	0.0	
% Gravel	2.0	3.0	
% SAND	51.1	31.6	
%C SAND	2.3	3.5	
%M SAND	13.2	7.7	
%F SAND	35.7	20.4	
% FINES	46.9	65.4	
% -2µ	9	20	
D_{100} (mm)	9.50	19.00	
D_{60} (mm)	0.17	0.06	
D_{30} (mm)	0.03	0.01	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"		100.0	
3/8"	100.0	98.6	
4	98.0	97.0	
10	95.7	93.5	
20	91.4	89.9	
40	82.5	85.8	
60	69.5	79.7	
100	58.0	73.1	
200	46.9	65.4	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	14.6				SC	Brown , Clayey sand	9/2/2015
■	15.4	32	16	16	CL	Brown, Sandy lean clay	9/2/2015
○							

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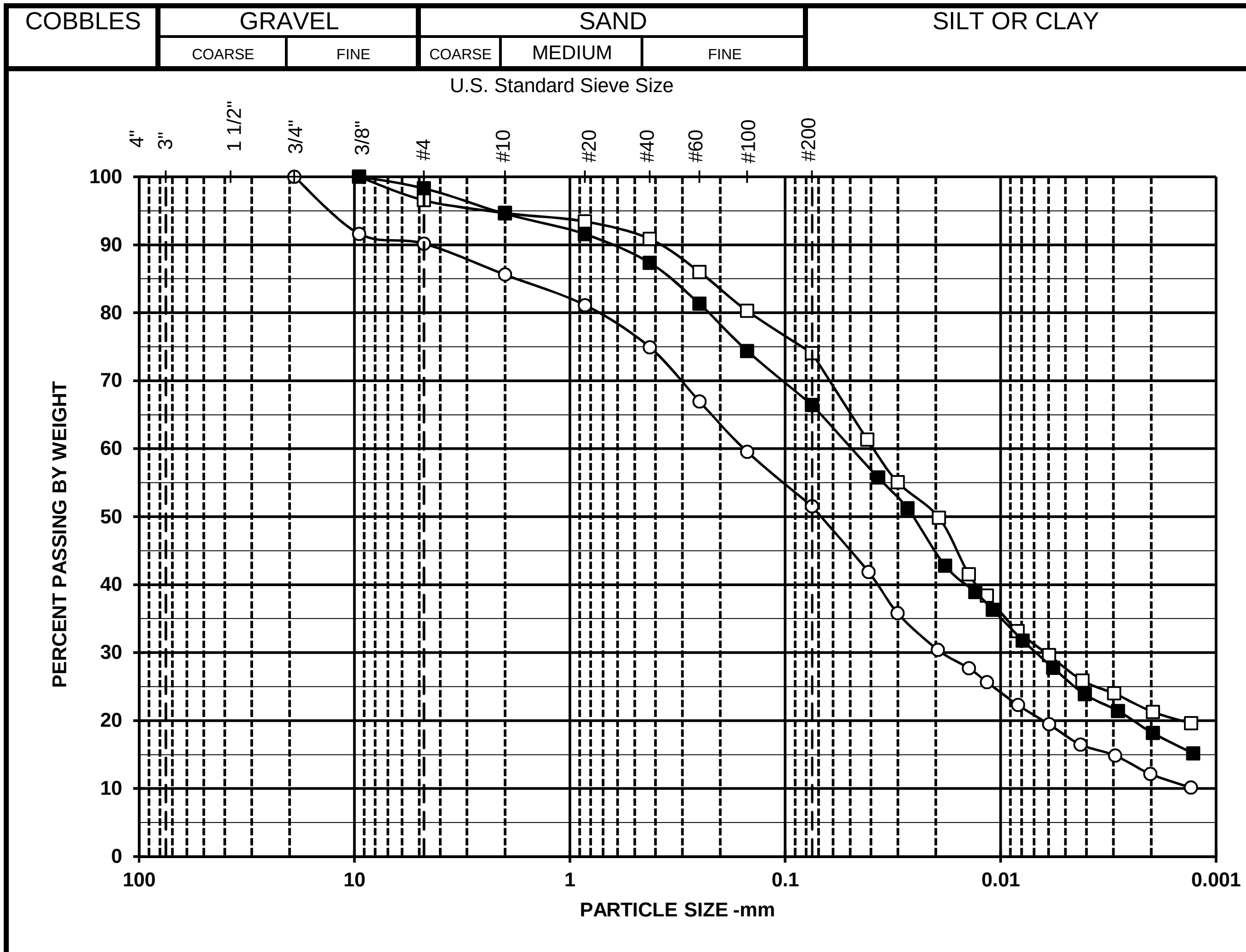

Symbol	□	■	○
Boring	NEW-B009	NEW-B009	NEW-B009
Sample	S-10	S-12	S-14
Depth	50-52	60-62	70-71.4
% +3"	0.0	0.0	0.0
% Gravel	3.5	1.7	9.8
% SAND	22.5	31.9	38.7
%C SAND	1.9	3.7	4.6
%M SAND	3.8	7.3	10.7
%F SAND	16.8	20.9	23.4
% FINES	74.0	66.4	51.5
% -2µ	21	18	12
D_{100} (mm)	9.50	9.50	19.00
D_{60} (mm)	0.04	0.05	0.16
D_{30} (mm)	0.01	0.01	0.02
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			100.0
3/8"	100.0	100.0	91.6
4	96.5	98.3	90.2
10	94.7	94.6	85.6
20	93.4	91.6	81.1
40	90.9	87.3	74.9
60	86.0	81.3	67.0
100	80.3	74.4	59.5
200	74.0	66.4	51.5

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	13.7				CL	Brown, Lean clay with sand	8/31/2015
■	13.5	24	16	8	CL	Brown, Sandy lean clay	9/2/2015
○	12.2				CL	Brown, Sandy lean clay	9/2/2015

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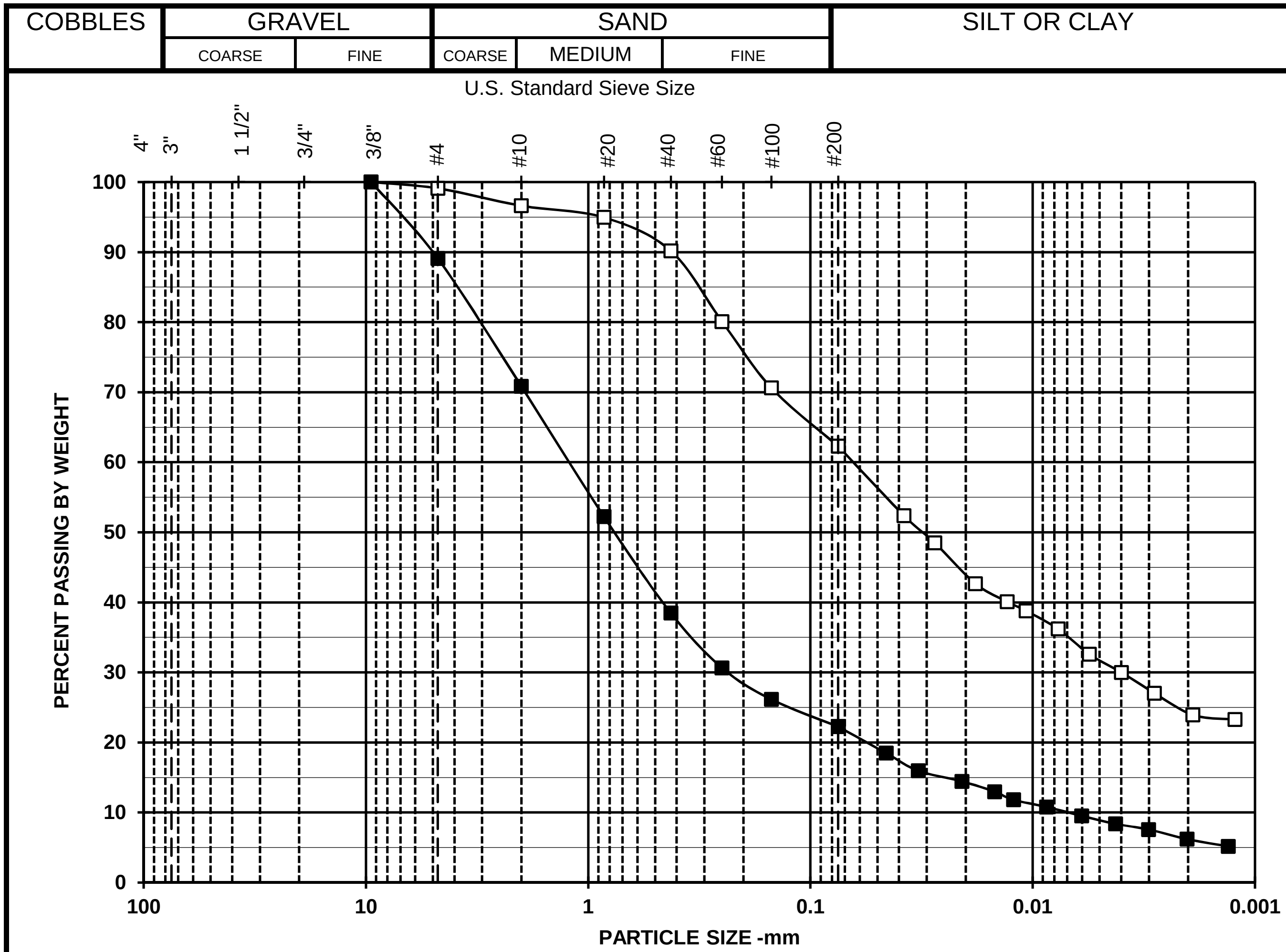

Symbol	□	■	○
Boring	NEW-B010	NEW-B010	
Sample	S-7	S-13	
Depth	30-32	50-50.8	
% +3"	0.0	0.0	
% Gravel	0.9	10.9	
% SAND	36.8	66.8	
%C SAND	2.5	18.3	
%M SAND	6.5	32.3	
%F SAND	27.9	16.2	
% FINES	62.3	22.3	
% -2μ	24	6	
D_{100} (mm)	9.50	9.50	
D_{60} (mm)	0.07	1.33	
D_{30} (mm)	0.00	0.24	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"	100.0	100.0	
4	99.1	89.1	
10	96.6	70.8	
20	95.0	52.2	
40	90.2	38.5	
60	80.1	30.6	
100	70.6	26.1	
200	62.3	22.3	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	21.0	49	16	33	CL	Brown , Sandy lean clay	9/2/2015
■	10.1				SC	Brown, Clayey sand	9/2/2015
○							

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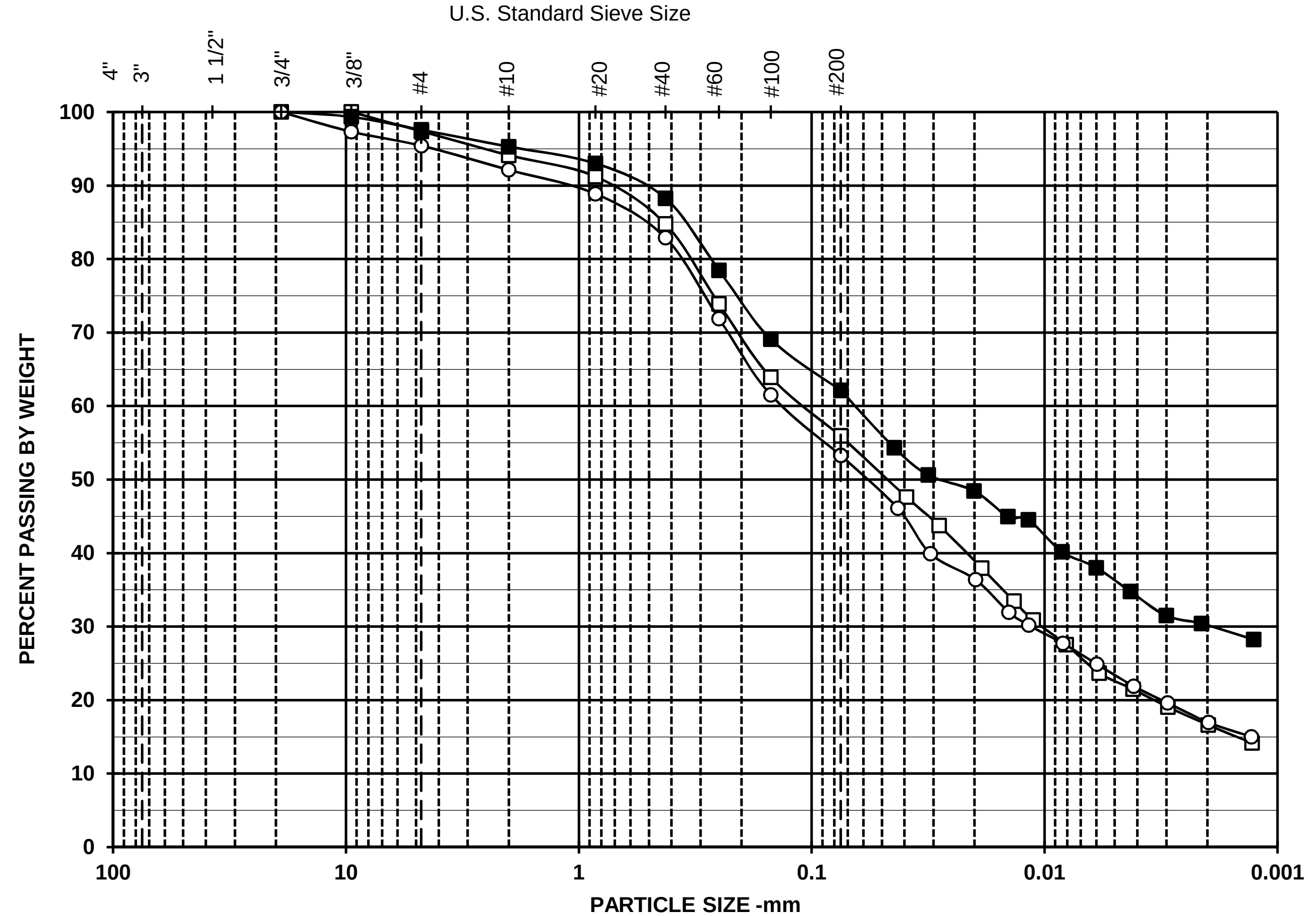
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	9.9				CL	Brown , Sandy lean clay	9/2/2015
■		43	14	29	CL	Brown, Sandy lean clay	9/23/2015
○	11.8	29	13	16	CL	Brown, Sandy lean clay	9/2/2015

Symbol	□	■	○
Boring	NEW-B012	NEW-B012	NEW-B012
Sample	S-11	ST-12C	S-18
Depth	40-42	46.4	75-77
% +3"	0.0	0.0	0.0
% Gravel	2.6	2.4	4.6
% SAND	41.5	35.5	42.1
%C SAND	3.3	2.3	3.3
%M SAND	9.3	7.0	9.2
%F SAND	28.8	26.1	29.6
% FINES	55.9	62.1	53.3
% -2µ	17	30	17
D_{100} (mm)	9.50	19.00	19.00
D_{60} (mm)	0.11	0.07	0.14
D_{30} (mm)	0.01	0.00	0.01
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER		
	□	■	○
4"			
3"			
1 1/2"			
3/4"		100.0	100.0
3/8"	100.0	99.4	97.3
4	97.4	97.6	95.4
10	94.1	95.3	92.1
20	91.2	93.0	88.9
40	84.8	88.3	82.9
60	73.9	78.5	71.9
100	63.9	69.1	61.5
200	55.9	62.1	53.3

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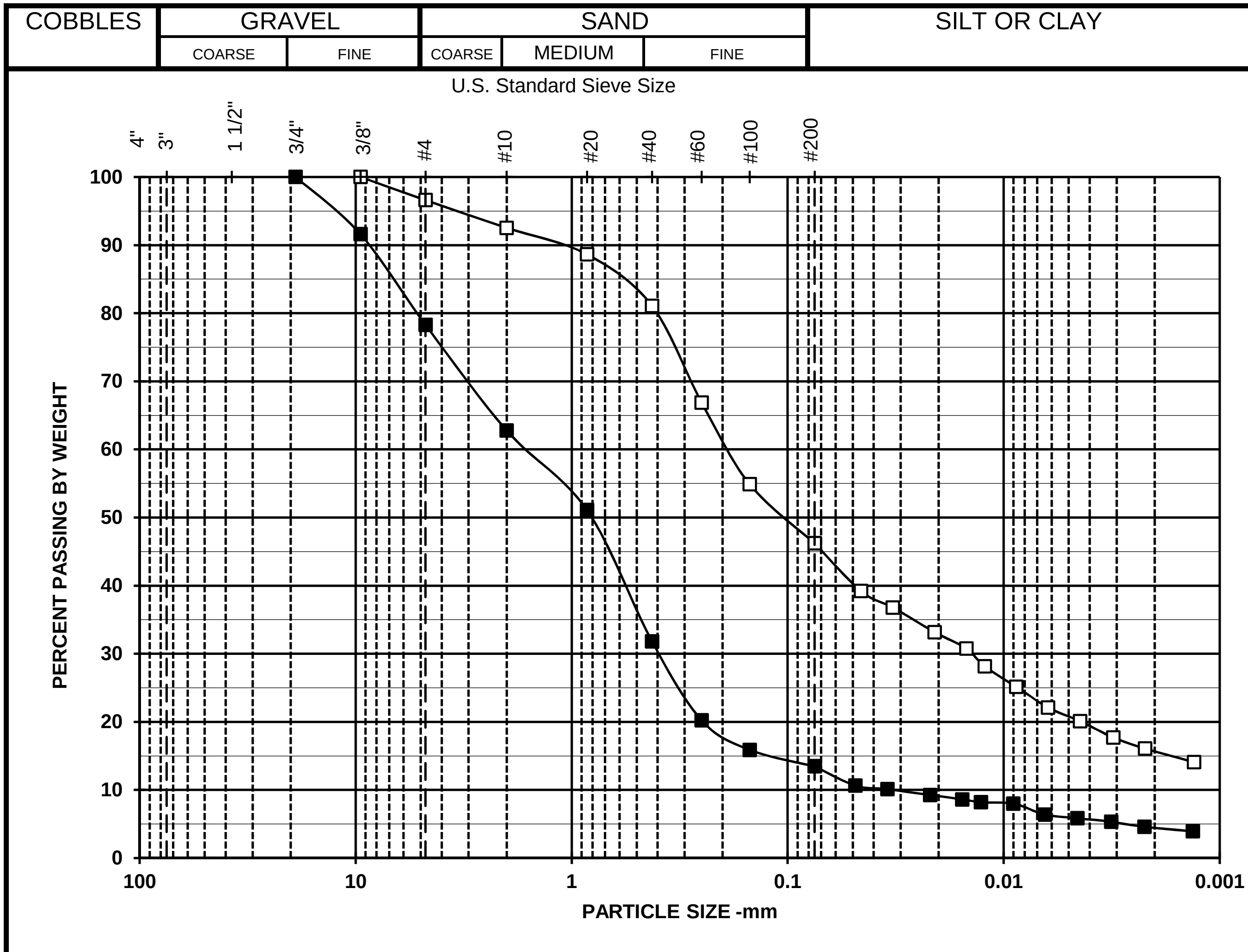

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	9.5	28	13	15	SC	Orange brown, Clayey sand	9/18/2015
■		38	13	25	SC	Brown, Clayey sand with gravel	9/23/2015
○							

Symbol	□	■	○
Boring	NEW-B014	NEW-B014	
Sample	ST-1B	ST-3C	
Depth	3.5	36.65	
% +3"	0.0	0.0	
% Gravel	3.4	21.7	
% SAND	50.4	64.8	
%C SAND	4.1	15.5	
%M SAND	11.5	31.0	
%F SAND	34.9	18.3	
% FINES	46.2	13.5	
% -2μ	16	4	
D_{100} (mm)	9.50	19.00	
D_{60} (mm)	0.19	1.73	
D_{30} (mm)	0.01	0.40	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"		100.0	
3/8"	100.0	91.6	
4	96.6	78.3	
10	92.5	62.8	
20	88.7	51.1	
40	81.1	31.8	
60	66.9	20.2	
100	54.9	15.9	
200	46.2	13.5	

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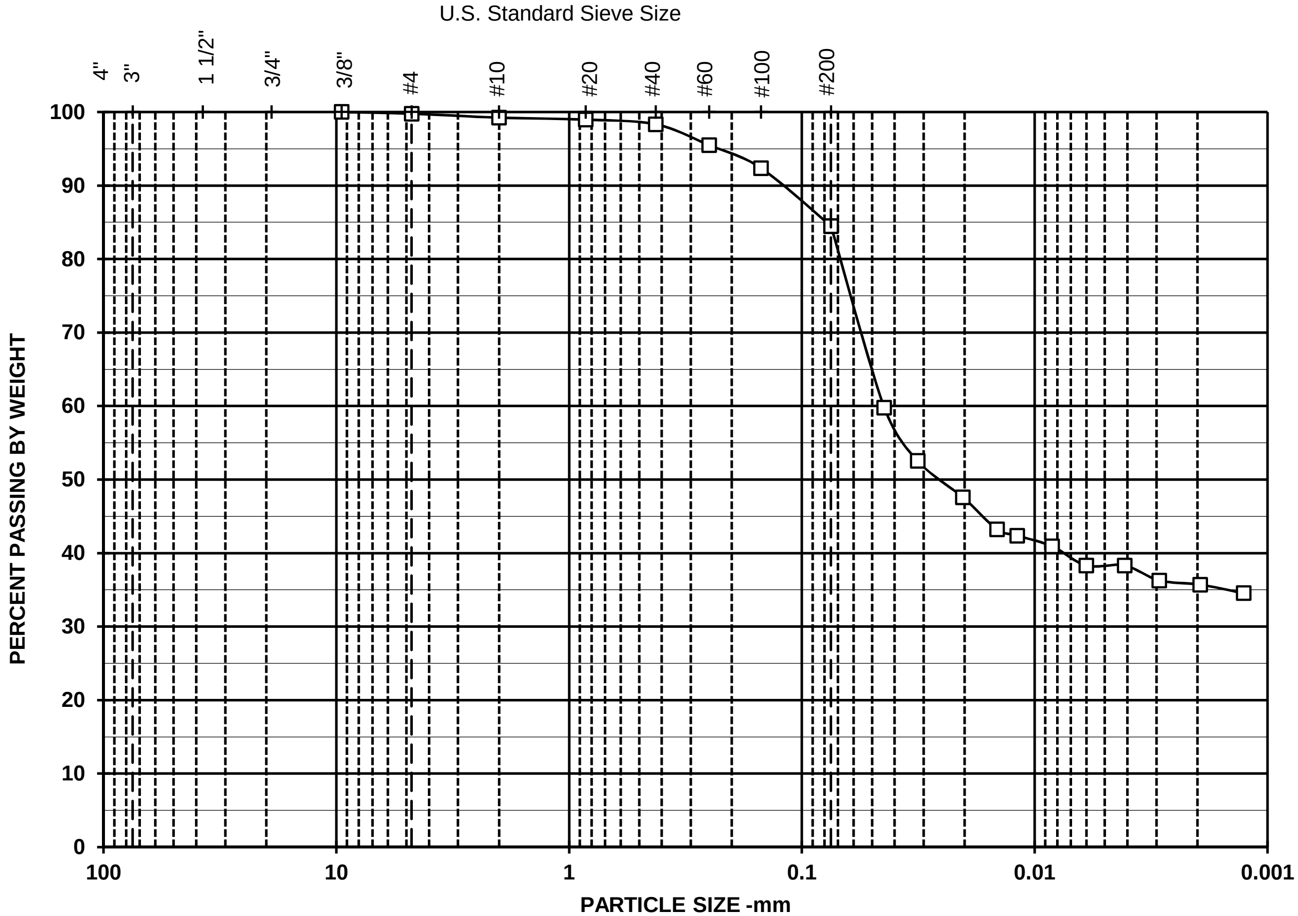
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	NEW-B015		
Sample	S-8		
Depth	35-37		
% +3"	0.0		
% Gravel	0.2		
% SAND	15.3		
%C SAND	0.5		
%M SAND	0.9		
%F SAND	13.8		
% FINES	84.5		
% -2µ	36		
D_{100} (mm)	9.50		
D_{60} (mm)	0.04		
D_{30} (mm)	0.00		
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"	100.0		
4	99.8		
10	99.2		
20	99.0		
40	98.3		
60	95.5		
100	92.4		
200	84.5		

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	21.5	46	14	32	CL	Brown , Lean clay with sand	9/2/2015
■							
○							

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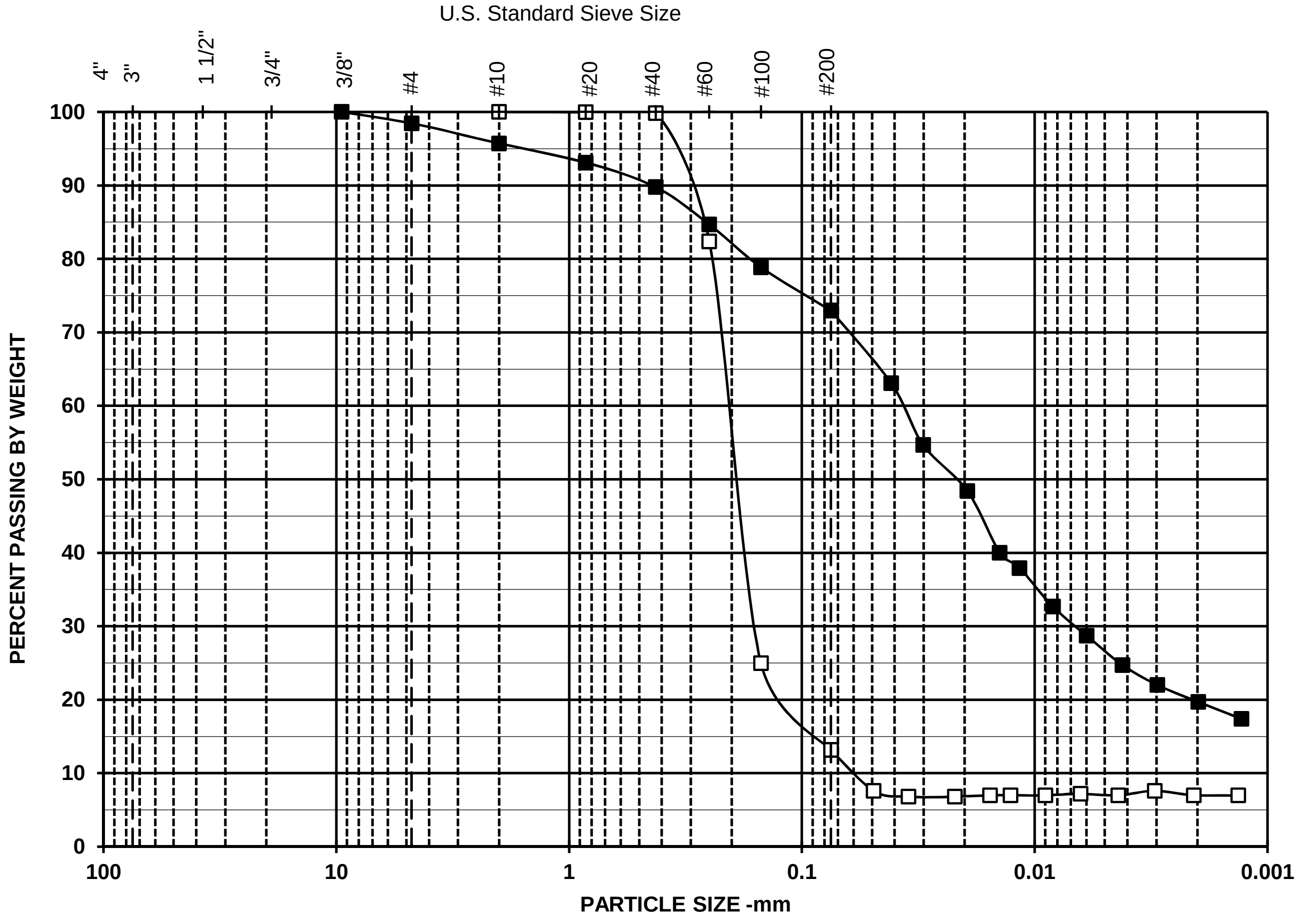
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	NEW-B016	NEW-B016	
Sample	S-3B	S-6	
Depth	6.5-7	15-17	
% +3"	0.0	0.0	
% Gravel	0.0	1.6	
% SAND	86.8	25.4	
%C SAND	0.0	2.7	
%M SAND	0.2	5.9	
%F SAND	86.7	16.8	
% FINES	13.2	73.0	
% -2µ	7	20	
D_{100} (mm)	2.00	9.50	
D_{60} (mm)	0.21	0.04	
D_{30} (mm)	0.16	0.01	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"		100.0	
4		98.4	
10	100.0	95.7	
20	100.0	93.1	
40	99.8	89.8	
60	82.4	84.7	
100	25.0	78.9	
200	13.2	73.0	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□					SM	Brown, Silty sand	9/1/2015
■	11.1	52	14	38	CH	Dark brown, Fat clay with sand	9/2/2015
○							

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PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE
ASTM D 5084 - Method F

Project No.: T60428794	BORING: NEW-B003		Test No.: P10611
Project Name: Dynegy CCR - Newton	SAMPLE: ST-3	DEPTH (ft): 28.3	

Specimen - Apparatus set-up - Test Information Cell No. D Apparatus No. 2 Stage No.: 4

Preliminary Length/Area Calculations

Lo =	4.021	in	Lo=	10.212	cm
dLc=	0.057	in	Ao =	42.07	cm^2
Lc=	3.964	in	Vo =	429.65	cm^3
			Lc=	10.068	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	18.27	cm^3
			Vc =	411.38	cm^3
Sc =	0.246	cm^{-1}	Ac=	40.862	cm^2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or
	x	with stones or		Stones with filter paper or top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination
3) During saturation: Water flushed up sides of specimen to remove air	x	No		Yes
4) During consolidation:	x	Top and bottom drainage or		Top / Bottom only
5) Direction of permeant :	x	Up during or		Down during permeation
6) Permeant: water used	x	Tap		Distilled
or		Demineralized		0.005 N calcium sulfate (CaSO4)

Equations Used

Kt = - 0.0000746 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 ºC = RT * Kt TubeC= 1.3214

Consol Stage-Trial No.	Temp. º C	Date	Time hr	min	sec	Initial σ_c psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20ºC cm/sec Dev. from Ave.
initial	21.0	10/27/15	09	13	00	120.8	100.0	60.70	42.60	1.01	9.84E-08
final	21.2	10/27/15	09	51	00			58.18	43.40		9.51E-08
1	RT = 0.978	dT =	38.00 min			σ'_c =	3.0 ksf	0.187	0.185	io= 22.6	-1%
initial	21.2	10/27/15	09	52	00	120.8	100.0	59.07	43.10	1.05	1.01E-07
final	21.5	10/27/15	10	30	00			56.79	43.80		9.72E-08
2	RT = 0.971	dT =	38.00 min			σ'_c =	3.0 ksf	0.170	0.162	io= 19.9	1%
initial	21.5	10/27/15	10	31	00	120.8	100.0	58.80	43.20	1.00	1.03E-07
final	21.8	10/27/15	11	15	00			56.22	44.03		9.82E-08
3	RT = 0.964	dT =	44.00 min			σ'_c =	3.0 ksf	0.192	0.192	io= 19.5	2%
initial	21.8	10/27/15	11	16	00	120.8	100.0	58.70	43.23	1.00	1.01E-07
final	22.3	10/27/15	12	07	00			55.84	44.15		9.53E-08
4	RT = 0.954	dT =	51.00 min			σ'_c =	3.0 ksf	0.213	0.213	io= 19.3	-1%
initial											
final											
5											
initial											
final											
6											

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	10.068	cm	ε_{axial} =	1.4%	
Ac =	41.331	cm^2			
Vc=	416.10	cm^3	ε_{vol} =	3.2%	
Sc =	0.244	cm^{-1}	Sc = Lc / Ac , final		

	w (%)	γ_τ (pcf)	γ_d (pcf)	S (%)
Initial	21.21	126.4	104.3	91.3
PreTest	21.34	130.7	107.7	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 ºC: **9.64E-08** cm/sec

(i_o)ave = 20.3

Tested By: BB Reviewed By: G. Thomas

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE
ASTM D 5084 - Method F

Project No.: T60428794 | BORING: NEW-B004 | Test No.: P10610

Project Name: Dynegy CCR - Newton | SAMPLE: ST-12 | DEPTH (ft): 33.2

Specimen - Apparatus set-up - Test Information | Cell No. 6 | Apparatus No. 3 | Stage No.: 5

Preliminary Length/Area Calculations

Lo =	3.994	in	Lo=	10.145	cm
dLc=	0.058	in	Ao =	42.13	cm^2
Lc=	3.936	in	Vo =	427.40	cm^3
			Lc=	9.997	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	18.62	cm^3
			Vc =	408.78	cm^3
Sc =	0.245	cm^{-1}	Ac=	40.889	cm^2

1) Specimen Tested in : [x] Triaxial Cell or [ ] Compaction Mold or
[x] with stones or [ ] Stones with filter paper or ____ top + bottom

2) Specimen orientation for: [x] Vertical or [ ] Horizontal permeability determination

3) During saturation: Water flushed up sides of specimen to remove air [x] No [ ] Yes

4) During consolidation: [x] Top and bottom drainage or [ ] Top [ ] Bottom only

5) Direction of permeant : [x] Up during or [ ] Down during permeation

6) Permeant: water used [x] Tap [ ] Distilled

or [ ] Demineralized [ ] 0.005 N calcium sulfate (CaSO4)

Equations Used

Kt = - 0.0000755 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 ºC = RT * Kt   TubeC= 1.3132

Consol Stage-Trial No.	Temp. º C	Date	Time hr	min	sec	Initial σ_c psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20ºC cm/sec Dev. from Ave.
initial	21.0	10/27/15	09	06	00	131.3	100.0	58.00	49.20	1.02	6.64E-06
final	21.0	10/27/15	09	08	00			54.56	50.26		6.41E-06
1	RT = 0.980	dT =	2.00 min			σ'_c =	4.5 ksf	0.257	0.253	io= 11.1	0%
initial	21.0	10/27/15	09	09	00	131.3	100.0	58.00	49.20	0.99	6.63E-06
final	21.0	10/27/15	09	12	00			53.58	50.60		6.40E-06
2	RT = 0.980	dT =	3.00 min			σ'_c =	4.5 ksf	0.330	0.334	io= 11.1	-1%
initial	21.0	10/27/15	09	13	00	131.3	100.0	58.00	49.20	1.00	6.65E-06
final	21.0	10/27/15	09	14	30			55.20	50.08		6.42E-06
3	RT = 0.980	dT =	1.50 min			σ'_c =	4.5 ksf	0.209	0.210	io= 11.1	0%
initial	21.0	10/27/15	09	16	00	131.3	100.0	58.00	49.20	0.97	6.76E-06
final	21.0	10/27/15	09	18	30			53.98	50.50		6.52E-06
4	RT = 0.980	dT =	2.50 min			σ'_c =	4.5 ksf	0.300	0.310	io= 11.1	1%
initial											
final											
5											
initial											
final											
6											

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 9.997 cm ε_{axial} = 1.5%

Ac = 41.520 cm^2

Vc= 415.09 cm^3 ε_{vol} = 2.9%

Sc = 0.241 cm^{-1} Sc = Lc / Ac , final

	w (%)	γ_τ (pcf)	γ_d (pcf)	S (%)
Initial	9.67	136.2	124.2	70.9
PreTest	12.18	143.5	127.9	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 ºC: **6.44E-06** cm/sec

(i_o)ave = 11.1

Tested By: BB   Reviewed By: G. Thomas

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE
ASTM D 5084 - Method F

Project No.: T60428794 | BORING: NEW-B006 | Test No.: P10597

Project Name: Dynegy CCR - Newton | SAMPLE: ST-3 | DEPTH (ft): 31.25

Specimen - Apparatus set-up - Test Information | Cell No. D | Apparatus No. 1 | Stage No.: 5

Preliminary Length/Area Calculations

Lo =	3.986 in	Lo=	10.124 cm		
dLc=	0.132 in	Ao =	41.97 cm^2		
Lc=	3.854 in	Vo =	424.87 cm^3		
		Lc=	9.789 cm		
dVc = 3 Vo * (dLc/Lo)		dVc=	42.21 cm^3		
		Vc =	382.66 cm^3		
Sc =	0.250 cm^{-1}	Ac=	39.091 cm^2		

1) Specimen Tested in : [x] Triaxial Cell or [ ] Compaction Mold or; [x] with stones or [ ] Stones with filter paper or ____ top + bottom

2) Specimen orientation for: [x] Vertical or [ ] Horizontal permeability determination

3) During saturation: Water flushed up sides of specimen to remove air [x] No [ ] Yes

4) During consolidation: [x] Top and bottom drainage or [ ] Top [ ] Bottom only

5) Direction of permeant : [x] Up during or [ ] Down during permeation

6) Permeant: water used [x] Tap [ ] Distilled

or [ ] Demineralized [ ] 0.005 N calcium sulfate (CaSO4)

Equations Used

Kt = - 0.0000757 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 ºC = RT * Kt TubeC= 1.3127

Consol Stage-Trial No.	Temp. º C	Date	Time hr	min	sec	Initial σ_c psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20ºC cm/sec Dev. from Ave.
initial	22.7	10/7/15	09	32	00	130.0	80.0	55.90	38.12	0.98	1.95E-07
final	22.5	10/7/15	10	57	00			48.00	40.65		1.70E-07
1	RT = 0.941	dT =	85.00 min			σ'c =	7.2 ksf	0.592	0.606	io= 22.8	5%
initial	22.6	10/7/15	11	52	00	130.0	80.0	55.90	38.10	0.99	1.86E-07
final	22.5	10/7/15	13	37	00			47.18	40.85		1.62E-07
2	RT = 0.942	dT =	105.00 min			σ'c =	7.2 ksf	0.653	0.659	io= 22.9	0%
initial	22.5	10/7/15	13	39	00	130.0	80.0	56.20	38.00	1.01	1.82E-07
final	22.7	10/7/15	14	44	00			49.75	40.00		1.59E-07
3	RT = 0.941	dT =	65.00 min			σ'c =	7.2 ksf	0.483	0.479	io= 23.4	-2%
initial	22.7	10/7/15	14	48	00	130.0	80.0	55.80	38.12	0.99	1.78E-07
final	22.8	10/7/15	17	24	00			45.44	41.40		1.55E-07
4	RT = 0.937	dT =	156.00 min			σ'c =	7.2 ksf	0.776	0.786	io= 22.7	-4%
initial											
final											
5		dT =				σ'c =					
initial											
final											
6		dT =				σ'c =					

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 9.789 cm ε_{axial} = 3.3%

Ac = 42.154 cm^2

Vc= 412.65 cm^3 ε_{vol} = 2.9%

Sc = 0.232 cm^{-1} Sc = Lc / Ac , final

	w (%)	γ_t (pcf)	γ_d (pcf)	S (%)
Initial	20.74	130.6	108.1	98.3
PreTest	19.44	133.0	111.3	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 ºC: **1.62E-07** cm/sec

(i_o)ave = 22.9

Tested By: BB Reviewed By: G. Thomas

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE
ASTM D 5084 - Method F

Project No.: T60428794 | BORING: NEW-B007 | Test No.: P10598

Project Name: Dynegy CCR - Newton | SAMPLE: ST-5A | DEPTH (ft): 50.3

Specimen - Apparatus set-up - Test Information | Cell No. 6 | Apparatus No. 2 | Stage No.: 5

Preliminary Length/Area Calculations

Lo =	3.981	in	Lo=	10.112	cm
dLc=	0.088	in	Ao =	42.06	cm^2
Lc=	3.893	in	Vo =	425.32	cm^3
			Lc=	9.888	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	28.21	cm^3
			Vc =	397.12	cm^3
Sc =	0.246	cm^{-1}	Ac=	40.161	cm^2

1) Specimen Tested in : [x] Triaxial Cell or [ ] Compaction Mold or
[x] with stones or [ ] Stones with filter paper or ______ top + bottom

2) Specimen orientation for: [x] Vertical or [ ] Horizontal permeability determination

3) During saturation: Water flushed up sides of specimen to remove air [x] No [ ] Yes

4) During consolidation: [x] Top and bottom drainage or [ ] Top [ ] Bottom only

5) Direction of permeant : [x] Up during or [ ] Down during permeation

6) Permeant: water used [x] Tap [ ] Distilled
or [ ] [ ] Demineralized [ ] 0.005 N calcium sulfate (CaSO4)

Equations Used

Kt = - 0.0000746 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 ºC = RT * Kt TubeC= 1.3214

Consol Stage-Trial No.	Temp. º C	Date	Time hr	min	sec	Initial σ_c psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20ºC cm/sec Dev. from Ave.
initial	22.8	10/8/15	09	06	00	132.0	80.0	60.40	42.75	1.02	4.30E-09
final	22.3	10/9/15	08	55	00			56.60	43.95		3.90E-09
1	RT = 0.942	dT =	1429.00 min			σ'_c =	7.5 ksf	0.283	0.278	io= 22.4	-24%
initial	22.3	10/9/15	08	59	00	132.0	80.0	60.75	42.65	0.99	5.83E-09
final	22.7	10/9/15	19	26	00			58.28	43.45		5.28E-09
2	RT = 0.943	dT =	627.00 min			σ'_c =	7.5 ksf	0.184	0.185	io= 23.0	3%
initial	22.7	10/9/15	19	31	00	132.0	80.0	60.30	42.80	1.02	5.81E-09
final	23.0	10/10/15	11	41	00			56.80	43.90		5.22E-09
3	RT = 0.935	dT =	970.00 min			σ'_c =	7.5 ksf	0.260	0.255	io= 22.2	2%
initial	23.1	10/10/15	12	10	00	132.0	80.0	60.35	42.70	0.98	5.99E-09
final	22.0	10/11/15	11	33	00			55.45	44.30		5.42E-09
4	RT = 0.942	dT =	1403.00 min			σ'_c =	7.5 ksf	0.365	0.370	io= 22.4	6%
initial	23.2	10/11/15	19	17	00	132.0	80.0	60.13	42.50	0.86	4.99E-09
final	22.9	10/13/15	16	42	00			53.15	45.10		4.46E-09
5	RT = 0.930	dT =	2725.00 min			σ'_c =	7.5 ksf	0.519	0.602	io= 22.4	-13%
initial	22.9	10/13/15	16	53	00	132.0	80.0	60.05	42.87	1.00	5.93E-09
final	22.4	10/14/15	08	45	00			56.61	43.98		5.36E-09
6	RT = 0.940	dT =	952.00 min			σ'_c =	7.5 ksf	0.256	0.257	io= 21.8	5%

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	9.888	cm	ε_{axial} =	2.2%	
Ac =	41.793	cm^2			
Vc=	413.25	cm^3	ε_{vol} =	2.8%	
Sc =	0.237	cm^{-1}	Sc = Lc / Ac , final		

	w (%)	γ_t (pcf)	γ_d (pcf)	S (%)
Initial	16.26	137.1	117.9	99.6
PreTest	14.82	139.3	121.3	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 2-6

ave K @ 20 ºC: **5.11E-09** cm/sec

(i_o)ave = 22.2

Tested By: BB Reviewed By: G. Thomas

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE
ASTM D 5084 - Method F

Project No.: T60428794 BORING: NEW-B012 Test No.: P10609
Project Name: Dynegy CCR - Newton SAMPLE: ST-7 DEPTH (ft): 20.6

Specimen - Apparatus set-up - Test Information Cell No. C Apparatus No. 1 Stage No.: 5

Preliminary Length/Area Calculations

Lo =	4.004	in	Lo=	10.171	cm
dLc=	0.045	in	Ao =	41.88	cm^2
Lc=	3.959	in	Vo =	425.95	cm^3
			Lc=	10.057	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	14.36	cm^3
			Vc =	411.59	cm^3
Sc =	0.246	cm^{-1}	Ac=	40.926	cm^2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or		
	x	with stones or		Stones with filter paper or		top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination		
3) During saturation: Water flushed up sides of specimen to remove ai			x	No		Yes
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only
5) Direction of permeant :	x	Up during or		Down during permeation		
6) Permeant: water used	x	Tap		Distilled		
or		Demineralized		0.005 N calcium sulfate (CaSO4)		

Equations Used

Kt = - 0.0000757 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 ºC = RT * Kt TubeC= 1.3127

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	10.057	cm	ε_{axial} =	1.1%	
Ac =	41.598	cm^2			
Vc=	418.35	cm^3	ε_{vol} =	1.8%	
Sc =	0.242	cm^{-1}	Sc = Lc / Ac , final		

	w (%)	γ_τ (pcf)	γ_d (pcf)	S (%)
Initial	13.28	137.1	121.0	88.9
PreTest	14.02	140.5	123.2	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 ºC: **7.77E-09** cm/sec

(i_o)ave = 26.8

Tested By: BB Reviewed By: G. Thomas

Consol Stage-Trial No.	Temp. º C	Date	Time hr	min	sec	Initial σ_c psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20ºC cm/sec Dev. from Ave.
initial	21.6	10/26/15	09	43	00	117.4	100.0	58.25	37.33	0.97	8.93E-09
final	22.5	10/26/15	12	19	00			57.10	37.70		8.38E-09
1	RT = 0.954	dT =	156.00 min			σ'c =	2.5 ksf	0.086	0.089	io= 26.2	8%
initial	22.5	10/26/15	12	20	00	117.4	100.0	58.63	37.24	1.04	8.86E-09
final	23.6	10/26/15	14	37	00			57.60	37.55		8.11E-09
2	RT = 0.930	dT =	137.00 min			σ'c =	2.5 ksf	0.077	0.074	io= 26.7	4%
initial	23.6	10/26/15	14	38	00	117.4	100.0	58.85	37.16	0.99	8.15E-09
final	23.5	10/26/15	18	00	00			57.45	37.60		7.36E-09
3	RT = 0.918	dT =	202.00 min			σ'c =	2.5 ksf	0.105	0.105	io= 27.1	-5%
initial	23.5	10/26/15	18	03	00	117.4	100.0	59.00	37.19	1.02	7.74E-09
final	21.0	10/27/15	08	44	00			53.90	38.75		7.23E-09
4	RT = 0.949	dT =	881.00 min			σ'c =	2.5 ksf	0.382	0.374	io= 27.3	-7%
initial											
final											
5											
initial											
final											
6											

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE
ASTM D 5084 - Method F

Project No.: T60428794 BORING: NEW-B015 Test No.: P10608

Project Name: Dynegy CCR - Newton SAMPLE: ST-2A DEPTH (ft): 25.45

Specimen - Apparatus set-up - Test Information Cell No. C Apparatus No. 3 Stage No.: 2

Preliminary Length/Area Calculations

Lo =	4.012	in	Lo=	10.191	cm
dLc=	0.025	in	Ao =	42.03	cm^2
Lc=	3.987	in	Vo =	428.31	cm^3
			Lc=	10.127	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	8.01	cm^3
			Vc =	420.30	cm^3
Sc =	0.244	cm^{-1}	Ac=	41.501	cm^2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or	
	x	with stones or		Stones with filter paper or	top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination	
3) During saturation: Water flushed up sides of specimen to remove air	x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top	Bottom only
5) Direction of permeant :	x	Up during or		Down during permeation	
6) Permeant: water used	x	Tap		Distilled	
or		Demineralized		0.005 N calcium sulfate (CaSO4)	

Equations Used

Kt = - 0.0000755 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 ºC = RT * Kt TubeC= 1.3132

Consol Stage- Trial No.	Temp. º C	Date	Time hr	min	sec	Initial σ_c psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20ºC cm/sec Dev. from Ave.
initial	22.5	10/16/15	09	48	00	106.9	100.0	63.45	47.50	0.86	3.95E-09
final	24.0	10/16/15	16	24	00			62.46	47.86		3.57E-09
1	RT = 0.925	dT =	396.00 min			σ'_c =	1.0 ksf	0.074	0.086	io= 19.8	95%
initial	21.0	10/19/15	09	42	00	106.9	100.0	64.94	47.00	0.80	2.38E-09
final	22.5	10/19/15	17	53	00			64.10	47.33		2.24E-09
2	RT = 0.962	dT =	491.00 min			σ'_c =	1.0 ksf	0.063	0.079	io= 22.3	22%
initial	22.5	10/19/15	17	54	00	106.9	100.0	66.26	46.67	0.87	2.07E-09
final	22.0	10/20/15	08	42	00			64.84	47.18		1.92E-09
3	RT = 0.949	dT =	888.00 min			σ'_c =	1.0 ksf	0.106	0.122	io= 24.3	5%
initial	22.0	10/20/15	08	45	00	106.9	100.0	66.70	46.50	0.89	1.67E-09
final	23.1	10/20/15	17	04	00			66.02	46.74		1.54E-09
4	RT = 0.942	dT =	499.00 min			σ'_c =	1.0 ksf	0.051	0.057	io= 25.1	-16%
initial	23.1	10/20/15	17	07	00	106.9	100.0	66.82	46.46	1.02	1.76E-09
final	21.5	10/21/15	08	45	00			65.49	46.87		1.63E-09
5	RT = 0.948	dT =	938.00 min			σ'_c =	1.0 ksf	0.099	0.098	io= 25.3	-11%
initial											
final											
6		dT =				σ'_c =					

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	10.127	cm	ε_{axial} =	0.6%
Ac =	42.456	cm^2		
Vc=	429.98	cm^3	ε_{vol} =	-0.4%
Sc =	0.239	cm^{-1}	Sc = Lc / Ac , final	

	w (%)	γ_τ (pcf)	γ_d (pcf)	S (%)
Initial	23.96	126.1	101.7	96.8
PreTest	24.99	126.6	101.3	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

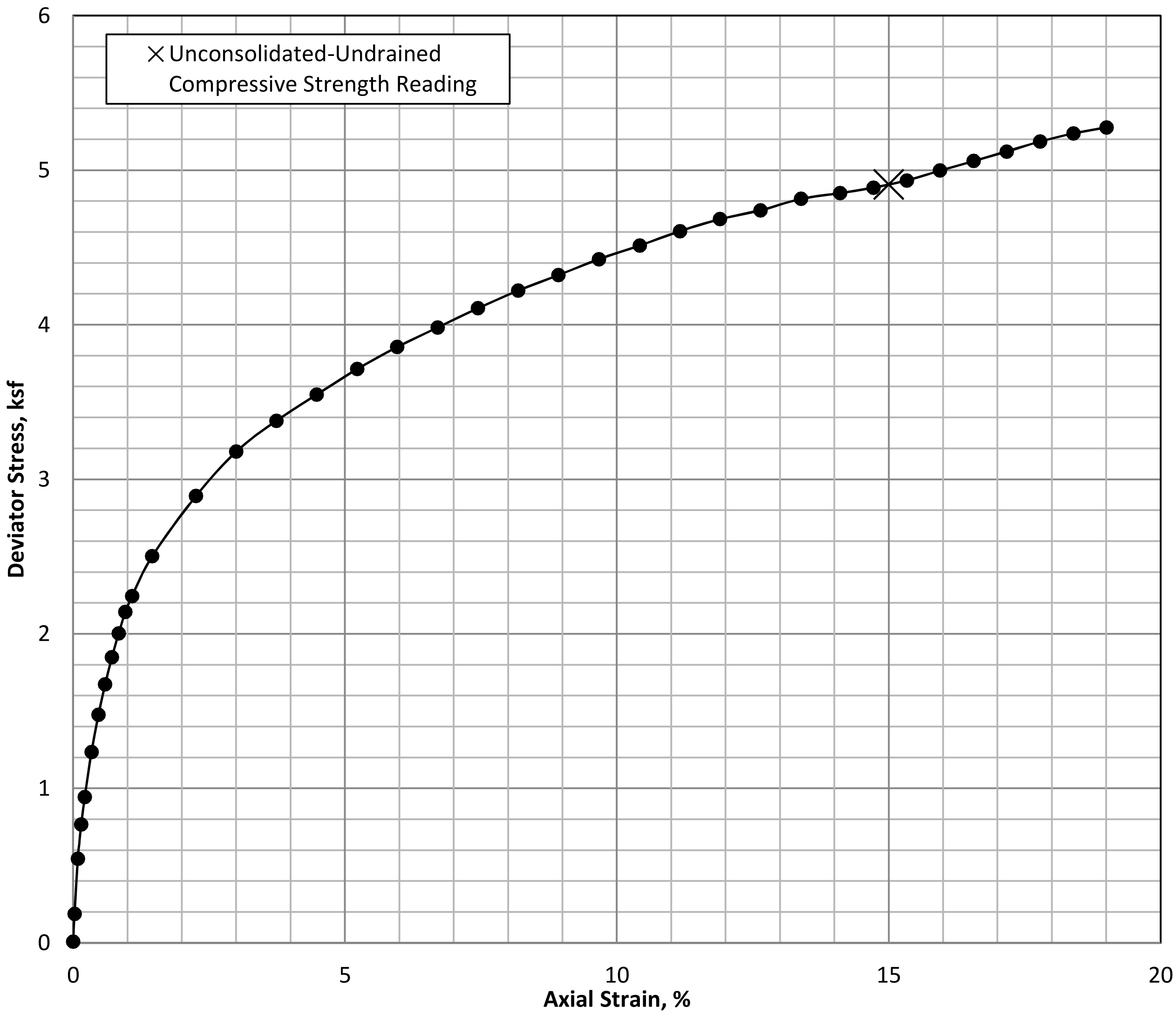
Averages for trials: 2-5

ave K @ 20 ºC: **1.83E-09** cm/sec

(i_o)ave = 24.2

Tested By: BB Reviewed By: G. Thomas

UNCONSOLIDATED-UNDRAINED COMPRESSIVE STRENGTH TEST, ASTM METHOD D2850



Specimen and Material Property Information

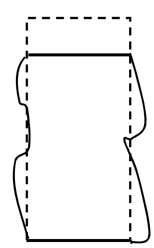
Sample Type: Intact tube sample

Description and/or Classification: CL, brown lean clay

Cell Pressure (ksf)	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)	19.4	130.9	109.7	0.56	94.8	5.999	2.880	2.1	43	26	2.74
4.0	19.4	132.2	110.8	0.54	97.5	5.979	2.870	2.1	17		

Failure Summary

U-U Compressive Strength (ksf)	U-U Shear Strength, s_u (ksf)	Strain to to Peak (%)	Strain Rate (%/min)
4.91	2.455	15.0	0.74



FAILURE SKETCH

Remarks and Notes:

(1) Water Content determined after shear from partial specimen.

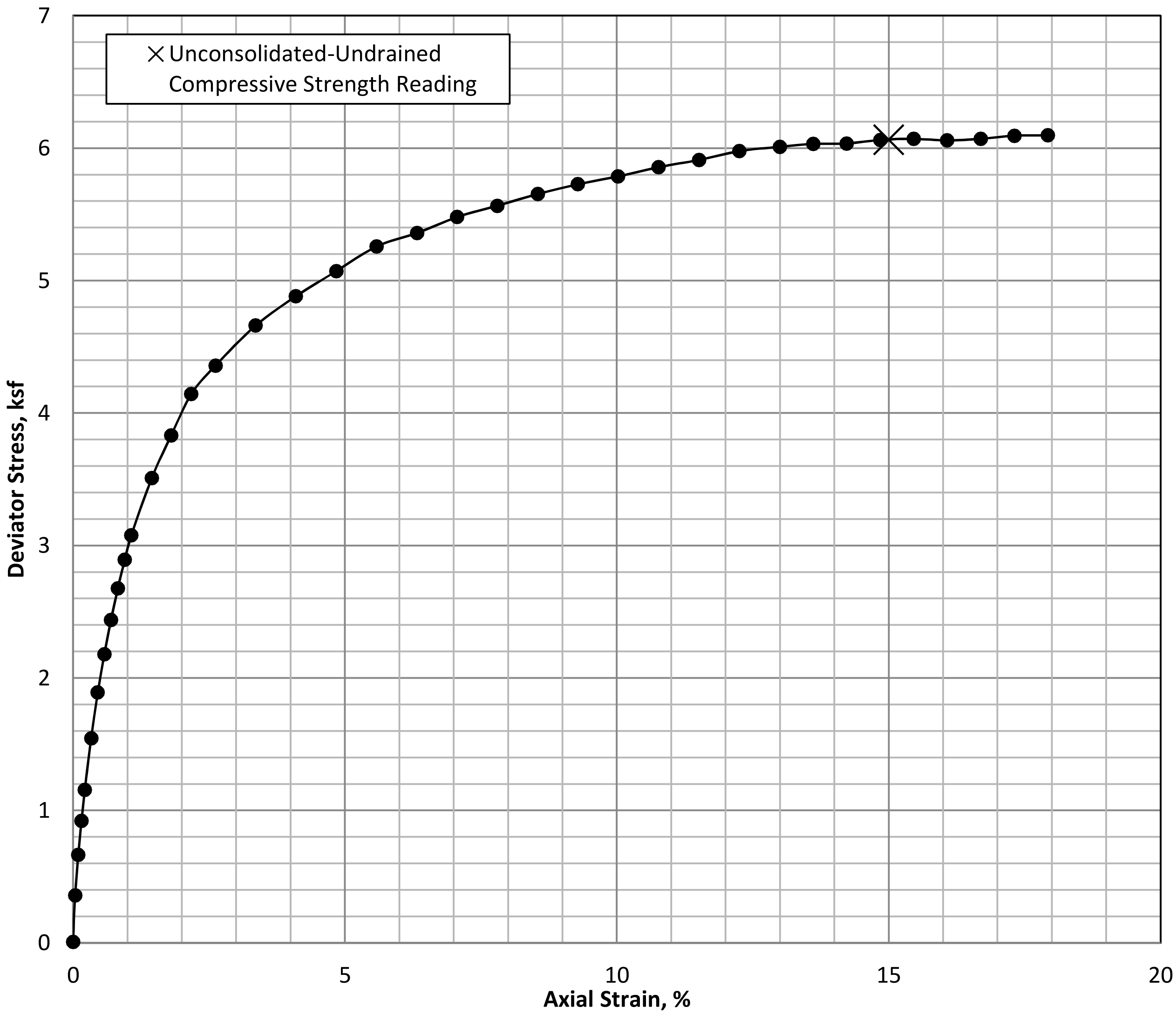
(2) Assumed specific gravity

Tested by: BB
Test Date: 10/23/2015

Reviewed by: GET
Review Date: 10/27/2015

AECOM **Project # 60428794-108** **TerraSense, LLC** **Project # T60428794**	**Dynegy CCR - Newton**	**UNCONSOLIDATED-UNDRAINED COMPRESSION TEST** **Boring: NEW-B003 Sample: ST-2** **Section: B Depth: 24.15 ft.**

UNCONSOLIDATED-UNDRAINED COMPRESSIVE STRENGTH TEST, ASTM METHOD D2850



Specimen and Material Property Information

Sample Type: Intact tube sample

Description and/or Classification: CH, brown fat clay

Cell Pressure (ksf)	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)	21.1	129.2	106.7	0.60	96.0	6.014	2.881	2.1	55	39	2.74
3.0	21.1	130.0	107.3	0.59	97.5	6.002	2.875	2.1	16		

Failure Summary

U-U Compressive Strength (ksf)	U-U Shear Strength, s_u (ksf)	Strain to to Peak (%)	Strain Rate (%/min)
6.06	3.03	15.0	0.74

FAILURE SKETCH

Remarks and Notes:

(1) Water Content determined after shear from partial specimen.

(2) Assumed specific gravity

Tested by: BB
Test Date: 10/23/2015

Reviewed by: GET
Review Date: 10/27/2015

AECOM
Project # 60428794-108

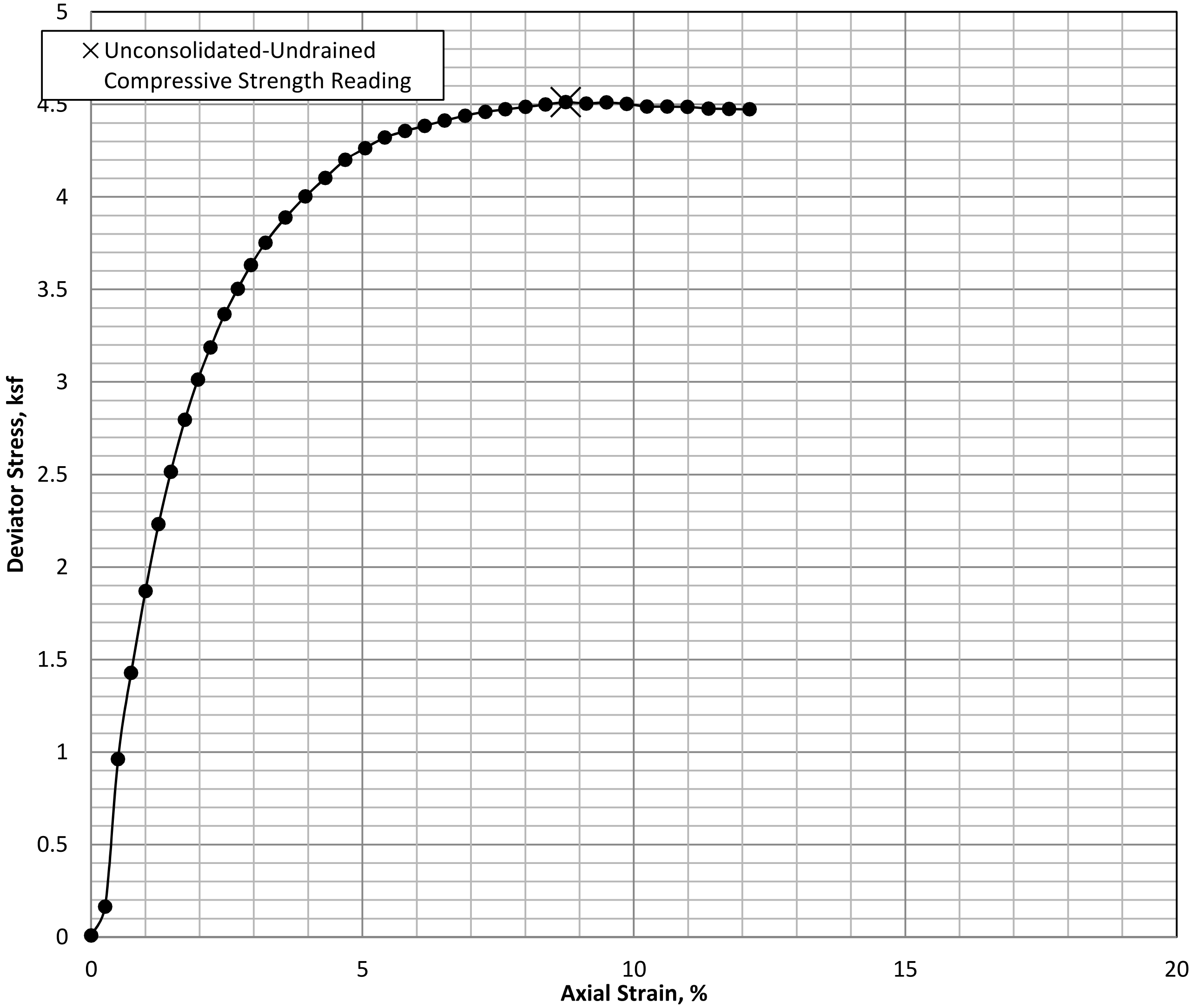
TerraSense, LLC
Project # T60428794

Dynegy CCR - Newton

UNCONSOLIDATED-UNDRAINED COMPRESSION TEST

Boring: NEW-B003 Sample: ST-3
Section: C Depth: 28.8 ft.

UNCONSOLIDATED-UNDRAINED COMPRESSIVE STRENGTH TEST, ASTM METHOD D2850



Specimen and Material Property Information

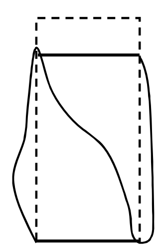
Sample Type: Intact tube sample

Description and/or Classification: CL, orange-brown clay

Cell Pressure (ksf)	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)	18.2	130.8	110.6	0.54	92.0	5.996	2.879	2.1	40	23	2.73
3.5	18.2	131.8	111.5	0.53	94.2	5.980	2.871	2.1	17		

Failure Summary

U-U Compressive Strength (ksf)	U-U Shear Strength, s_u (ksf)	Strain to to Peak (%)	Strain Rate (%/min)
4.51	2.255	8.7	0.74



FAILURE SKETCH

Remarks and Notes:

(1) Water Content determined after shear from partial specimen.

(2) Assumed specific gravity

Tested by: BB
Test Date: 10/28/2015

Reviewed by: GET
Review Date: 11/2/2015

AECOM
Project # 60428794-108

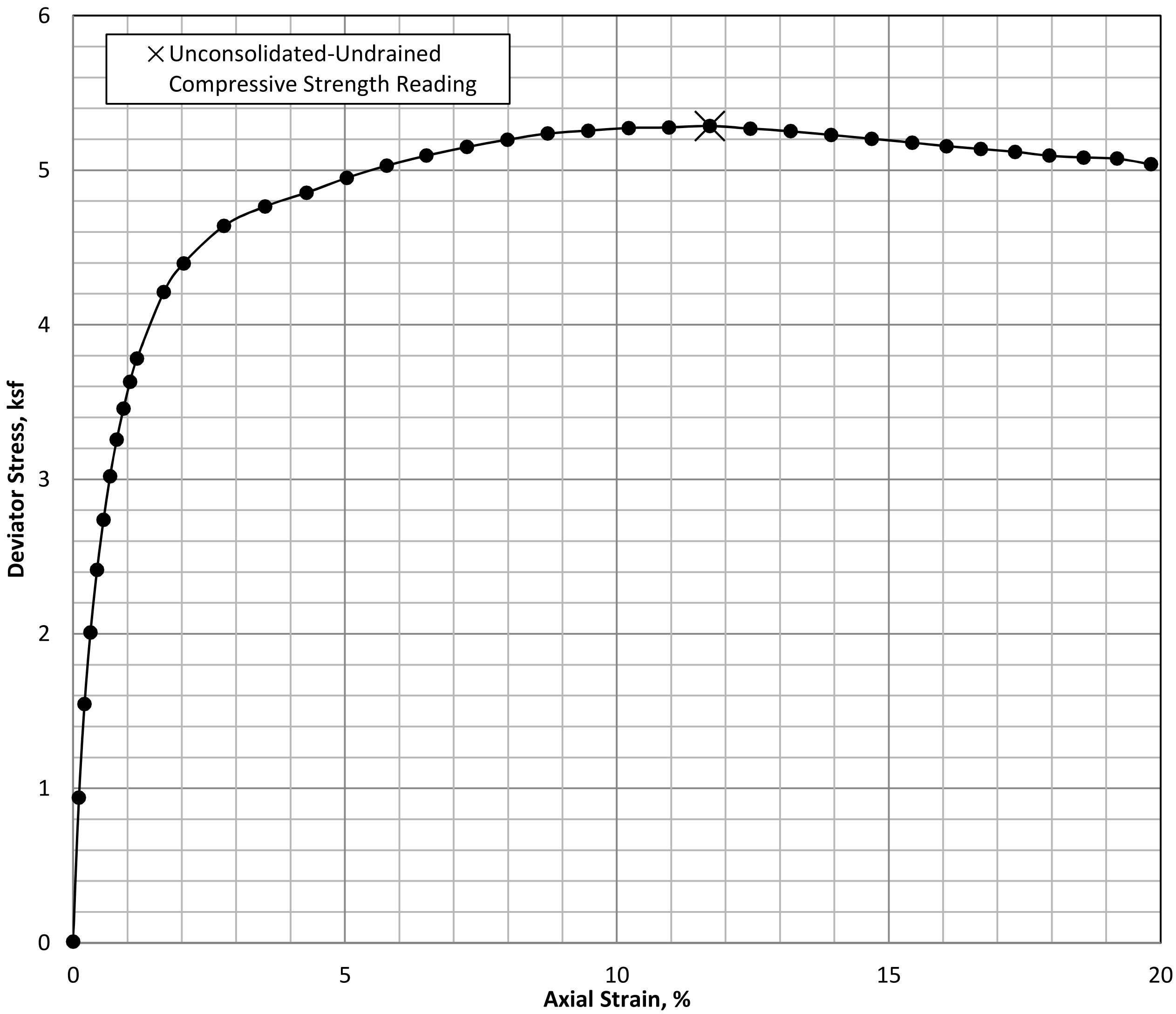
TerraSense, LLC
Project # T60428794

Dynegy CCR - Newton

UNCONSOLIDATED-UNDRAINED COMPRESSION TEST

Boring: NEW-B006 Sample: ST-1
Section: B Depth: 21.20 ft.

UNCONSOLIDATED-UNDRAINED COMPRESSIVE STRENGTH TEST, ASTM METHOD D2850



Specimen and Material Property Information

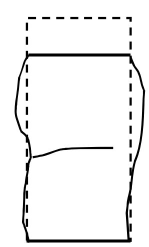
Sample Type: Intact tube sample

Description and/or Classification: CH, brown fat clay

Cell Pressure (ksf)	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)	21.5	132.0	108.6	0.61	98.9	5.987	2.877	2.1	52	40	2.80
6.0	21.5	133.0	109.4	0.60	100.9	5.972	2.870	2.1	12		

Failure Summary

U-U Compressive Strength (ksf)	U-U Shear Strength, s_u (ksf)	Strain to to Peak (%)	Strain Rate (%/min)
5.29	2.645	11.7	0.74



FAILURE SKETCH

Remarks and Notes:

(1) Water Content determined after shear from partial specimen.

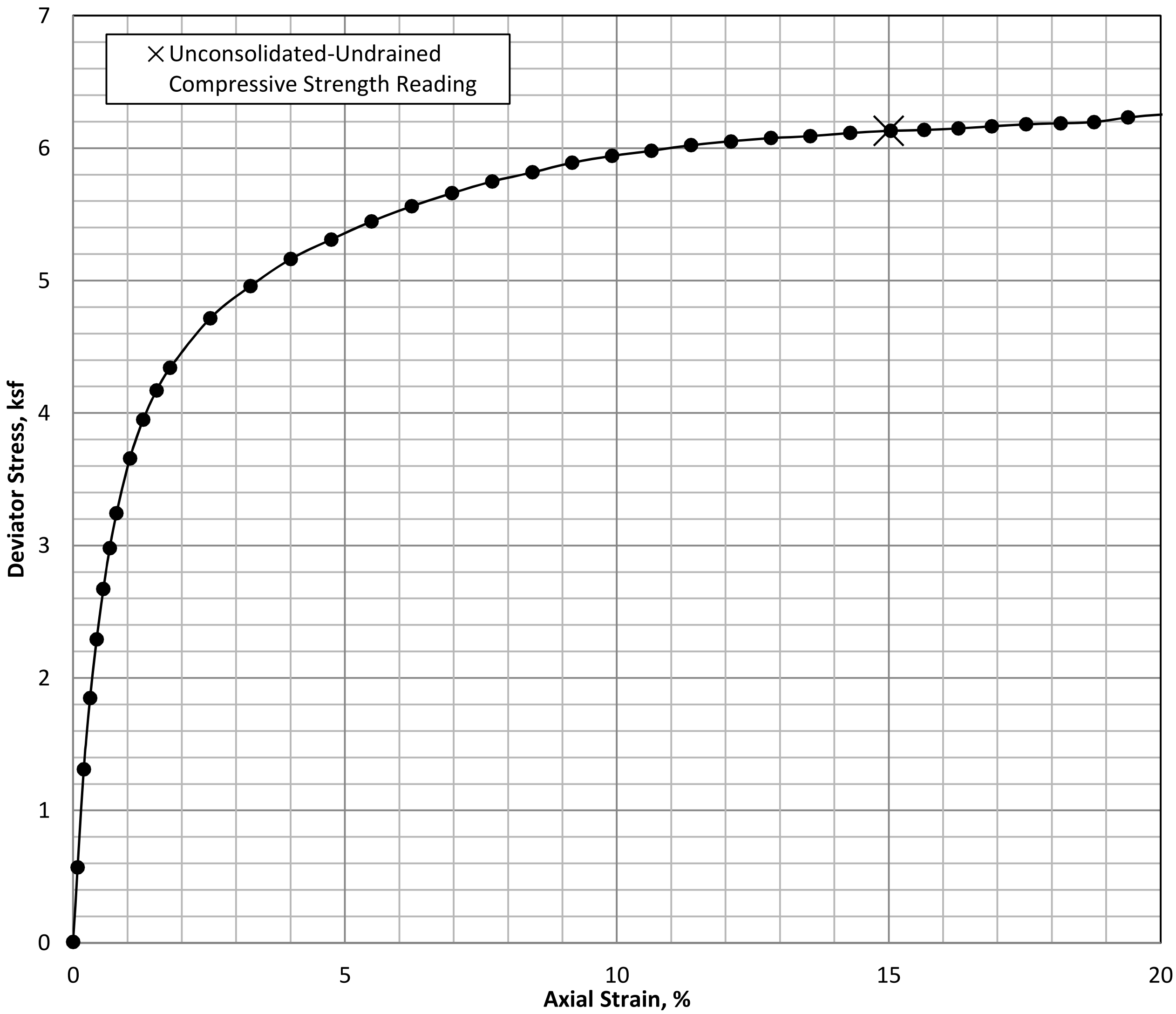
(2) Assumed specific gravity

Tested by: BB
Test Date: 10/15/2015

Reviewed by: CMJ
Review Date: 10/26/2015

AECOM Project # 60428794-108	**Dynegy CCR - Newton**	**UNCONSOLIDATED-UNDRAINED COMPRESSION TEST**
TerraSense, LLC Project # T60428794		**Boring: NEW-B007 Sample: ST-3C Section: Depth: 31.70 ft.**

UNCONSOLIDATED-UNDRAINED COMPRESSIVE STRENGTH TEST, ASTM METHOD D2850



Specimen and Material Property Information

Sample Type: Intact tube sample

Description and/or Classification: CH, brown fat clay

Cell Pressure (ksf)	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)	16.7	136.3	116.8	0.46	98.2	5.986	2.882	2.1	50	37	2.74
2.5	16.7	136.7	117.2	0.46	99.3	5.979	2.878	2.1	13		

Failure Summary

U-U Compressive Strength (ksf)	U-U Shear Strength, s_u (ksf)	Strain to to Peak (%)	Strain Rate (%/min)
6.13	3.065	15.0	0.74

Tested by: BB
Test Date: 10/15/2015

Reviewed by: CMJ
Review Date: 10/26/2015

FAILURE SKETCH

Remarks and Notes:

(1) Water Content determined after shear from partial specimen.

(2) Assumed specific gravity

AECOM
Project # 60428794-108

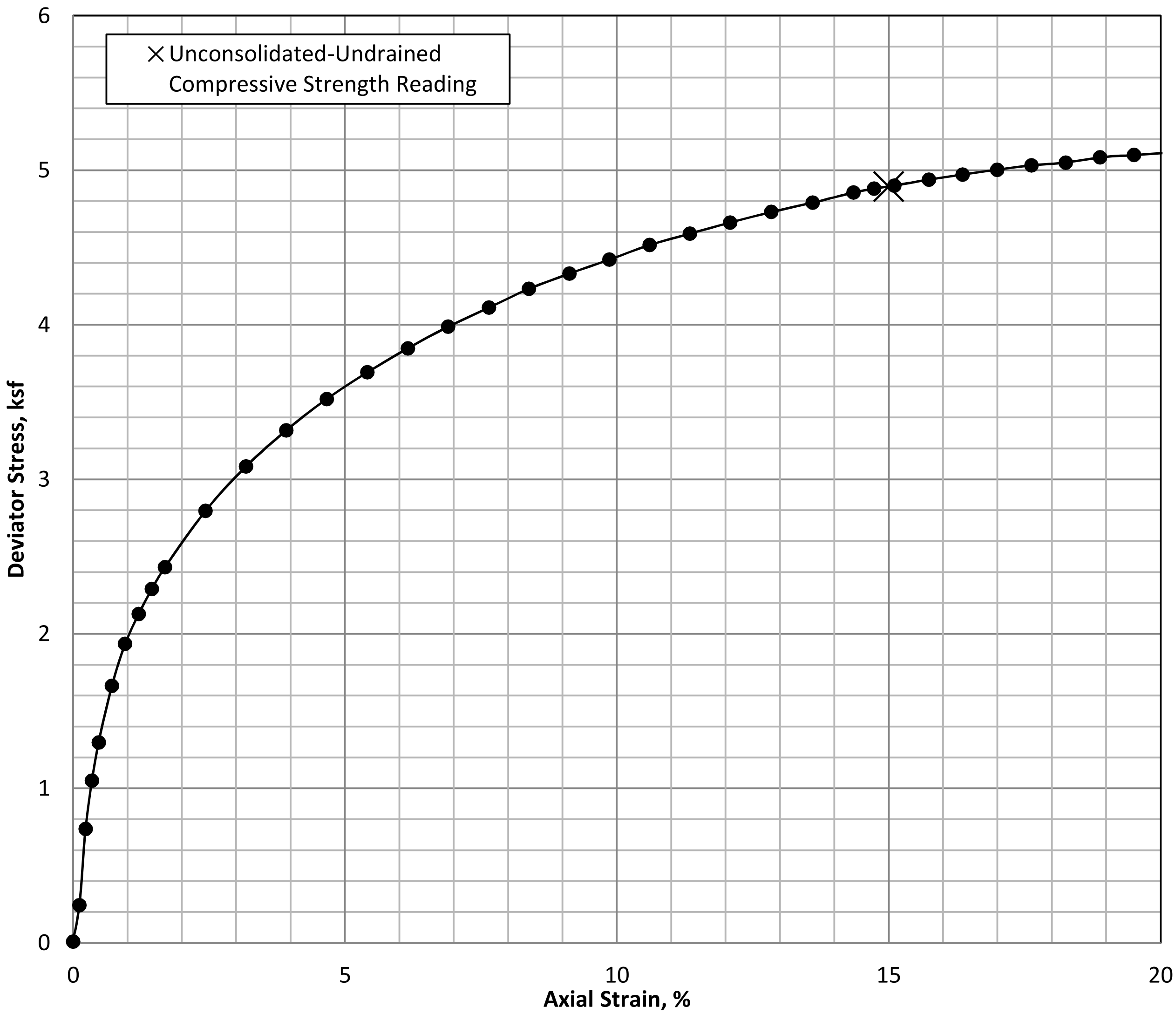
TerraSense, LLC
Project # T60428794

Dynegy CCR - Newton

UNCONSOLIDATED-UNDRAINED COMPRESSION TEST

Boring: NEW-B008 Sample: ST-1C
Section: Depth: 16.65 ft.

UNCONSOLIDATED-UNDRAINED COMPRESSIVE STRENGTH TEST, ASTM METHOD D2850



Specimen and Material Property Information

Sample Type: Intact tube sample

Description and/or Classification: CL, brown lean clay

Cell Pressure (ksf)	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)	19.0	132.3	111.2	0.52	98.6	5.982	2.874	2.1	47	32	2.71
2.0	19.0	132.7	111.6	0.52	99.6	5.975	2.870	2.1	15		

Failure Summary

U-U Compressive Strength (ksf)	U-U Shear Strength, s_u (ksf)	Strain to to Peak (%)	Strain Rate (%/min)
4.9	2.45	15.0	0.75

FAILURE SKETCH

Remarks and Notes:

(1) Water Content determined after shear from partial specimen.

(2) Assumed specific gravity

Tested by: BB
Test Date: 10/15/2015

Reviewed by: CMJ
Review Date: 10/26/2015

AECOM
Project # 60428794-108

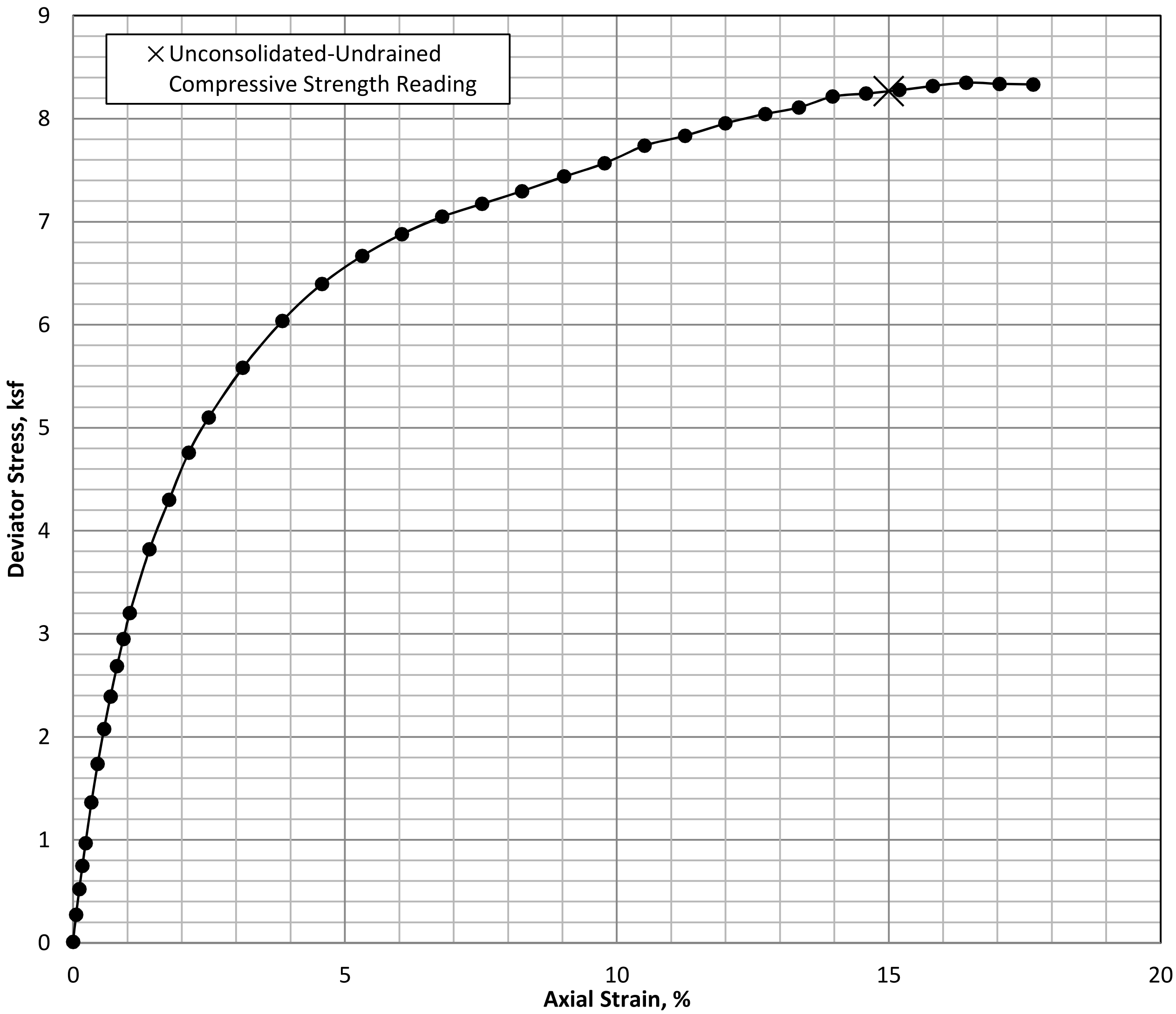
TerraSense, LLC
Project # T60428794

Dynegy CCR - Newton

UNCONSOLIDATED-UNDRAINED COMPRESSION TEST

Boring: NEW-B009 Sample: ST-1B
Section: Depth: 9.75 ft.

UNCONSOLIDATED-UNDRAINED COMPRESSIVE STRENGTH TEST, ASTM METHOD D2850



Specimen and Material Property Information

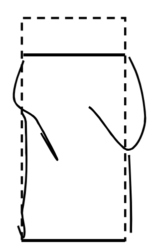
Sample Type: Intact tube sample

Description and/or Classification: CL, brown sandy clay, trace gravel

Cell Pressure (ksf)	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)	12.6	139.6	123.9	0.38	91.1	6.033	2.883	2.1	34	21	2.74
1.5	12.6	140.3	124.5	0.37	92.7	6.023	2.878	2.1	13		

Failure Summary

U-U Compressive Strength (ksf)	U-U Shear Strength, s_u (ksf)	Strain to to Peak (%)	Strain Rate (%/min)
8.27	4.135	15.0	0.74



FAILURE SKETCH

Tested by: BB
Test Date: 10/23/2015

Reviewed by: GET
Review Date: 10/29/2015

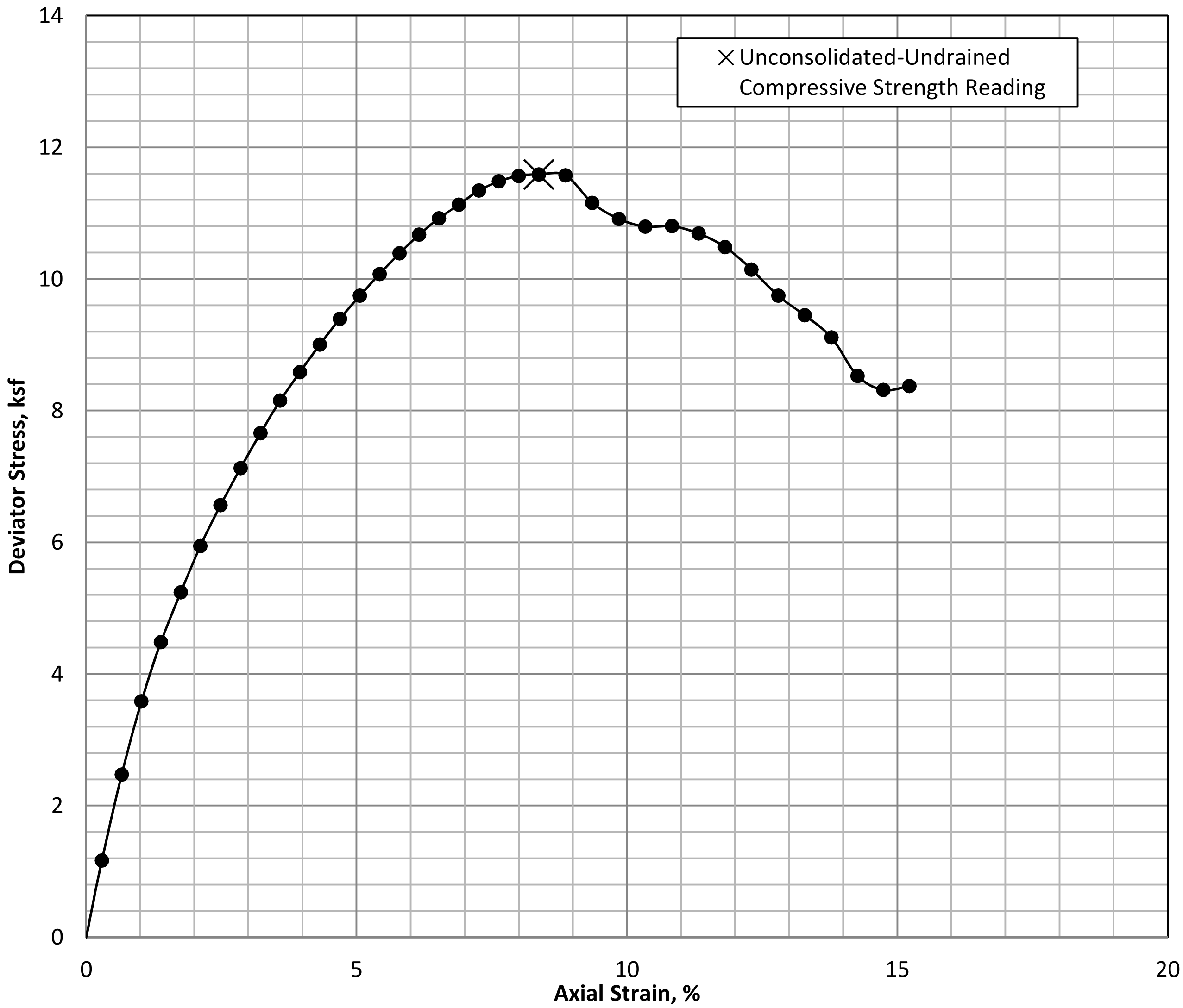
Remarks and Notes:

(1) Water Content determined after shear from partial specimen.

(2) Assumed specific gravity

AECOM **Project # 60428794-108**	**Dynegy CCR - Newton**	**UNCONSOLIDATED-UNDRAINED COMPRESSION TEST**
TerraSense, LLC **Project # T60428794**		**Boring: NEW-B012 Sample: ST-4** **Section: C Depth: 9.45 ft.**

UNCONSOLIDATED-UNDRAINED COMPRESSIVE STRENGTH TEST, ASTM METHOD D2850



Specimen and Material Property Information

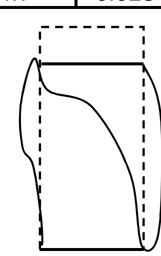
Sample Type: Intact tube sample

Description and/or Classification: SC, orange brown clayey sand

Cell Pressure (ksf)	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)	9.5	142.7	130.3	0.31	84.3	6.025	2.886	2.1	28	15	2.73
0.5	9.5	142.9	130.4	0.31	84.7	6.023	2.885	2.1	13		

Failure Summary

U-U Compressive Strength (ksf)	U-U Shear Strength, s_u (ksf)	Strain to to Peak (%)	Strain Rate (%/min)
11.6	5.8	8.4	0.73



FAILURE SKETCH

Remarks and Notes:

(1) Water Content determined after shear from partial specimen.

(2) Assumed specific gravity

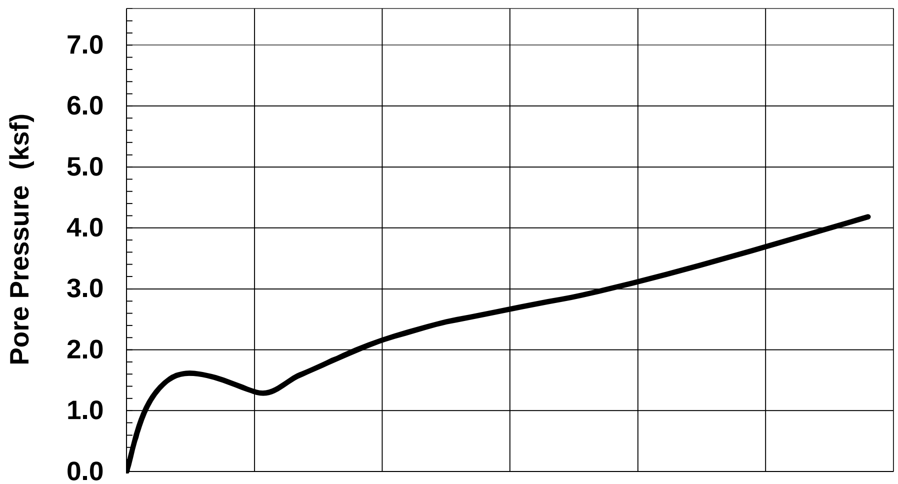
Tested by: BB

Test Date: 9/17/2015

Reviewed by: GET

Review Date: 10/27/2015

AECOM Project # 60428794-108	**Dynegy CCR - Newton**	**UNCONSOLIDATED-UNDRAINED COMPRESSION TEST**
TerraSense, LLC Project # T60428794		**Boring: NEW-B014 Sample: ST-1 Section: B Depth: 3.50 ft.**



SAMPLE INFORMATION

Boring: NEW-B007 Sample: ST-5 Depth: 51.05 feet
Type: Intact tube sample
Description: CL, stiff brown clay, trace c-f sand, fine gravel
LL = 32 PL = 16 PI = 16

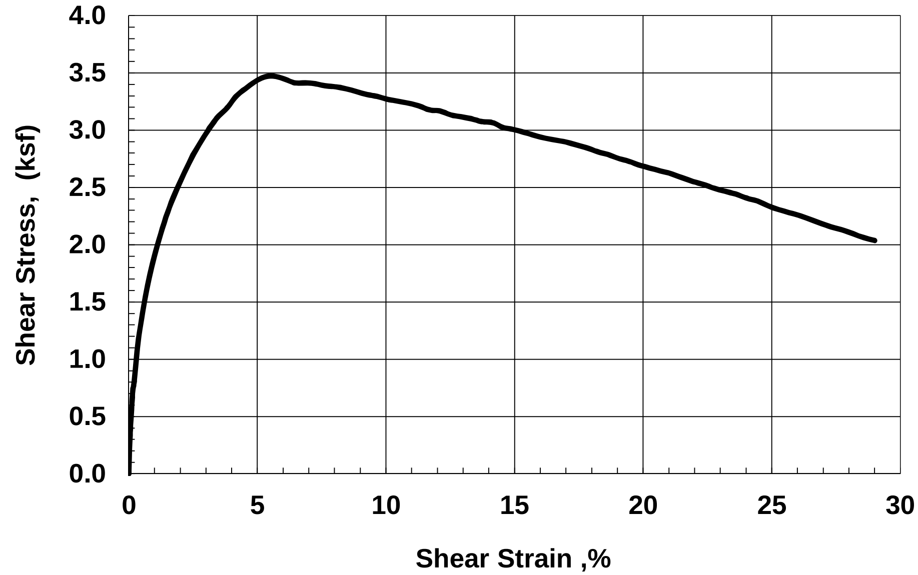
SPECIMEN INFORMATION (Initial)

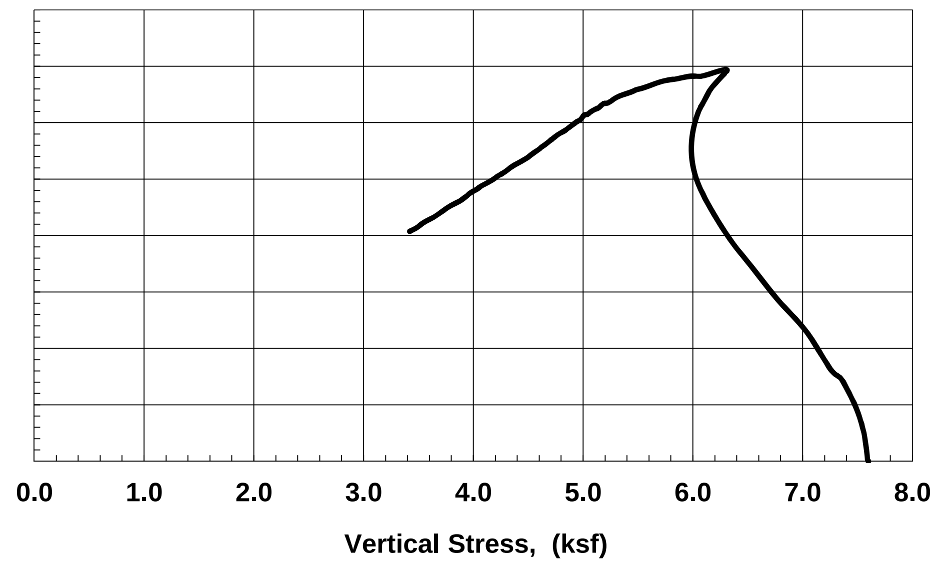
Height: 0.72 Diameter: 2.63 inch Area: 5.42 in²
Water Content: 13.9 % Total Unit Weight: 136.1 pcf

TEST SUMMARY

Vertical Consolidation Stress: 7.60 ksf OCR = 1.0
Water Content: 14.8 % Total Unit Weight: 139.9 pcf
Peak Shear Strength: 3.47 ksf @ 5.6 % Strain
Strain Rate: 0.064 %/min

REMARKS:

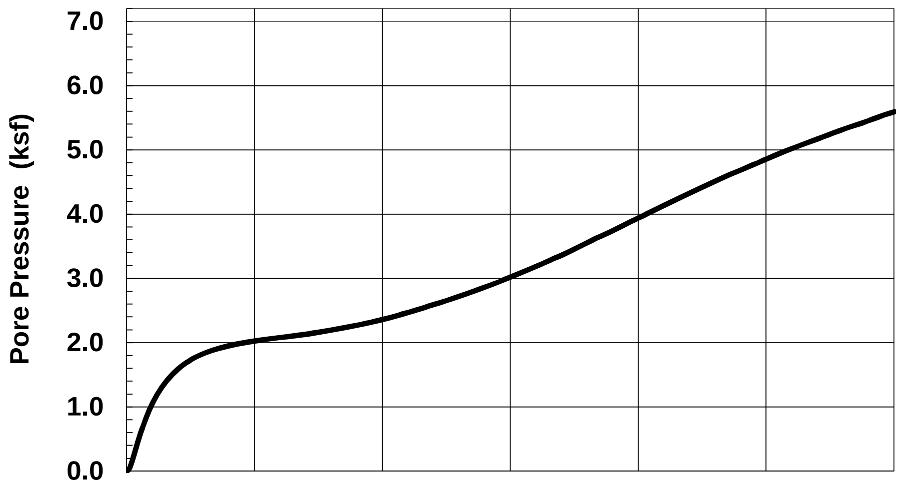




Test by: D Tso	Project No. T60428794	AECOM #60428794 Dynegy CCR - Newton	CONSTANT VOLUME	
Checked by: GET	**TerraSense, LLC**		DIRECT SIMPLE SHEAR Boring NEW-B007 Sample ST-5	October-15

Analysis File: DSSV5a.XLS

10/28/2015 DSS855



SAMPLE INFORMATION

Boring: NEW-B012 Sample: ST-15 Depth: 61.45 feet
Type: Intact tube sample
Description: CL, brown clay
LL = 42 PL = 14 PI = 28

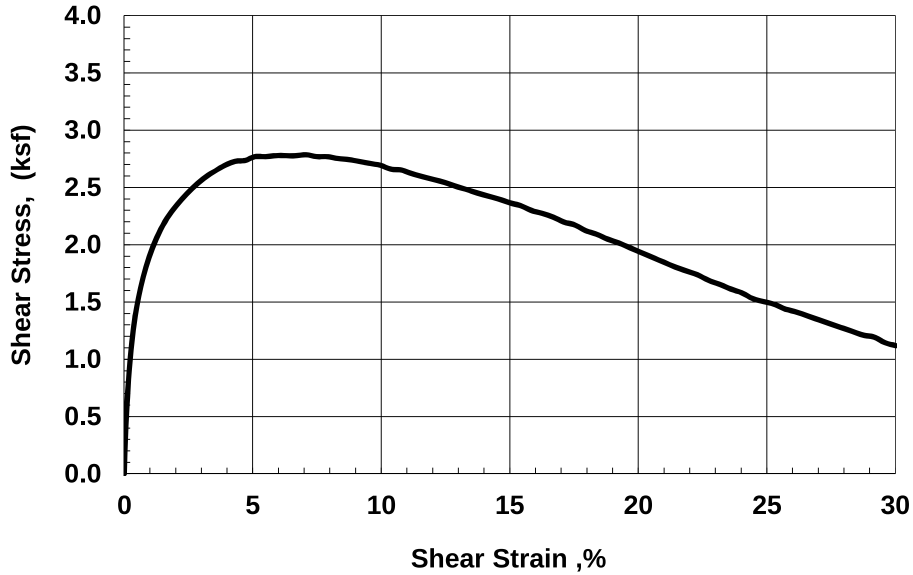
SPECIMEN INFORMATION (Initial)

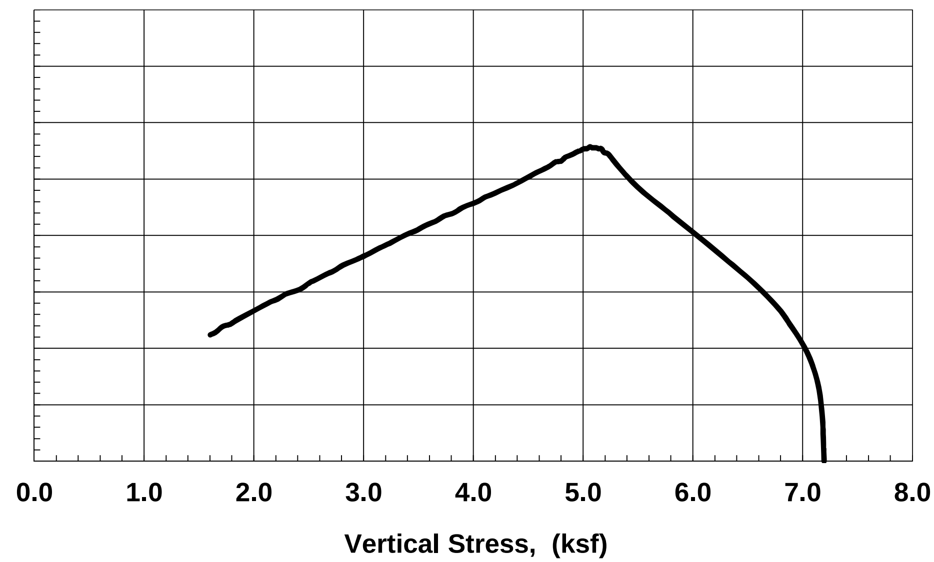
Height: 0.72 Diameter: 2.63 inch Area: 5.45 in²
Water Content: 12.8 % Total Unit Weight: 132.5 pcf

TEST SUMMARY

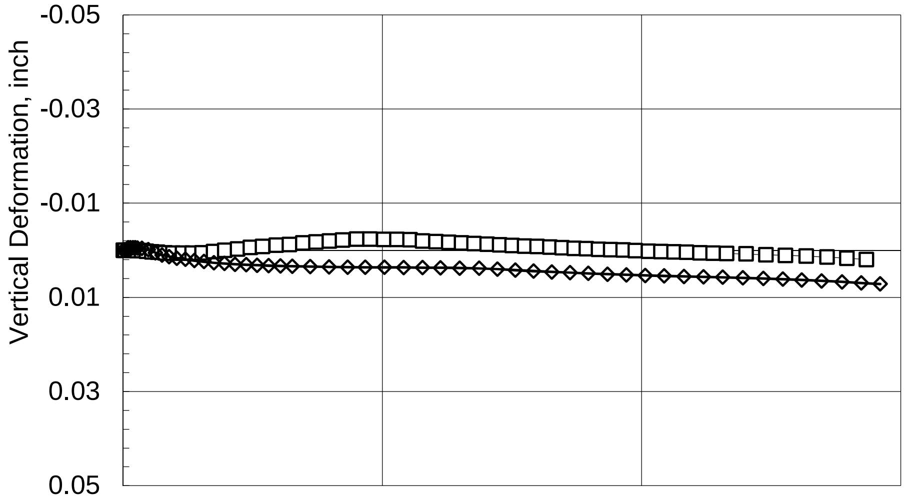
Vertical Consolidation Stress: 7.20 ksf OCR = 1.0
Water Content: 13.6 % Total Unit Weight: 138.6 pcf
Peak Shear Strength: 2.79 ksf @ 7.1 % Strain
Strain Rate: 0.067 %/min

REMARKS:





Test by:	G. Thomas	Project No. T60428794	AECOM #60428794 Dynegy CCR - Newton	CONSTANT VOLUME DIRECT SIMPLE SHEAR Boring NEW-B012 Sample ST-15	
Checked by:	GET	TerraSense, LLC			October-15



SAMPLE INFORMATION

Boring: NEW-B006 Sample: ST- 4 Depth: 35-35.8 feet
Type: Intact tube sample
Description: CL, brown sandy clay

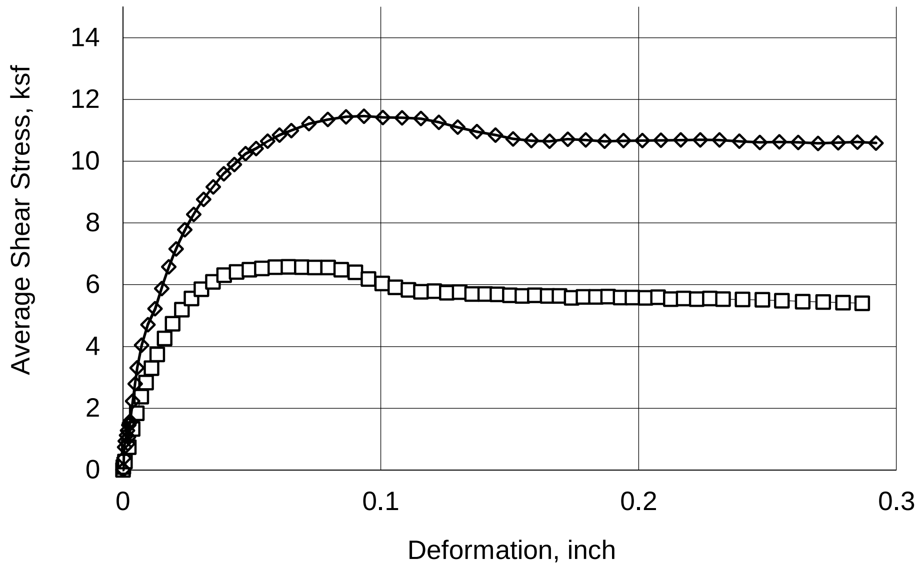
TEST INFORMATION

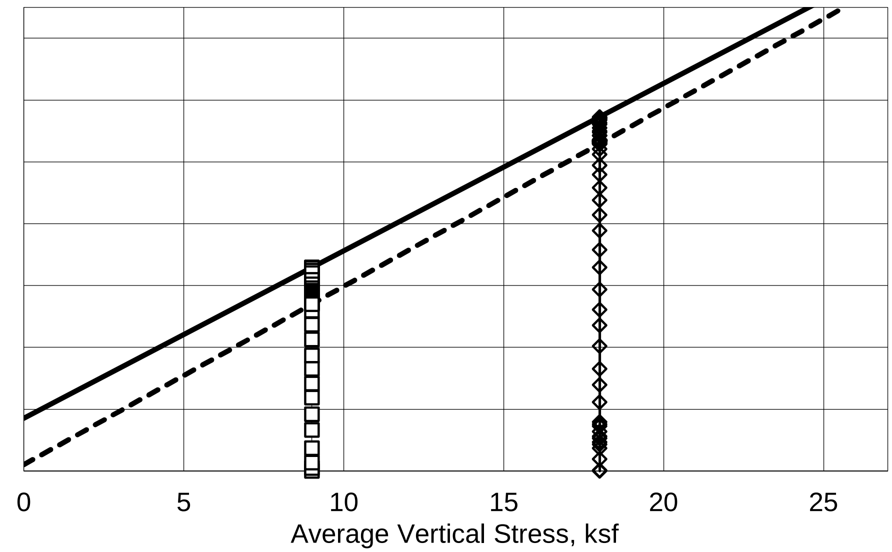
Test	Symbol	Vertical Stress (ksf)	Deformation Rate (inch/min.)
DS1619	□	9.0	0.0022
DS1617	◊	18.0	0.0020

TEST SUMMARY

Peak Effective Friction Angle: 28.4°, cohesion = 1.7ksf (solid line)
Final Effective Friction Angle: 30.0°, cohesion = 0.2ksf (dashed line)

REMARKS:





AECOM #60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **SERIES SUMMARY** Boring: NEW-B006 Sample: ST- 4 Depth: 35-35.8	
TerraSense, LLC	T60428794		November 2015

Prepared by: MHC
Checked by: GET

Analysis File: Ds_sumv8 DSsumB006ST4.xls 11/17/2015

STAGED DRAINED DIRECT SHEAR TEST SERIES

Boring No / Sample/ Specimen	Depth (ft) / Test ID	w_o / w_c (estimated) (%)	γ_{to} / γ_{tc} (estimated) (pcf)	γ_{do} / γ_{dc} (estimated) (pcf)	$\sigma'_{v,c}$ (ksf) / $\varepsilon_{v,c}$ (%)	Deformation rate (inch/min) / t_c (days)	at Peak Shear Stress / at High Deformation: ΔL (inch)	τ_h (ksf)	ε_v (%)	Φ' for c'=0	Remarks
NEW-B006	35.4	11.1	140.2	126.2	9.00	2.2E-3	0.06	6.58	-0.12	36.2	
ST- 4	DS1619	12.7	142.9	126.9	2.4	0.05	0.29	5.39	0.19	30.9	
NEW-B006	35.6	15.8	147.4	127.2	18.00	2.0E-3	0.09	11.46	0.36	32.5	
ST- 4	DS1617	12.4	148.1	131.7	27.0	0.16	0.29	10.59	0.71	30.5	

Description of Material Tested and Remarks

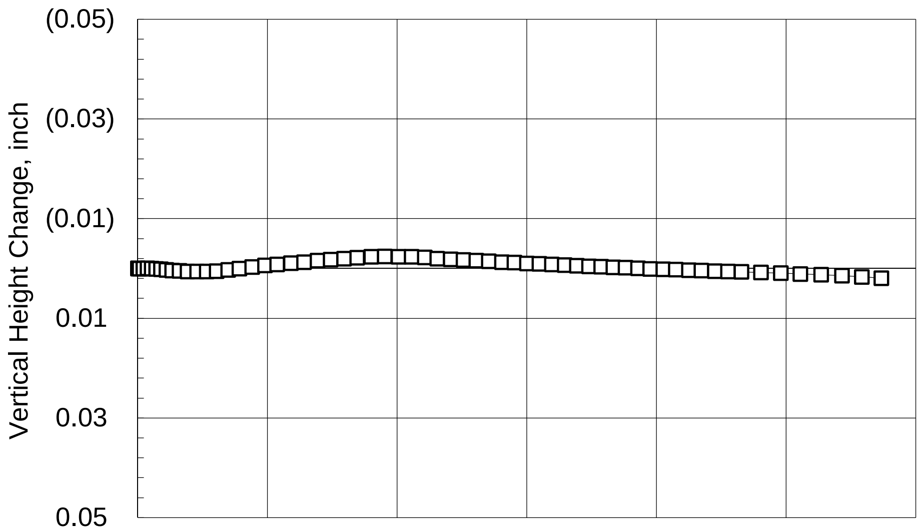
DS1619	CL, brown sandy clay
DS1617	CL, brown sandy clay

Strength Envelope Summary

Test Series	Failure Criterion	Φ' (degree)	c' (ksf)
1	1	28.4	1.7
	2	30.0	0.2

Failure Criterion: 1. Peak shear stress; 2. High deformation

Prepared by: MHC Checked by: GET	AECOM #60428794 **TerraSense, LLC**	Dynegy CCR - Newton T60428794	**DRAINED DIRECT SHEAR SERIES SUMMARY** Boring: NEW-B006 Sample: ST- 4 Depth: 35-35.8 ft



SAMPLE INFORMATION

Boring: NEW-B006 Sample: ST- 4 Specimen: B Depth: 35.4 ft

Type: Intact tube sample

SPECIMEN INFORMATION (Initial)

Description: CL, brown sandy clay

Height: 1.01 inch Diameter: 2.50 inch Area: 4.91 in²

Water Content: 11.1 % Dry Unit Weight: 126.2 pcf

TEST SUMMARY

Vertical Consolidation Stress: 9.00 ksf

Water Content: 12.7 % Dry Unit Weight: 126.9 pcf

Deformation Rate: 0.00224 inch/min.

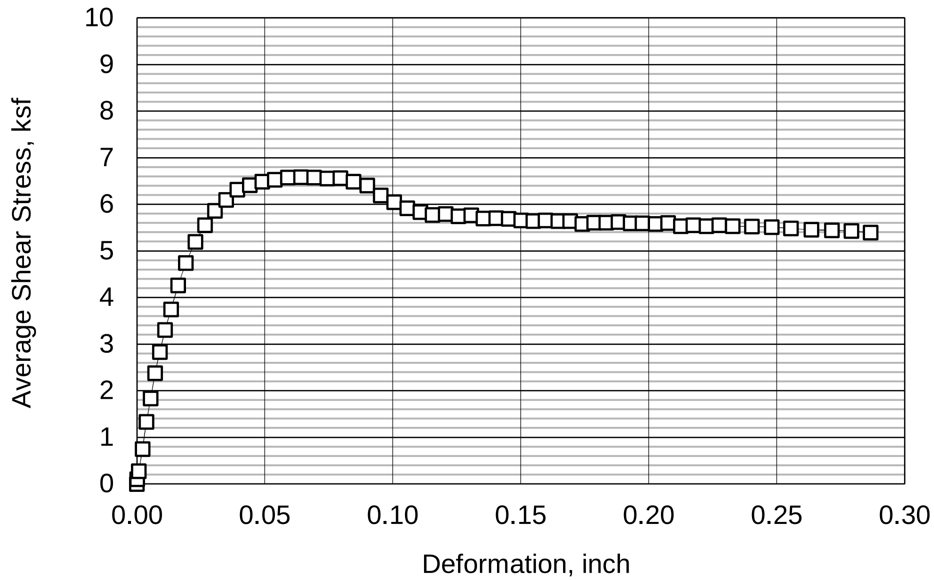
Peak Shear Strength: 6.58 ksf @ 0.06 inch deformation

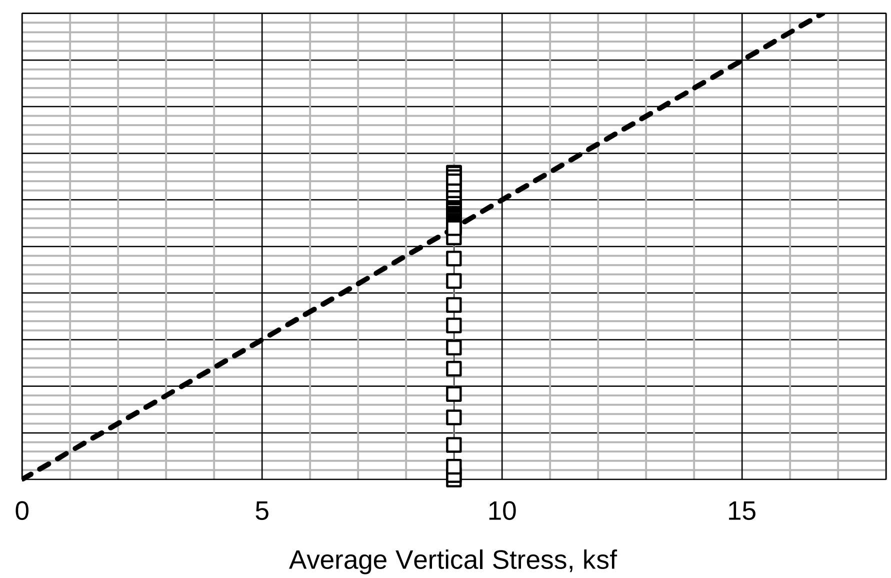
Peak Effective Friction Angle: 36.2°, cohesion = 0.0ksf

Final Shear Strength: 5.39 ksf @ 0.29 inch deformation

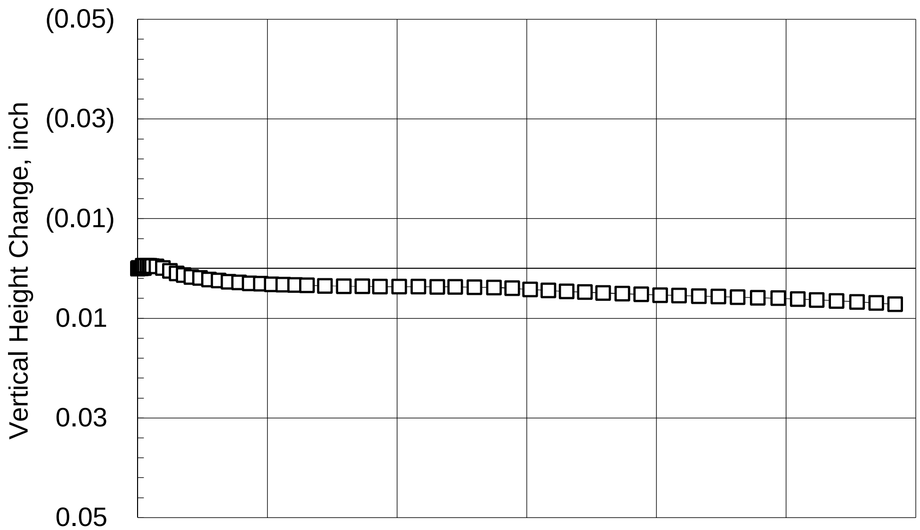
Final Effective Friction Angle: 30.9° (Shown)

REMARKS:





Prepared by: MHC Checked by: GET	AECOM 60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **TEST SUMMARY** Boring: NEW-B006 Sample: ST- 4 Specimen: B Depth: 35.4 ft	
	TerraSense, LLC	T60428794		November 15



SAMPLE INFORMATION

Boring: NEW-B006 Sample: ST- 4 Specimen: A Depth: 35.55 ft

Type: Intact tube sample

SPECIMEN INFORMATION (Initial)

Description: CL, brown sandy clay

Height: 1.01 inch Diameter: 2.50 inch Area: 4.91 in²

Water Content: 15.8 % Dry Unit Weight: 127.2 pcf

TEST SUMMARY

Vertical Consolidation Stress: 18.00 ksf

Water Content: 12.4 % Dry Unit Weight: 131.7 pcf

Deformation Rate: 0.00200 inch/min.

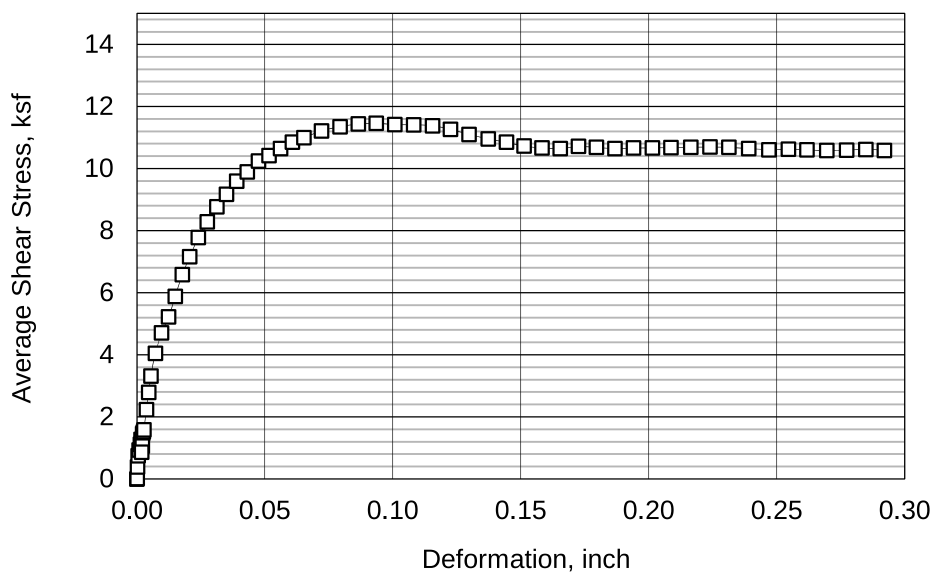
Peak Shear Strength: 11.46 ksf @ 0.09 inch deformation

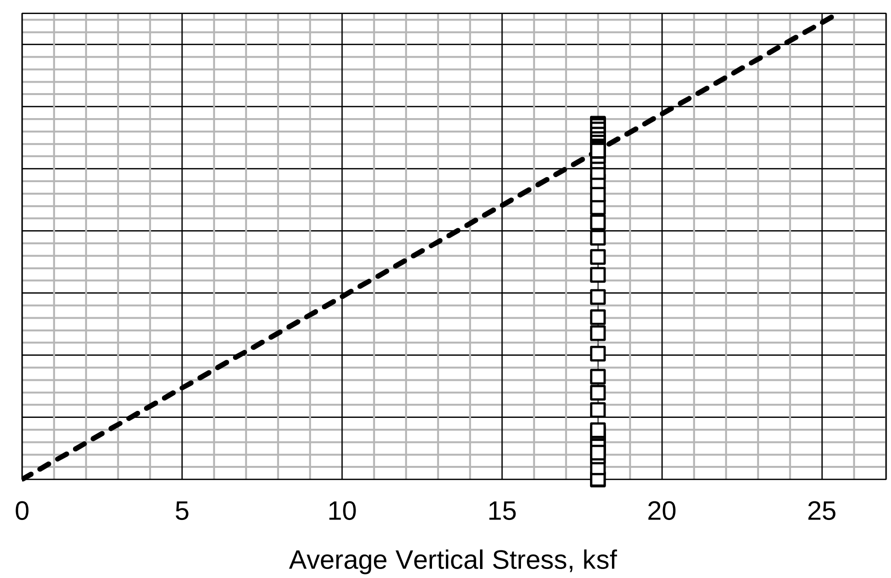
Peak Effective Friction Angle: 32.5°, cohesion = 0.0ksf

Final Shear Strength: 10.59 ksf @ 0.29 inch deformation

Final Effective Friction Angle: 30.5° (Shown)

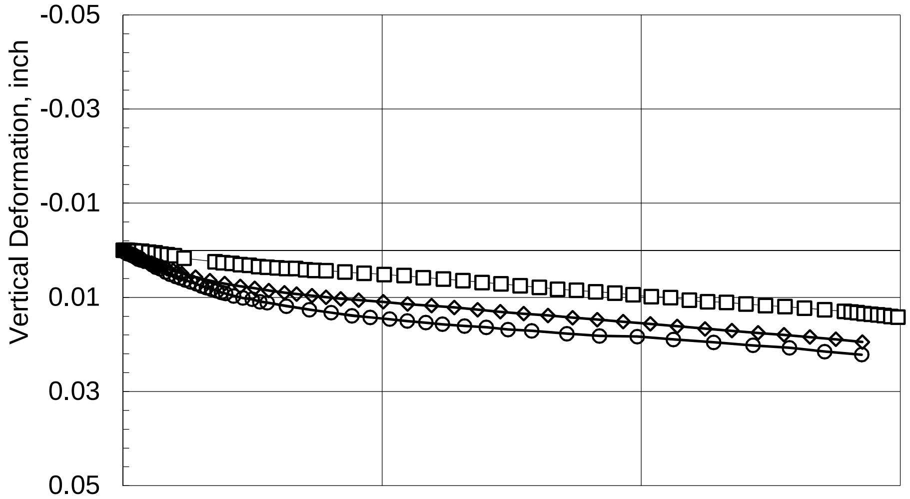
REMARKS:





Prepared by: MHC Checked by: GET	AECOM 60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **TEST SUMMARY** Boring: NEW-B006 Sample: ST- 4 Specimen: A Depth: 35.55 ft	
	TerraSense, LLC	T60428794		November 15

Analysis File: DsV8.xlsx DS1617.xlsx 11/17/2015



SAMPLE INFORMATION

Boring: NEW-B007 Sample: ST-4 Depth: 40-42 feet

Type: Intact tube sample

Description: CH, brown clay with sand

TEST INFORMATION

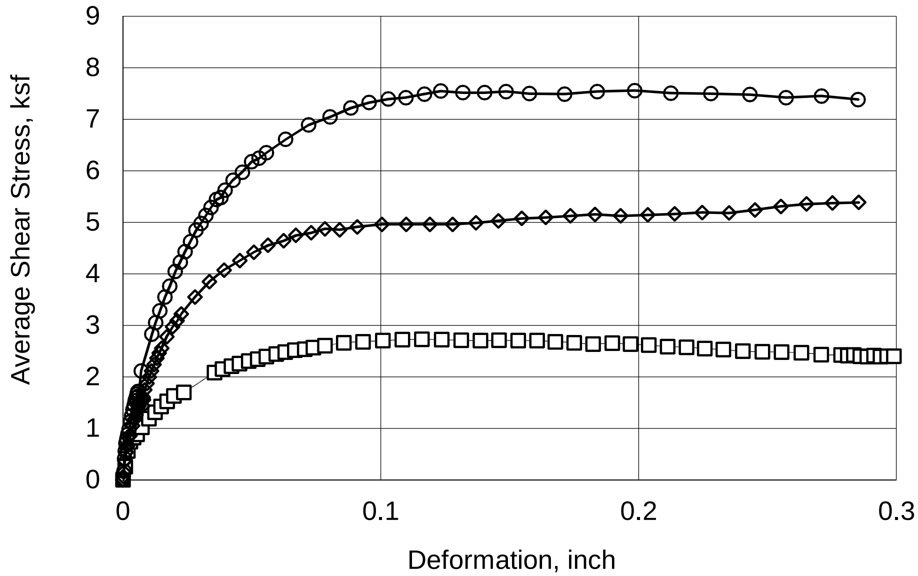
Test	Symbol	Vertical Stress (ksf)	Deformation Rate (inch/min.)
DS1620	□	5.0	0.0022
DS1621	◊	10.0	0.0002
DS1622	○	15.0	0.0001

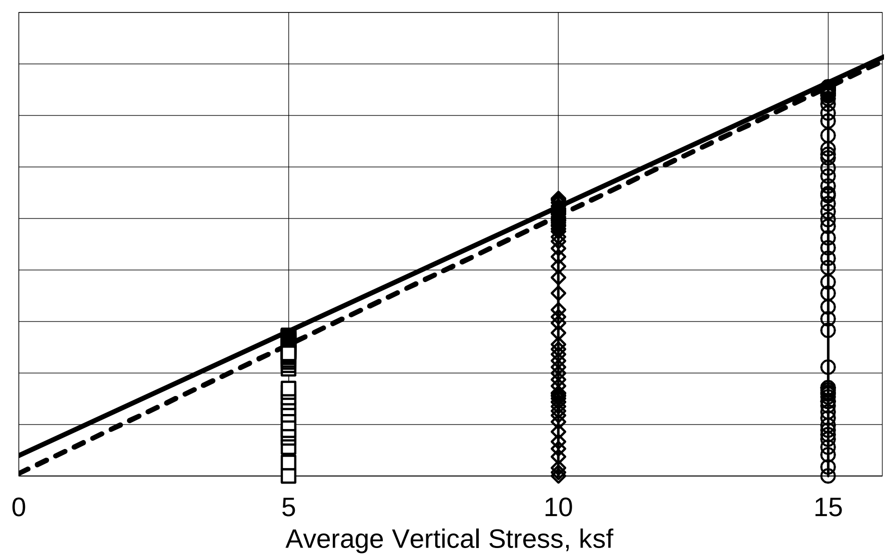
TEST SUMMARY

Peak Effective Friction Angle: 25.8°, cohesion = 0.4ksf ———

Final Effective Friction Angle: 26.6°, cohesion = 0.1ksf - - - -

REMARKS:





Prepared by: MHC Checked by: GET	AECOM #60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **SERIES SUMMARY** Boring: NEW-B007 Sample: ST-4 Depth: 40-42	November 2015
	TerraSense, LLC	T60428794		

STAGED DRAINED DIRECT SHEAR TEST SERIES

Boring No / Sample/ Specimen	Depth (ft) / Test ID	w_o / w_c (estimated) (%)	γ_{to} / γ_{tc} (estimated) (pcf)	γ_{do} / γ_{dc} (estimated) (pcf)	$\sigma'_{v,c}$ (ksf) / $\varepsilon_{v,c}$ (%)	Deformation rate (inch/min) / t_c (days)	at Peak Shear Stress / at High Deformation: ΔL (inch)	τ_h (ksf)	ε_v (%)	Φ' for c'=0	Remarks
NEW-B007	41.0	17.5	129.9	110.5	5.00	2.2E-3	0.12	2.73	0.58	28.6	
ST-4	DS1620	18.6	131.8	111.1	2.9	1.69	0.30	2.38	1.45	25.5	
NEW-B007	41.3	14.7	128.7	112.2	10.00	1.8E-4	0.29	5.39	1.91	28.3	
ST- 4	DS1621	16.3	132.9	114.2	4.7	0.71	0.29	5.39	1.91	28.3	
NEW-B007	41.5	16.1	132.6	114.2	15.00	1.3E-4	0.20	7.56	1.83	26.7	
ST- 4	DS1622	14.8	138.9	121.0	8.5	0.78	0.29	7.38	2.21	26.2	

Description of Material Tested and Remarks	
DS1620	CH, brown clay with sand
DS1621	CH, brown clay with sand
DS1622	CH, brown clay with sand

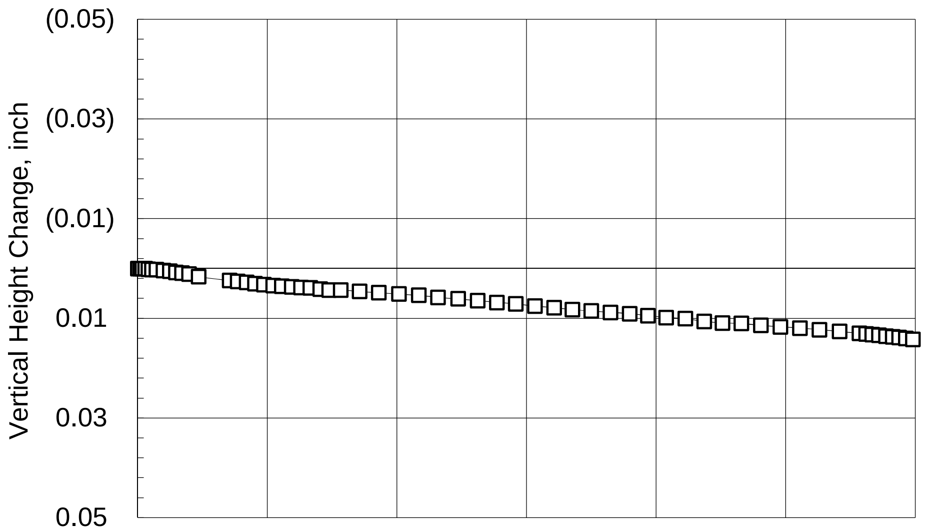
Strength Envelope Summary

Test Series	Failure Criterion	Φ' (degree)	c' (ksf)
1	1	25.8	0.4
	2	26.6	0.1

Failure Criterion: 1. Peak shear stress; 2. High deformation

Prepared by: MHC
Checked by: GET

AECOM #60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR SERIES SUMMARY**
TerraSense, LLC	T60428794	Boring: NEW-B007 Sample: ST-4 Depth: 40-42 ft



SAMPLE INFORMATION

Boring: NEW-B007 Sample: ST-4 Specimen: B Depth: 41 ft

Type: Intact tube sample

SPECIMEN INFORMATION (Initial)

Description: CH, brown clay with sand

Height: 1.00 inch Diameter: 2.50 inch Area: 4.91 in²

Water Content: 17.5 % Dry Unit Weight: 110.5 pcf

TEST SUMMARY

Vertical Consolidation Stress: 5.00 ksf

Water Content: 18.6 % Dry Unit Weight: 111.1 pcf

Deformation Rate: 0.00222 inch/min.

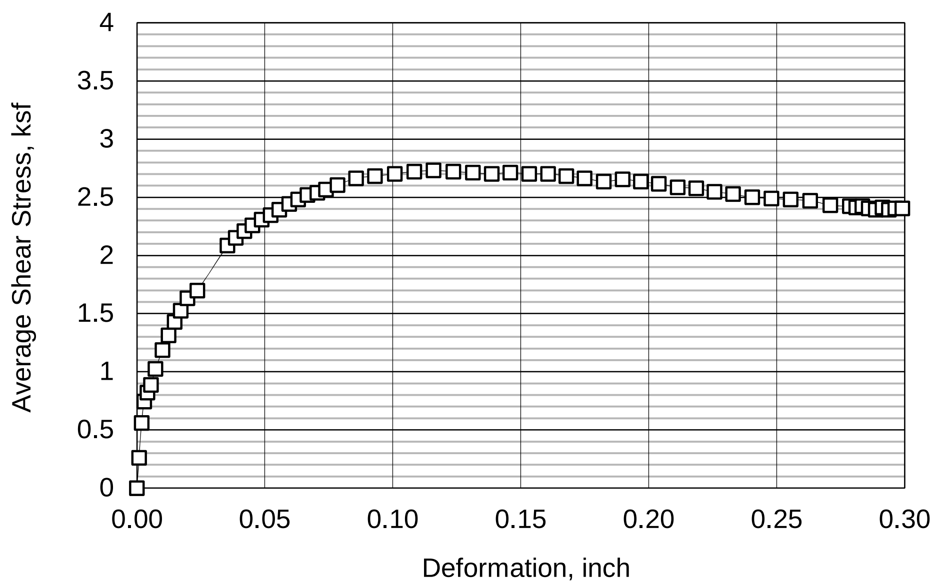
Peak Shear Strength: 2.73 ksf @ 0.12 inch deformation

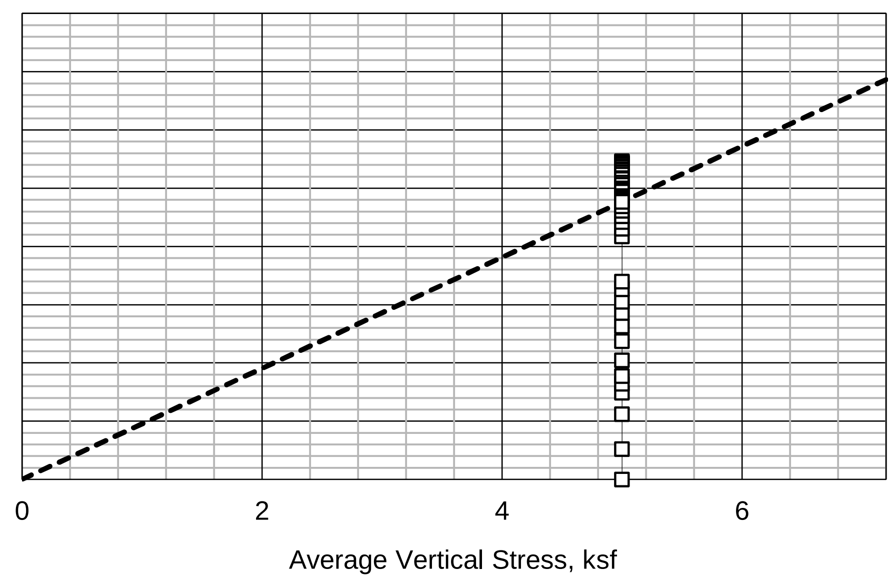
Peak Effective Friction Angle: 28.6°, cohesion = 0.0ksf

Final Shear Strength: 2.38 ksf @ 0.30 inch deformation

Final Effective Friction Angle: 25.5° (Shown)

REMARKS:





Prepared by: MHC Checked by: GET	AECOM 60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **TEST SUMMARY** Boring: NEW-B007 Sample: ST-4 Specimen: B Depth: 41 ft	November 15
	TerraSense, LLC	T60428794		

SAMPLE INFORMATION

Boring: NEW-B007 Sample: ST- 4 Specimen: C Depth: 41.25 ft

Type: Intact tube sample

SPECIMEN INFORMATION (Initial)

Description: CH, brown clay with sand

Height: 1.02 inch Diameter: 2.50 inch Area: 4.91 in²

Water Content: 14.7 % Dry Unit Weight: 112.2 pcf

TEST SUMMARY

Vertical Consolidation Stress: 10.00 ksf

Water Content: 16.3 % Dry Unit Weight: 114.2 pcf

Deformation Rate: 0.00018 inch/min.

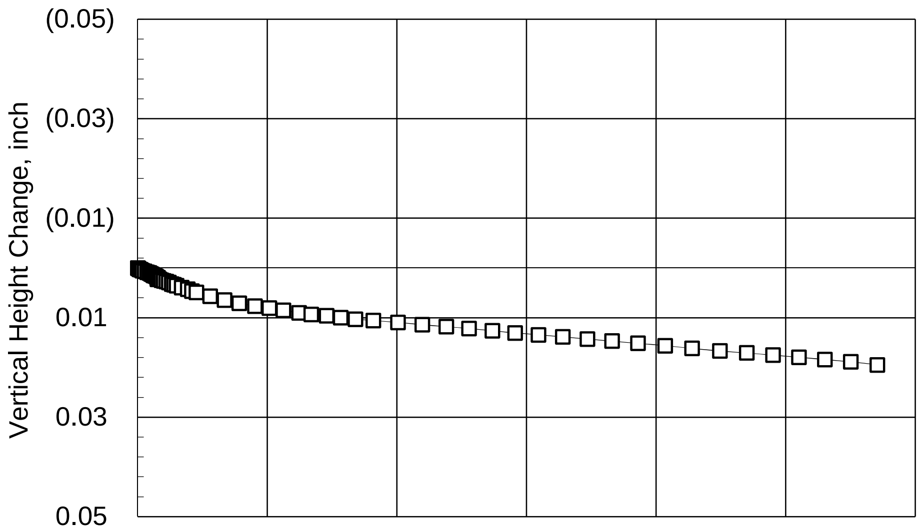
Peak Shear Strength: 5.39 ksf @ 0.29 inch deformation

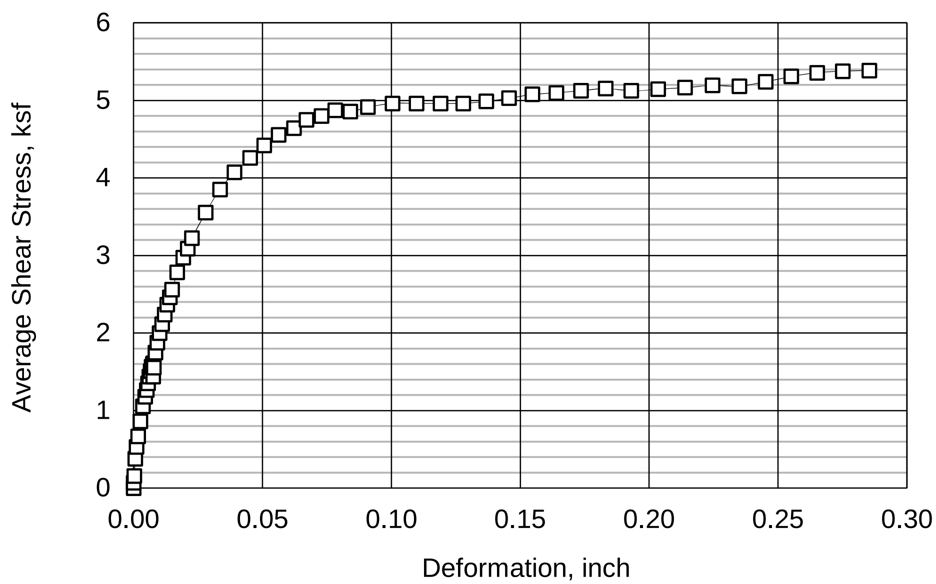
Peak Effective Friction Angle: 28.3°, cohesion = 0.0ksf

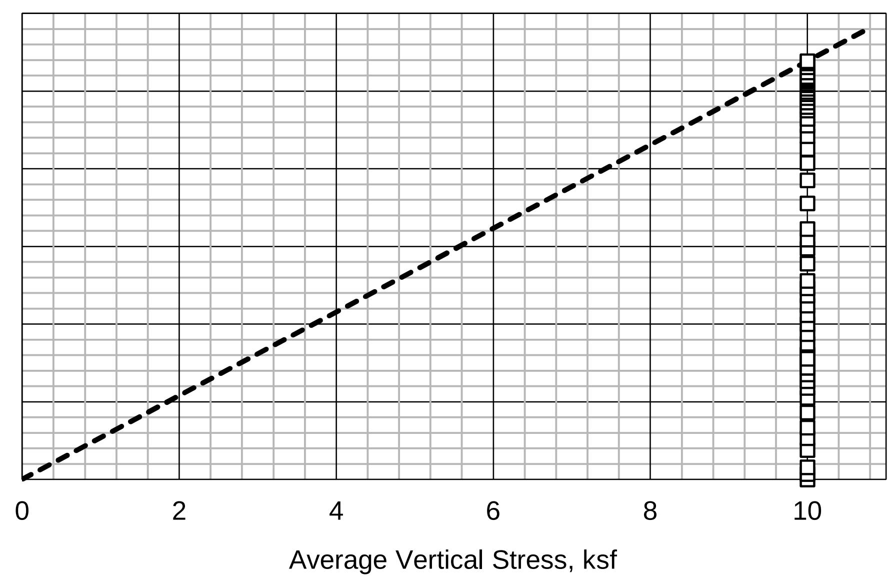
Final Shear Strength: 5.39 ksf @ 0.29 inch deformation

Final Effective Friction Angle: 28.3° (Shown)

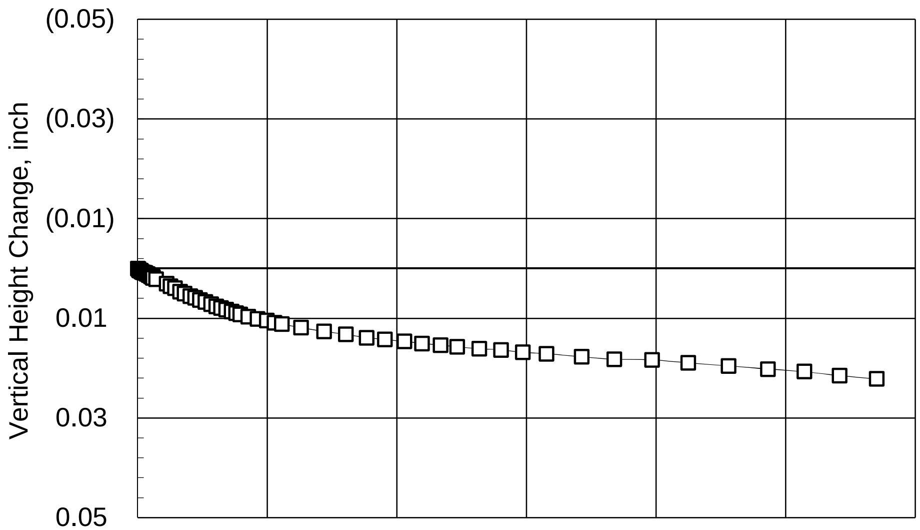
REMARKS:







	AECOM 60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **TEST SUMMARY**	
Prepared by: MHC Checked by: GET	**TerraSense, LLC**	T60428794	Boring: NEW-B007 Sample: ST- 4 Specimen: C Depth: 41.25 ft	November 15



SAMPLE INFORMATION

Boring: NEW-B007 Sample: ST- 4 Specimen: D Depth: 41.45 ft

Type: Intact tube sample

SPECIMEN INFORMATION (Initial)

Description: CH, brown clay with sand

Height: 1.00 inch Diameter: 2.50 inch Area: 4.91 in²

Water Content: 16.1 % Dry Unit Weight: 114.2 pcf

TEST SUMMARY

Vertical Consolidation Stress: 15.00 ksf

Water Content: 14.8 % Dry Unit Weight: 121.0 pcf

Deformation Rate: 0.00013 inch/min.

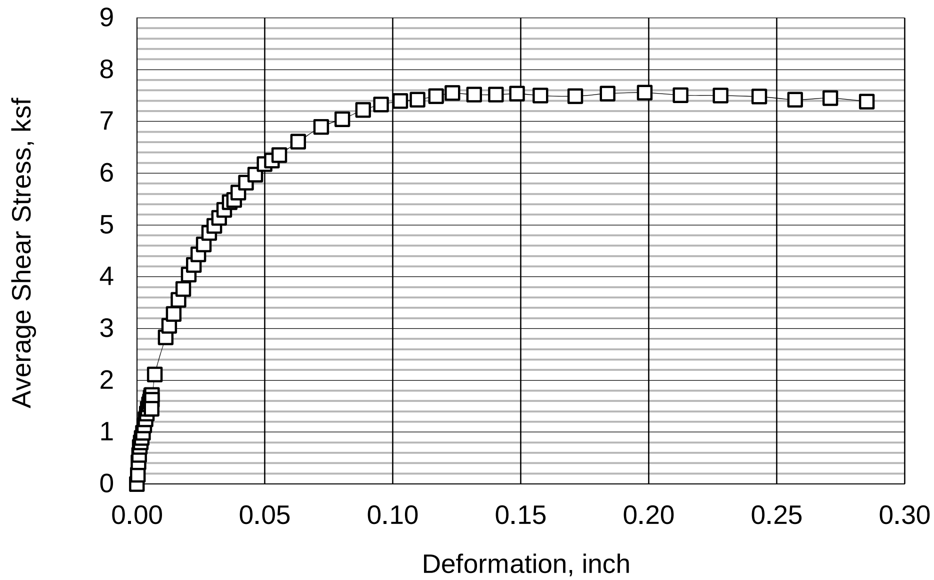
Peak Shear Strength: 7.56 ksf @ 0.20 inch deformation

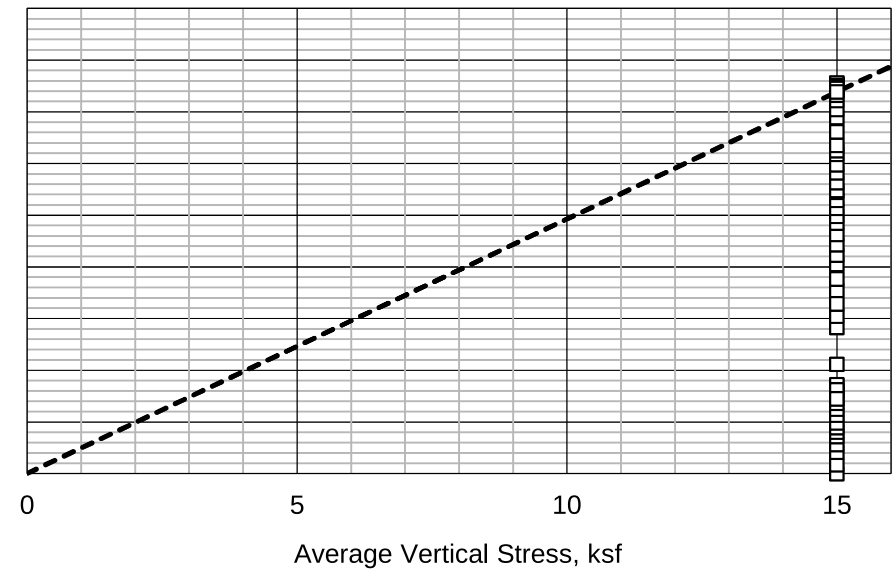
Peak Effective Friction Angle: 26.7°, cohesion = 0.0ksf

Final Shear Strength: 7.38 ksf @ 0.29 inch deformation

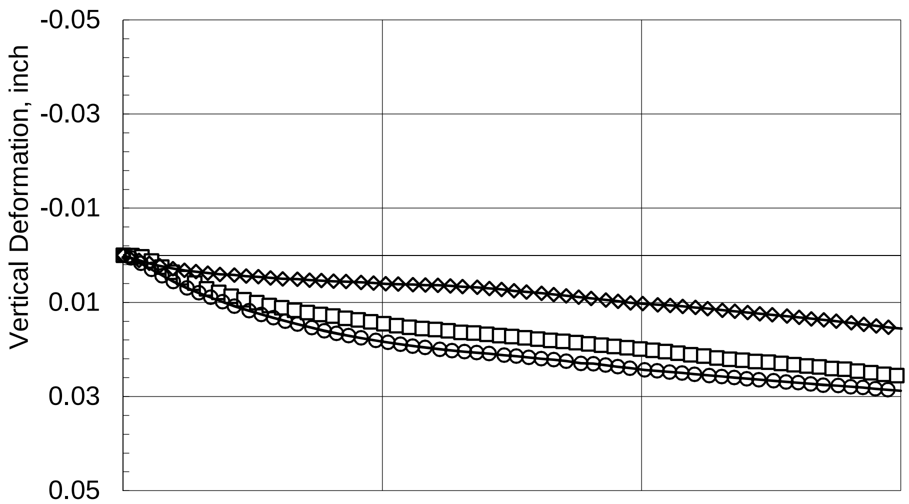
Final Effective Friction Angle: 26.2° (Shown)

REMARKS:





Prepared by: MHC Checked by: GET	AECOM 60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **TEST SUMMARY** Boring: NEW-B007 Sample: ST- 4 Specimen: D Depth: 41.45 ft	
	TerraSense, LLC	T60428794		November 15



SAMPLE INFORMATION

Boring: NEW-B008 Sample: ST-2 Depth: 27.5-28.75 feet
Type: Intact tube sample
Description: CL, dark brown sandy clay with gravel

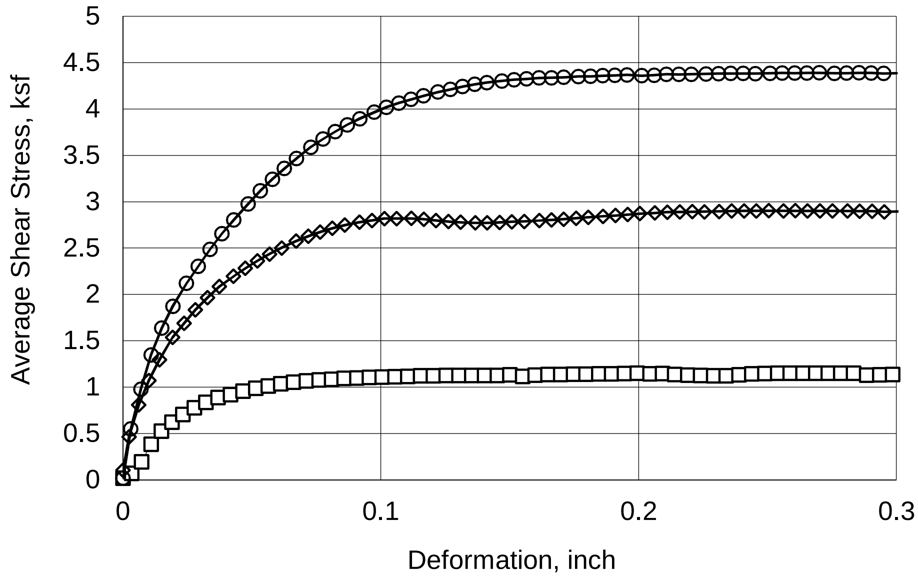
TEST INFORMATION

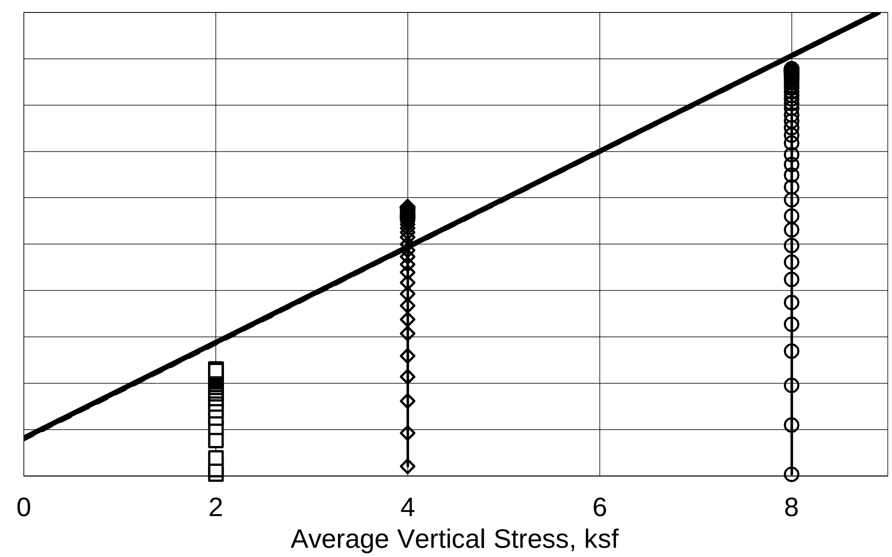
Test	Symbol	Vertical Stress (ksf)	Deformation Rate (inch/min.)
DS1624	□	2.0	0.0002
DS1626	◊	4.0	0.0002
DS1628	○	8.0	0.0002

TEST SUMMARY

Peak Effective Friction Angle: 27.3°, cohesion = 0.4ksf
Final Effective Friction Angle: 27.3°, cohesion = 0.4ksf

REMARKS:





Prepared by: MHC
Checked by: GET

AECOM #60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **SERIES SUMMARY** Boring: NEW-B008 Sample: ST-2 Depth: 27.5-28.75	
TerraSense, LLC	T60428794		November 2015

Analysis File: Ds_sumv8 DSsumB008ST02.xls 11/6/2015

STAGED DRAINED DIRECT SHEAR TEST SERIES

Boring No / Sample/ Specimen	Depth (ft) / Test ID	w_o / w_c (estimated) (%)	γ_{to} / γ_{tc} (estimated) (pcf)	γ_{do} / γ_{dc} (estimated) (pcf)	$\sigma'_{v,c}$ (ksf) / $\varepsilon_{v,c}$ (%)	Deformation rate (inch/min) / t_c (days)	at Peak Shear Stress / at High Deformation: ΔL (inch)	τ_h (ksf)	ε_v (%)	Φ' for c'=0	Remarks
NEW-B008	27.7	20.3	122.5	101.8	2.00	1.9E-4	0.27	1.15	2.29	29.9	
ST-2	DS1624	20.9	126.7	104.8	4.0	0.33	0.28	1.15	2.34	29.9	
NEW-B008	28.0	14.4	133.8	117.0	4.00	1.9E-4	0.25	2.90	1.26	36.0	
ST-2	DS1626	19.3	143.5	120.3	4.4	0.67	0.29	2.90	1.46	35.9	
NEW-B008	28.4	16.4	133.2	114.5	8.00	1.9E-4	0.29	4.39	2.79	28.8	
ST-2	DS1628	18.2	141.6	119.9	7.2	0.67	0.29	4.39	2.79	28.8	

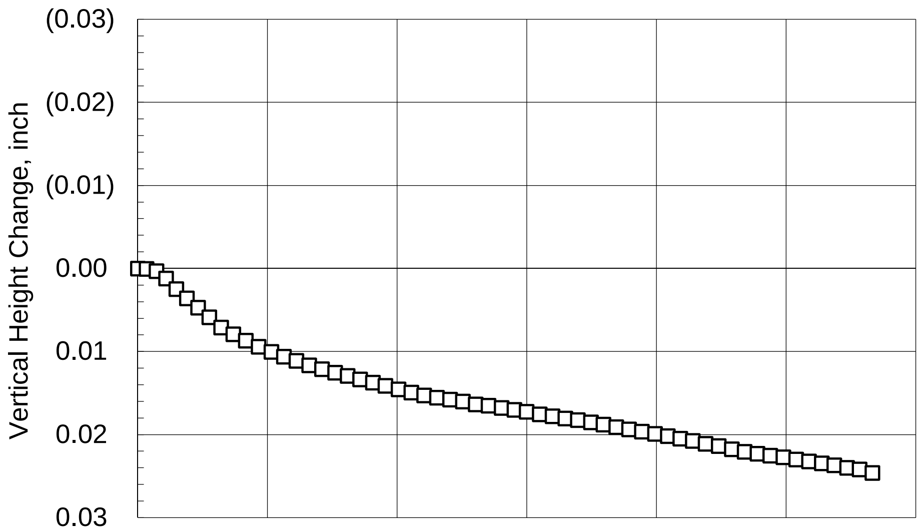
Description of Material Tested and Remarks	
DS1624	CL, dark brown sandy clay with gravel
DS1626	CL, dark brown sandy clay with gravel
DS1628	CL, dark brown clay with sand and gravel

Strength Envelope Summary

Test Series	Failure Criterion	Φ' (degree)	c' (ksf)
1	1	27.3	0.4
	2	27.3	0.4

Failure Criterion: 1. Peak shear stress; 2. High deformation

Prepared by: MCH Checked by: GET	AECOM #60428794 **TerraSense, LLC**	Dynegy CCR - Newton T60428794	**DRAINED DIRECT SHEAR SERIES SUMMARY** Boring: NEW-B008 Sample: ST-2 Depth: 27.5-28.75 ft

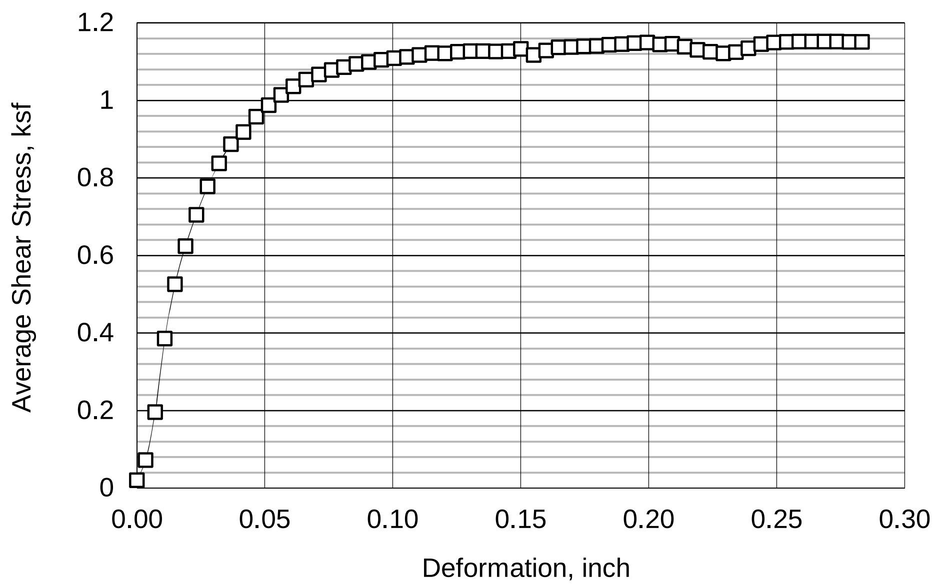


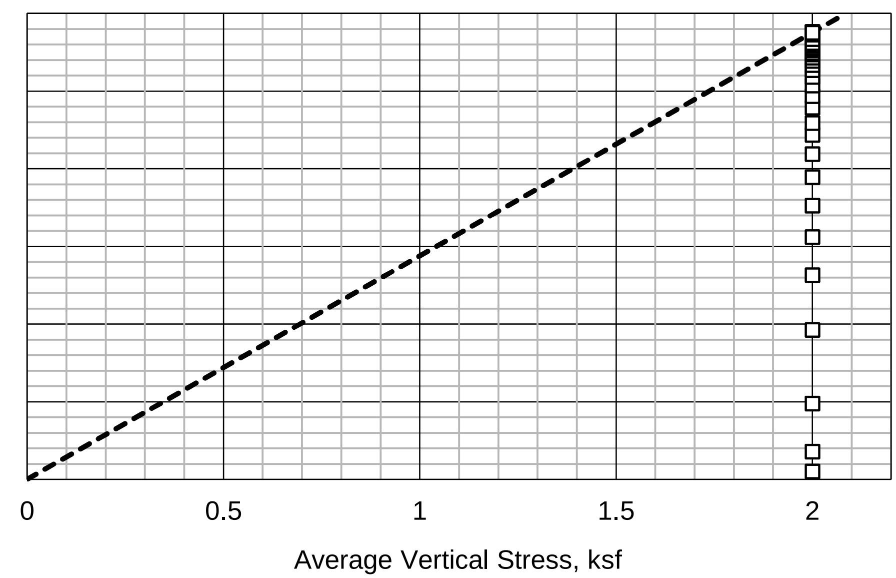
SAMPLE INFORMATION
Boring: NEW-B008 Sample: ST-2 Specimen: A Depth: 27.7 ft
Type: Intact tube sample

SPECIMEN INFORMATION (Initial)
Description: CL, dark brown clay with sand and gravel
Height: 1.05 inch Diameter: 2.50 inch Area: 4.91 in²
Water Content: 20.3 % Dry Unit Weight: 101.8 pcf

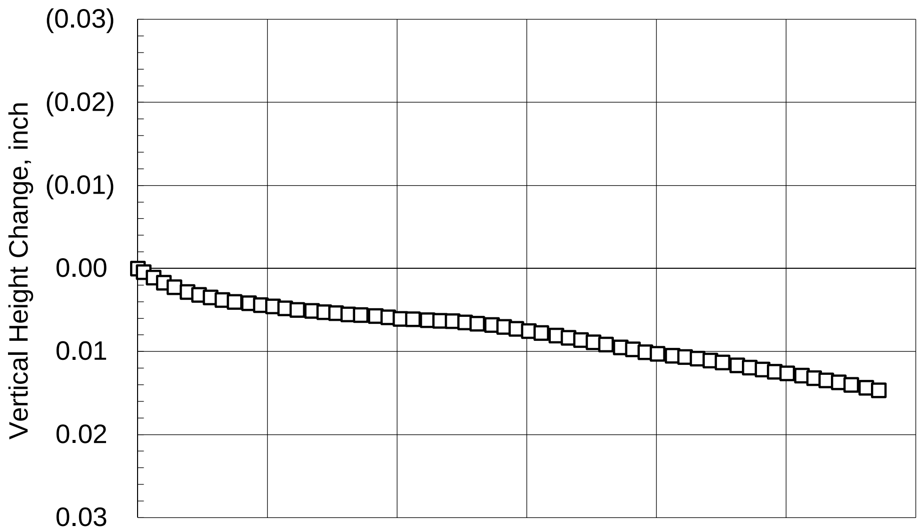
TEST SUMMARY
Vertical Consolidation Stress: 2.00 ksf
Water Content: 20.9 % Dry Unit Weight: 104.8 pcf
Deformation Rate: 0.00019 inch/min.
Peak Shear Strength: 1.15 ksf @ 0.27 inch deformation
Peak Effective Friction Angle: 29.9°, cohesion = 0.0 ksf
Final Shear Strength: 1.15 ksf @ 0.28 inch deformation
Final Effective Friction Angle: 29.9° (Shown)

REMARKS:





Prepared by: MCH Checked by: GET	AECOM 60428794 **TerraSense, LLC**	Dynegy CCR - Newton T60428794	**DRAINED DIRECT SHEAR** **TEST SUMMARY** Boring: NEW-B008 Sample: ST-2 Specimen: A Depth: 27.7 ft	November 15

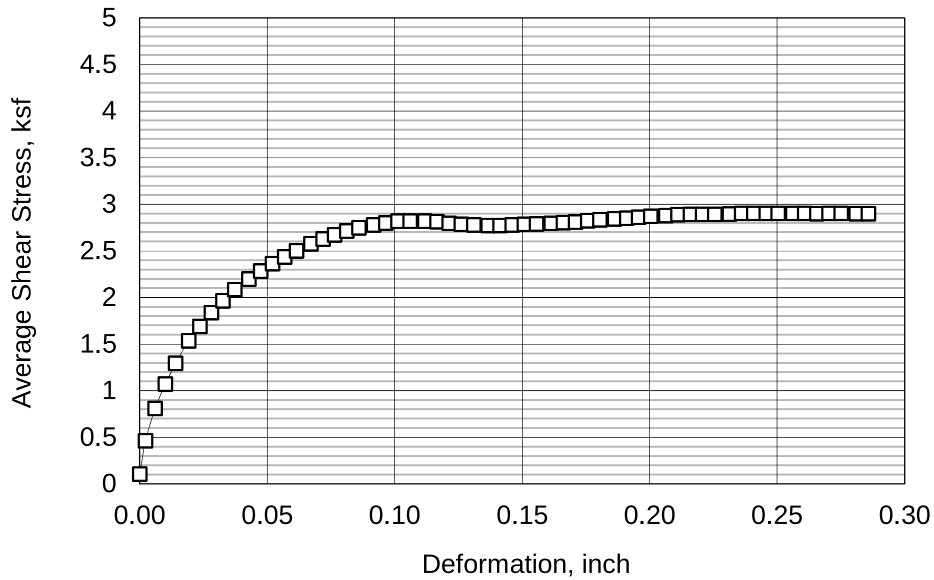


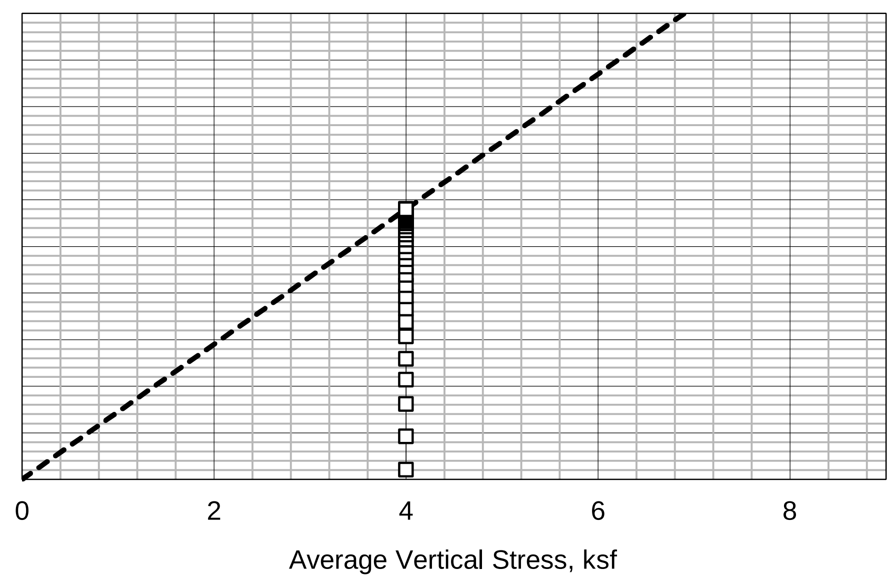
SAMPLE INFORMATION
Boring: NEW-B008 Sample: ST-2 Specimen: B Depth: 28 ft
Type: Intact tube sample

SPECIMEN INFORMATION (Initial)
Description: CL, dark brown sandy clay with gravel
Height: 1.00 inch Diameter: 2.50 inch Area: 4.91 in²
Water Content: 14.4 % Dry Unit Weight: 117.0 pcf

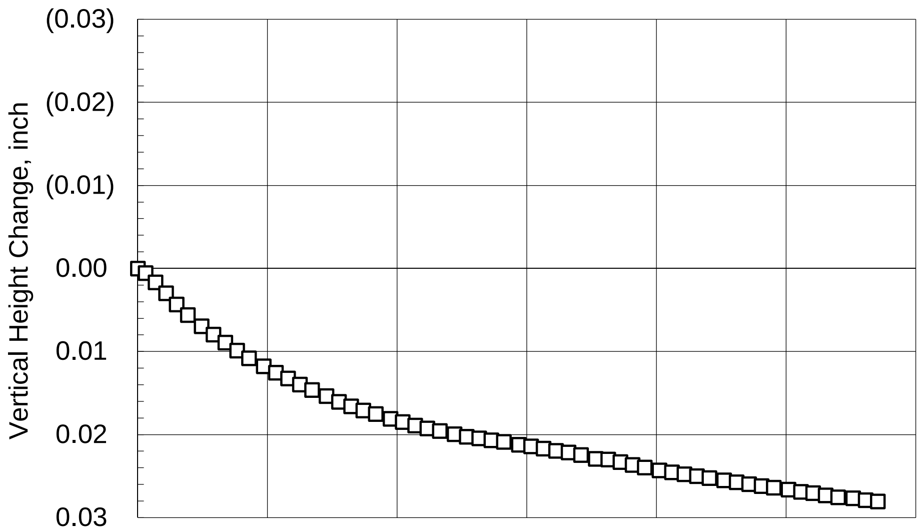
TEST SUMMARY
Vertical Consolidation Stress: 4.00 ksf
Water Content: 19.3 % Dry Unit Weight: 120.3 pcf
Deformation Rate: 0.00019 inch/min.
Peak Shear Strength: 2.90 ksf @ 0.25 inch deformation
Peak Effective Friction Angle: 36.0°, cohesion = 0.0 ksf
Final Shear Strength: 2.90 ksf @ 0.29 inch deformation
Final Effective Friction Angle: 35.9° (Shown)

REMARKS:





Prepared by: MCH Checked by: GET	AECOM 60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **TEST SUMMARY** Boring: NEW-B008 Sample: ST-2 Specimen: B Depth: 28 ft	
	TerraSense, LLC	T60428794		November 15



SAMPLE INFORMATION

Boring: NEW-B008 Sample: ST-2 Specimen: C Depth: 28.4 ft

Type: Intact tube sample

SPECIMEN INFORMATION (Initial)

Description: CL, dark brown sandy clay with gravel

Height: 1.01 inch Diameter: 2.50 inch Area: 4.91 in²

Water Content: 16.4 % Dry Unit Weight: 114.5 pcf

TEST SUMMARY

Vertical Consolidation Stress: 8.00 ksf

Water Content: 18.2 % Dry Unit Weight: 119.9 pcf

Deformation Rate: 0.00019 inch/min.

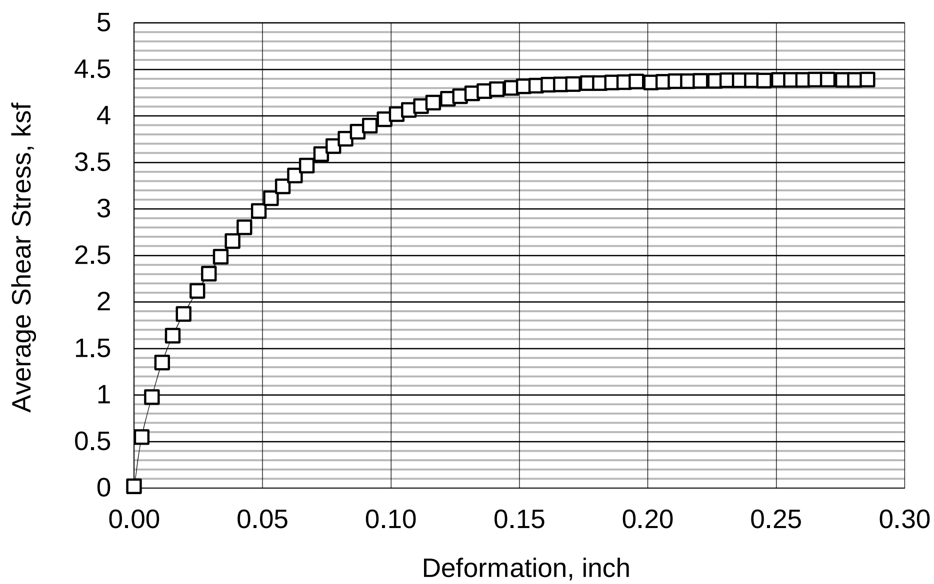
Peak Shear Strength: 4.39 ksf @ 0.29 inch deformation

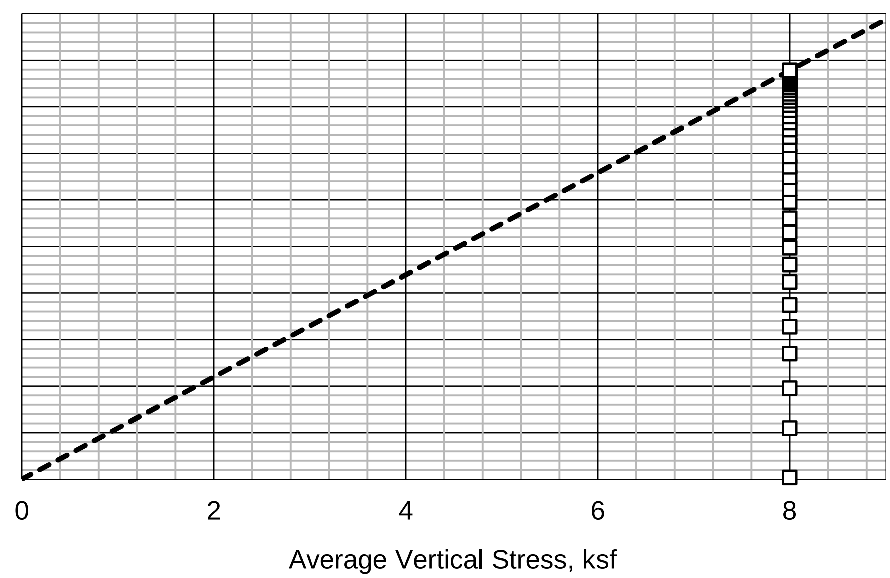
Peak Effective Friction Angle: 28.8°, cohesion = 0.0 ksf

Final Shear Strength: 4.39 ksf @ 0.29 inch deformation

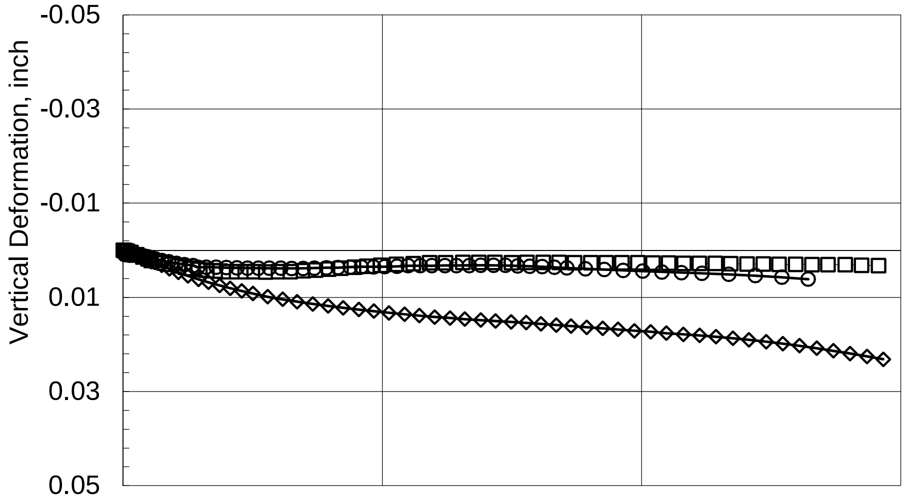
Final Effective Friction Angle: 28.8° (Shown)

REMARKS:





	AECOM 60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **TEST SUMMARY** Boring: NEW-B008 Sample: ST-2 Specimen: C Depth: 28.4 ft	
Prepared by: MCH Checked by: GET	**TerraSense, LLC**	T60428794		November 15



SAMPLE INFORMATION

Boring: NEW-B012 Sample: ST-19 A Depth: 80-82 feet

Type: Intact tube sample

Description: SC, brown clayey sand

TEST INFORMATION

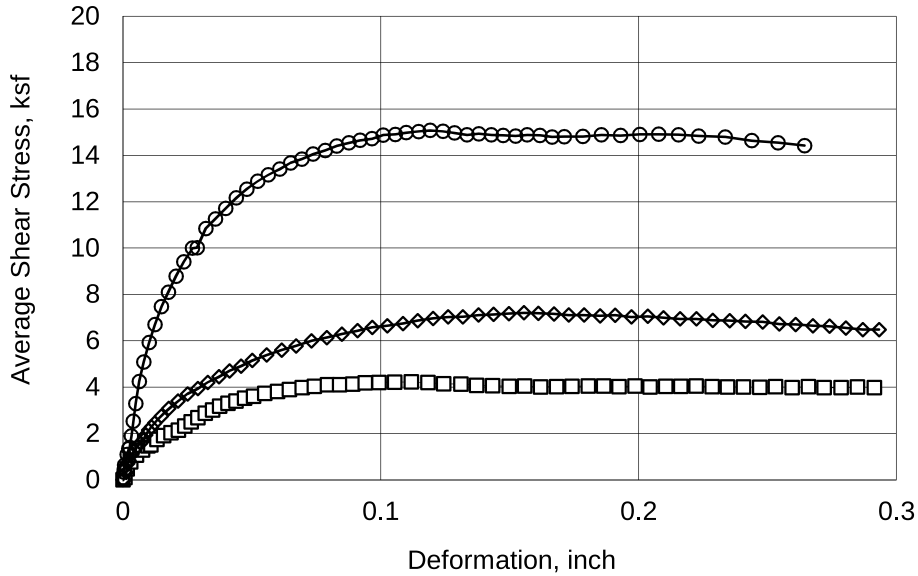
Test	Symbol	Vertical Stress (ksf)	Deformation Rate (inch/min.)
DS1611	□	6.0	0.0022
DS1613	◊	12.0	0.0021
DS1612	○	24.0	0.0017

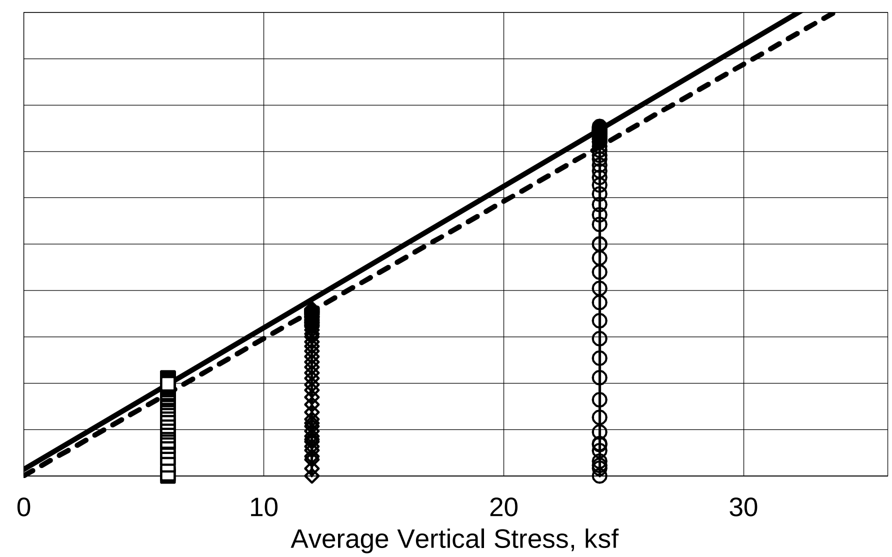
TEST SUMMARY

Peak Effective Friction Angle: 31.4°, cohesion = 0.3ksf (solid line)

Final Effective Friction Angle: 30.6°, cohesion = 0.0ksf (dashed line)

REMARKS:





Prepared by: MHC Checked by: GET	AECOM #60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **SERIES SUMMARY** Boring: NEW-B012 Sample: ST-19 A Depth: 80-82	
	TerraSense, LLC	T60428794		November 2015

STAGED DRAINED DIRECT SHEAR TEST SERIES

Boring No / Sample/ Specimen	Depth (ft) / Test ID	w_o / w_c (estimated) (%)	γ_{to} / γ_{tc} (estimated) (pcf)	γ_{do} / γ_{dc} (estimated) (pcf)	$\sigma'_{v,c}$ (ksf) / $\varepsilon_{v,c}$ (%)	Deformation rate (inch/min) / t_c (days)	at Peak Shear Stress / at High Deformation: ΔL (inch)	τ_h (ksf)	ε_v (%)	Φ' for c'=0	Remarks
NEW-B012	81.1	11.2	136.8	122.9	6.00	2.2E-3	0.11	4.23	0.28	35.2	
ST-19 A	DS1611	12.1	140.7	125.5	4.4	0.06	0.29	3.98	0.32	33.5	
NEW-B012	81.8	16.9	130.5	111.7	12.00	2.1E-3	0.16	7.21	1.54	31.0	
ST-19	DS1613	16.7	136.2	116.7	8.6	1.81	0.29	6.49	2.32	28.4	
NEW-B012	81.5	10.5	139.2	126.0	24.00	1.7E-3	0.12	15.08	0.33	32.1	
ST-19	DS1612	10.9	145.6	131.3	14.6	0.13	0.26	14.42	0.61	31.0	

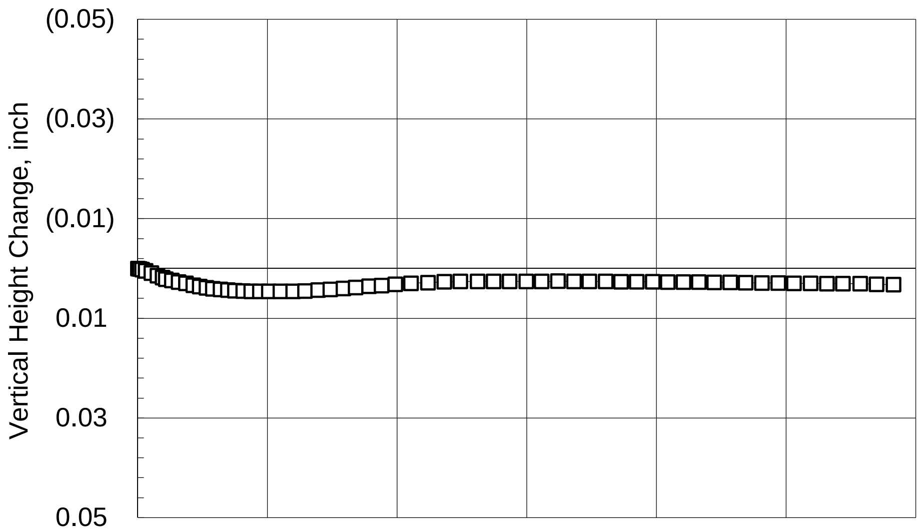
Description of Material Tested and Remarks	
DS1611	SC, brown clayey sand
DS1613	SC, brown clayey sand
DS1612	SC, brown clayey sand

Strength Envelope Summary

Test Series	Failure Criterion	Φ' (degree)	c' (ksf)
1	1	31.4	0.3
	2	30.6	0.0

Failure Criterion: 1. Peak shear stress; 2. High deformation

Prepared by: MHC Checked by: GET	AECOM #60428794 **TerraSense, LLC**	Dynegy CCR - Newton T60428794	**DRAINED DIRECT SHEAR SERIES SUMMARY** Boring: NEW-B012 Sample: ST-19 A Depth: 80-82 ft



SAMPLE INFORMATION

Boring: NEW-B012 Sample: ST-19 A Specimen: 1 Depth: 81.1 ft

Type: Intact tube sample

SPECIMEN INFORMATION (Initial)

Description: SC, brown clayey sand

Height: 1.00 inch Diameter: 2.50 inch Area: 4.91 in²

Water Content: 11.2 % Dry Unit Weight: 122.9 pcf

TEST SUMMARY

Vertical Consolidation Stress: 6.00 ksf

Water Content: 12.1 % Dry Unit Weight: 125.5 pcf

Deformation Rate: 0.00222 inch/min.

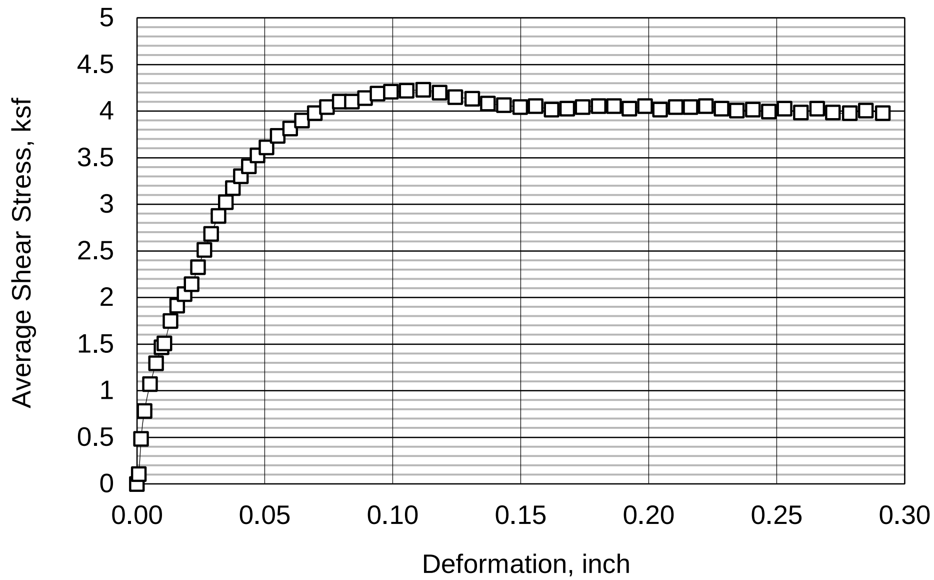
Peak Shear Strength: 4.23 ksf @ 0.11 inch deformation

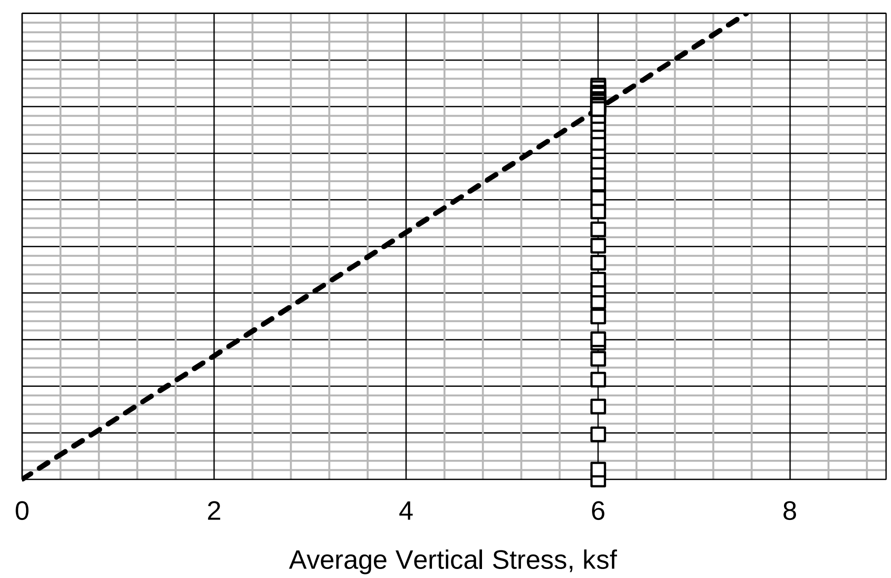
Peak Effective Friction Angle: 35.2°, cohesion = 0.0ksf

Final Shear Strength: 3.98 ksf @ 0.29 inch deformation

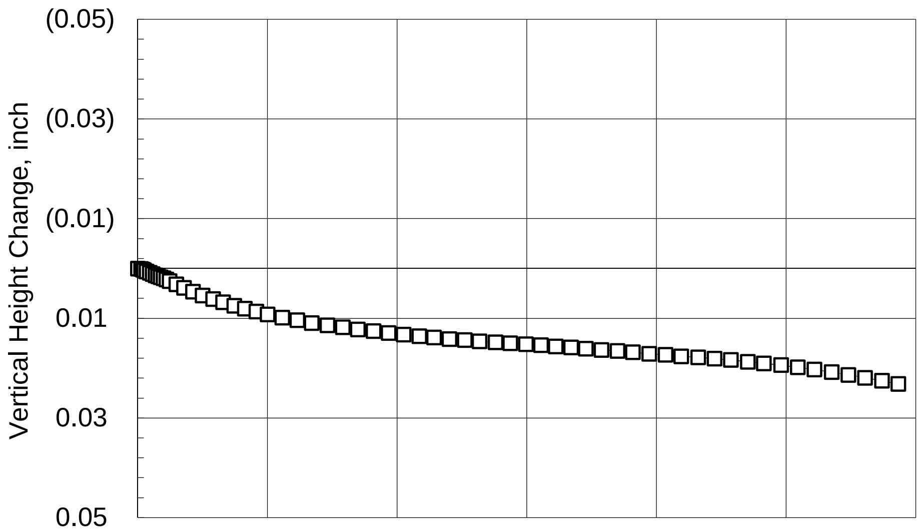
Final Effective Friction Angle: 33.5° (Shown)

REMARKS:





Prepared by: MHC Checked by: GET	AECOM 60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **TEST SUMMARY** Boring: NEW-B012 Sample: ST-19 A Specimen: 1 Depth: 81.1 ft	November 15
	TerraSense, LLC	T60428794		



SAMPLE INFORMATION

Boring: NEW-B012 Sample: ST-19 Specimen: C Depth: 81.8 ft

Type: Intact tube sample

SPECIMEN INFORMATION (Initial)

Description: SC, brown clayey sand

Height: 1.00 inch Diameter: 2.50 inch Area: 4.91 in²

Water Content: 16.9 % Dry Unit Weight: 111.7 pcf

TEST SUMMARY

Vertical Consolidation Stress: 12.00 ksf

Water Content: 16.7 % Dry Unit Weight: 116.7 pcf

Deformation Rate: 0.00211 inch/min.

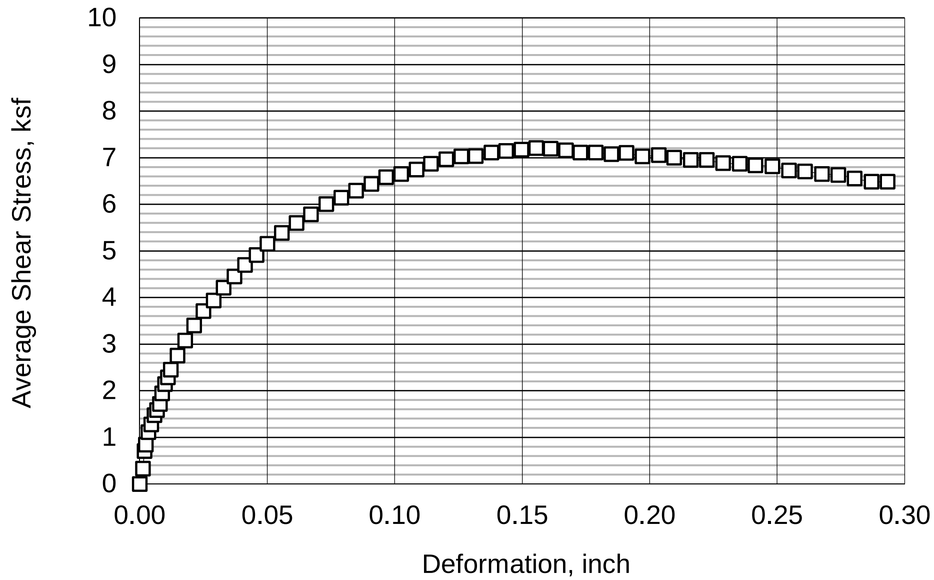
Peak Shear Strength: 7.21 ksf @ 0.16 inch deformation

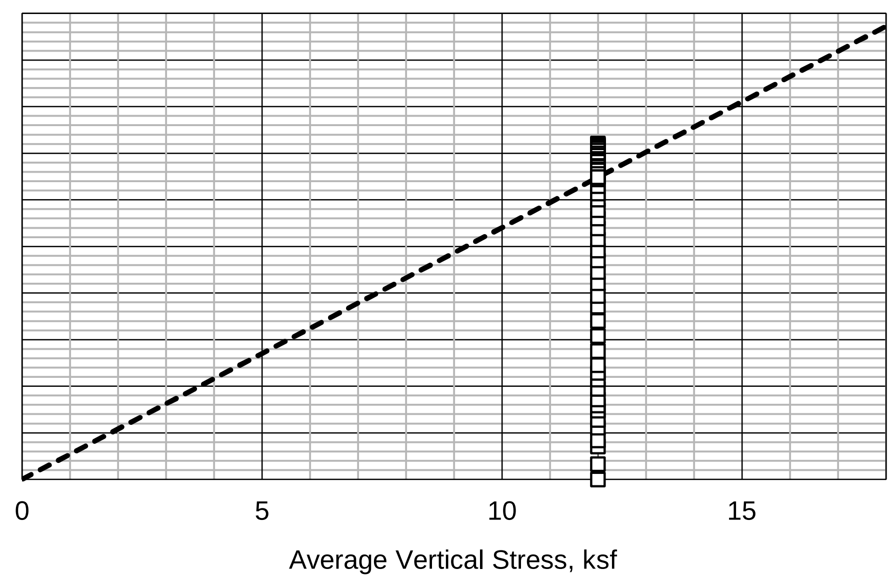
Peak Effective Friction Angle: 31.0°, cohesion = 0.0ksf

Final Shear Strength: 6.49 ksf @ 0.29 inch deformation

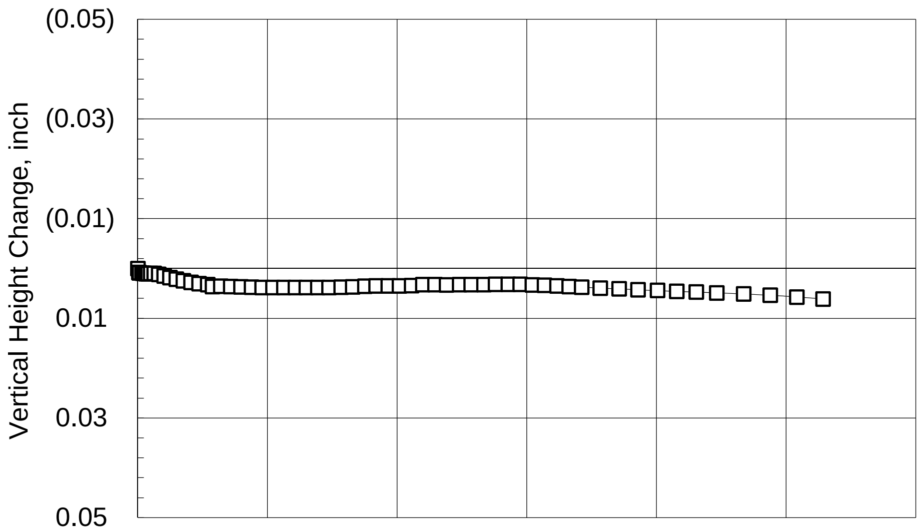
Final Effective Friction Angle: 28.4° (Shown)

REMARKS:





Prepared by: MHC Checked by: GET	AECOM 60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **TEST SUMMARY** Boring: NEW-B012 Sample: ST-19 Specimen: C Depth: 81.8 ft	November 15
	TerraSense, LLC	T60428794		

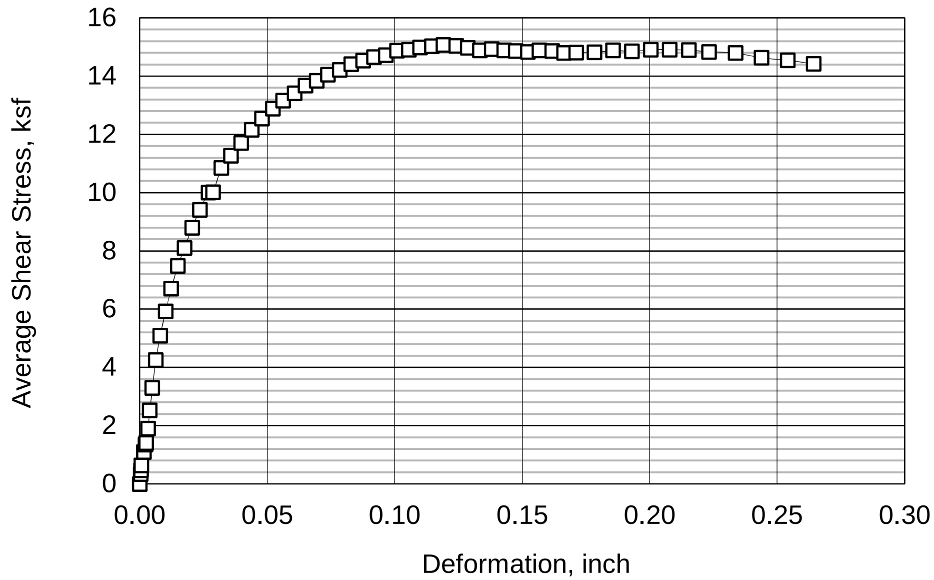


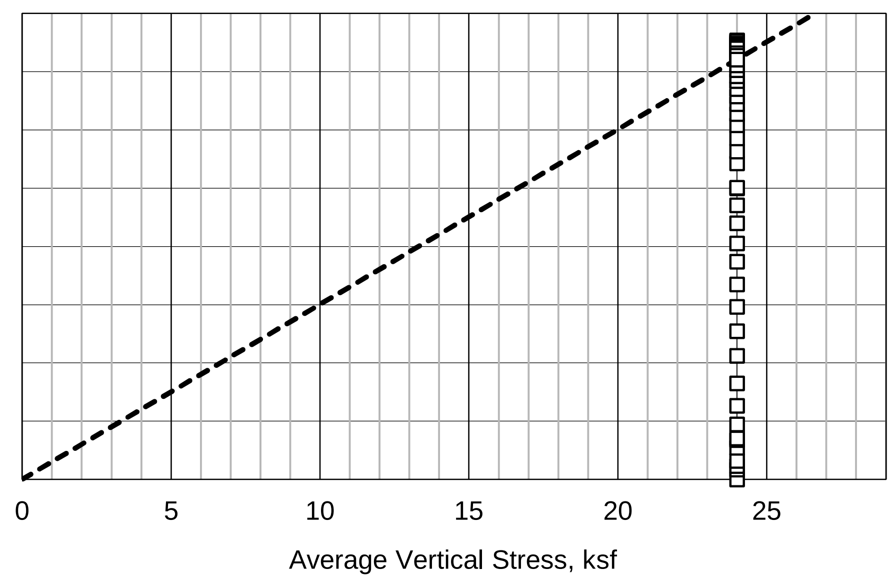
SAMPLE INFORMATION
Boring: NEW-B012 Sample: ST-19 Specimen: B Depth: 81.5 ft
Type: Intact tube sample

SPECIMEN INFORMATION (Initial)
Description: SC, brown clayey sand
Height: 1.00 inch Diameter: 2.50 inch Area: 4.91 in²
Water Content: 10.5 % Dry Unit Weight: 126.0 pcf

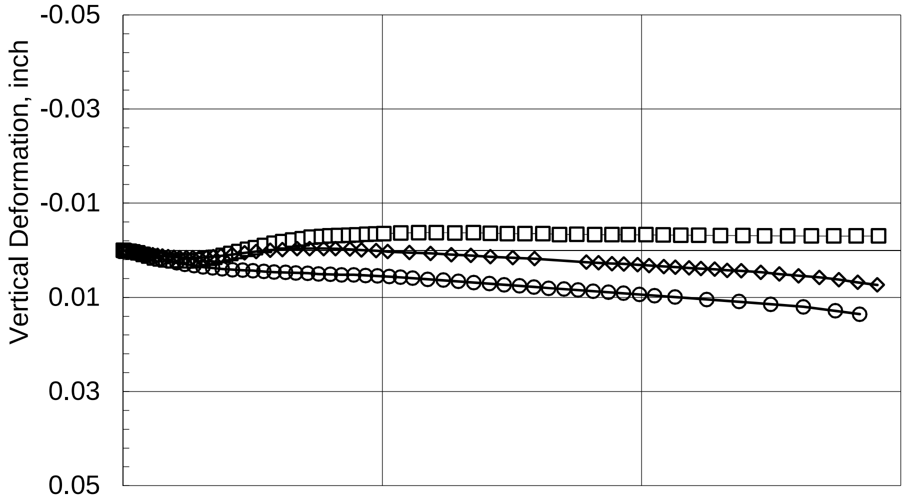
TEST SUMMARY
Vertical Consolidation Stress: 24.00 ksf
Water Content: 10.9 % Dry Unit Weight: 131.3 pcf
Deformation Rate: 0.00171 inch/min.
Peak Shear Strength: 15.08 ksf @ 0.12 inch deformation
Peak Effective Friction Angle: 32.1°, cohesion = 0.0ksf
Final Shear Strength: 14.42 ksf @ 0.26 inch deformation
Final Effective Friction Angle: 31.0° (Shown)

REMARKS:





Prepared by: MHC Checked by: GET	AECOM 60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **TEST SUMMARY** Boring: NEW-B012 Sample: ST-19 Specimen: B Depth: 81.5 ft	
	TerraSense, LLC	T60428794		November 15



SAMPLE INFORMATION

Boring: NEW-B015 Sample: ST-3 Depth: 60-61.3 feet
Type: Intact tube sample
Description: CL, brown clay with sand and gravel

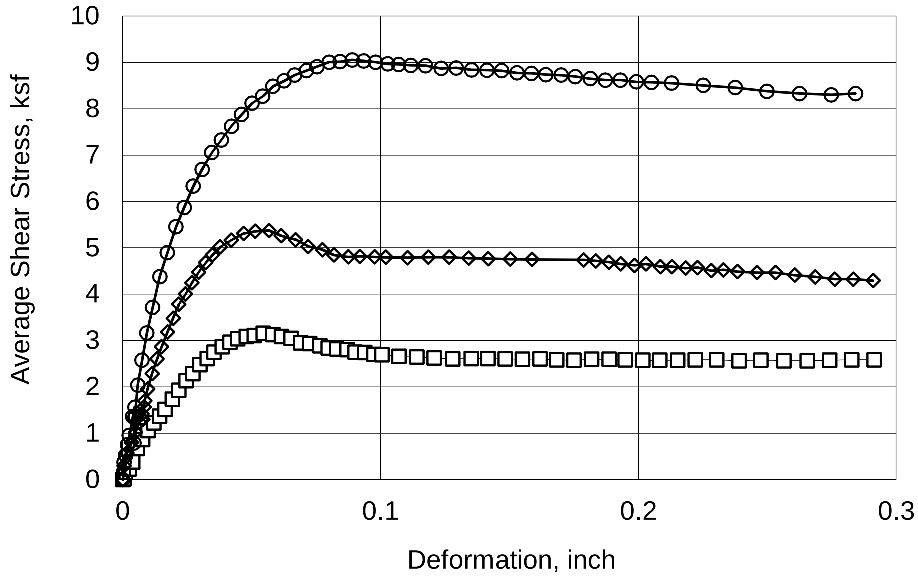
TEST INFORMATION

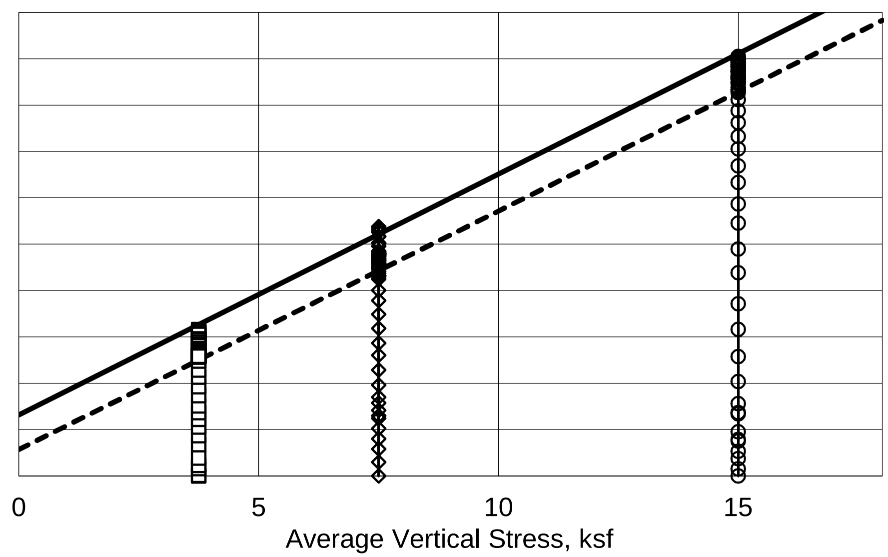
Test	Symbol	Vertical Stress (ksf)	Deformation Rate (inch/min.)
DS1623	□	3.8	0.0008
DS1625	◊	7.5	0.0008
DS1627	○	15.0	0.0007

TEST SUMMARY

Peak Effective Friction Angle: 27.4°, cohesion = 1.3ksf (solid line)
Final Effective Friction Angle: 27.2°, cohesion = 0.6ksf (dashed line)

REMARKS:





AECOM #60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **SERIES SUMMARY** Boring: NEW-B015 Sample: ST-3 Depth: 60-61.3	
TerraSense, LLC	T60428794		November 2015

Prepared by: MHC
Checked by: GET

STAGED DRAINED DIRECT SHEAR TEST SERIES

Boring No / Sample/ Specimen	Depth (ft) / Test ID	w_o / w_c (estimated) (%)	γ_{to} / γ_{tc} (estimated) (pcf)	γ_{do} / γ_{dc} (estimated) (pcf)	$\sigma'_{v,c}$ (ksf) / $\varepsilon_{v,c}$ (%)	Deformation rate (inch/min) / t_c (days)	at Peak Shear Stress / at High Deformation: ΔL (inch)	τ_h (ksf)	ε_v (%)	Φ' for c'=0	Remarks
NEW-B015	60.4	11.2	139.6	125.5	3.75	8.2E-4	0.05	3.16	-0.10	40.1	
ST-3	DS1623	12.0	141.2	126.1	2.8	0.63	0.29	2.59	-0.30	34.6	
NEW-B015	60.8	11.9	140.2	125.3	7.50	7.8E-4	0.06	5.38	0.00	35.6	
ST-3	DS1625	13.3	142.1	125.5	2.7	0.24	0.29	4.29	0.73	29.8	
NEW-B015	61.1	12.7	139.8	124.1	15.00	6.6E-4	0.09	9.05	0.51	31.1	
ST-3	DS1627	12.0	141.4	126.2	4.9	1.08	0.28	8.33	1.33	29.0	

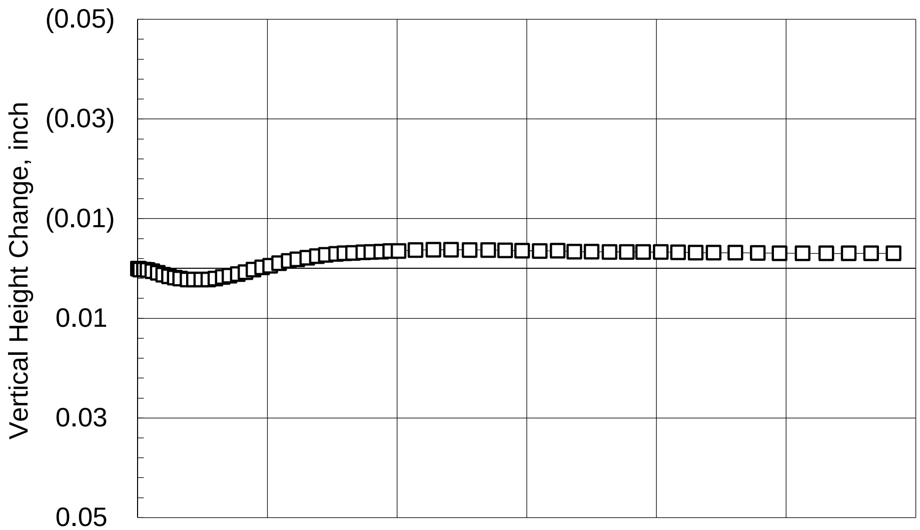
Description of Material Tested and Remarks	
DS1623	CL, brown clay with sand and gravel
DS1625	CL, brown clay with sand
DS1627	CL, brown clay with sand

Strength Envelope Summary

Test Series	Failure Criterion	Φ' (degree)	c' (ksf)
1	1	27.4	1.3
	2	27.2	0.6

Failure Criterion: 1. Peak shear stress; 2. High deformation

Prepared by: MHC Checked by: GET	AECOM #60428794 **TerraSense, LLC**	Dynegy CCR - Newton T60428794	**DRAINED DIRECT SHEAR SERIES SUMMARY** Boring: NEW-B015 Sample: ST-3 Depth: 60-61.3 ft



SAMPLE INFORMATION

Boring: NEW-B015 Sample: ST-3 Specimen: B Depth: 60.35 ft

Type: Intact tube sample

SPECIMEN INFORMATION (Initial)

Description: CL, brown clay with sand and gravel

Height: 1.01 inch Diameter: 2.50 inch Area: 4.91 in²

Water Content: 11.2 % Dry Unit Weight: 125.5 pcf

TEST SUMMARY

Vertical Consolidation Stress: 3.75 ksf

Water Content: 12.0 % Dry Unit Weight: 126.1 pcf

Deformation Rate: 0.00082 inch/min.

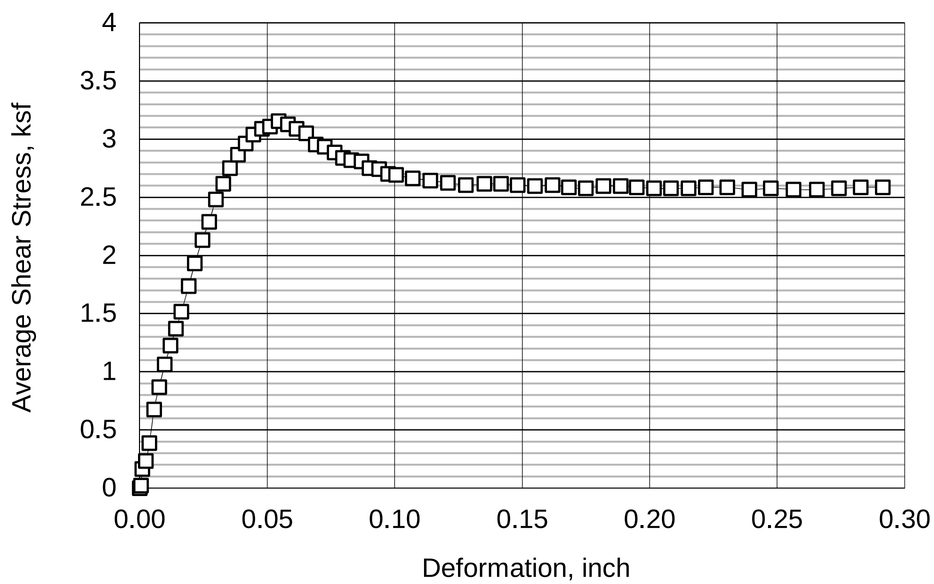
Peak Shear Strength: 3.16 ksf @ 0.05 inch deformation

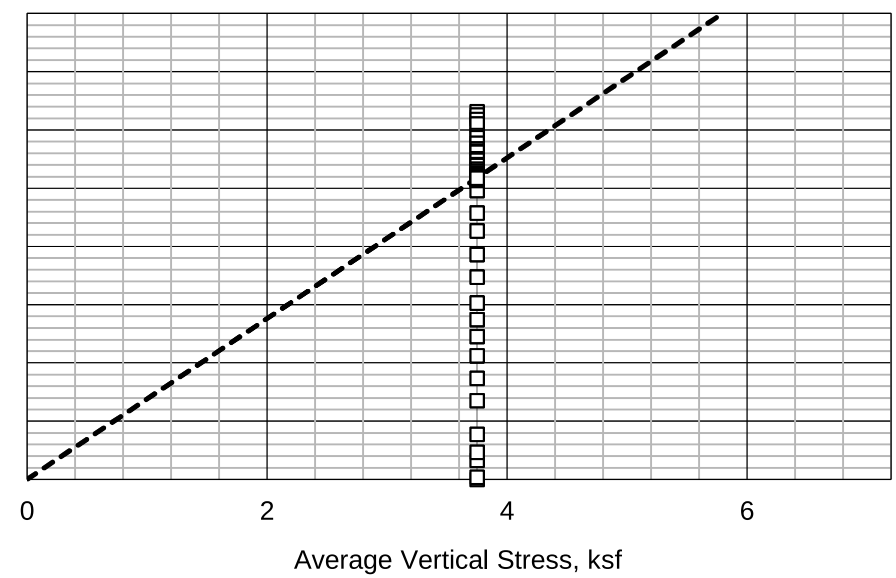
Peak Effective Friction Angle: 40.1°, cohesion = 0.0ksf

Final Shear Strength: 2.59 ksf @ 0.29 inch deformation

Final Effective Friction Angle: 34.6° (Shown)

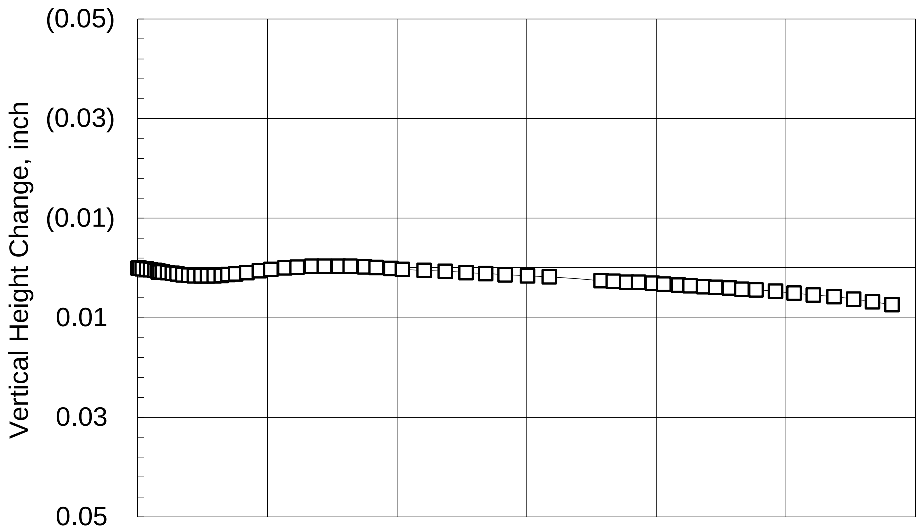
REMARKS:





AECOM 60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **TEST SUMMARY** Boring: NEW-B015 Sample: ST-3 Specimen: B Depth: 60.35 ft	
TerraSense, LLC	T60428794		November 15

Prepared by: MHC
Checked by: GET



SAMPLE INFORMATION

Boring: NEW-B015 Sample: ST-3 Specimen: C Depth: 60.75 ft

Type: Intact tube sample

SPECIMEN INFORMATION (Initial)

Description: CL, brown clay with sand

Height: 1.00 inch Diameter: 2.50 inch Area: 4.91 in²

Water Content: 11.9 % Dry Unit Weight: 125.3 pcf

TEST SUMMARY

Vertical Consolidation Stress: 7.50 ksf

Water Content: 13.3 % Dry Unit Weight: 125.5 pcf

Deformation Rate: 0.00078 inch/min.

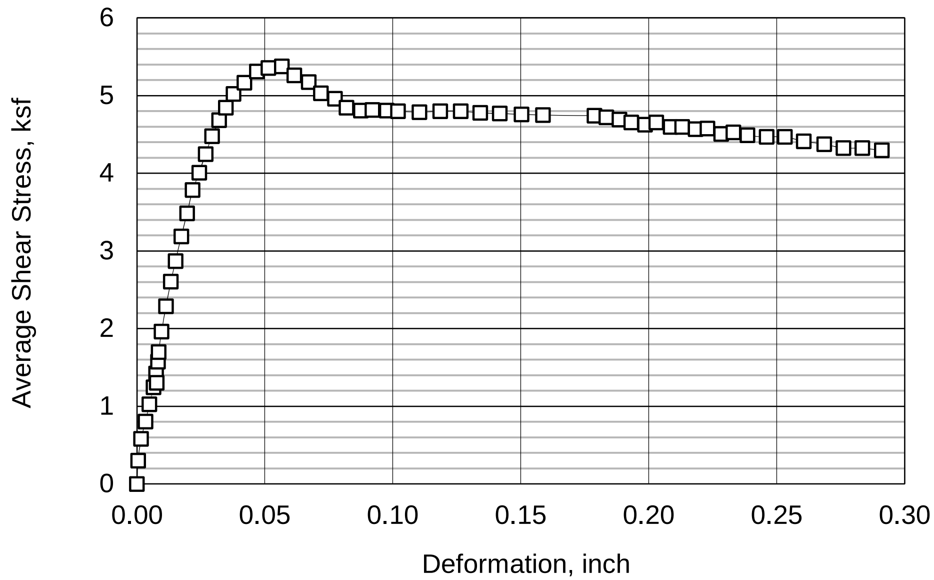
Peak Shear Strength: 5.38 ksf @ 0.06 inch deformation

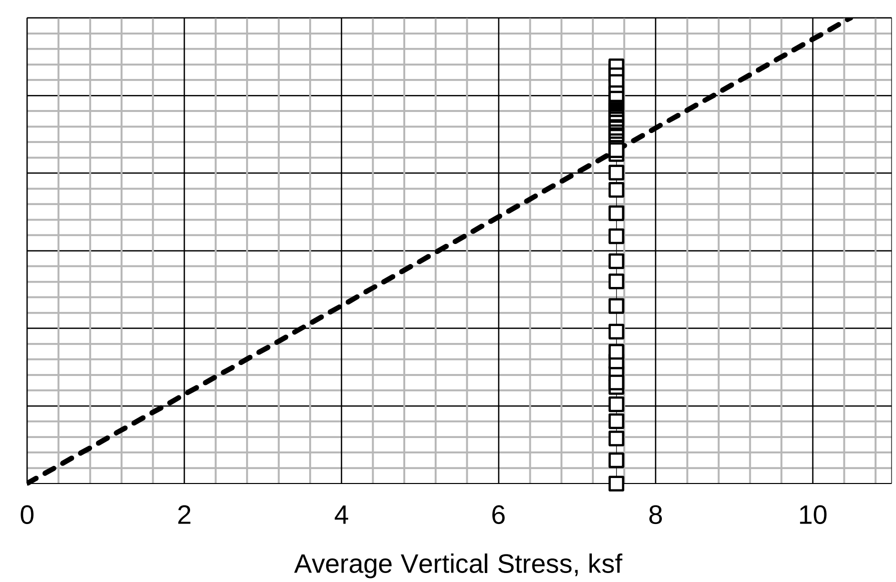
Peak Effective Friction Angle: 35.6°, cohesion = 0.0ksf

Final Shear Strength: 4.29 ksf @ 0.29 inch deformation

Final Effective Friction Angle: 29.8° (Shown)

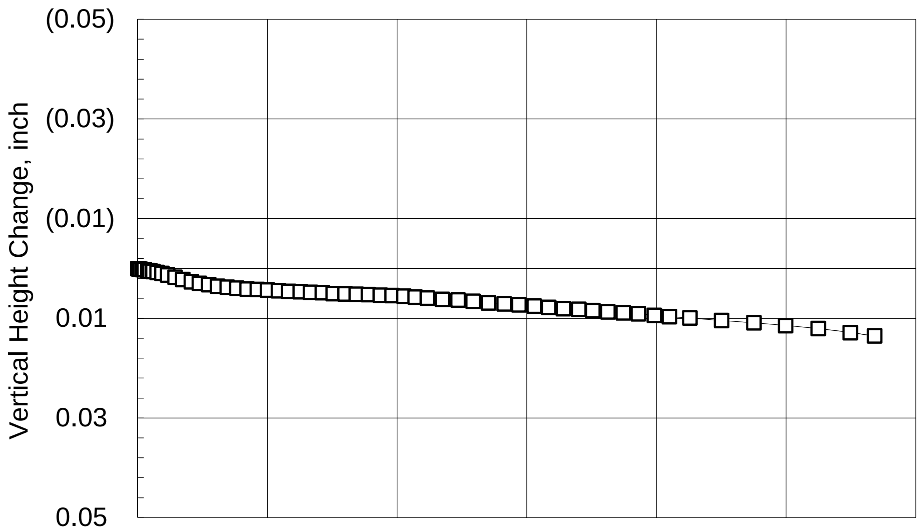
REMARKS:





Prepared by: MHC Checked by: GET	AECOM 60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **TEST SUMMARY** Boring: NEW-B015 Sample: ST-3 Specimen: C Depth: 60.75 ft	
	TerraSense, LLC	T60428794		November 15

Analysis File: DsV8.xlsx DS1625.xlsx 11/17/2015



SAMPLE INFORMATION

Boring: NEW-B015 Sample: ST-3 Specimen: D Depth: 61.05 ft

Type: Intact tube sample

SPECIMEN INFORMATION (Initial)

Description: CL, brown clay with sand

Height: 1.02 inch Diameter: 2.50 inch Area: 4.91 in²

Water Content: 12.7 % Dry Unit Weight: 124.1 pcf

TEST SUMMARY

Vertical Consolidation Stress: 15.00 ksf

Water Content: 12.0 % Dry Unit Weight: 126.2 pcf

Deformation Rate: 0.00066 inch/min.

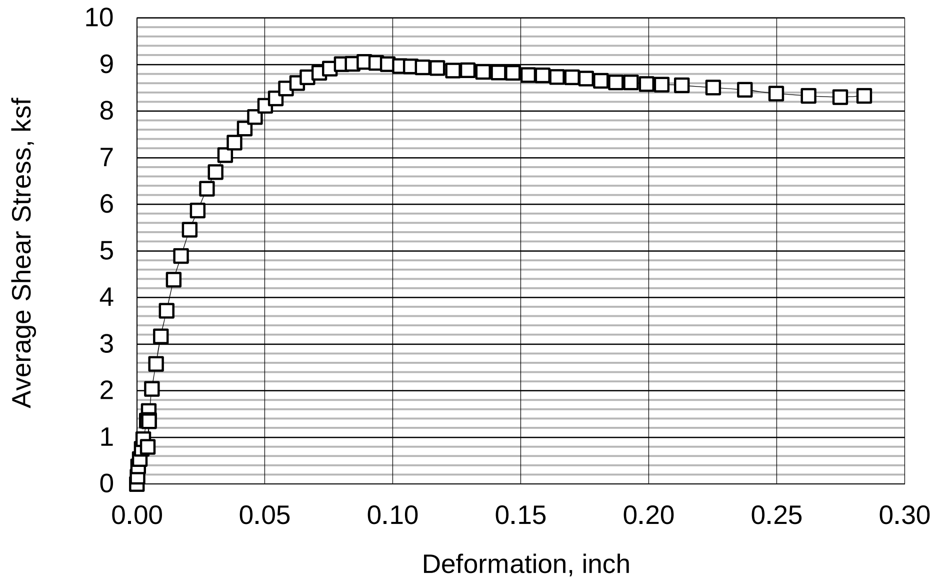
Peak Shear Strength: 9.05 ksf @ 0.09 inch deformation

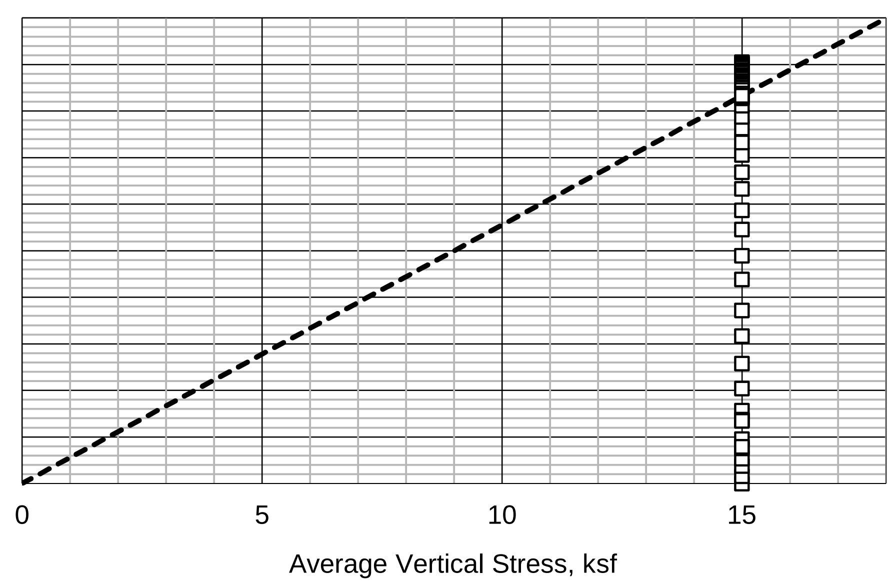
Peak Effective Friction Angle: 31.1°, cohesion = 0.0ksf

Final Shear Strength: 8.33 ksf @ 0.28 inch deformation

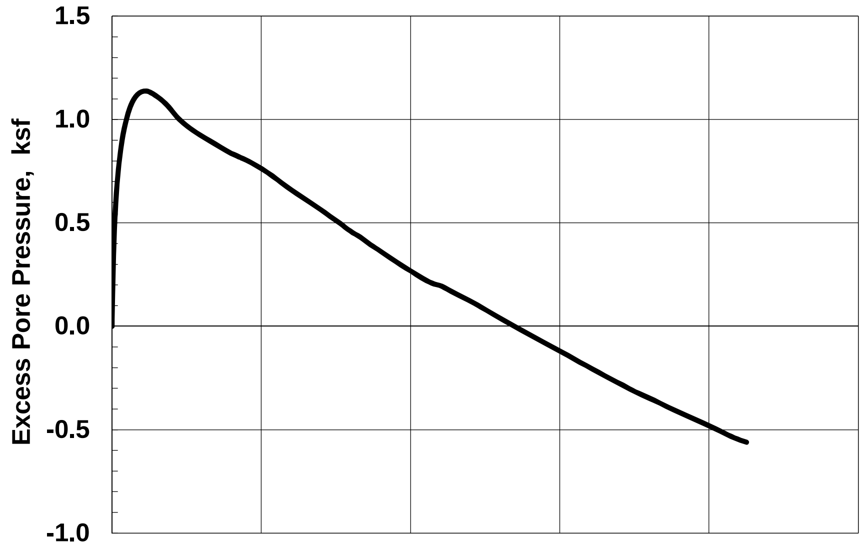
Final Effective Friction Angle: 29.0° (Shown)

REMARKS:





Prepared by: MHC Checked by: GET	AECOM 60428794	Dynegy CCR - Newton	**DRAINED DIRECT SHEAR** **TEST SUMMARY** Boring: NEW-B015 Sample: ST-3 Specimen: D Depth: 61.05 ft	
	TerraSense, LLC	T60428794		November 15

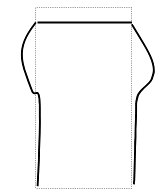


SAMPLE INFORMATION

Boring: NEW-B001 Sample: ST-5 Depth: 10.75 ft
Type: Intact tube sample
Description: CH, gray fat clay
LL = 50 PL = 14 PI = 36

SPECIMEN INFORMATION (Initial)

Height: 6.00 inch Diameter: 2.88 inch Area: 6.51 in²
Water Content: 18.1 % Total Unit Weight: 132.6 pcf

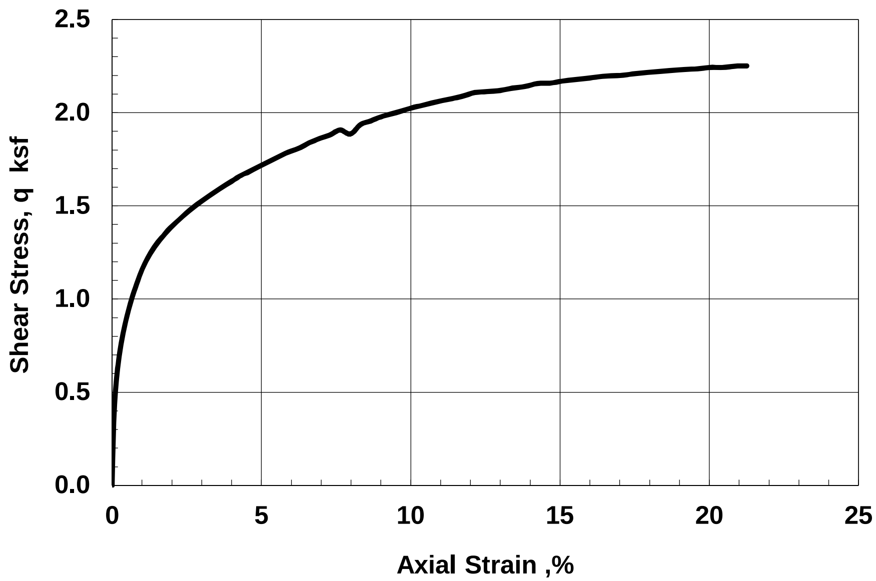


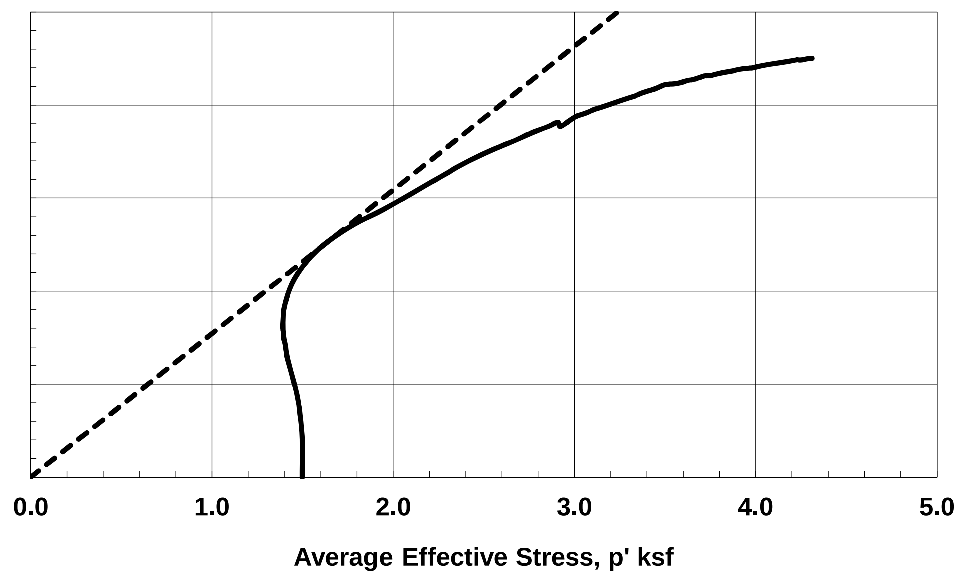
Failure
Sketch

TEST SUMMARY

Consolidation Stresses: 1.50 ksf vertical, 1.50 ksf lateral
Water Content: 19.1 % Total Unit Weight: 133.4 pcf
B Coefficient: 99.6 Strain Rate: 0.021 %/min
Peak Shear Strength: 2.25 ksf @ 21.3 % Strain
Peak Effective Friction Angle: 50.5°

REMARKS:





Test by: BB

Checked by: GET

Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
TerraSense, LLC		Boring: NEW-B001 Sample: ST-5	November-15

SAMPLE INFORMATION

Boring: NEW-B001 Sample: ST-7B Depth: 21.1 ft

Type: Intact tube sample

Description: CL, gray brown sandy lean clay

LL = 49 PL = 13 PI = 36

SPECIMEN INFORMATION (Initial)

Height: 6.00 inch Diameter: 2.88 inch Area: 6.51 in²

Water Content: 16.2 % Total Unit Weight: 134.5 pcf

TEST SUMMARY

Consolidation Stresses: 3.00 ksf vertical, 3.00 ksf lateral

Water Content: 17.0 % Total Unit Weight: 136.5 pcf

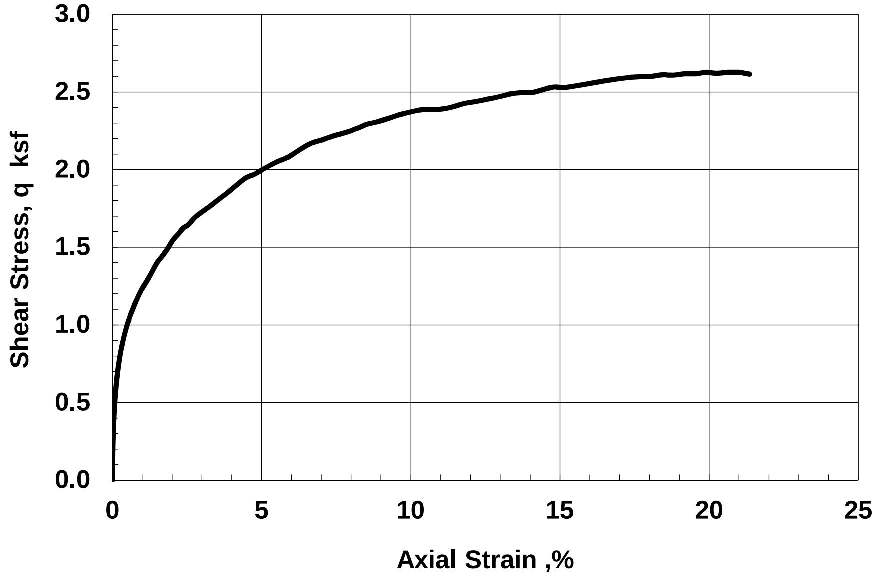
B Coefficient: 99.14 Strain Rate: 0.023 %/min

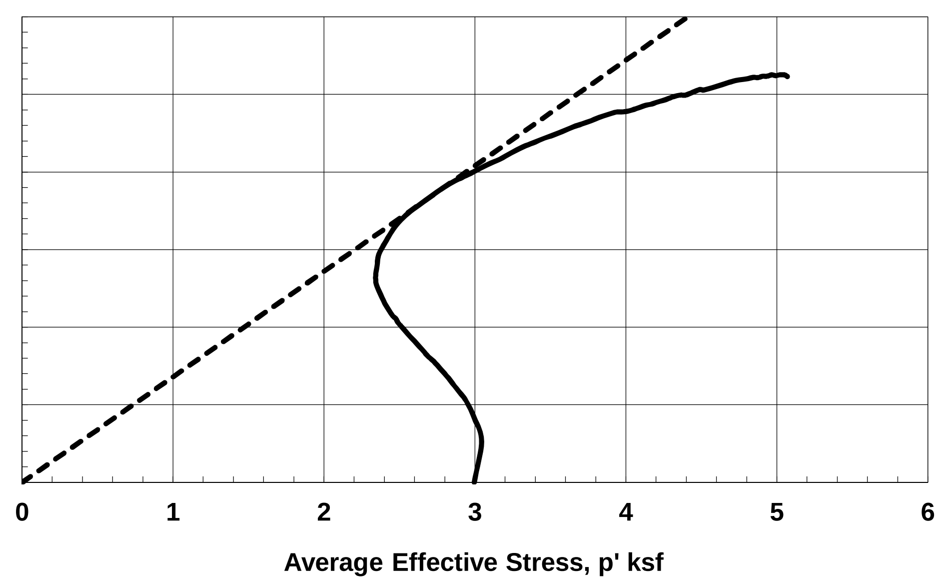
Peak Shear Strength: 2.63 ksf @ 20.6 % Strain

Peak Effective Friction Angle: 42.9°

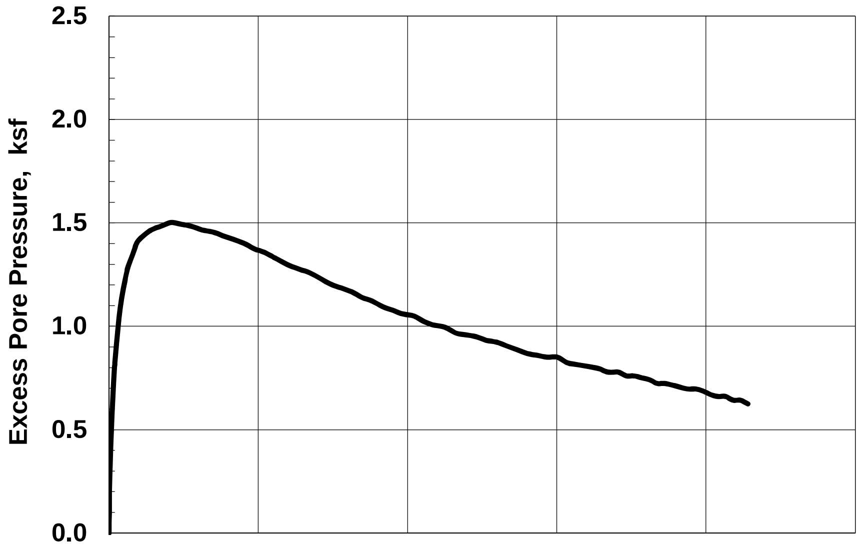
Failure Sketch

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements Boring: NEW-B001 Sample: ST-7B
Checked by: GET	TerraSense, LLC		November-15

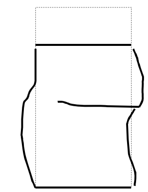


SAMPLE INFORMATION

Boring: NEW-B003 Sample: ST-1C Depth: 15.35 ft
Type: Intact tube sample
Description: CH, gray brown fat clay with sand
LL = 59 PL = 15 PI = 44

SPECIMEN INFORMATION (Initial)

Height: 6.00 inch Diameter: 2.87 inch Area: 6.49 in²
Water Content: 20.9 % Total Unit Weight: 129.5 pcf

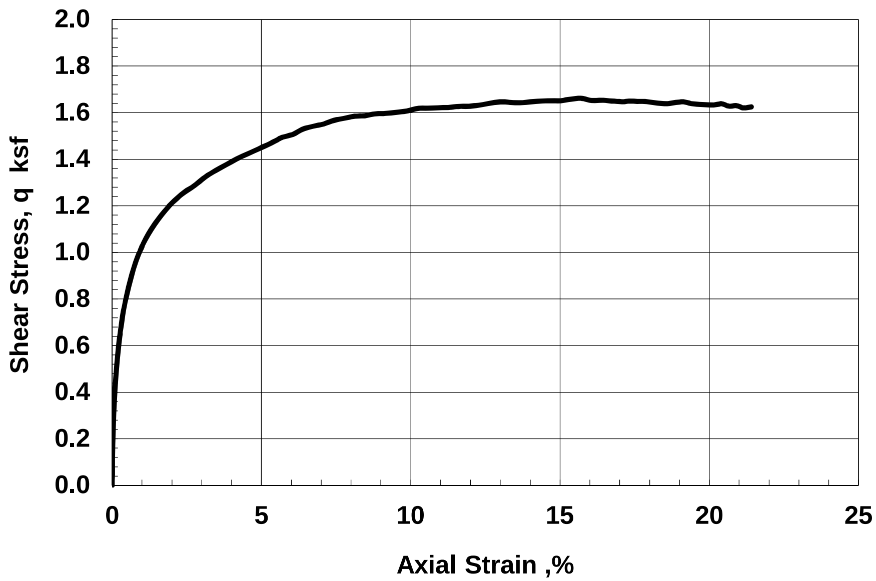


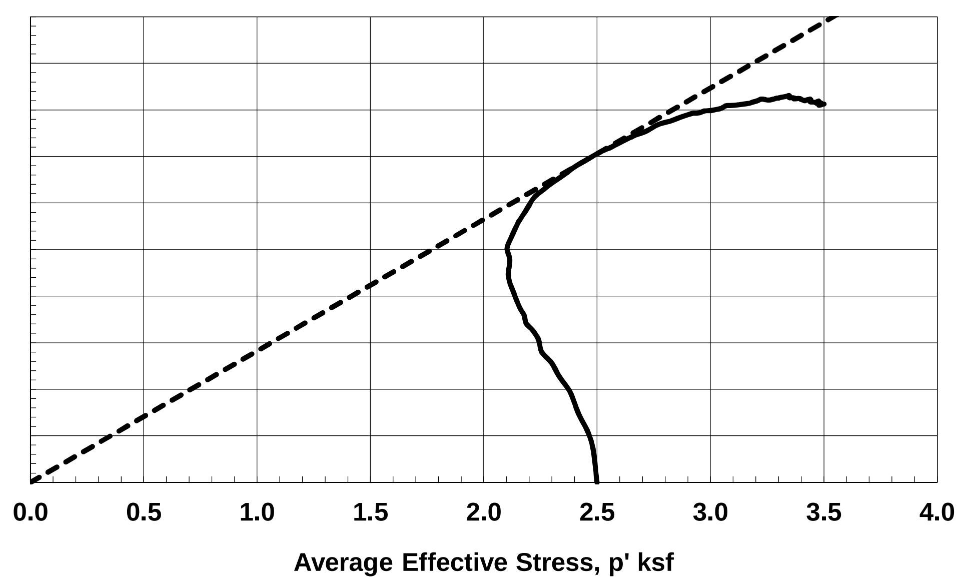
Failure Sketch

TEST SUMMARY

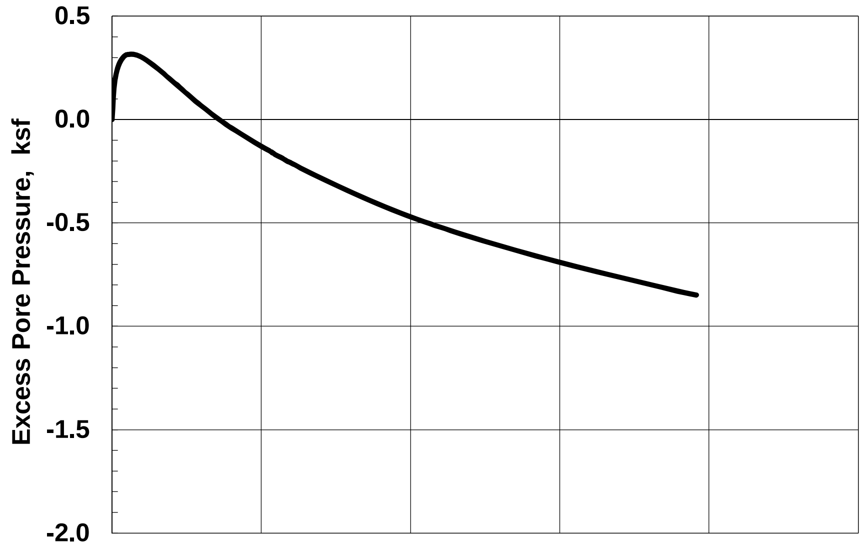
Consolidation Stresses: 2.50 ksf vertical, 2.50 ksf lateral
Water Content: 21.1 % Total Unit Weight: 131.8 pcf
B Coefficient: 99.52 Strain Rate: 0.021 %/min
Peak Shear Strength: 1.66 ksf @ 15.7 % Strain
Peak Effective Friction Angle: 34.4°

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: NEW-B003 Sample: ST-1C	November-15

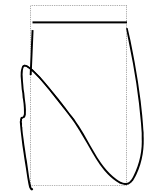


SAMPLE INFORMATION

Boring: NEW-B004 Sample: ST-4 Depth: 9.5 ft
Type: Intact tube sample
Description: CH, gray fat clay with sand
LL = 50 PL = 13 PI = 37

SPECIMEN INFORMATION (Initial)

Height: 6.00 inch Diameter: 2.88 inch Area: 6.52 in²
Water Content: 18.5 % Total Unit Weight: 131.3 pcf

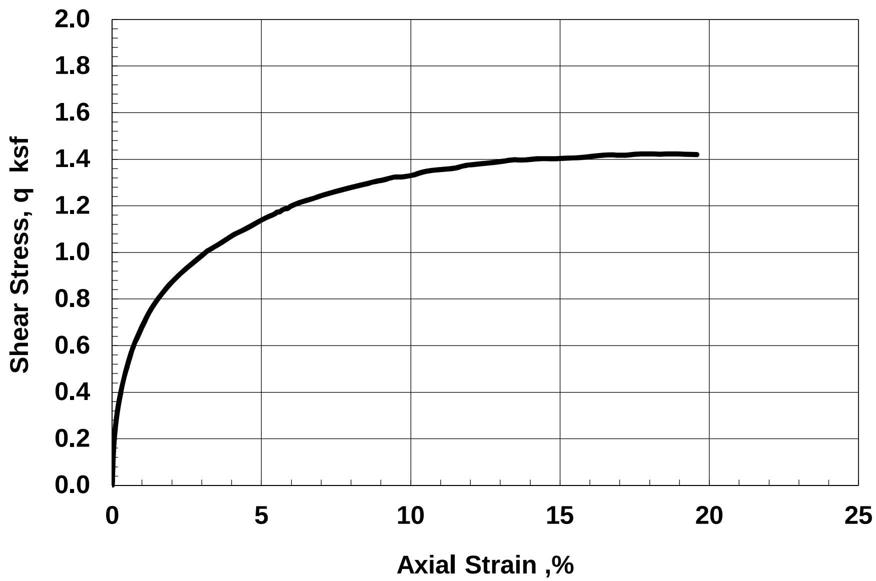


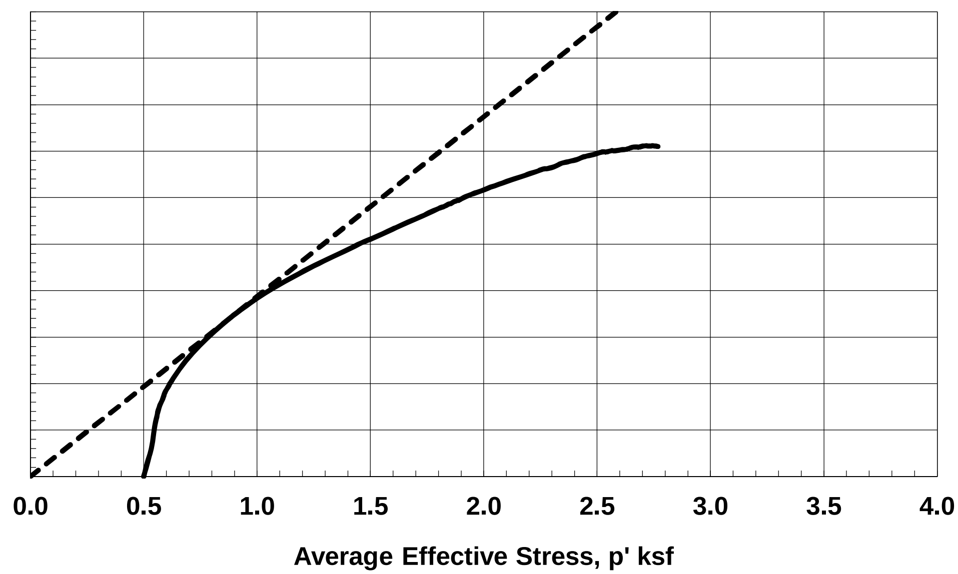
Failure Sketch

TEST SUMMARY

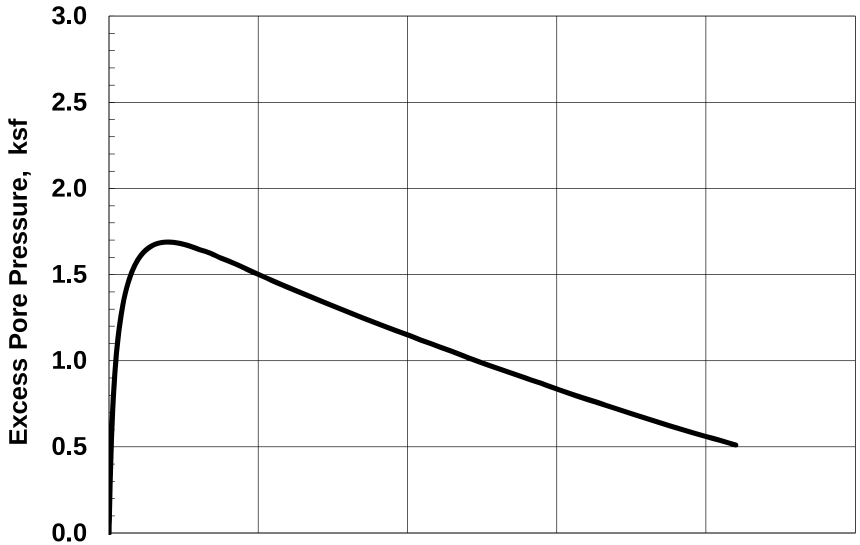
Consolidation Stresses: 0.50 ksf vertical, 0.50 ksf lateral
Water Content: 19.7 % Total Unit Weight: 132.6 pcf
B Coefficient: 99 Strain Rate: 0.022 %/min
Peak Shear Strength: 1.42 ksf @ 17.9 % Strain
Peak Effective Friction Angle: 50.7°

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: NEW-B004 Sample: ST-4	November-15

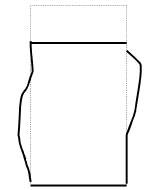


SAMPLE INFORMATION

Boring: NEW-B004 Sample: ST-7C Depth: 19.35 ft
Type: Intact tube sample
Description: CH, gray brown fat clay with sand
LL = 52 PL = 15 PI = 37

SPECIMEN INFORMATION (Initial)

Height: 6.01 inch Diameter: 2.88 inch Area: 6.50 in²
Water Content: 18.3 % Total Unit Weight: 128.5 pcf

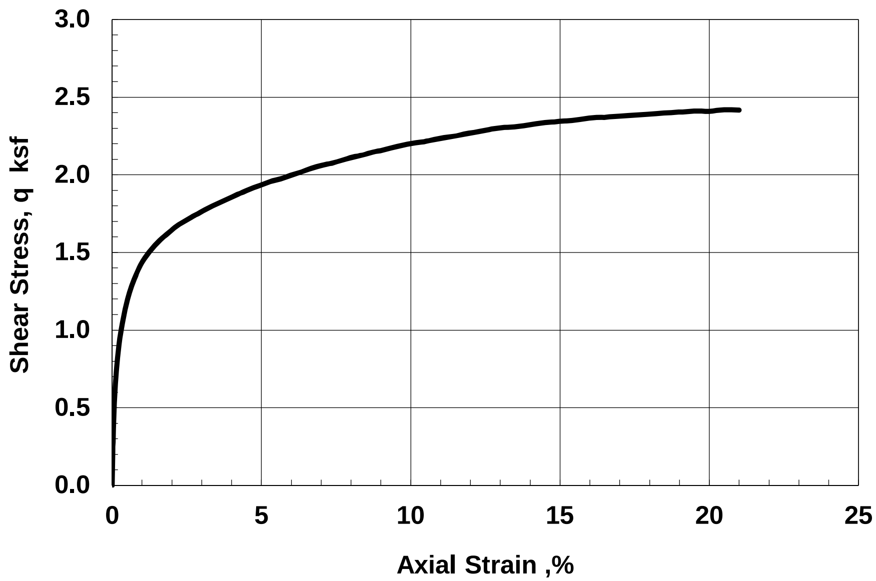


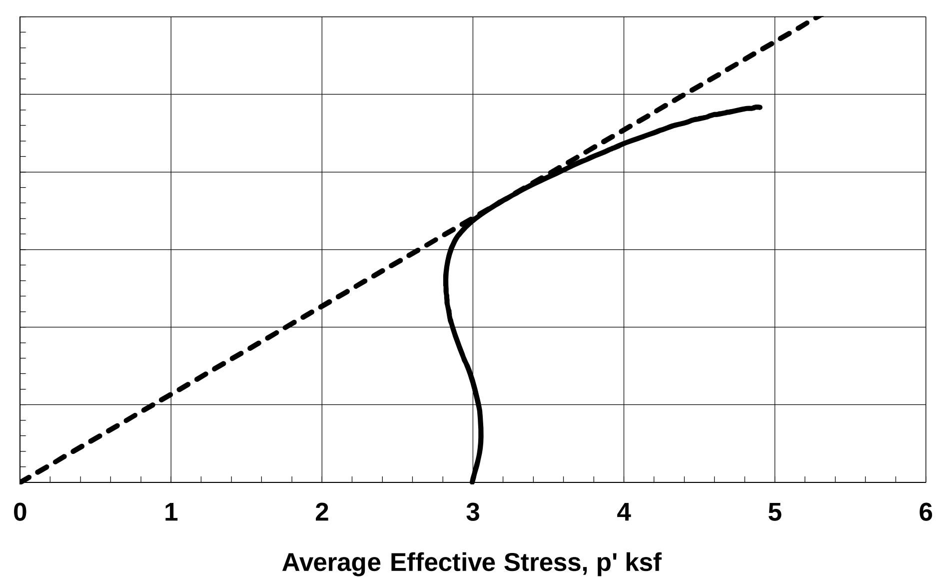
Failure
Sketch

TEST SUMMARY

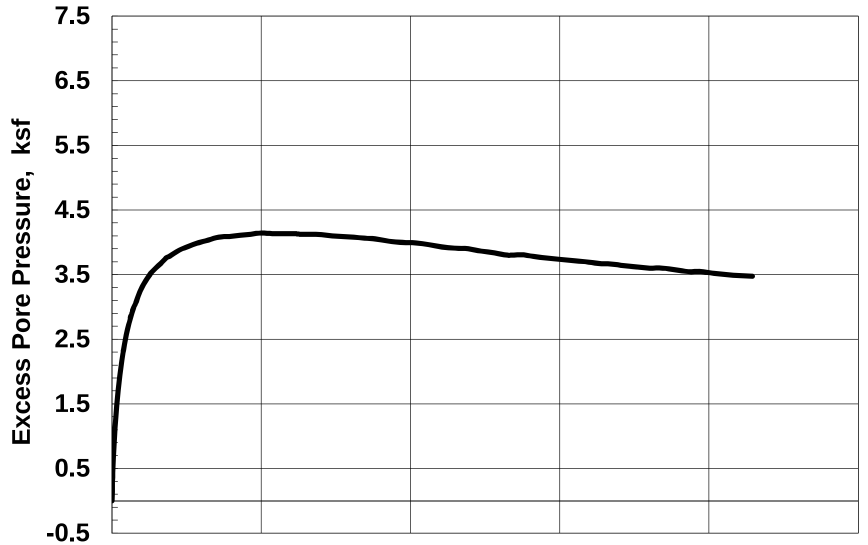
Consolidation Stresses: 3.00 ksf vertical, 3.00 ksf lateral
Water Content: 19.6 % Total Unit Weight: 133.7 pcf
B Coefficient: 99.56 Strain Rate: 0.021 %/min
Peak Shear Strength: 2.42 ksf @ 20.5 % Strain
Peak Effective Friction Angle: 34.6°

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements
Checked by: GET	TerraSense, LLC		Boring: NEW-B004 Sample: ST-7C — November-15

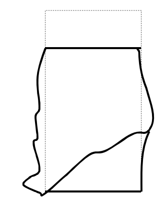


SAMPLE INFORMATION

Boring: NEW-B006 Sample: ST-2 Depth: 26.75 ft
Type: Intact tube sample
Description: CL, gray sandy clay
LL = 44 PL = 12 PI = 32

SPECIMEN INFORMATION (Initial)

Height: 6.01 inch Diameter: 2.88 inch Area: 6.52 in²
Water Content: 19.7 % Total Unit Weight: 128.8 pcf

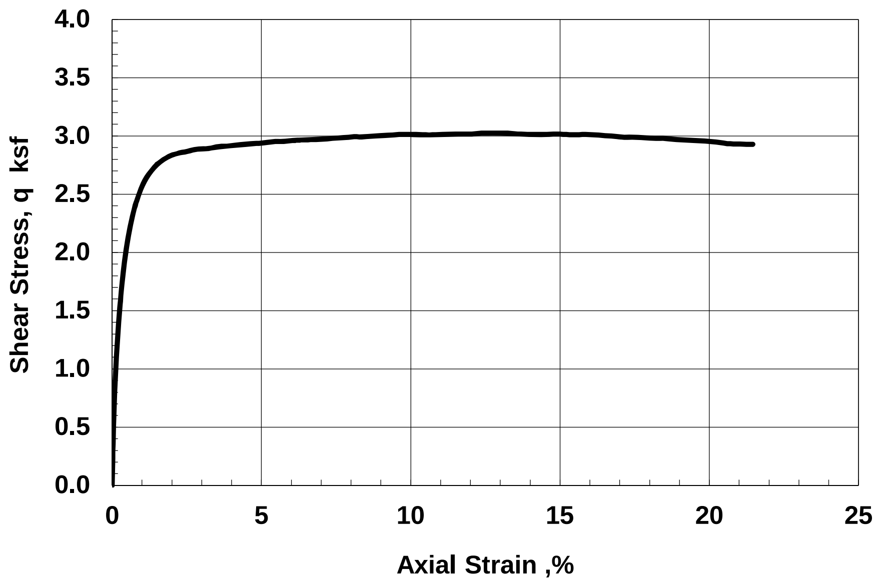


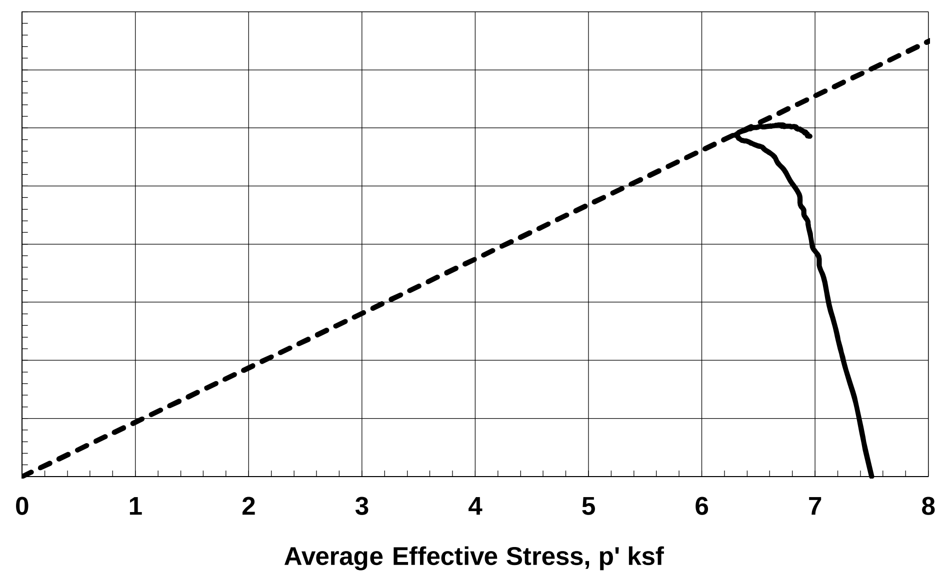
Failure Sketch

TEST SUMMARY

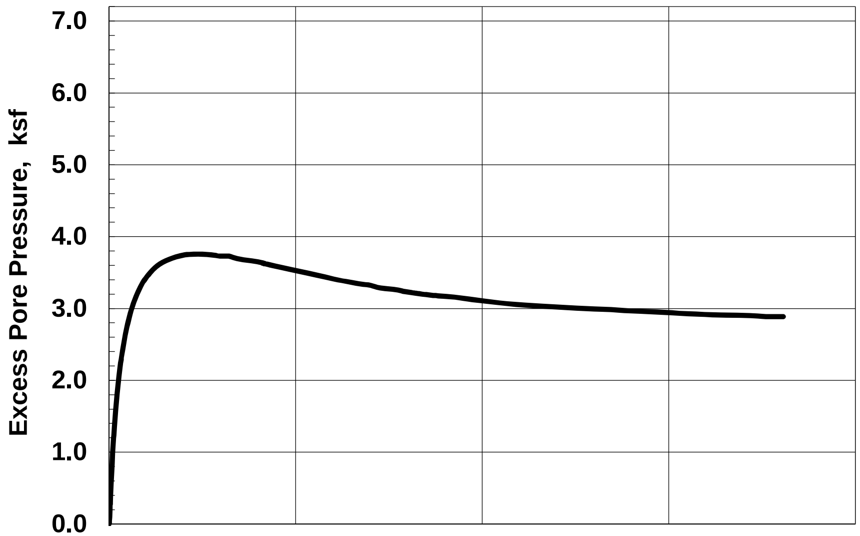
Consolidation Stresses: 7.50 ksf vertical, 7.50 ksf lateral
Water Content: 18.2 % Total Unit Weight: 134.6 pcf
B Coefficient: 97.7 Strain Rate: 0.022 %/min
Peak Shear Strength: 3.03 ksf @ 12.8 % Strain
Peak Effective Friction Angle: 27.9°

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: NEW-B006 Sample: ST-2	November-15

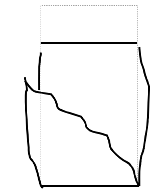


SAMPLE INFORMATION

Boring: NEW-B006 Sample: ST-3C Depth: 31.8 ft
Type: Intact tube sample
Description: CL, dark brown sandy lean clay
LL = 37 PL = 15 PI = 22

SPECIMEN INFORMATION (Initial)

Height: 6.00 inch Diameter: 2.88 inch Area: 6.52 in²
Water Content: 18.3 % Total Unit Weight: 133.3 pcf

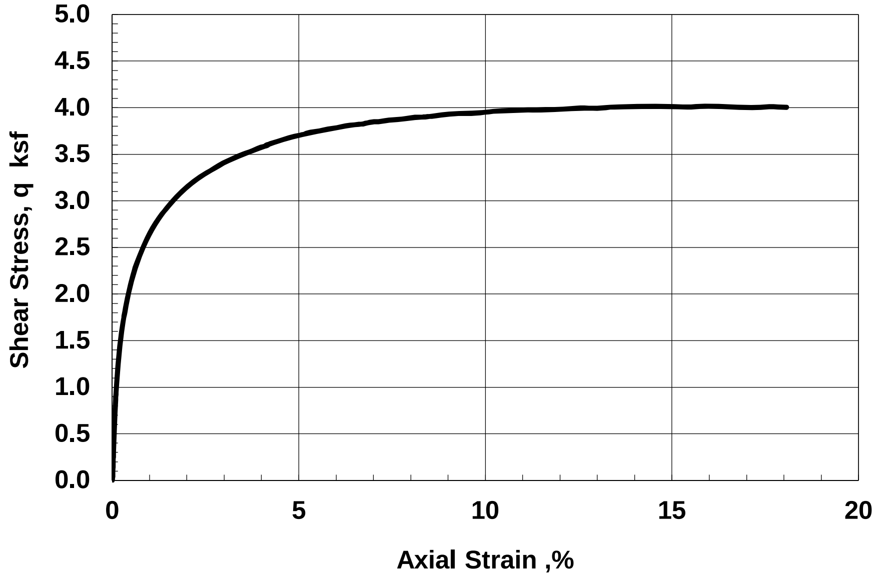


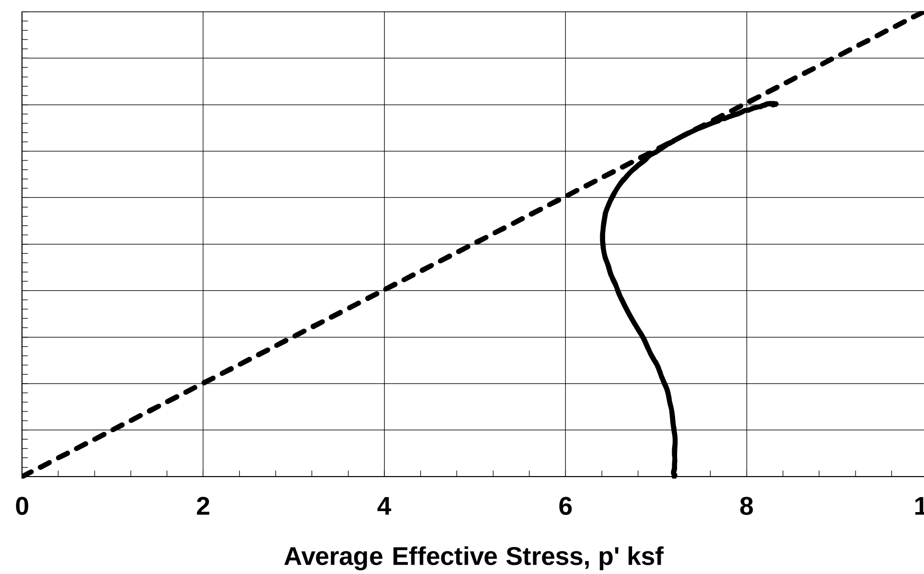
Failure Sketch

TEST SUMMARY

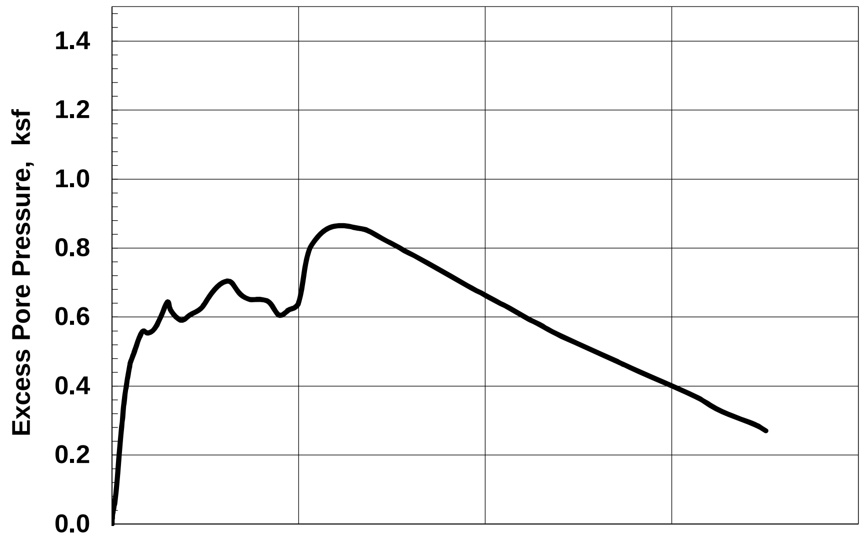
Consolidation Stresses: 7.20 ksf vertical, 7.20 ksf lateral
Water Content: 17.0 % Total Unit Weight: 138.2 pcf
B Coefficient: Strain Rate: 0.019 %/min
Peak Shear Strength: 4.01 ksf @ 14.8 % Strain
Peak Effective Friction Angle: 30.2°

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET		**TerraSense, LLC**	Boring: NEW-B006 Sample: ST-3C	November-15



SAMPLE INFORMATION

Boring: NEW-C006 Sample: ST-1B Depth: 11.3 ft

Type: Intact tube sample

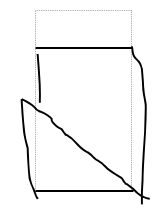
Description: CH, brown fat clay with sand

LL = 54 PL = 16 PI = 38

SPECIMEN INFORMATION (Initial)

Height: 6.03 inch Diameter: 2.87 inch Area: 6.48 in²

Water Content: 25.2 % Total Unit Weight: 124.1 pcf



Failure Sketch

TEST SUMMARY

Consolidation Stresses: 1.50 ksf vertical, 1.50 ksf lateral

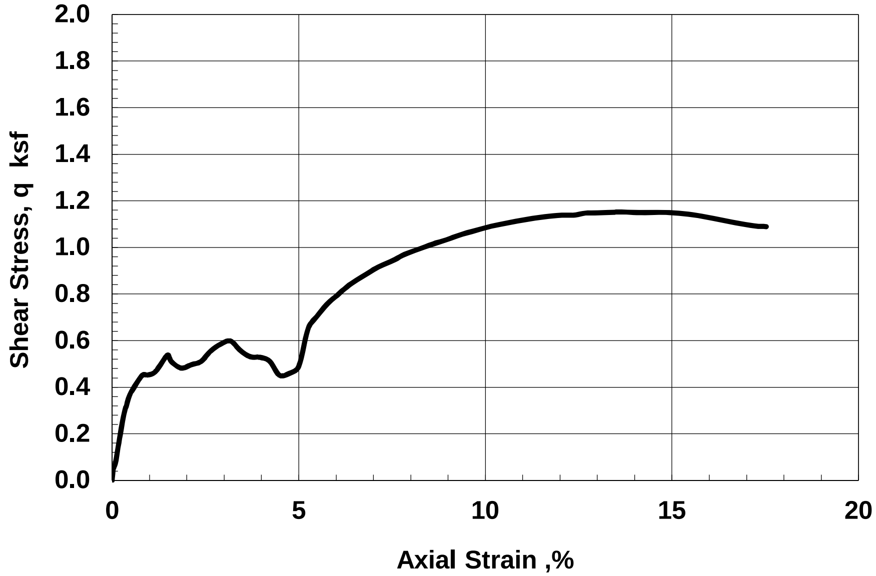
Water Content: 25.0 % Total Unit Weight: 127.5 pcf

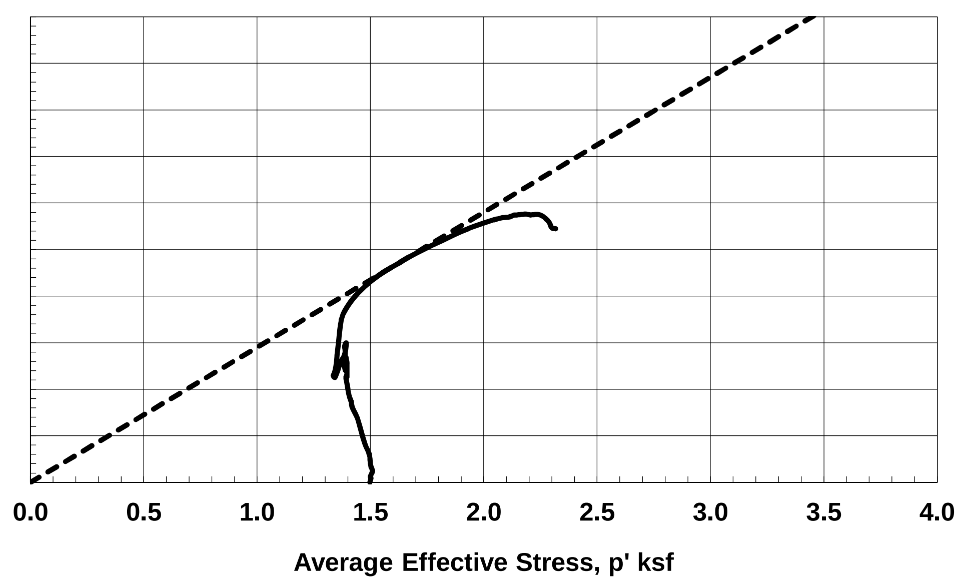
B Coefficient: Strain Rate: 0.021 %/min

Peak Shear Strength: 1.15 ksf @ 13.7 % Strain

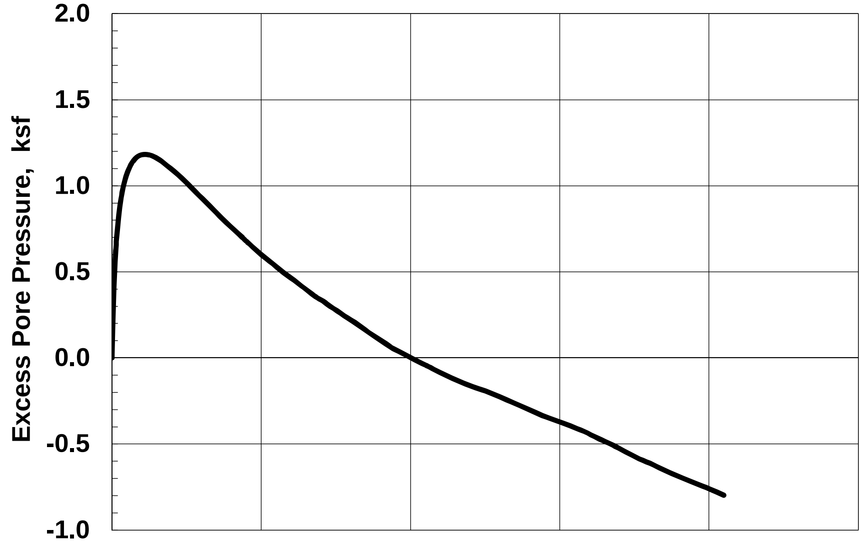
Peak Effective Friction Angle: 35.5°

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET		**TerraSense, LLC**	Boring: NEW-C006 Sample: ST-1B	November-15

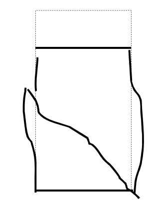


SAMPLE INFORMATION

Boring: NEW-C006 Sample: ST-2B Depth: 13 ft
Type: Intact tube sample
Description: CH, brown fat clay
LL = 53 PL = 14 PI = 39

SPECIMEN INFORMATION (Initial)

Height: 6.02 inch Diameter: 2.88 inch Area: 6.49 in²
Water Content: 18.9 % Total Unit Weight: 131.5 pcf

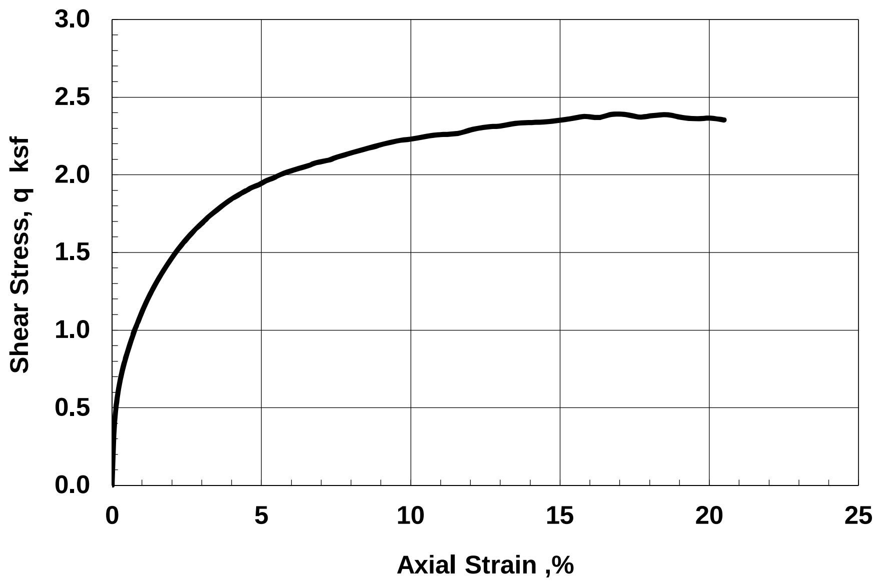


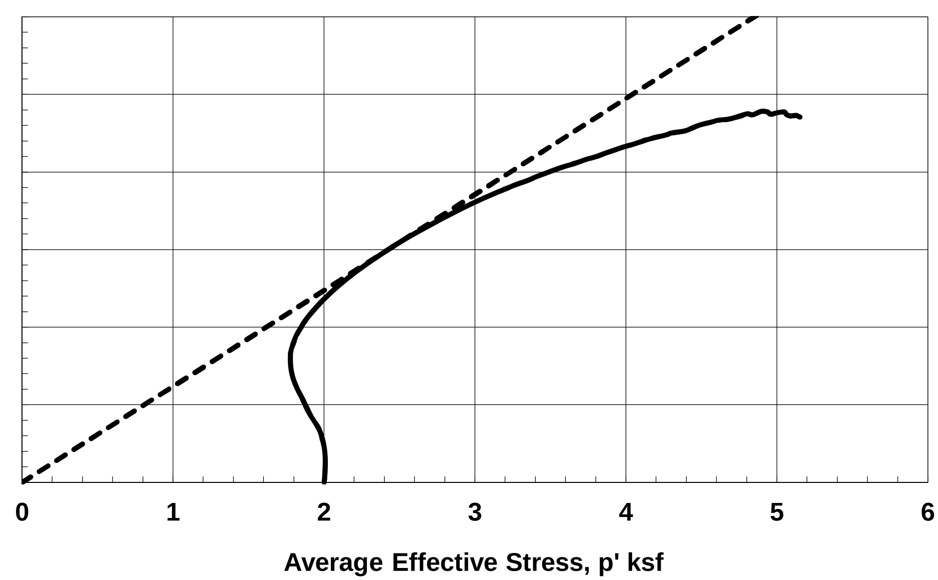
Failure Sketch

TEST SUMMARY

Consolidation Stresses: 2.00 ksf vertical, 2.00 ksf lateral
Water Content: 19.4 % Total Unit Weight: 134.0 pcf
B Coefficient: Strain Rate: 0.020 %/min
Peak Shear Strength: 2.39 ksf @ 16.7 % Strain
Peak Effective Friction Angle: 38.2°

REMARKS:





Test by: BB

Checked by: GET

Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
TerraSense, LLC		Boring: NEW-C006 Sample: ST-2B	November-15

SAMPLE INFORMATION

Boring: NEW-B007 Sample: ST-1C Depth: 11.55 ft

Type: Intact tube sample

Description: CL, brown lean clay with sand

LL = 38 PL = 14 PI = 24

SPECIMEN INFORMATION (Initial)

Height: 6.01 inch Diameter: 2.88 inch Area: 6.51 in²

Water Content: 15.4 % Total Unit Weight: 135.1 pcf

TEST SUMMARY

Consolidation Stresses: 1.00 ksf vertical, 1.00 ksf lateral

Water Content: 15.9 % Total Unit Weight: 137.7 pcf

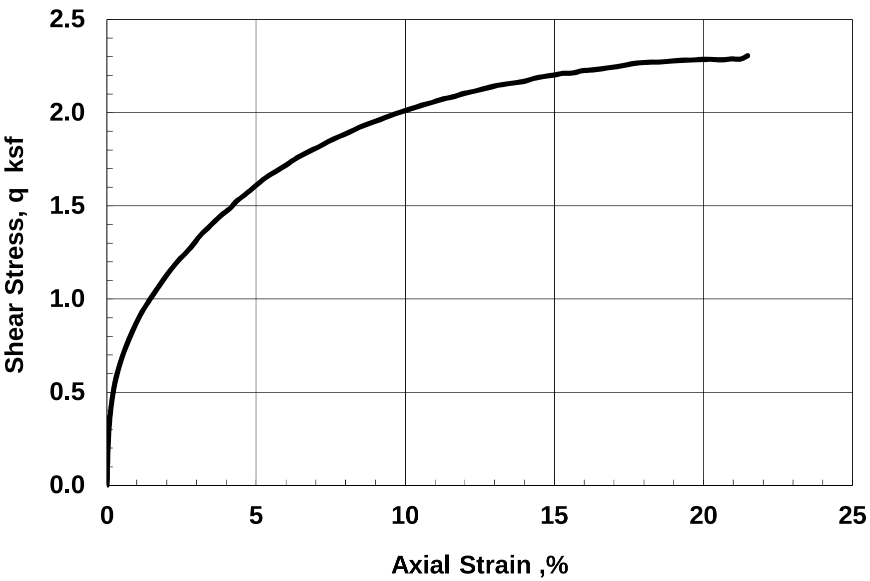
B Coefficient: 99.2 Strain Rate: 0.021 %/min

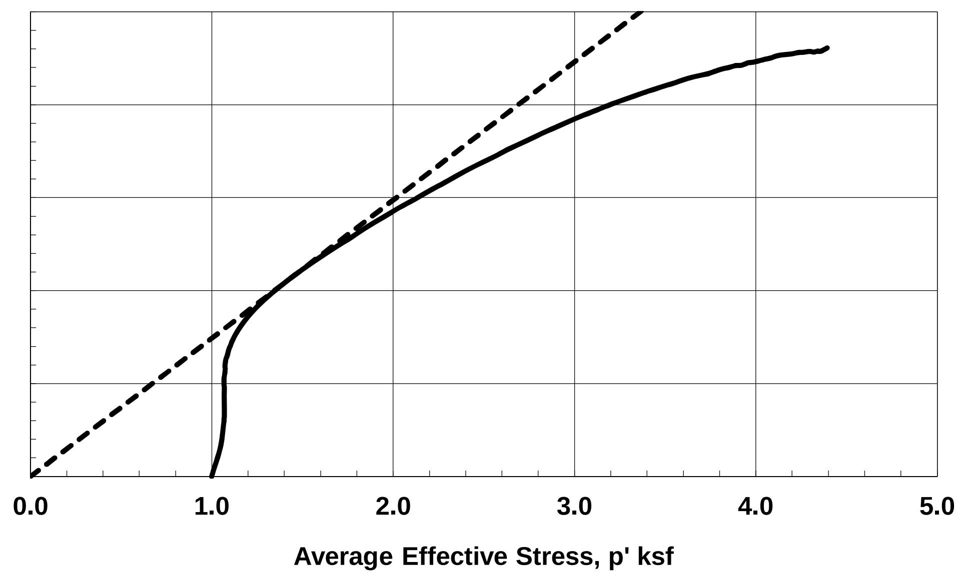
Peak Shear Strength: 2.31 ksf @ 21.5 % Strain

Peak Effective Friction Angle: 48.0°

Failure Sketch

REMARKS:

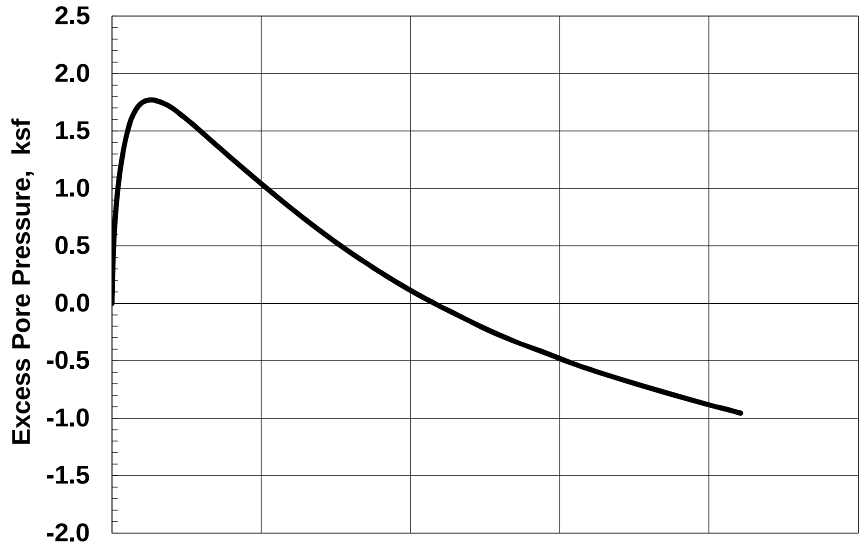




Test by: BB

Checked by: GET

Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
TerraSense, LLC		Boring: NEW-B007 Sample: ST-1C	November-15

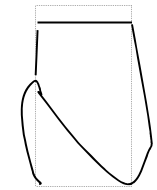


SAMPLE INFORMATION

Boring: NEW-B007 Sample: ST-2 Depth: 21 ft
Type: Intact tube sample
Description: CL, brown sandy lean clay
LL = 30 PL = 13 PI = 17

SPECIMEN INFORMATION (Initial)

Height: 5.99 inch Diameter: 2.88 inch Area: 6.50 in²
Water Content: 12.1 % Total Unit Weight: 140.5 pcf

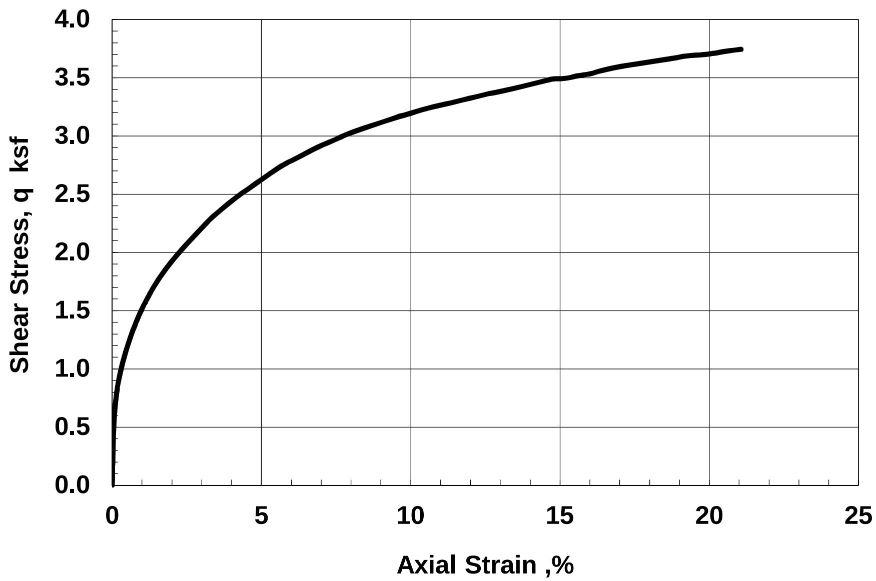


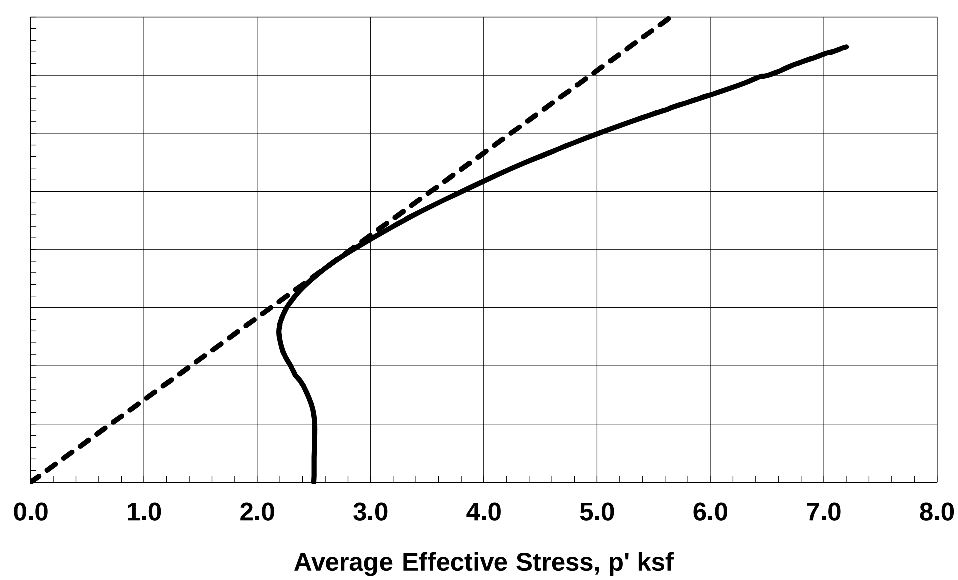
Failure Sketch

TEST SUMMARY

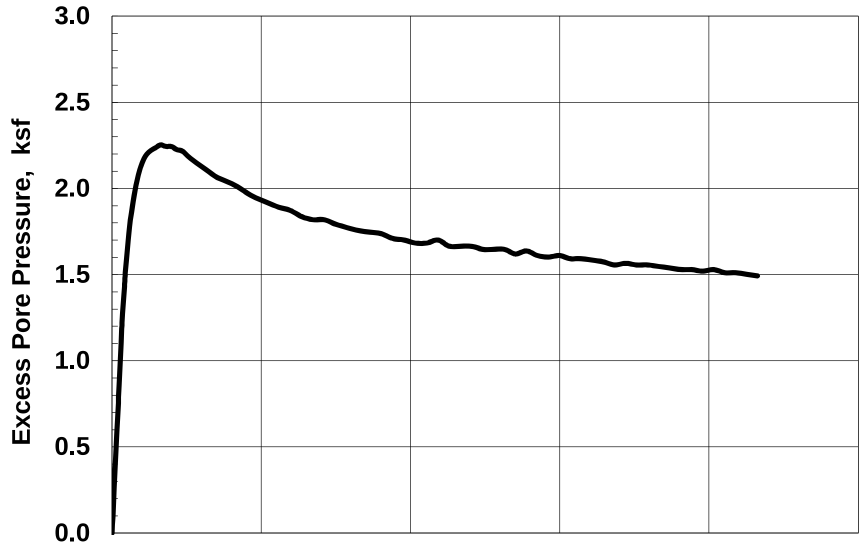
Consolidation Stresses: 2.50 ksf vertical, 2.50 ksf lateral
Water Content: 12.5 % Total Unit Weight: 142.9 pcf
B Coefficient: 99.62 Strain Rate: 0.021 %/min
Peak Shear Strength: 3.74 ksf @ 21.1 % Strain
Peak Effective Friction Angle: 45.1°

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements Boring: NEW-B007 Sample: ST-2
Checked by: GET	TerraSense, LLC		November-15

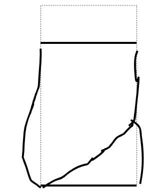


SAMPLE INFORMATION

Boring: NEW-B009 Sample: ST-2B Depth: 30 ft
Type: Intact tube sample
Description: CL, yellowish brown lean clay with sand
LL = 31 PL = 14 PI = 17

SPECIMEN INFORMATION (Initial)

Height: 5.96 inch Diameter: 2.89 inch Area: 6.55 in²
Water Content: 16.7 % Total Unit Weight: 132.6 pcf

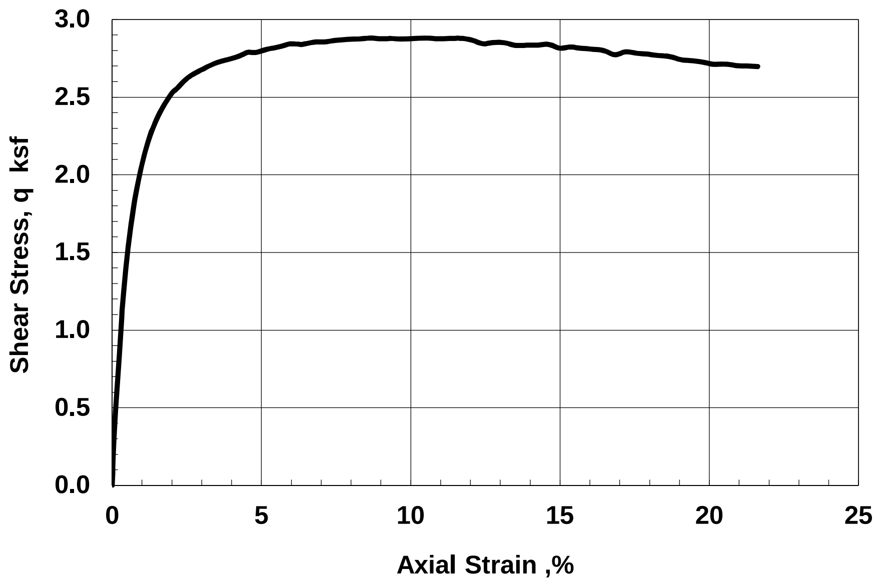


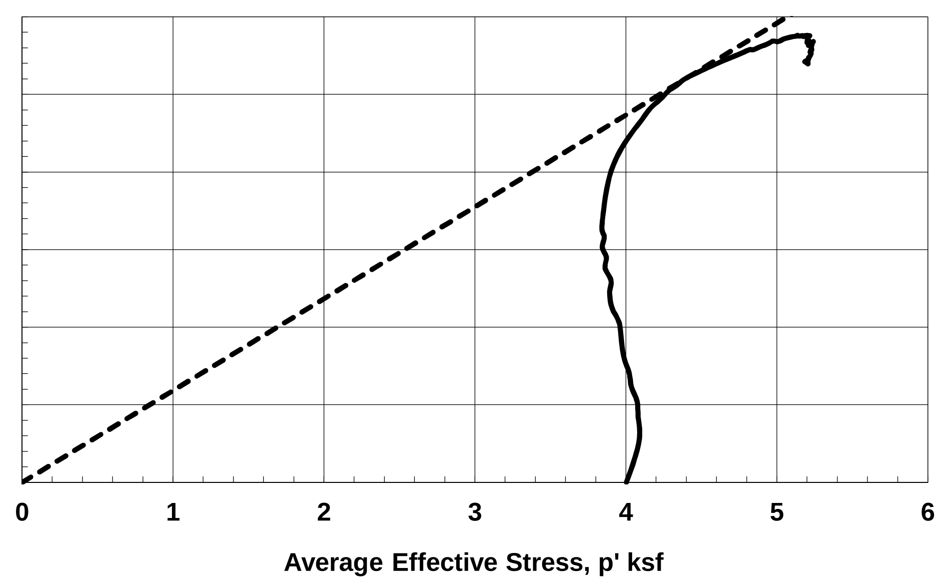
Failure Sketch

TEST SUMMARY

Consolidation Stresses: 4.00 ksf vertical, 4.00 ksf lateral
Water Content: 17.1 % Total Unit Weight: 136.8 pcf
B Coefficient: 98.02 Strain Rate: 0.023 %/min
Peak Shear Strength: 2.88 ksf @ 10.5 % Strain
Peak Effective Friction Angle: 36.3°

REMARKS:





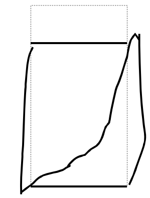
Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements
Checked by: GET	TerraSense, LLC		Boring: NEW-B009 Sample: ST-2B
			November-15

SAMPLE INFORMATION

Boring: NEW-B010 Sample: ST-1C Depth: 6.3 ft
Type: Intact tube sample
Description: CL, brown lean clay with sand
LL = 24 PL = 13 PI = 11

SPECIMEN INFORMATION (Initial)

Height: 6.05 inch Diameter: 2.88 inch Area: 6.51 in²
Water Content: 10.2 % Total Unit Weight: 140.5 pcf

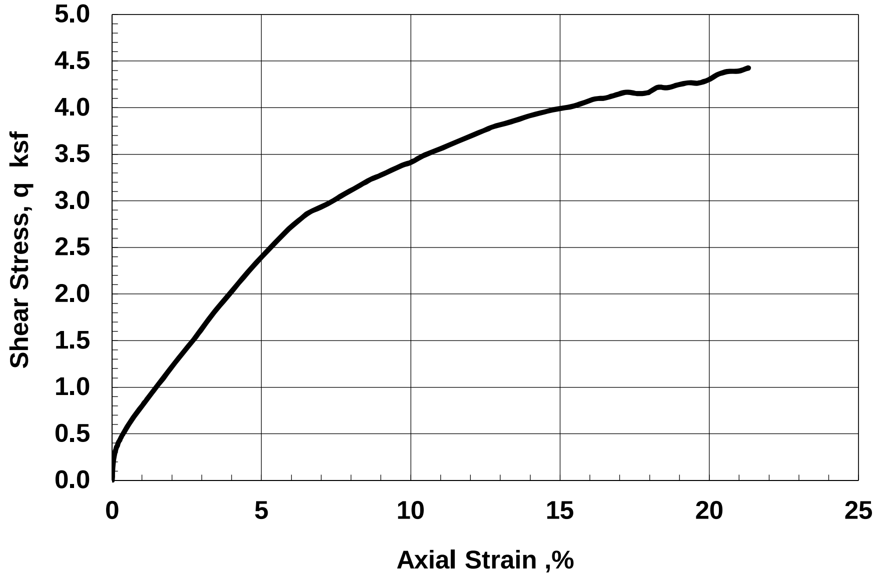


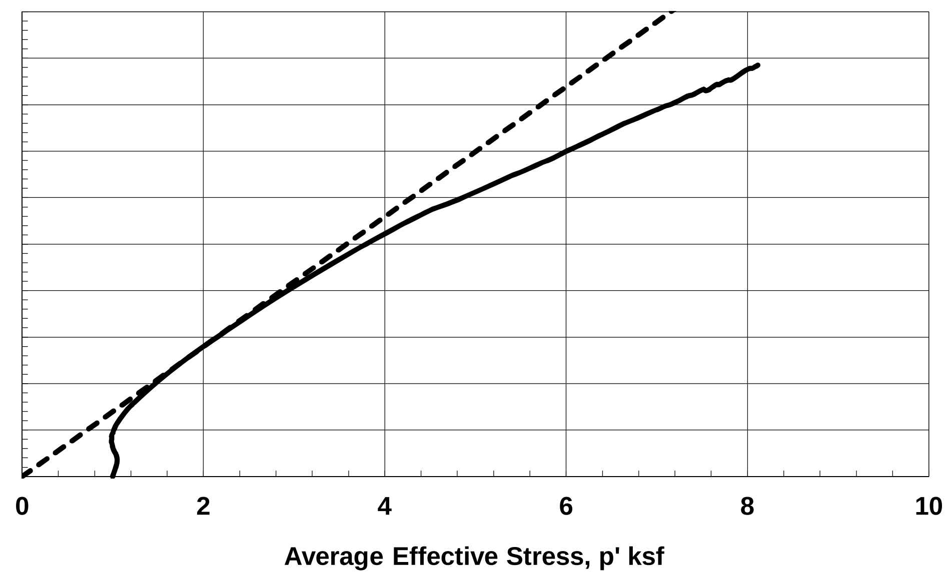
Failure
Sketch

TEST SUMMARY

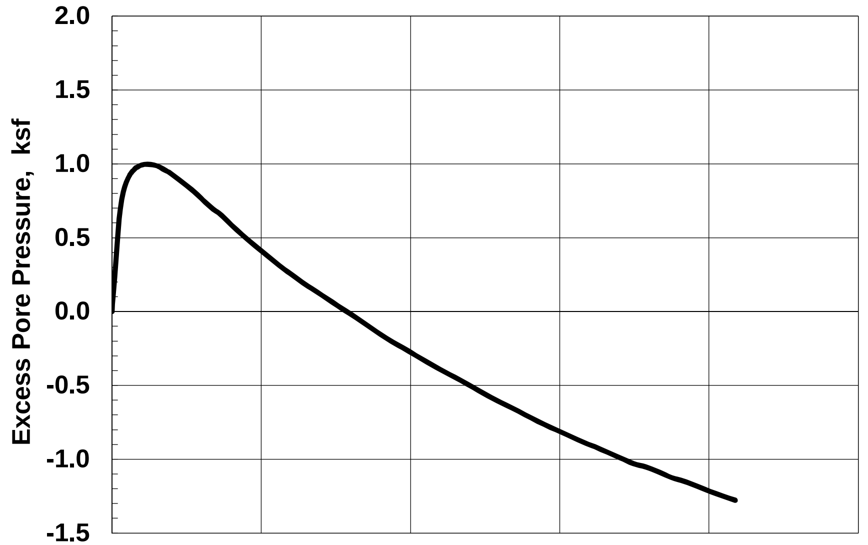
Consolidation Stresses: 1.00 ksf vertical, 1.00 ksf lateral
Water Content: 11.6 % Total Unit Weight: 145.2 pcf
B Coefficient: 98.32 Strain Rate: 0.021 %/min
Peak Shear Strength: 4.43 ksf @ 21.3 % Strain
Peak Effective Friction Angle: 44.4°

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: NEW-B010 Sample: ST-1C	November-15

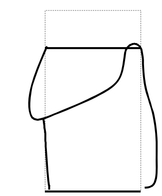


SAMPLE INFORMATION

Boring: NEW-B010 Sample: ST-2 Depth: 16.5 ft
Type: Intact tube sample
Description: CL, yellowish brown lean clay with sand, some m-f gravel
LL = 33 PL = 13 PI = 20

SPECIMEN INFORMATION (Initial)

Height: 6.02 inch Diameter: 2.88 inch Area: 6.53 in²
Water Content: 13.8 % Total Unit Weight: 137.3 pcf

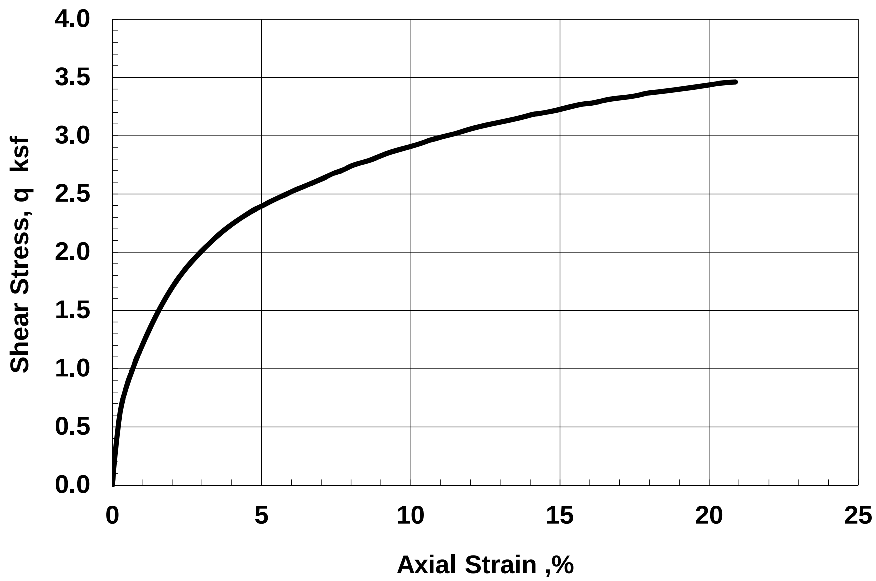


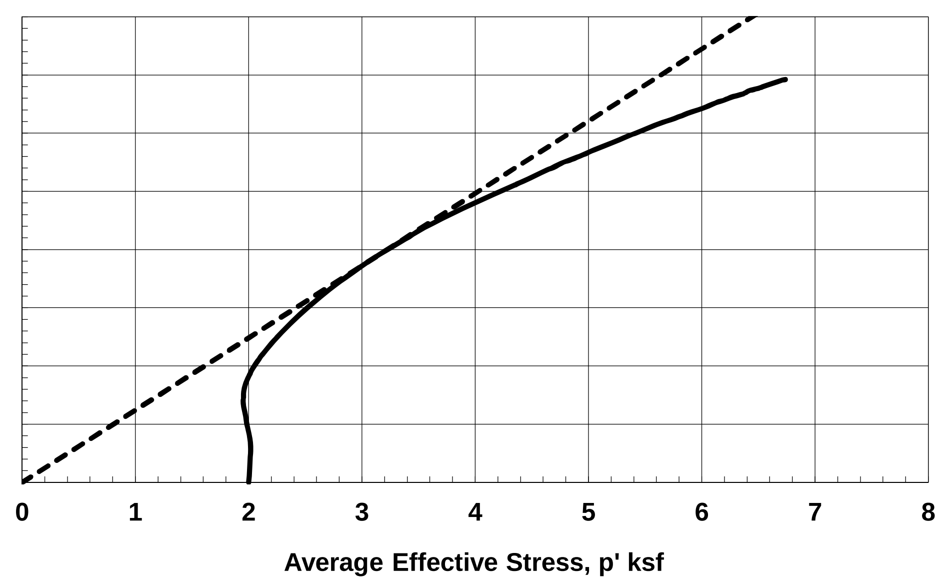
Failure Sketch

TEST SUMMARY

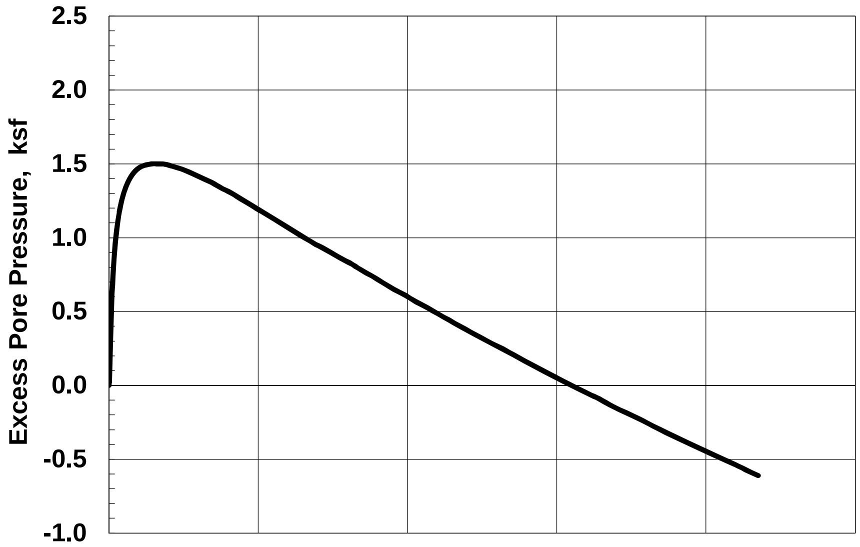
Consolidation Stresses: 2.00 ksf vertical, 2.00 ksf lateral
Water Content: 14.7 % Total Unit Weight: 139.5 pcf
B Coefficient: 99.6 Strain Rate: 0.022 %/min
Peak Shear Strength: 3.46 ksf @ 20.9 % Strain
Peak Effective Friction Angle: 38.4°

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: NEW-B010 Sample: ST-2	November-15

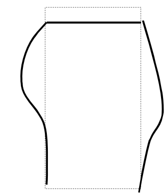


SAMPLE INFORMATION

Boring: NEW-B012 Sample: ST-7 Depth: 21.15 ft
Type: Intact tube sample
Description: CL, brown sandy clay
LL = 35 PL = 13 PI = 22

SPECIMEN INFORMATION (Initial)

Height: 6.00 inch Diameter: 2.88 inch Area: 6.52 in²
Water Content: 13.3 % Total Unit Weight: 138.4 pcf

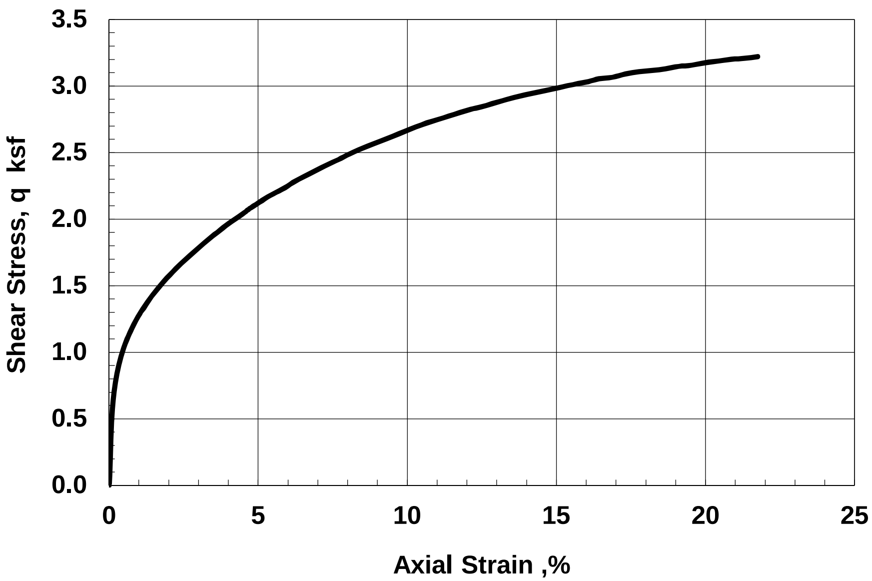


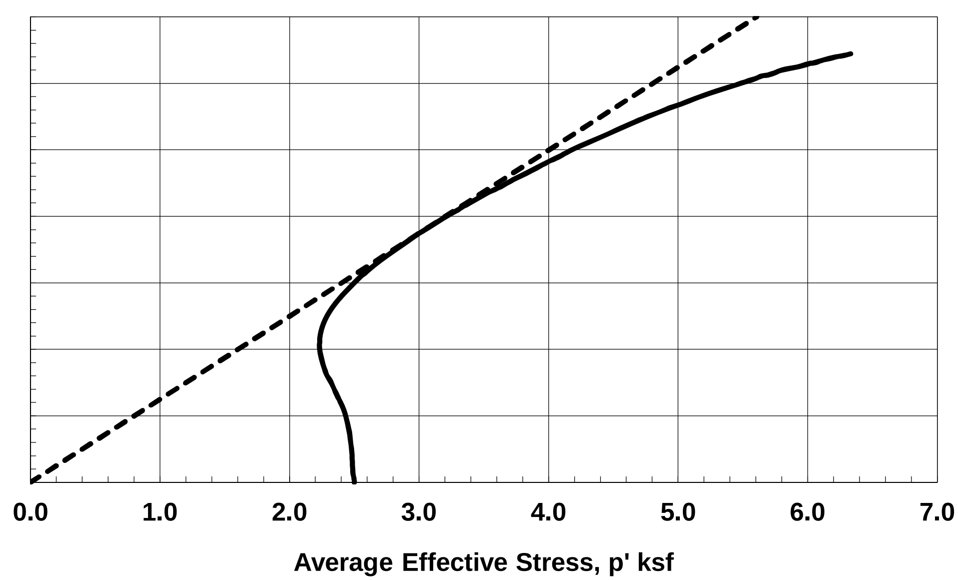
Failure
Sketch

TEST SUMMARY

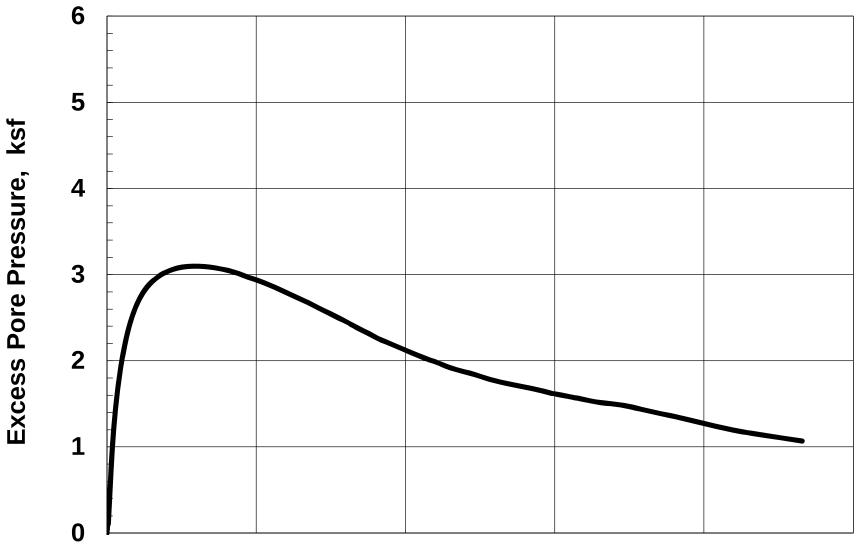
Consolidation Stresses: 2.50 ksf vertical, 2.50 ksf lateral
Water Content: 14.0 % Total Unit Weight: 140.6 pcf
B Coefficient: 97.9 Strain Rate: 0.023 %/min
Peak Shear Strength: 3.22 ksf @ 21.8 % Strain
Peak Effective Friction Angle: 38.6°

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: NEW-B012 Sample: ST-7	November-15

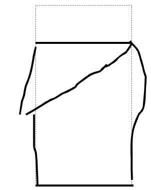


SAMPLE INFORMATION

Boring: NEW-B012 Sample: ST-12C Depth: 46.4 ft
Type: Intact tube sample
Description: CL, brown sandy lean clay
LL = 43 PL = 14 PI = 29

SPECIMEN INFORMATION (Initial)

Height: 6.04 inch Diameter: 2.88 inch Area: 6.52 in²
Water Content: 17.5 % Total Unit Weight: 133.6 pcf

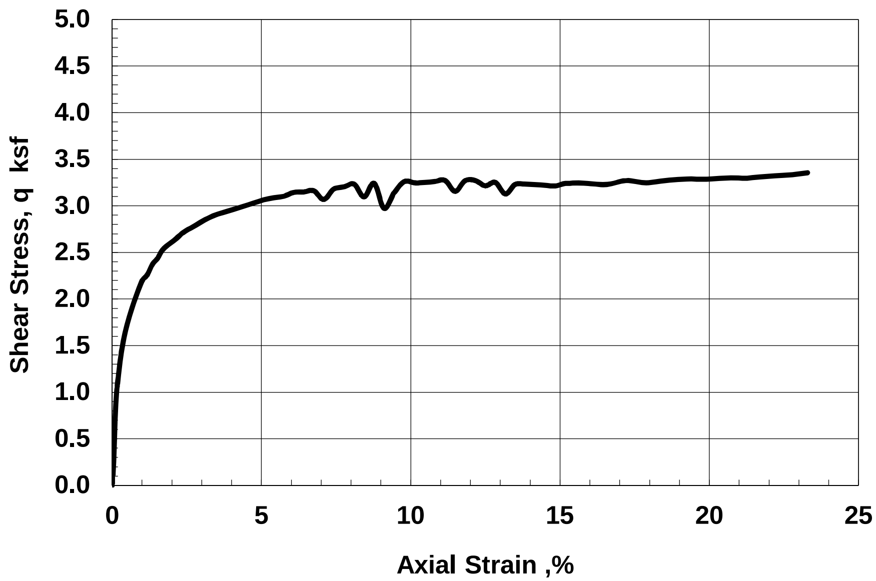


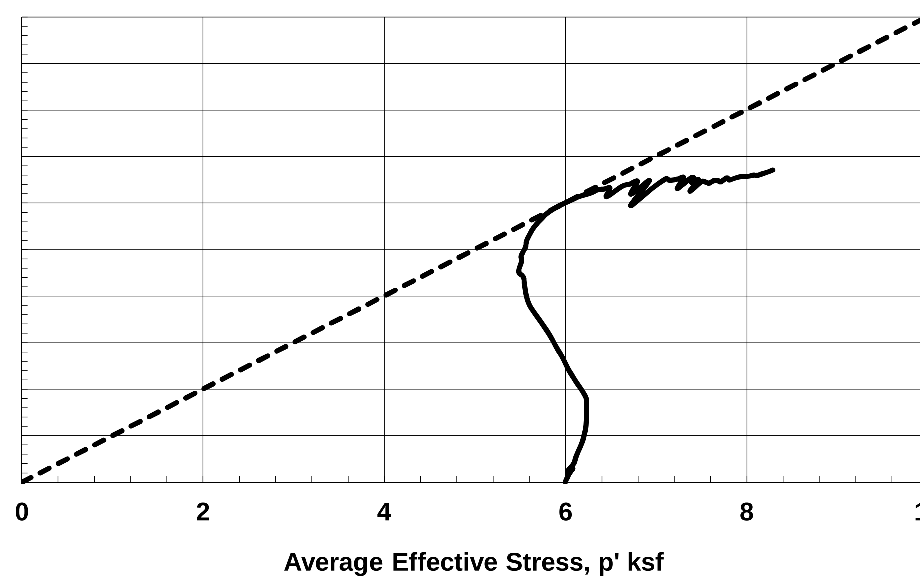
Failure Sketch

TEST SUMMARY

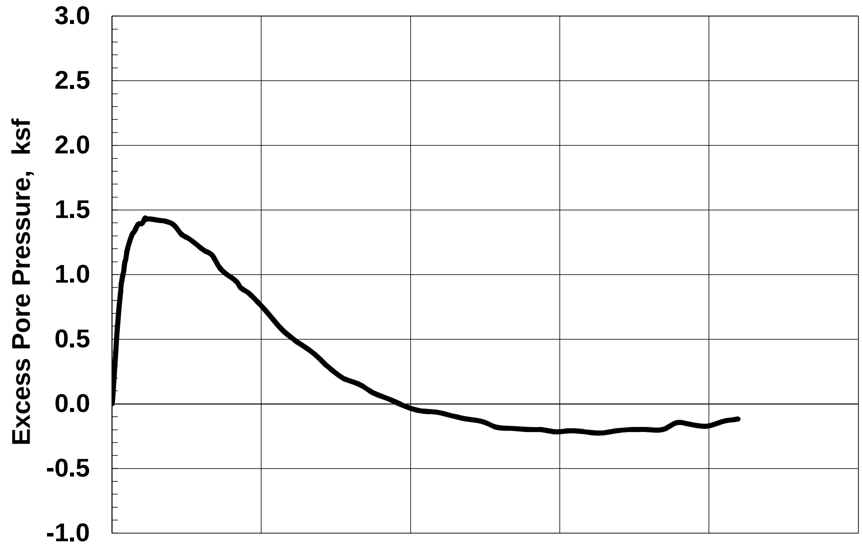
Consolidation Stresses: 6.00 ksf vertical, 6.00 ksf lateral
Water Content: 17.2 % Total Unit Weight: 137.3 pcf
B Coefficient: 96.31 Strain Rate: 0.021 %/min
Peak Shear Strength: 3.36 ksf @ 23.3 % Strain
Peak Effective Friction Angle: 30.1°

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: NEW-B012 Sample: ST-12C	November-15



SAMPLE INFORMATION

Boring: NEW-B014 Sample: ST-3C Depth: 36.65 ft

Type: Intact tube sample

Description: SC, brown clayey sand with gravel

LL = 38 PL = 13 PI = 25

SPECIMEN INFORMATION (Initial)

Height: 6.06 inch Diameter: 2.90 inch Area: 6.62 in²

Water Content: 16.3 % Total Unit Weight: 132.6 pcf

TEST SUMMARY

Consolidation Stresses: 3.00 ksf vertical, 3.00 ksf lateral

Water Content: 15.1 % Total Unit Weight: 134.8 pcf

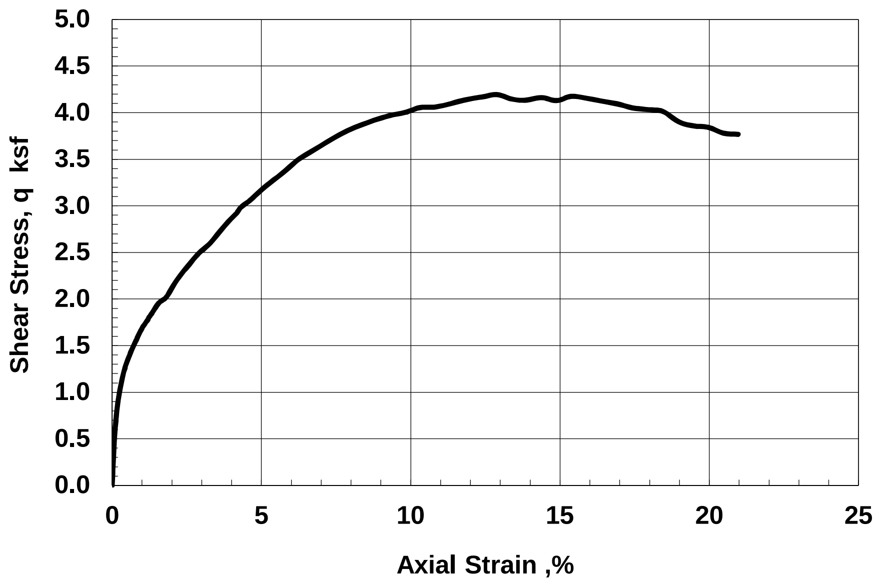
B Coefficient: Strain Rate: 0.021 %/min

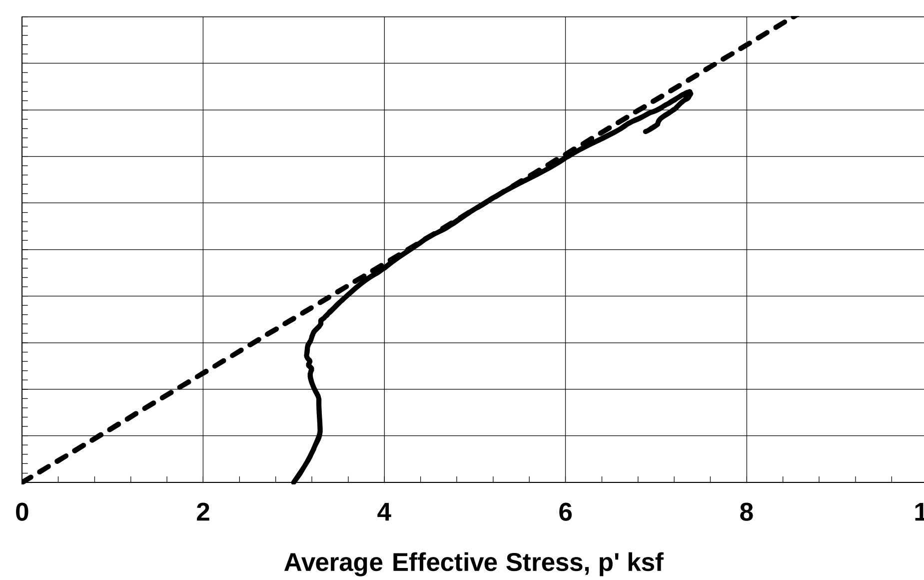
Peak Shear Strength: 4.19 ksf @ 12.9 % Strain

Peak Effective Friction Angle: 36.0°

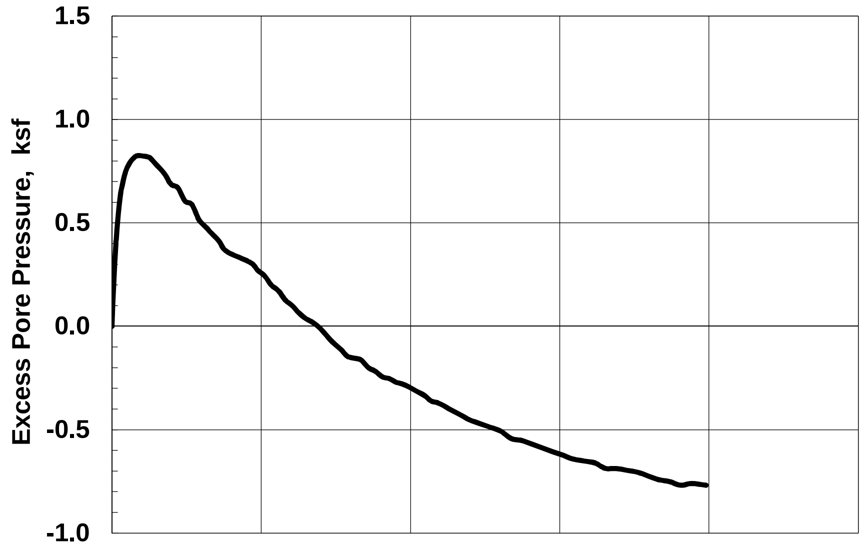
Failure Sketch

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements
Checked by: GET		TerraSense, LLC	Boring: NEW-B014 Sample: ST-3C
			November-15

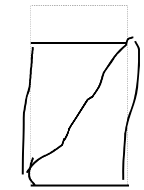


SAMPLE INFORMATION

Boring: NEW-B015 Sample: ST-1B Depth: 10.95 ft
Type: Intact tube sample
Description: CH, gray brown fat clay
LL = 59 PL = 15 PI = 44

SPECIMEN INFORMATION (Initial)

Height: 6.02 inch Diameter: 2.89 inch Area: 6.56 in²
Water Content: 23.0 % Total Unit Weight: 126.0 pcf

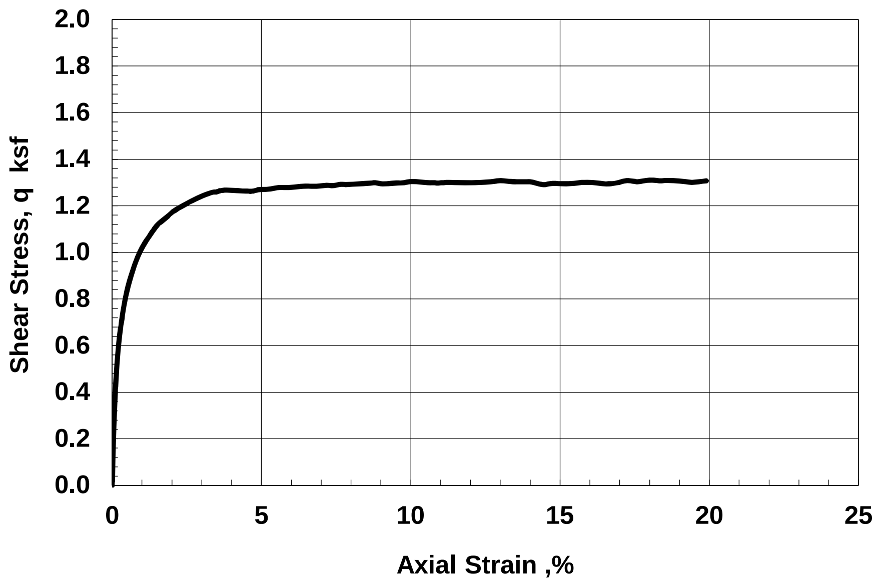


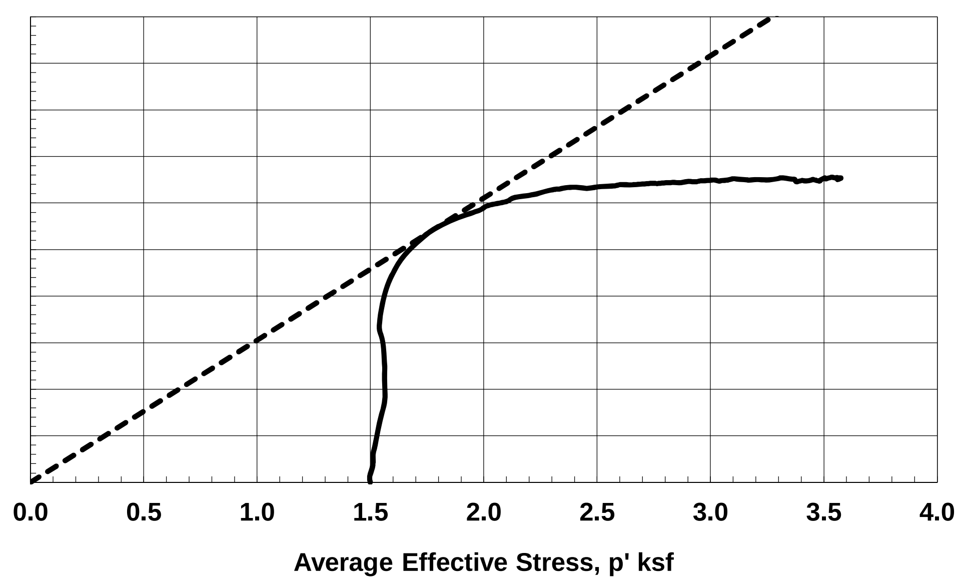
Failure Sketch

TEST SUMMARY

Consolidation Stresses: 1.50 ksf vertical, 1.50 ksf lateral
Water Content: 23.6 % Total Unit Weight: 128.1 pcf
B Coefficient: Strain Rate: 0.020 %/min
Peak Shear Strength: 1.31 ksf @ 18.0 % Strain
Peak Effective Friction Angle: 37.7°

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements
Checked by: GET	**TerraSense, LLC**		Boring: NEW-B015 Sample: ST-1B — November-15

SAMPLE INFORMATION

Boring: NEW-B015 Sample: ST-2 Depth: 26 ft

Type: Intact tube sample

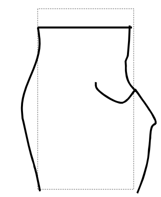
Description: CH, gray fat clay

LL = 52 PL = 15 PI = 37

SPECIMEN INFORMATION (Initial)

Height: 6.00 inch Diameter: 2.88 inch Area: 6.50 in²

Water Content: 19.5 % Total Unit Weight: 131.4 pcf



Failure Sketch

TEST SUMMARY

Consolidation Stresses: 5.00 ksf vertical, 5.00 ksf lateral

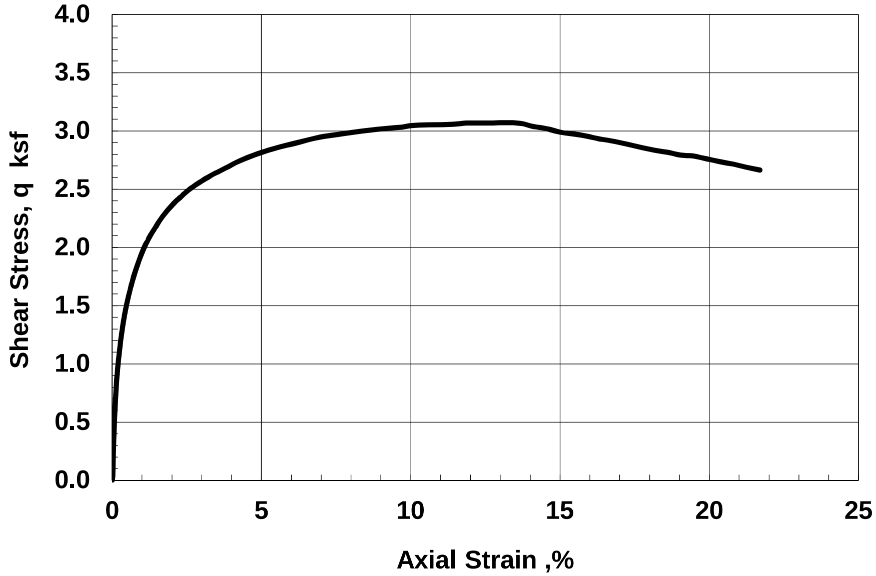
Water Content: 19.6 % Total Unit Weight: 132.8 pcf

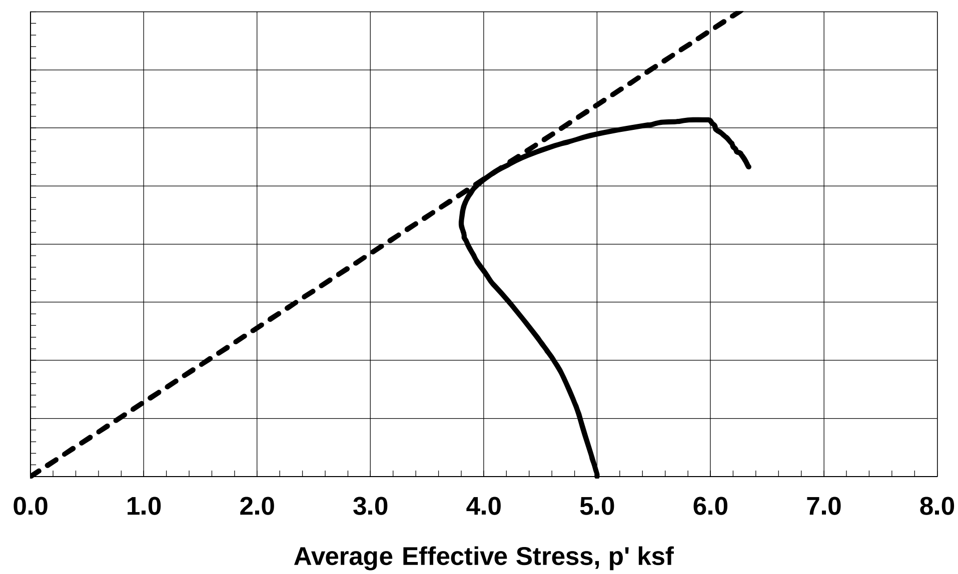
B Coefficient: 99.27 Strain Rate: 0.023 %/min

Peak Shear Strength: 3.07 ksf @ 13.2 % Strain

Peak Effective Friction Angle: 39.8°

REMARKS:





Test by: BB	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: NEW-B015 Sample: ST-2	November-15

SAMPLE INFORMATION

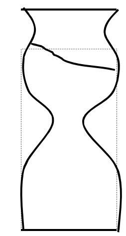
Boring: NEW-B014 Sample: ST-2 Depth: 15.85 ft
Type: Intact tube sample
Description: CL, gray clay, some f-c sand, trace gravel
LL = 31 PL = 14 PI = 17

SPECIMEN INFORMATION (Initial)

Height: 6.03 inch Diameter: 2.88 inch Area: 6.50 in²
Water Content: 12.2 % Total Unit Weight: 139.2 pcf

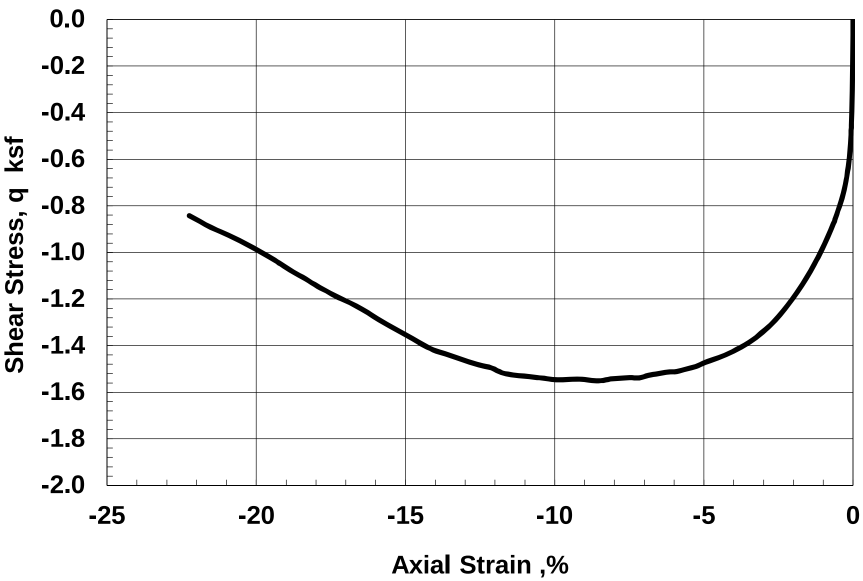
TEST SUMMARY

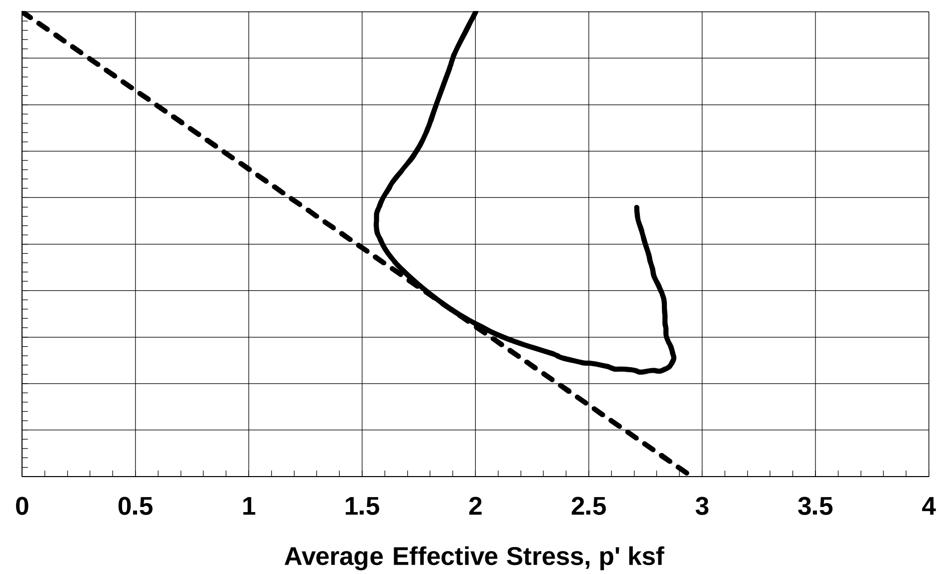
Consolidation Stresses: 2.00 ksf vertical, 2.00 ksf lateral
Water Content: 12.8 % Total Unit Weight: 142.5 pcf
B Coefficient: 98 Strain Rate: -0.020 %/min
Peak Shear Strength: -1.55 ksf @ -8.4 % Strain
Peak Effective Friction Angle: 42.6°



Failure Sketch

REMARKS:





Test by: GT	Project No. T60428794	AECOM Dynegy CCR - Newton	CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: NEW-B014 Sample: ST-2	November-15

Attachment E: Slope Stability Analysis Calcluations

SUMMARY

The slope stability analyses were performed for 10 cross-sections (A through K) around the Primary Ash Pond embankment at the Newton Power Station. Cross-section J was not analyzed as it pertains to the Newton Secondary Pond not covered by the CCR regulation. The slope stability analyses performed included: steady-state static and pseudostatic cases under normal pool elevation, steady-state static case under flood pool elevation and rapid drawdown of Newton Lake (where applicable). A site plan showing the locations of the slope stability cross-sections is presented in Figure 1.

OBJECTIVE

This calculation package presents the details of the limit equilibrium slope stability analyses for the Primary Ash Pond at the Newton Power Station in Newton, Illinois owned and operated by Illinois Power Generating Company (IPGC). The purpose of the slope stability analyses is to calculate the factors of safety against failure of the embankment slopes under the following loading scenarios:

1. Steady-state (static) case for
    i. normal pool conditions
    ii. flood pool conditions
2. Pseudostatic case
3. Rapid Drawdown case (where applicable)

The calculated factors of safety are used to assess the risk of embankment slope failure and to meet the minimum values required by the USEPA CCR Rule. The minimum factors of safety are summarized in Table 1 below.

Table 1 – Programmatic Minimum Factors of Safety for Stability

Embankment Loading Condition	Minimum Factor of Safety
Steady-State (Static)	1.50
Flood Pool	1.40
Pseudostatic	1.00
Rapid Drawdown	1.30

Post-earthquake (i.e. "liquefaction") slope stability analyses were not performed. The field exploration program primarily identified cohesive soils at the site, and did not identify zones of saturated, cohesionless material within the embankment or foundation that are likely to be susceptible to liquefaction. Because the embankment and foundation soils at the site are generally stiff clays, they were assumed to not be susceptible to cyclic softening based on inspection. Therefore, seismically-induced strength losses in the embankment or foundation soils are not expected during or after the design seismic event.

Therefore, per the CCR Rule, post-earthquake analyses are not required. However, in the seismic (pseudostatic) analyses, the CCR material retained by the embankment was assigned a strength value corresponding to a residual post-liquefaction condition. Although this material is not part of the dike or foundation, the potential for liquefaction in the CCR is considered in the pseudostatic analysis.

DATA AVAILABLE

- Laboratory testing performed as part of the 2015 AECOM geotechnical investigation
- Laboratory testing performed as part of the 2011 Geotechnology Stability Evaluation (Geotechnology 2011) provided by IPGC
- AutoCAD Civil 3D topography and bathymetry produced in 2015 as part of this project, provided by IPGC. 2015 survey data from IPGC and 2012 survey data from the State of Illinois were used in the topography provided
- Groundwater and geology information in the 2009 Rapps report (Rapps 2009) provided by IPGC
- Report (AMEC 2012)
- Report (Kleinfelder 2011)

MATERIAL PROPERTIES

The unit weights and strengths assigned to the materials in the stability analyses were based on laboratory testing performed on samples recovered during the 2015 AECOM investigation. Samples from relatively undisturbed Shelby tubes were subjected to isotropically consolidated undrained (CIU), unconsolidated undrained (UU), direct shear (DS), and direct simple shear (DSS) tests. The tests included a range of confining pressures on samples from across the site to simulate conditions at the site.

Table 2 presents the material strength parameters used in the stability analyses.

Undrained Strengths

To assign undrained strengths to the embankment fill and upper clay foundation soils, the shear stress at peak obliquity (for CIU tests) and the undrained shear strength (for UU tests) were plotted against the effective consolidation pressure (for CIU tests) and the effective cell pressure (for UU tests) to develop a strength envelope. More weight was given to the CIU data and a trendline was plotted through the CIU data points to form the basis for the c_u/σ'_c (c/p) slope, where c_u is the shear stress on the failure plane at failure (τ_{ff}). The c_u/σ'_c trendline was modelled in SLOPE/W for the pseudostatic cases using a strength function.

Embankment Fill

For the pseudostatic analysis, the value of c_u/σ'_c is equal to 1.388 between an effective stress of 0 kips per square foot (ksf) to 0.5 ksf. The value of c_u/σ'_c is equal to 0.410 beyond an effective stress of 0.5 ksf. A plot of the undrained shear strength parameters is presented in Figure 2.

Upper Clay Foundation

For the pseudostatic analysis, the value of c_u/σ'_c is equal to 0.633 between an effective stress of 0 kips per square foot (ksf) to 2 ksf. The value of c_u/σ'_c is equal to 0.400 beyond an effective stress of 2 ksf. A plot of the undrained shear strength parameters is presented in Figure 4.

To assign undrained shear strength to the lower clay foundation soil, a correlation between the mobilized undrained shear strength of clay and N_{60} presented in *Soil Mechanics in Engineering Practice* (Terzaghi, Peck, and Mesri 1996) was used:

$$s_u(mob) = xN_{60}\ (kPa)$$

Where: *$s_u(mob)$ = the mobilized undrained shear strength of the clay in kilopascals (kPa)*

x = a ratio related to the plasticity index of the clay = 6.7 for clays with a plasticity index of 15

N_{60} = the dynamic standard penetration test blow count corresponding to a combined efficiency of 60 percent = N_{field}(Energy Ratio/60), where the energy ratios for the hammers used at the site are approximately 68 and 83 percent.*

$$s_u(mob) = x\left[N_{field}\left(\frac{Energy\ Ratio}{60}\right)\right]$$

$$s_u(mob) = 6.7\left[50\left(\frac{68\%}{60}\right)\right]$$

$$s_u(mob) = 379\ kPa = 7{,}930\ psf$$

The undrained shear strength of 7,930 psf was then reduced to 5,000 psf to account for potential variations in material. The lower clay is a variable glacial till that is very stiff and has significant quantities of sand. Slip surfaces are unlikely to pass through the lower clay.

The undrained strength of the ash was assigned as $c_u/\sigma'_c = 0.050$ based on AECOM's experience with saturated CCR at other project sites. This corresponds to a residual post-liquefaction shear strength of the ash.

Drained Strength

To assign drained strengths, the q_f and p'_f values at peak obliquity from CIU tests were selected and transformed to obtain the normal stress and shear stress on the failure plane using:

$$\sigma'_{ff} = p'_f - q_f \sin\phi' \quad \text{and} \quad \tau_{ff} = q_f \cos\phi'$$

Where: σ'_{ff} = *the normal stress on the failure plane at failure*

τ_{ff} = *the shear stress on the failure plane at failure*

p'_f = *the mean effective stress at failure*

q_f = *the maximum shear stress at failure*

ϕ' = *the effective friction angle of the material*

To develop drained strengths for the embankment fill and upper clay foundation soils, the shear stress at peak obliquity (for CIU tests) and the shear stress at 10 percent strain (for DS tests) were plotted against the effective normal stress at failure (for CIU tests) and the effective vertical stress (for DS tests) to develop a strength envelope. A trendline was plotted to form the basis for the relationship used for drained strength versus effective normal stress. The drained cohesion intercept was fixed at a value of 0 psf and a trendline was drawn to approximate the lower boundary of the majority of CIU and DS tests resulting in effective friction angles of approximately 31 and 29 degrees for the embankment fill and upper clay foundation, respectively. Note that DS tests representing higher-than-anticipated effective vertical stress conditions are not presented on the plot. Figure 3 and Figure 5 show the drained strength envelopes for the embankment fill and upper clay foundation materials, respectively.

To assign drained strength to the lower clay foundation soil, a correlation for normally consolidated clays between the plasticity index (PI) and drained friction angle (ϕ_{CD}) was used (Kulhawy and Mayne, 1990):

$$\sin(\phi_{CD})=0.8-0.094*\ln(PI)$$

The lower clay is a glacial deposit and exhibits over consolidated behaviour, so this approach is conservative. A PI of 15 results in a friction angle of 33 degrees. Because the lower clay is a composite material (consisting of both sand and clay) a cohesion (c) of 3,700 psf was also assigned to consider the stiff and glacial nature of the layer, thereby accounting for the highly overconsolidated nature of the material.

The drained strength of the ash was assigned as ϕ' = 30 degrees based on AECOM's experience with CCR at other project sites.

Drawdown Strength

Drained-undrained (R-envelope) soil strengths were taken from the design C_u/σ'_c ratio ratios presented above. R-envelope strengths are used to estimate the available undrained shear strength during sudden drawdown as a function of the vertical effective consolidation stress on the failure plane, prior to undrained loading. As this is a different presentation of the same failure envelope used to develop the C_u/σ'_c characterization, the undrained failure envelope was converted to an R-envelope. This was performed by taking the tangent of the C_u/σ'_c ratio to determine ϕ_R. It should be noted that both C_u/σ'_c characterizations assumed a bi-linear strength envelope, with a steeper envelope at lower confining stresses. As SLOPE/W cannot account for nonlinear failure envelopes during sudden drawdown, the bi-linear failure envelope was not used, and the flatter portion of the linear failure envelope (higher confining stresses) was extrapolated to estimate the corresponding value of c_R.

It should be noted that drawdown strengths were not assigned to the lower clay (glacial till) and ash. The glacial till is a high-strength material, and critical slip surfaces are expected to pass through the lower-strength overlying upper clay and embankment fill. Therefore, the assignment of drawdown strengths to the glacial till is not critical for performing the sudden drawdown stability analysis. For the ash, it is separated from the downstream pool (Newton Lake or the Secondary Pond) by the clay embankment dike, and is therefore not affected by drawdown of the downstream water body. Therefore, stress changes induced by downstream pool drawdown are not expected to occur in the ash, and the material is likely to behave in a drained manner during drawdown of the downstream water body.

Unit Weight

Based on the 2015 laboratory test data, the embankment and foundation soils were all assigned a total unit weight equal to 130 pounds per cubic foot (pcf). This unit weight generally corresponded to the typical undisturbed unit weight measured in the laboratory samples. It was assumed to be applicable to both the embankment and foundation materials because the embankment was constructed using soils excavated at the site. Impounded ash was assigned a total unit weight of 90 pcf based on AECOM's experience with saturated CCR at other project sites.

Table 2 – AECOM (2015) Material Strength Parameters

Material	Density (pcf)	Drained Strength		Undrained Strength		Drawdown Strength	
		Effective Friction Angle f′ (°)	Effective Cohesion c′ (psf)	c_u/s'_c (psf)	Minimum Strength (psf)	f_R (°)	c_R (psf)
Embankment Fill	130	31	0	1.388 ($0< \sigma'_c<0.5$ ksf) 0.410 ($\sigma'_c > 0.5$ ksf)	-	22	500
Upper Clay	130	29	0	0.633 ($0 < \sigma'_c < 2$ ksf) 0.400 ($\sigma'_c > 2$ ksf)	-	22	470
Lower Clay	130	33	3,700	-	5,000	-	-
Ash	90	30	0	0.050	-	-	-

EMBANKMENT GEOMETRY

The embankment surface geometry used in the slope stability models was derived from cross-sections cut using the 2015 AutoCAD Civil 3D surface. The subsurface profile was interpreted using the CPT tip resistance data and boring logs from the 2015 AECOM geotechnical investigation, original ground surface information from the Sargent and Lundy design drawings provided by IPGC (Sargent and Lundy 1974), and engineering judgment. Table 3 summarizes the embankment geometry and associated portions of the 2015 AECOM and 2011 Geotechnology geotechnical investigation. Unless otherwise noted, all elevations in this report are listed in the NAVD 88 datum.

Table 3 – Embankment Geometry and Associated Investigations

Cross-Section	Crest Elevation (ft)	Crest Width (ft)	Crest Height (ft)	Upstream Slope	Downstream Slope	Associated Investigations		
						CPT	Boring[1]	Piezometer
A	554	46.1	38	3.0H:1V	3.2H:1V	NEW-SC001	B-2, B-3, B-4	-
B	554	43.1	42	3.4H:1V	3.1H:1V	NEW-SC018	NEW-B012 NEW-B014	NEW-P012 NEW-P014
C	554	47.1	38.2	2.5H:1V	2.8H:1V	NEW-C017 NEW-SC019	NEW-B010	NEW-P010 (32′) NEW-P010 (50′)
D	554	48.3	38	2.6H:1V	3.1H:1V	NEW-C015	NEW-B009	NEW-P009
E	554	25.8	14	3.1H:1V	3.1H:1V	NEW-C013	NEW-B008	NEW-P008
F	554	30.3	16	3.1H:1V	3.1H:1V	-	NEW-B007	NEW-P007
G	552	36	16	2.9H:1V	2.6H:1V	NEW-C007	NEW-B006	NEW-P006
H	552	30.6	24	2.9H:1V	3.4H:1V	NEW-C005	NEW-B004 NEW-B004A NEW-B005	NEW-P004 NEW-P005
I	554	11.7	34	3.7H:1V	2.9H:1V	NEW-C002	NEW-B001	NEW-P001
K	554	48	38	3.3H:1V	3.4H:1V	-	NEW-B015 NEW-B016	NEW-P015 NEW-P016

1. Borings B-2, B-3, and B-4 are from Geotechnology (2011). Borings labelled as NEW-BXXX are from AECOM (2015).

PHREATIC SURFACE

Based on the topographic survey provided by Weaver Consultants Group (2015), the water level in the Primary Ash Pond was approximated at El. 534 feet (normal pool level) and the water level in the Secondary Pond was approximated at El. 551 feet (normal pool level). At the time of the 2015 AECOM geotechnical investigation, the water level in Newton Lake was approximated at El. 506 feet. According to the Hydrologic and Hydraulic Summary Report for Newton Power Station, during a 1,000-yr storm event, the Primary Ash Pond pool elevation is anticipated to rise by approximately 1 foot to El. 534.91 feet (flood pool elevation). It was assumed that the flood pool elevation of the Secondary Pond would also rise by 1 foot (El. 552 feet). The phreatic surface within the embankment in each model was extrapolated using data from the piezometers and CPT soundings performed during the 2015 AECOM investigation.

SLOPE STABILITY ANALYSES

All analyses were performed within SLOPE/W Version 8.15, which is part of the GeoStudio 2012 software package. The following settings were used in the analysis:

- Analysis Method: Spencer
- Optimization: Critical slip surfaces were optimized
- Pore Pressures: From piezometric line
- Tension Cracks: Water-filled tension cracks were included in the analyses, if necessary to remove interslice tensile forces
- Minimum Slip Surface Depth: 5 ft
- Slip Surface Definition: Slip surfaces were defined using the entry-exit method for global slip surfaces

Static Analyses

Long term and surcharge static slope stability analyses were performed to assess the factor of safety against slope instability for the downstream slopes of the Primary Ash Pond under steady-state normal pool and flood pool conditions, respectively. Drained material properties were used for these analyses.

Pseudostatic Analyses

Pseudostatic analyses were performed to assess the factor of safety against slope instability for the downstream slopes of the Primary Ash Pond under seismic loading conditions. Pseudostatic analyses were selected based on the assumption the soils composing the embankment and foundation are not likely to cyclically soften or liquefy following the design seismic event. Undrained material properties were used for these analyses

As part of the 2015 AECOM investigation, a site-specific seismic hazard analysis was conducted for the Newton Plant. The peak ground acceleration based on a 2,475-year return period uniform hazard spectra on soil was estimated to be 0.182g. The peak transverse crest acceleration was then estimated by amplifying the peak ground acceleration comparable with documented cases from historical earthquakes and presented in the *Variations of Recorded Peak Crest Accelerations versus those Recorded at the Base of Earth and Rock Fill Dams* (Idriss 2015). Based on the Idriss 2015 chart for previous earthquakes, the peak transverse crest acceleration is approximately 0.450g. Makdisi and Seed (1977) suggested that the maximum acceleration ratio (0.450g) can be reduced if the failure surface is deep enough compared to the height of the embankment. Based on the results of the pseudostatic stability analyses, the failure surfaces extend from the crest to the native soil and can be reduced by approximately 66% from 0.450g to 0.153g. Therefore, the design seismic coefficient k_h, equals 0.153g.

Rapid Drawdown Analyses

The analyses were performed using the staged Duncan et al (1990) approach within SLOPE/W. This approach uses combined drained and undrained soil properties to evaluate soil shear strength during drawdown.

Only drawdown analysis of the downstream slope during drawdown from Newton Lake from normal pool to an empty pool condition was considered. It was assumed that if a high pool event (i.e. flood pool) in Newton Lake were to occur, that drawdown to normal pool would occur in a relatively short amount of time, meaning that the slopes of the Newton Ash Pond would not have time to become saturated above their normal level, and that sudden drawdown conditions from flood to normal pool would not exist. This is also the intent of the CCR Rule; as it expressly states …*maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body*. Drawdown of a downstream water body from flood pool to normal pool is not mentioned.

Additionally, drawdown of the upstream slope was not analyzed, as this analysis case is not mentioned in the CCR Rule.

RESULTS AND CONCLUSIONS

Table 4 presents the results of the slope stability analyses. The calculated factors of safety are above the required factors of safety for all of the scenarios investigated.

Table 4 – Slope Stability Results

Cross-Section	Analysis Case	Factor of Safety	
		Required	Calculated
A	Long Term (Drained)	1.50	1.82
	Surcharge (Drained)	1.40	1.82
	Pseudostatic (Undrained)	1.00	1.26
B	Long Term (Drained)	1.50	1.81
	Surcharge (Drained)	1.40	1.81
	Pseudostatic (Undrained)	1.00	1.07
	Rapid Drawdown	1.30	1.6
C	Long Term (Drained)	1.50	1.67
	Surcharge (Drained)	1.40	1.67
	Pseudostatic (Undrained)	1.00	1.11
	Rapid Drawdown	1.30	1.7
D	Long Term (Drained)	1.50	1.76
	Surcharge (Drained)	1.40	1.76
	Pseudostatic (Undrained)	1.00	1.23
	Rapid Drawdown	1.30	1.8
E	Long Term (Drained)	1.50	2.18
	Surcharge (Drained)	1.40	2.18
	Pseudostatic (Undrained)	1.00	1.91
F	Long Term (Drained)	1.50	1.99
	Surcharge (Drained)	1.40	1.95
	Pseudostatic (Undrained)	1.00	1.50
G	Long Term (Drained)	1.50	2.05
	Surcharge (Drained)	1.40	2.04
	Pseudostatic (Undrained)	1.00	1.59
H	Long Term (Drained)	1.50	1.81
	Surcharge (Drained)	1.40	1.81
	Pseudostatic (Undrained)	1.00	1.36
I	Long Term (Drained)	1.50	1.66
	Surcharge (Drained)	1.40	1.66
	Pseudostatic (Undrained)	1.00	1.42
	Rapid Drawdown	1.30	1.6
K	Long Term (Drained)	1.50	1.92
	Surcharge (Drained)	1.40	1.91
	Pseudostatic (Undrained)	1.00	1.28
	Rapid Drawdown	1.30	1.9

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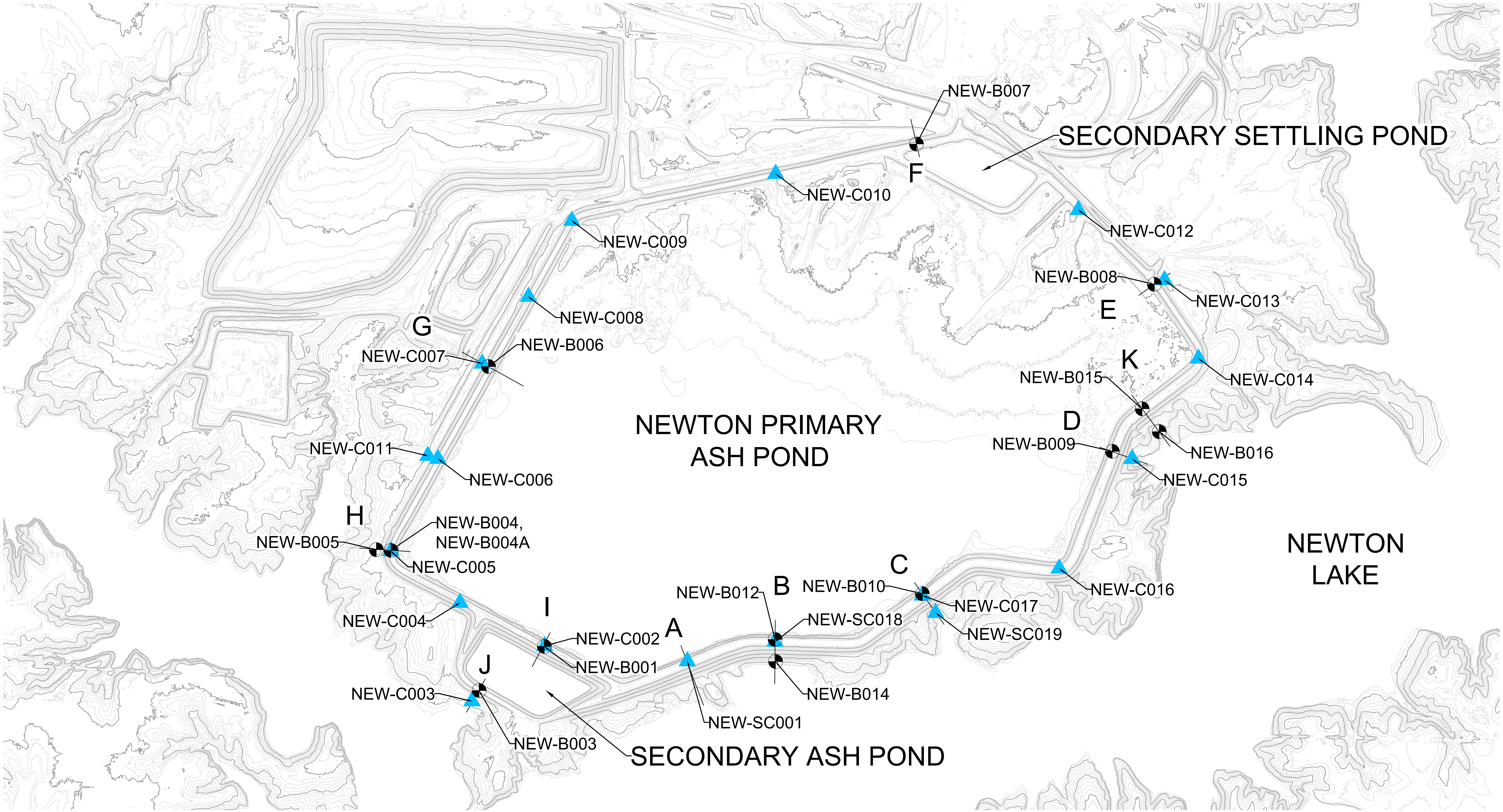
FIGURES

ATTACHMENTS

FIGURES



LEGEND

2015 Boring (NEW-B001 to NEW-B016)

2015 CPT (NEW-SC001, NEW-C002 to NEW-C017, NEW-SC018, and NEW-SC019)

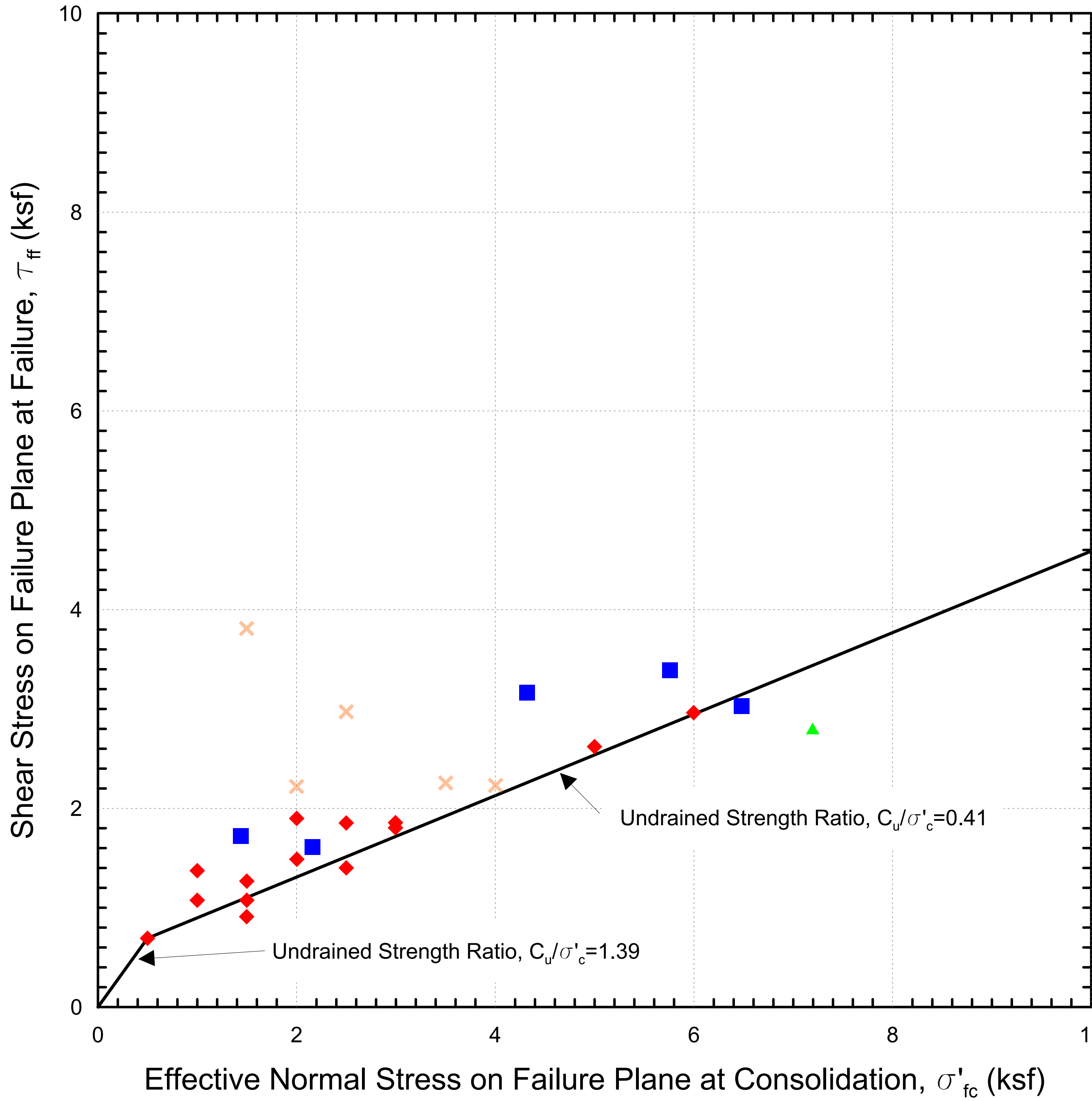
N

0 375 750 1500 2250

SCALE IN FEET
1"=750'

NOTE: Section J at the Secondary Pond was not analyzed as the Secondary Pond is not a CCR Unit.

PROJECT NO. 60440378	DYNEGY NEWTON POWER STATION	FIELD INVESTIGATION AND CROSS–SECTION LOCATIONS	FIGURE 1
AECOM	JASPER COUNTY, ILLINOIS		



Notes:

1. Failure defined at peak obliquity (i.e., maximum principle stress ratio) for undisturbed isotropically consolidated undrained compression tests (CIU)

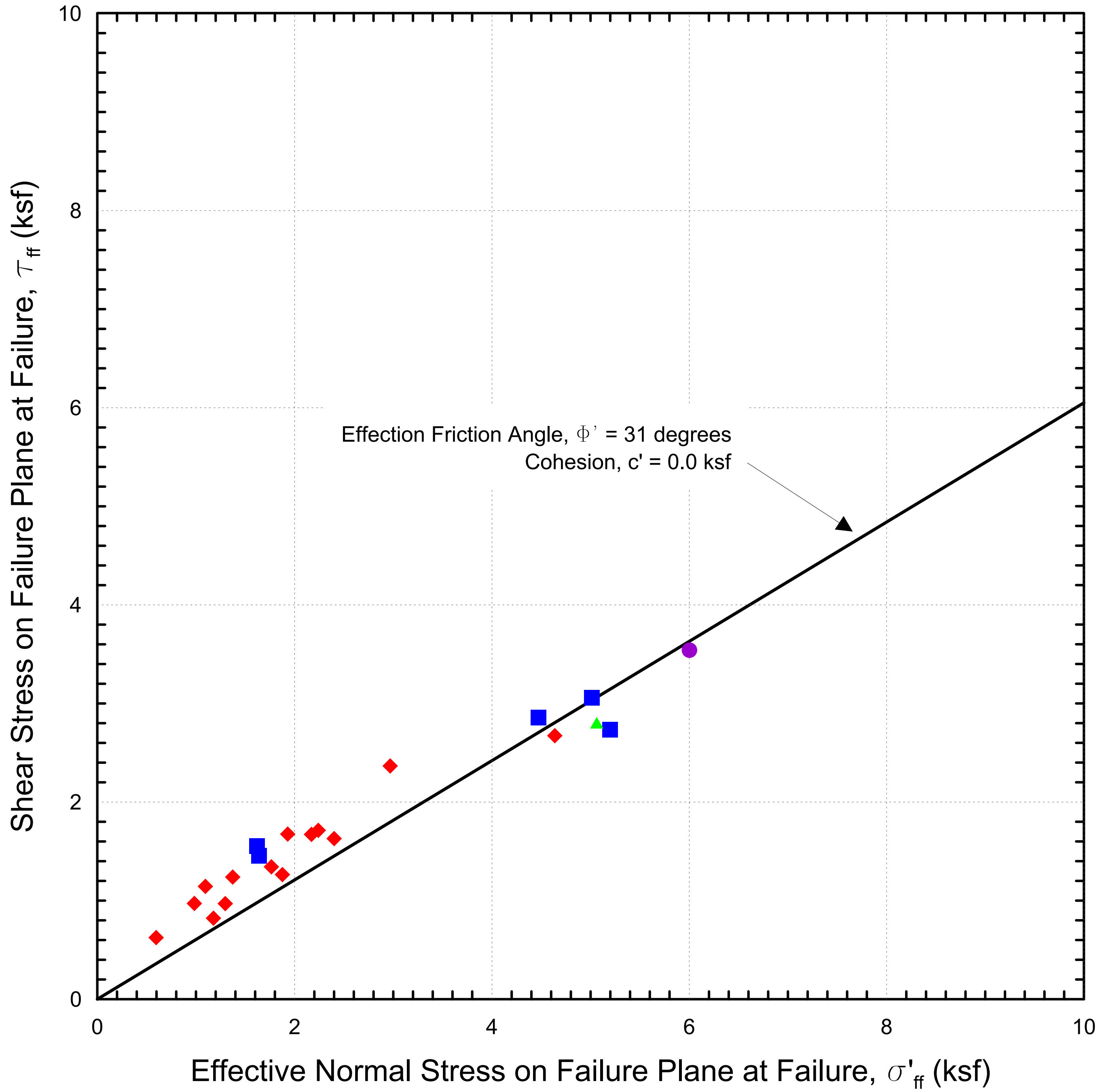
2. Failure defined at maximum shear stress (<10% shear strain) for undisturbed consolidated undrained direct simple shear tests (DSS)

3. Failure defined at 10% axial strain for undisturbed unconsolidated undrained compression tests (UU)

4. Unconsolidated undrained compression tests (UU) are plotted only for reference and are plotted against total confining pressure rather than consolidation pressure.

PROJECT NO. 60440378	DYNEGY NEWTON POWER STATION	PRIMARY ASH POND UNDRAINED SHEAR STRENGTH EMBANKMENT CLAY	FIGURE 2
AECOM	NEWTON, ILLINOIS		

Q:\Projects\DOE\0 Projects\Dynegy\Newton\05_Analysis and Engineering\Stability Analysis\Figure 4 - Embankment Clay Drained Strength.grf 02/11/2016 8:43 AM



Notes:

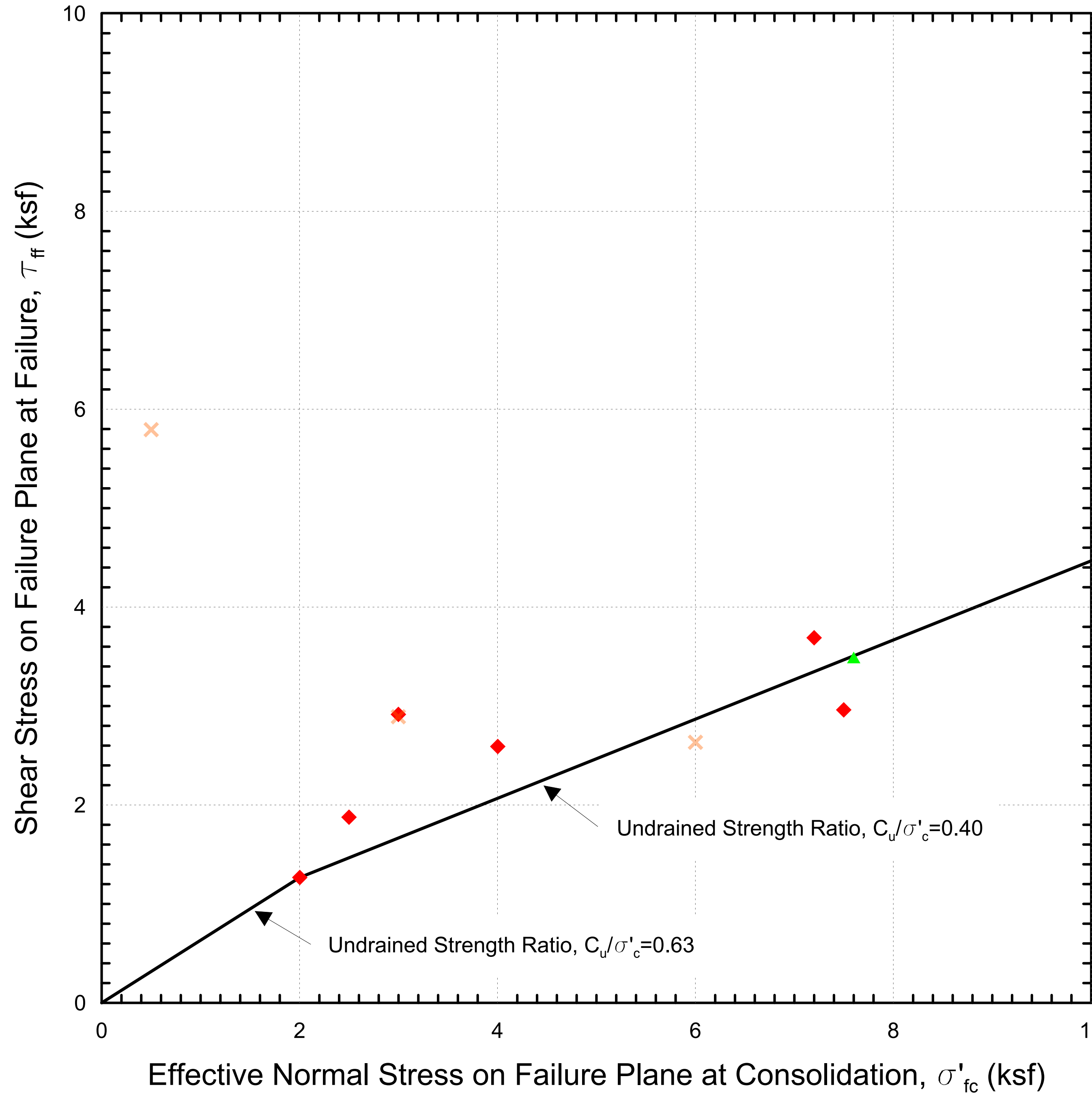
1. Failure defined at peak obliquity (i.e., maximum principle stress ratio) for undisturbed isotropically consolidated undrained compression tests (CIU)

2. Failure defined at maximum shear stress (<10% shear strain) for undisturbed consolidated undrained direct simple shear tests (DSS)

3. Failure defined at 10% shear strain for undisturbed consolidated drained direct shear tests (DS)

- 2011 Geotechnology (CIU)
- 2015 AECOM (CIU)
- 2015 AECOM (DSS)
- 2015 AECOM (DS)
- 2015 AECOM (UU)

PROJECT NO. 60440378	DYNEGY NEWTON POWER STATION	PRIMARY ASH POND DRAINED SHEAR STRENGTH EMBANKMENT CLAY	FIGURE 3
AECOM	NEWTON, ILLINOIS		



Notes:

1. Failure defined at peak obliquity (i.e., maximum principle stress ratio) for undisturbed isotropically consolidated undrained compression tests (CIU)

2. Failure defined at maximum shear stress (<10% shear strain) for undisturbed consolidated undrained direct simple shear tests (DSS)

3. Failure defined at 10% axial strain for undisturbed unconsolidated undrained compression tests (UU)

4. Unconsolidated undrained compression tests (UU) are plotted only for reference and are plotted against total confining pressure rather than consolidation pressure.

- 2011 Geotechnology (CIU)
- 2015 AECOM (CIU)
- 2015 AECOM (DSS)
- 2015 AECOM (DS)
- 2015 AECOM (UU)

PROJECT NO. 60440378	DYNEGY NEWTON POWER STATION	PRIMARY ASH POND UNDRAINED SHEAR STRENGTH UPPER FOUNDATION CLAY	FIGURE 4
AECOM	NEWTON, ILLINOIS		

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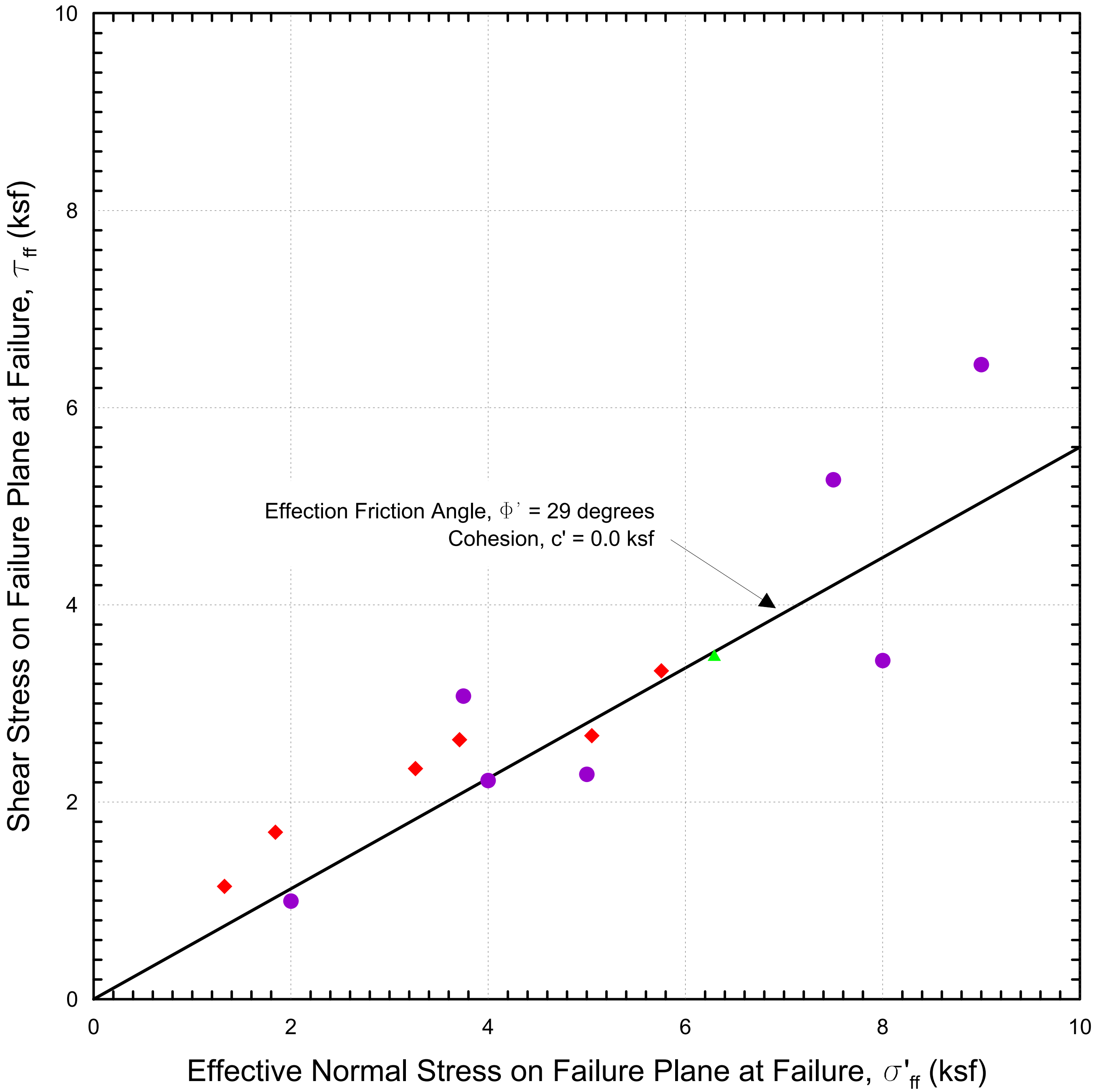

Notes:

1. Failure defined at peak obliquity (i.e., maximum principle stress ratio) for undisturbed isotropically consolidated undrained compression tests (CIU)

2. Failure defined at maximum shear stress (<10% shear strain) for undisturbed consolidated undrained direct simple shear tests (DSS)

3. Failure defined at 10% shear strain for undisturbed consolidated drained direct shear tests (DS)

- 2011 Geotechnology (CIU)
- 2015 AECOM (CIU)
- 2015 AECOM (DSS)
- 2015 AECOM (DS)
- 2015 AECOM (UU)

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PROJECT NO. 60440378	DYNEGY NEWTON POWER STATION	PRIMARY ASH POND DRAINED SHEAR STRENGTH UPPER FOUNDATION CLAY	FIGURE 5
AECOM	NEWTON, ILLINOIS		

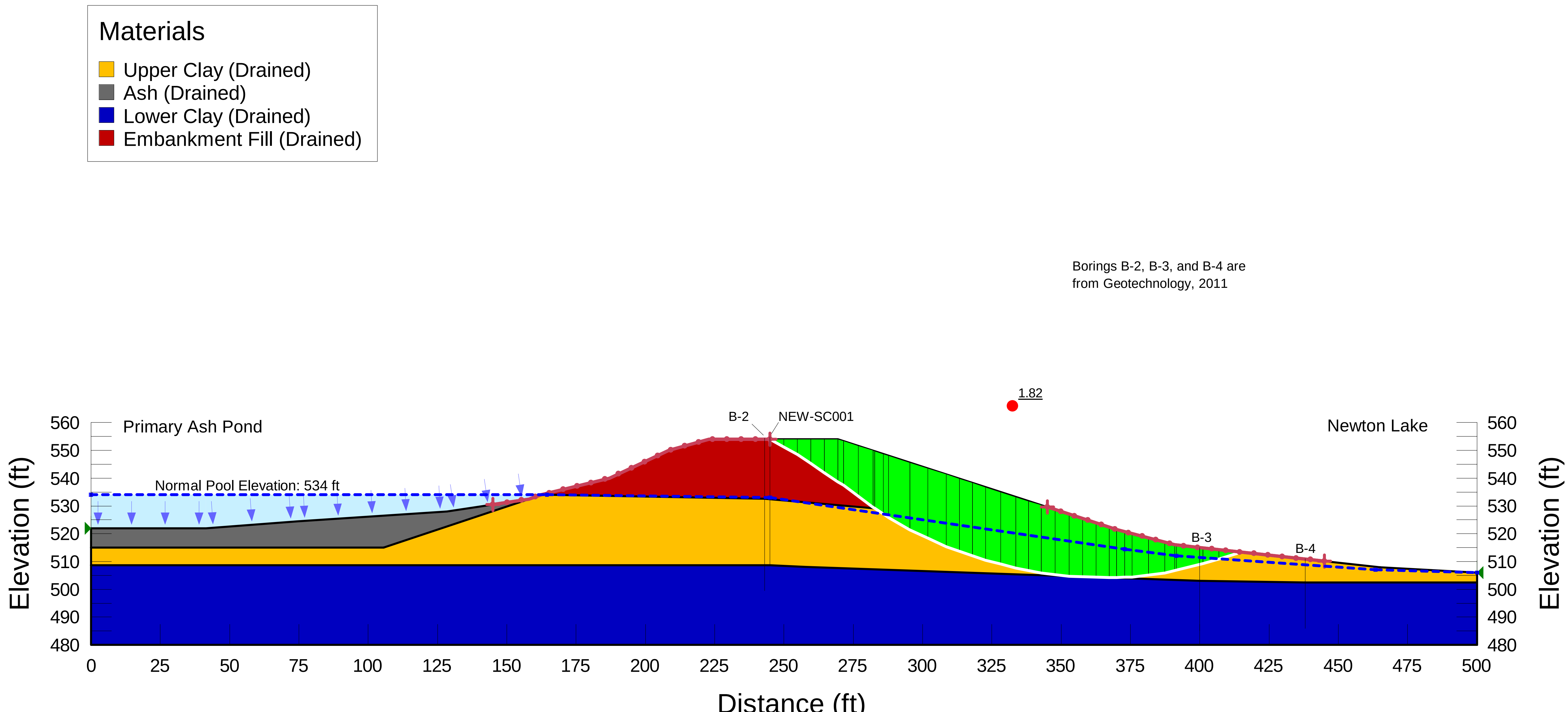
ATTACHMENTS

Project Name: Newton Primary Ash Pond Stability Analysis-Section A
Project Number: 60501553.02

Calculated By: MJN Date: 6/17/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Long Term (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Ash (Drained) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 30 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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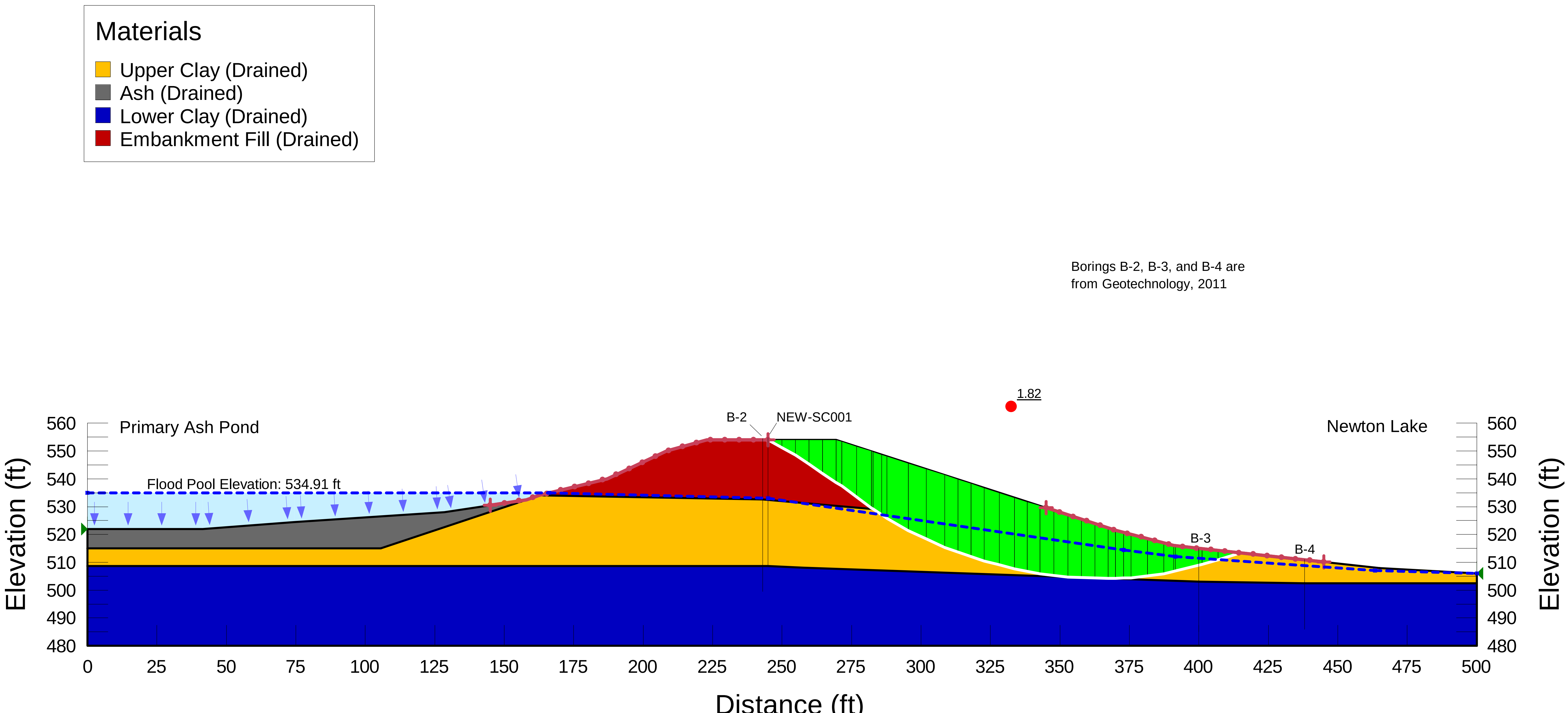
Project Name: Newton Primary Ash Pond Stability Analysis-Section A
Project Number: 60501553.02

Calculated By: MJN Date: 6/17/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Surcharge (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Ash (Drained) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 30 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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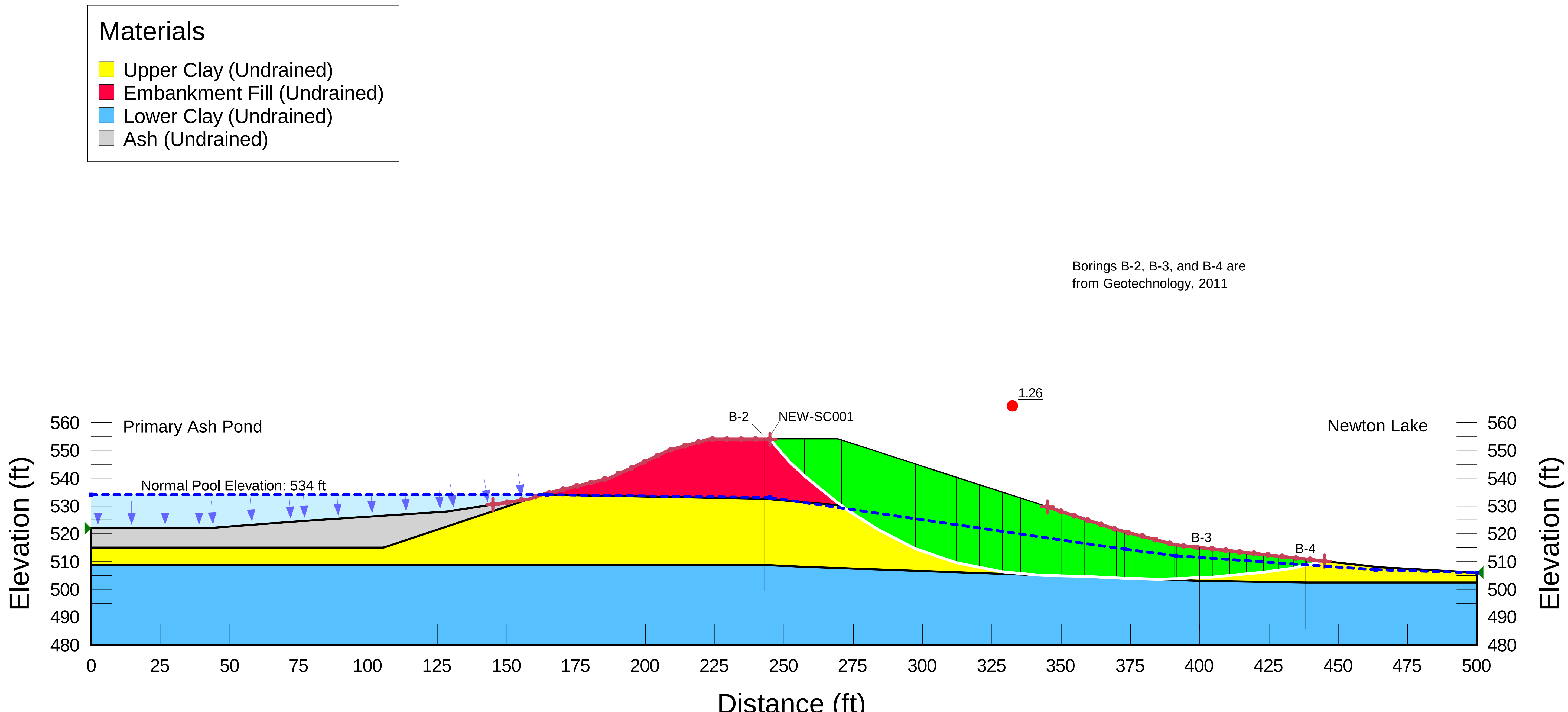
Project Name: Newton Primary Ash Pond Stability Analysis-Section A
Project Number: 60501553.02

Calculated By: MJN Date: 6/17/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Pseudostatic (Undrained)
Horizontal Seismic Coefficient = 0.153g

Name: Upper Clay (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Upper Clay (Undrained)
Name: Embankment Fill (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Embankment Fill (Undrained)
Name: Lower Clay (Undrained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 5,000 psf Phi': 0 °
Name: Ash (Undrained) Model: S=f(overburden) Unit Weight: 90 pcf Tau/Sigma Ratio: 0.05 Minimum Strength: 0 psf



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Project Name: Newton Primary Ash Pond Stability Analysis-Section B
Project Number: 60501553.02

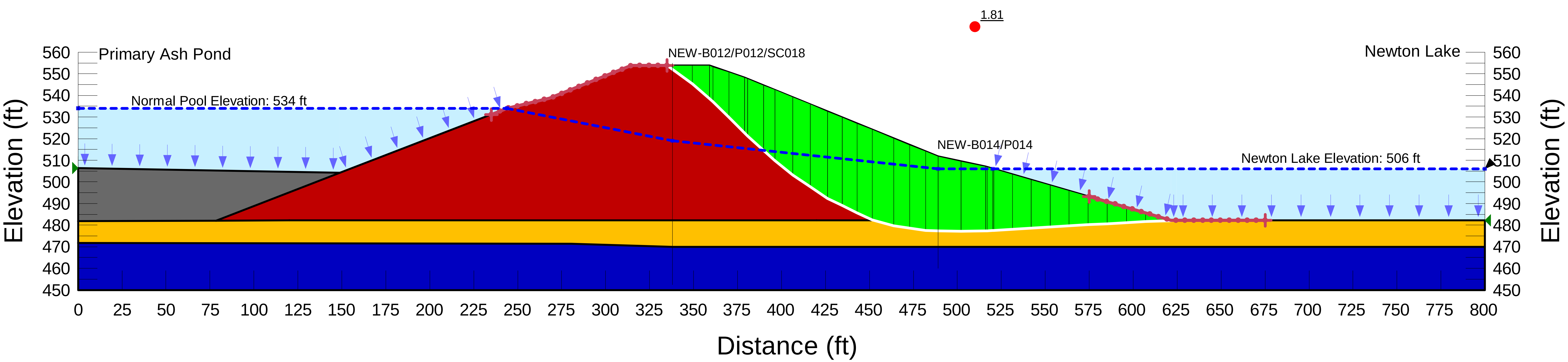
Calculated By: MJN Date: 6/20/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Long Term (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Ash (Drained) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 30 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °

Materials

- Upper Clay (Drained)
- Ash (Drained)
- Lower Clay (Drained)
- Embankment Fill (Drained)



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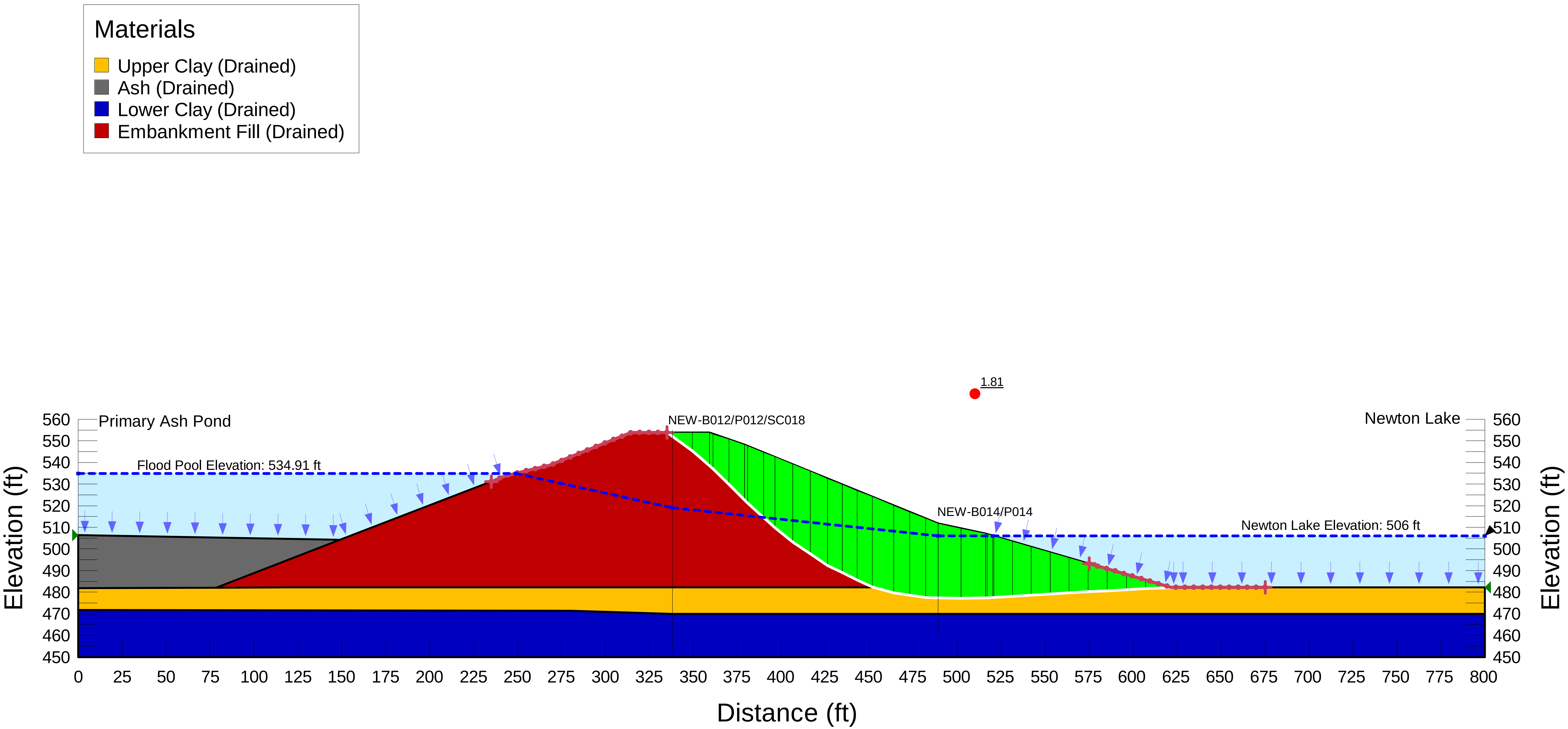
Project Name: Newton Primary Ash Pond Stability Analysis-Section B
Project Number: 60501553.02

Calculated By: MJN Date: 6/20/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Surcharge (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Ash (Drained) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 30 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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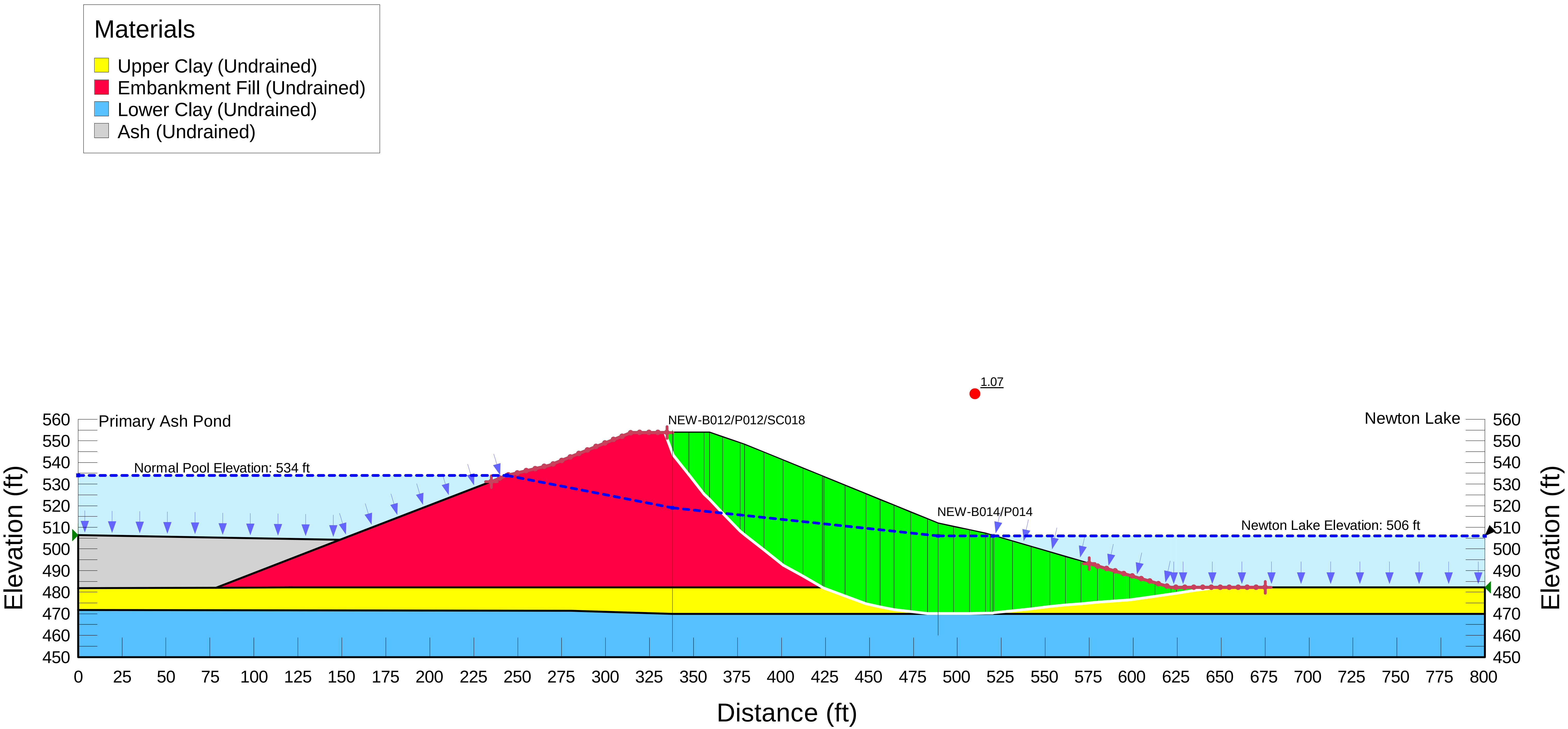
Project Name: Newton Primary Ash Pond Stability Analysis-Section B
Project Number: 60501553.02

Calculated By: MJN Date: 6/20/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Pseudostatic (Undrained)
Horizontal Seismic Coefficient = 0.153g

Name: Upper Clay (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Upper Clay (Undrained)
Name: Embankment Fill (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Embankment Fill (Undrained)
Name: Lower Clay (Undrained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 5,000 psf Phi': 0 °
Name: Ash (Undrained) Model: S=f(overburden) Unit Weight: 90 pcf Tau/Sigma Ratio: 0.05 Minimum Strength: 0 psf



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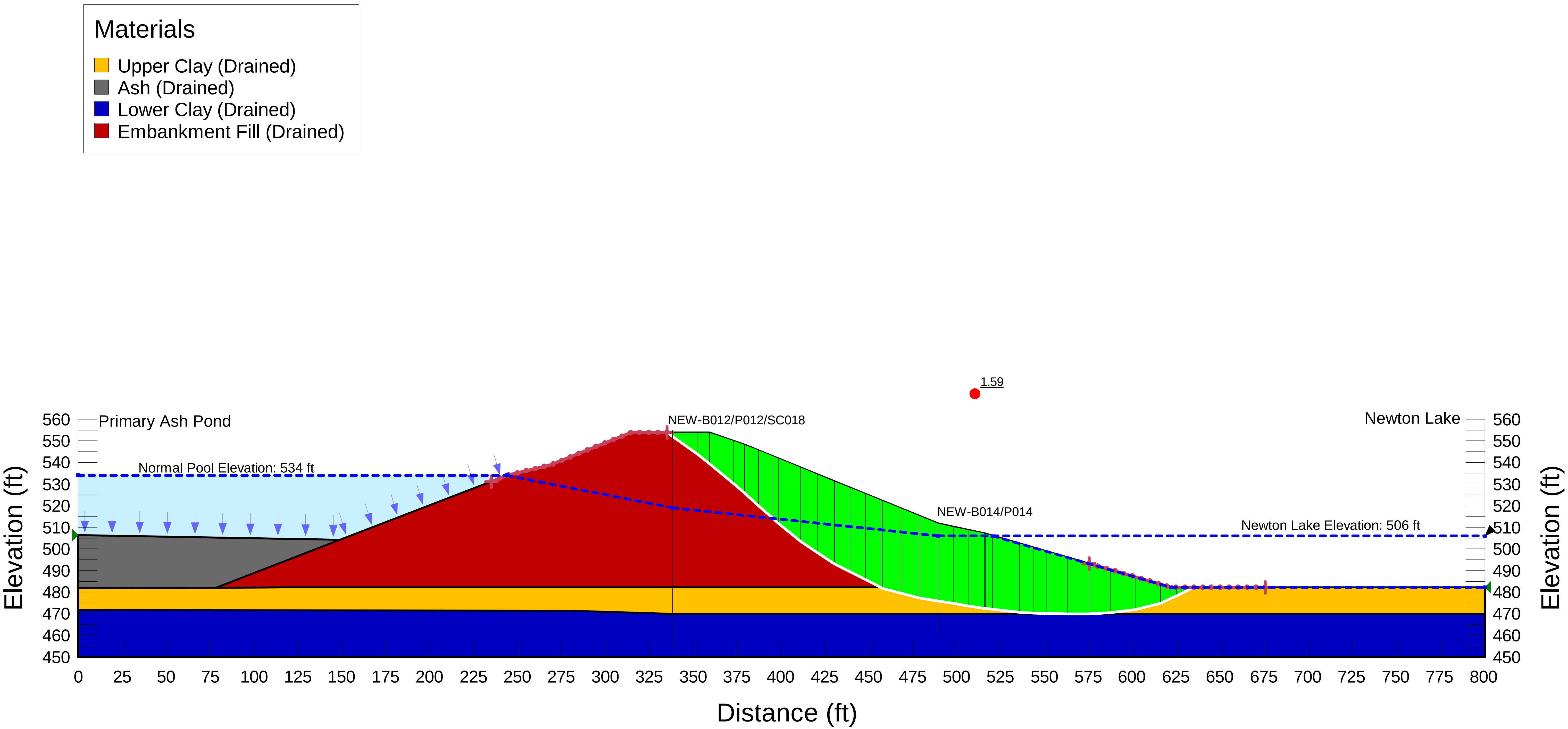
Project Name: Newton Primary Ash Pond Stability Analysis-Section B
Project Number: 60501553.02

Analysis: Rapid Drawdown

Calculated By: MJN Date: 6/20/2016
Checked By: VMCh Date: 6/20/2016

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 ° Cohesion R: 470 psf Phi R: 22 ° Piezometric Line After Drawdown: 2
Name: Ash (Drained) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 30 ° Cohesion R: 0 psf Phi R: 0 ° Piezometric Line After Drawdown: 2
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 ° Cohesion R: 0 psf Phi R: 0 ° Piezometric Line After Drawdown: 2
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 ° Cohesion R: 500 psf Phi R: 22 ° Piezometric Line After Drawdown: 2



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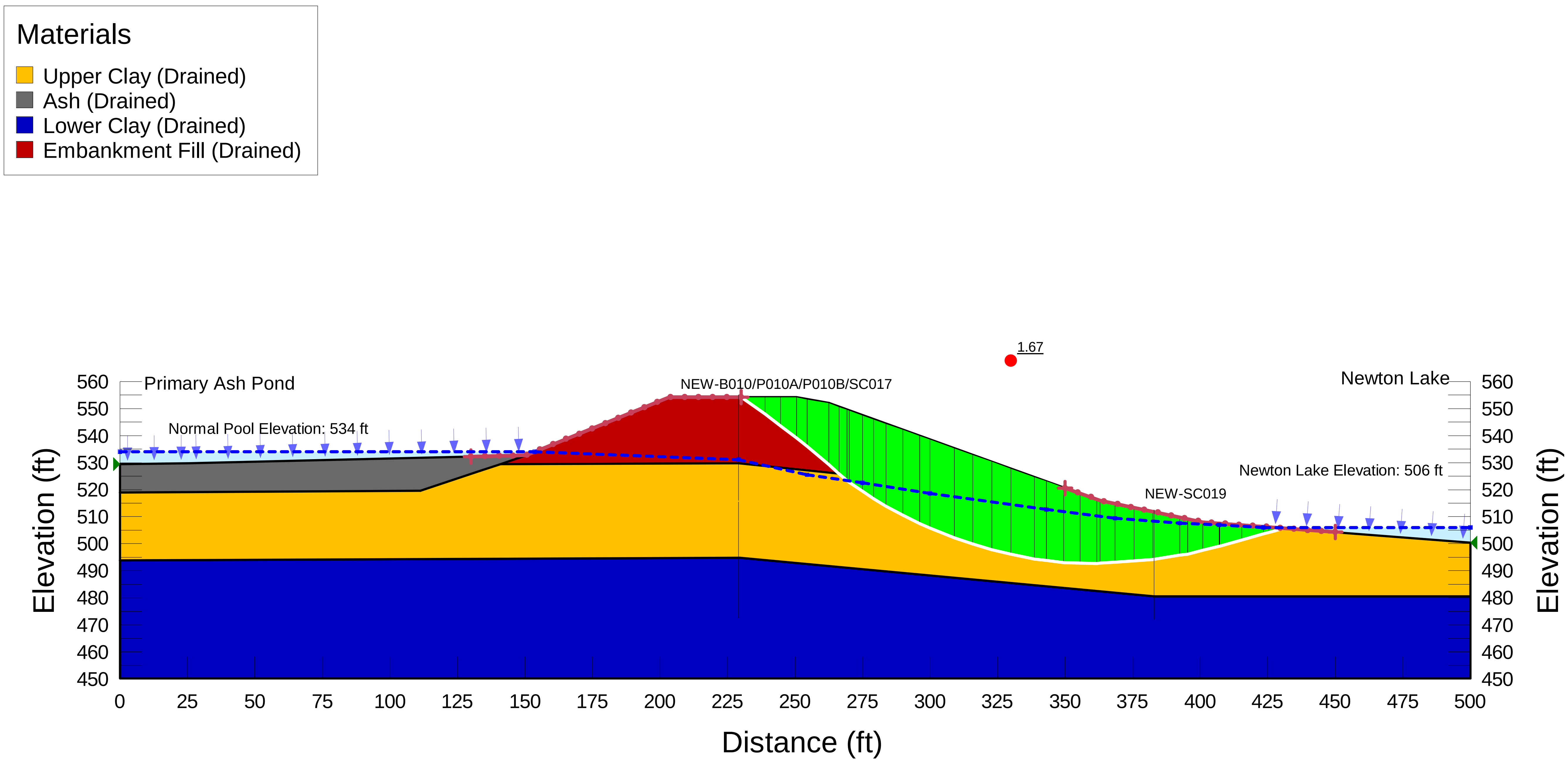
Project Name: Newton Primary Ash Pond Stability Analysis-Section C
Project Number: 60501553.02

Calculated By: MJN Date: 6/20/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Long Term (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Ash (Drained) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 30 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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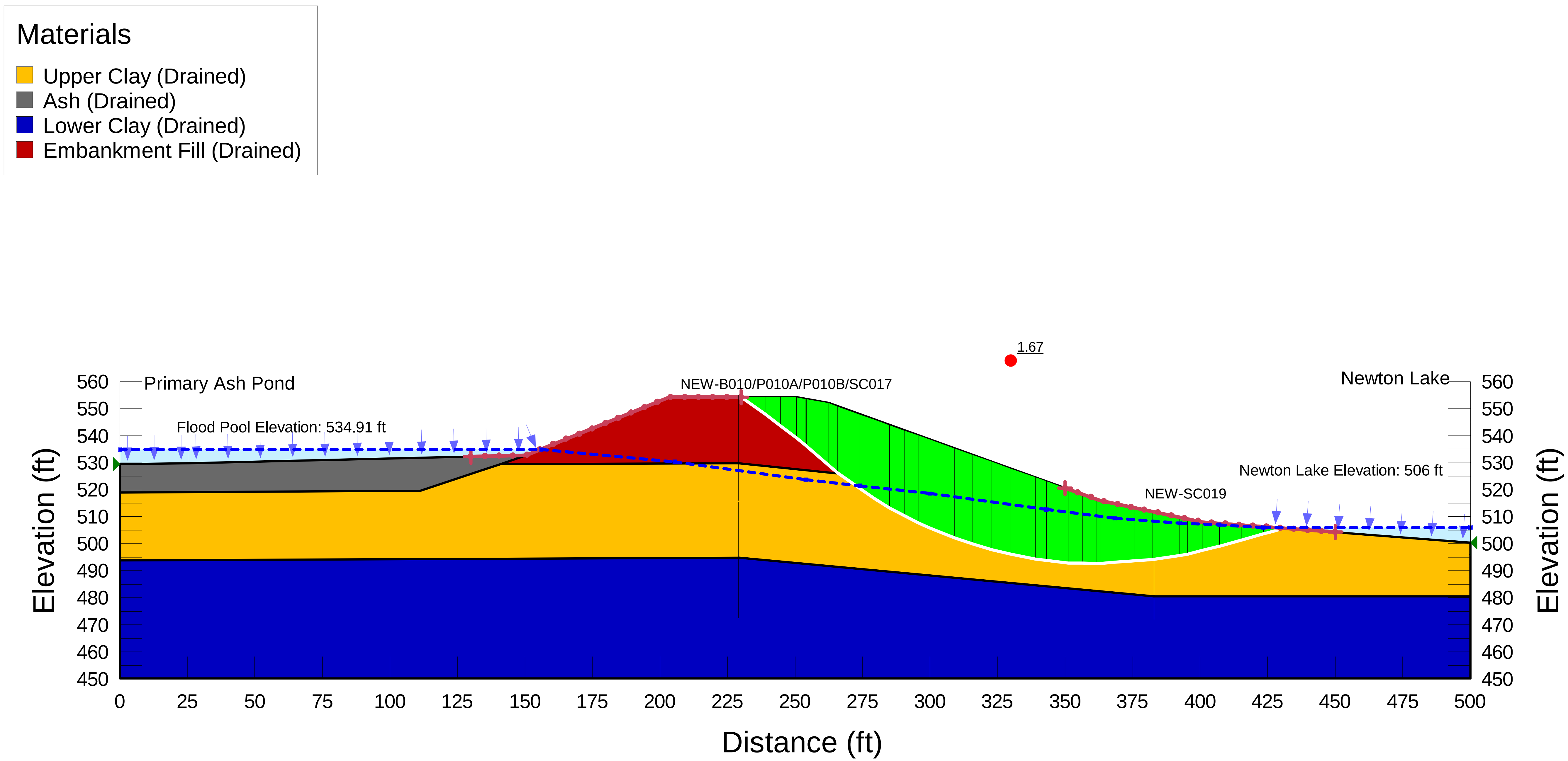
Project Name: Newton Primary Ash Pond Stability Analysis-Section C
Project Number: 60501553.02

Calculated By: MJN Date: 6/20/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Surcharge (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Ash (Drained) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 30 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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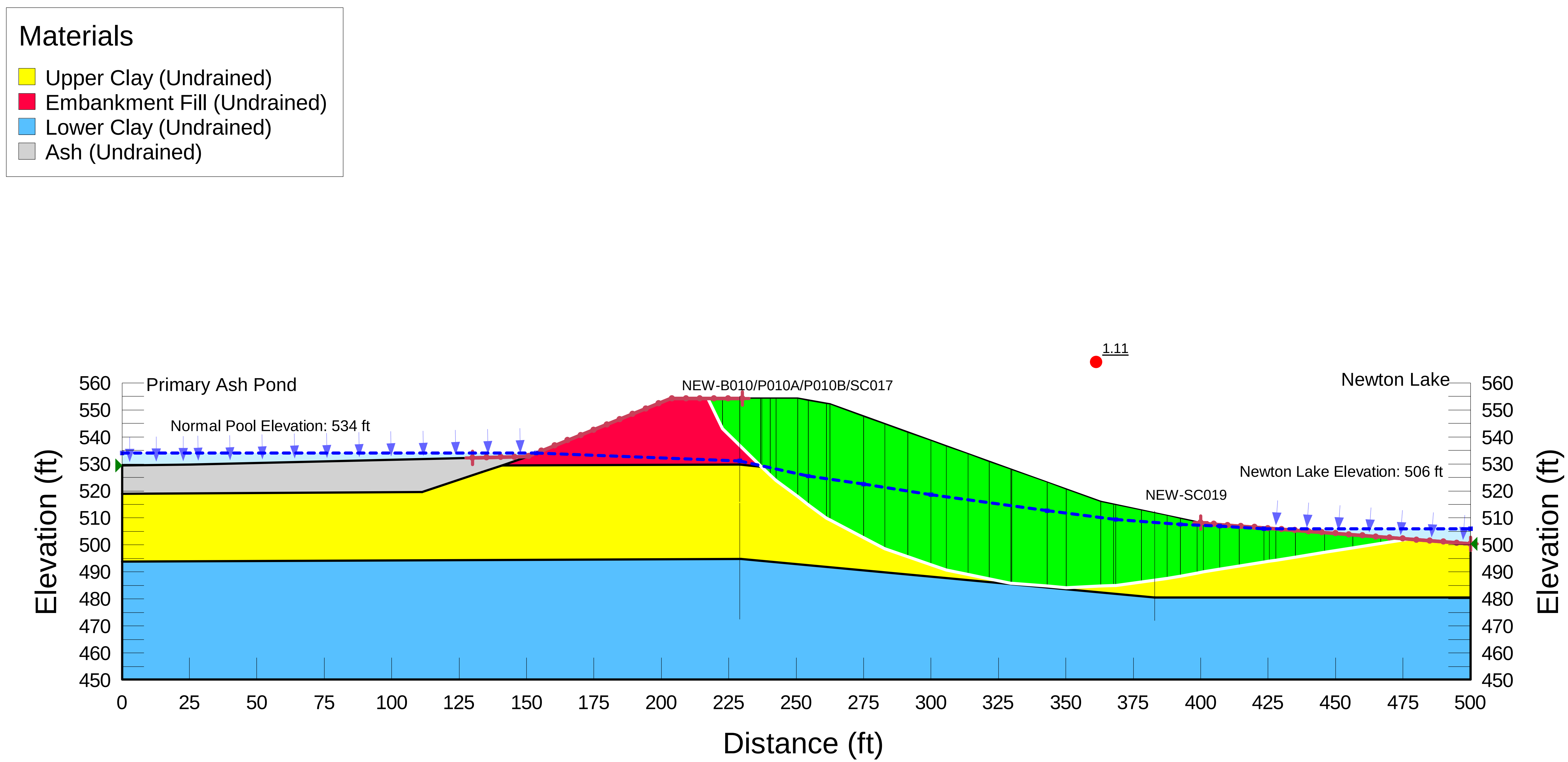
Project Name: Newton Primary Ash Pond Stability Analysis-Section C
Project Number: 60501553.02

Calculated By: MJN Date: 6/20/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Pseudostatic (Undrained)

Horizontal Seismic Coefficient = 0.153g

Name: Upper Clay (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Upper Clay (Undrained)
Name: Embankment Fill (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Embankment Fill (Undrained)
Name: Lower Clay (Undrained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 5,000 psf Phi': 0 °
Name: Ash (Undrained) Model: S=f(overburden) Unit Weight: 90 pcf Tau/Sigma Ratio: 0.05 Minimum Strength: 0 psf



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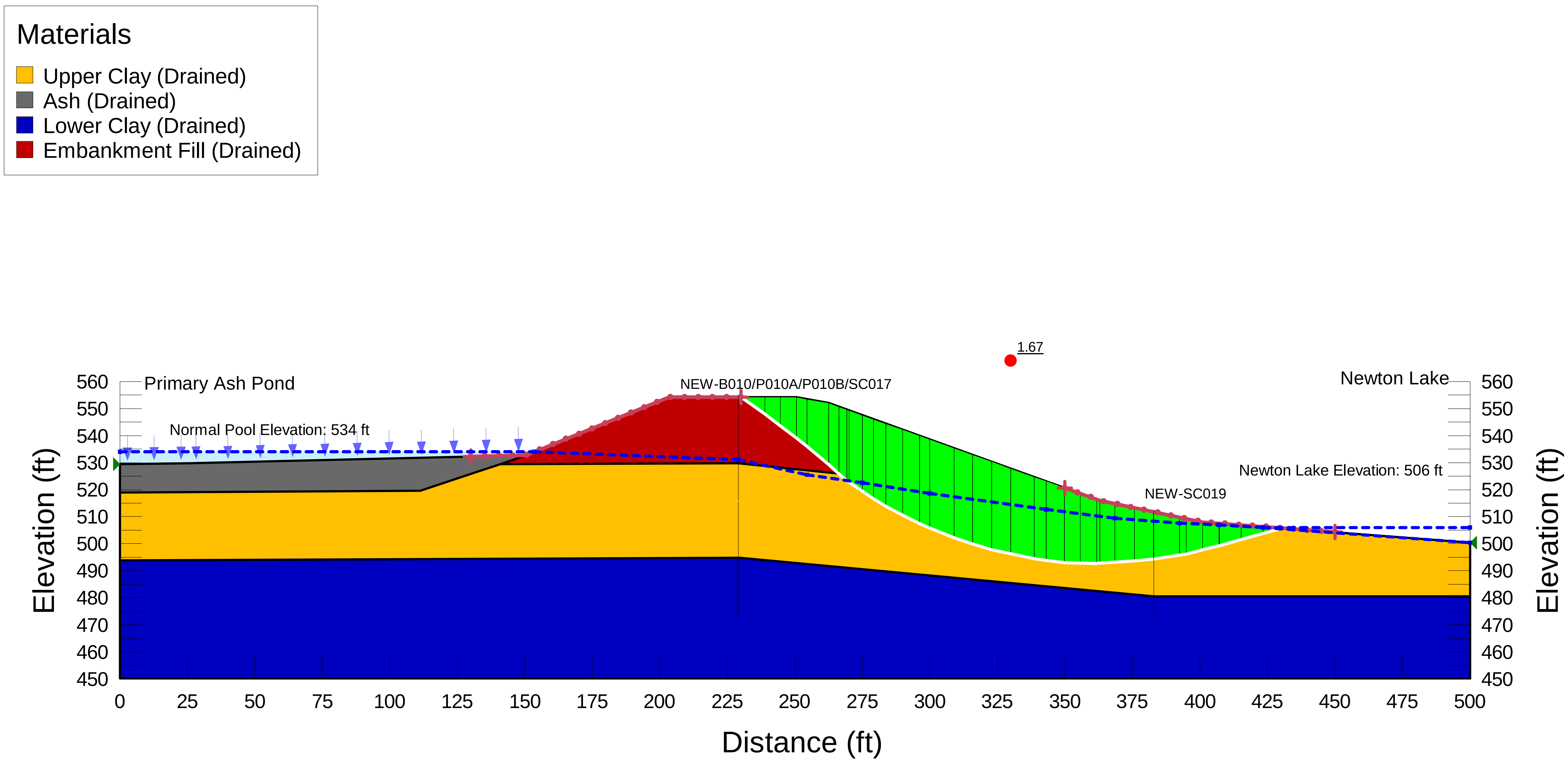
Project Name: Newton Primary Ash Pond Stability Analysis-Section C
Project Number: 60501553.02

Calculated By: MJN Date: 6/20/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Rapid Drawdown

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 ° Cohesion R: 470 psf Phi R: 22 ° Piezometric Line After Drawdown: 2
Name: Ash (Drained) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 30 ° Cohesion R: 0 psf Phi R: 0 ° Piezometric Line After Drawdown: 2
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 ° Cohesion R: 0 psf Phi R: 0 ° Piezometric Line After Drawdown: 2
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 ° Cohesion R: 500 psf Phi R: 22 ° Piezometric Line After Drawdown: 2



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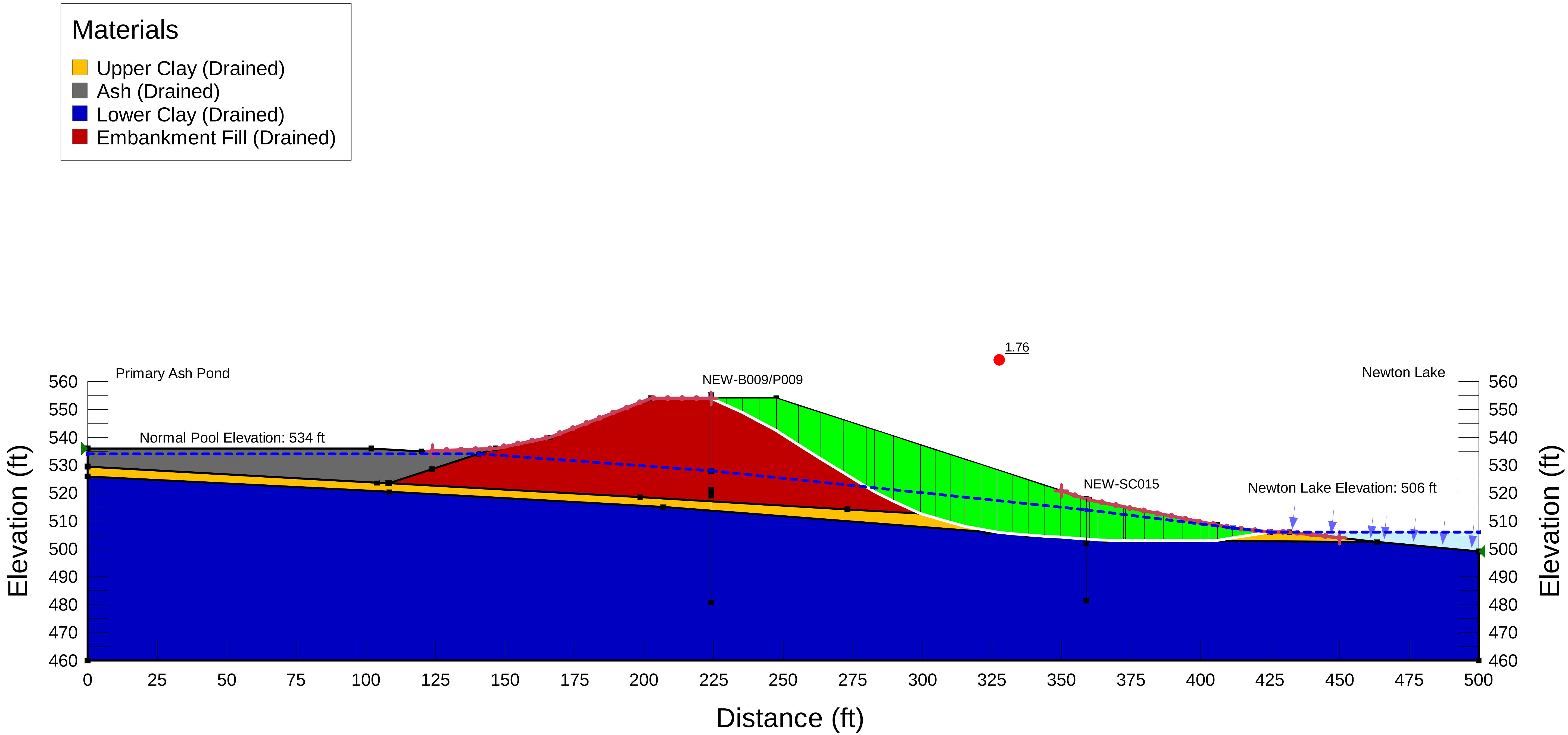
Project Name: **Newton Primary Ash Pond Stability Analysis-Section D**
Project Number: 60501553.02

Calculated By: MJN Date: 6/20/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Long Term (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Ash (Drained) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 30 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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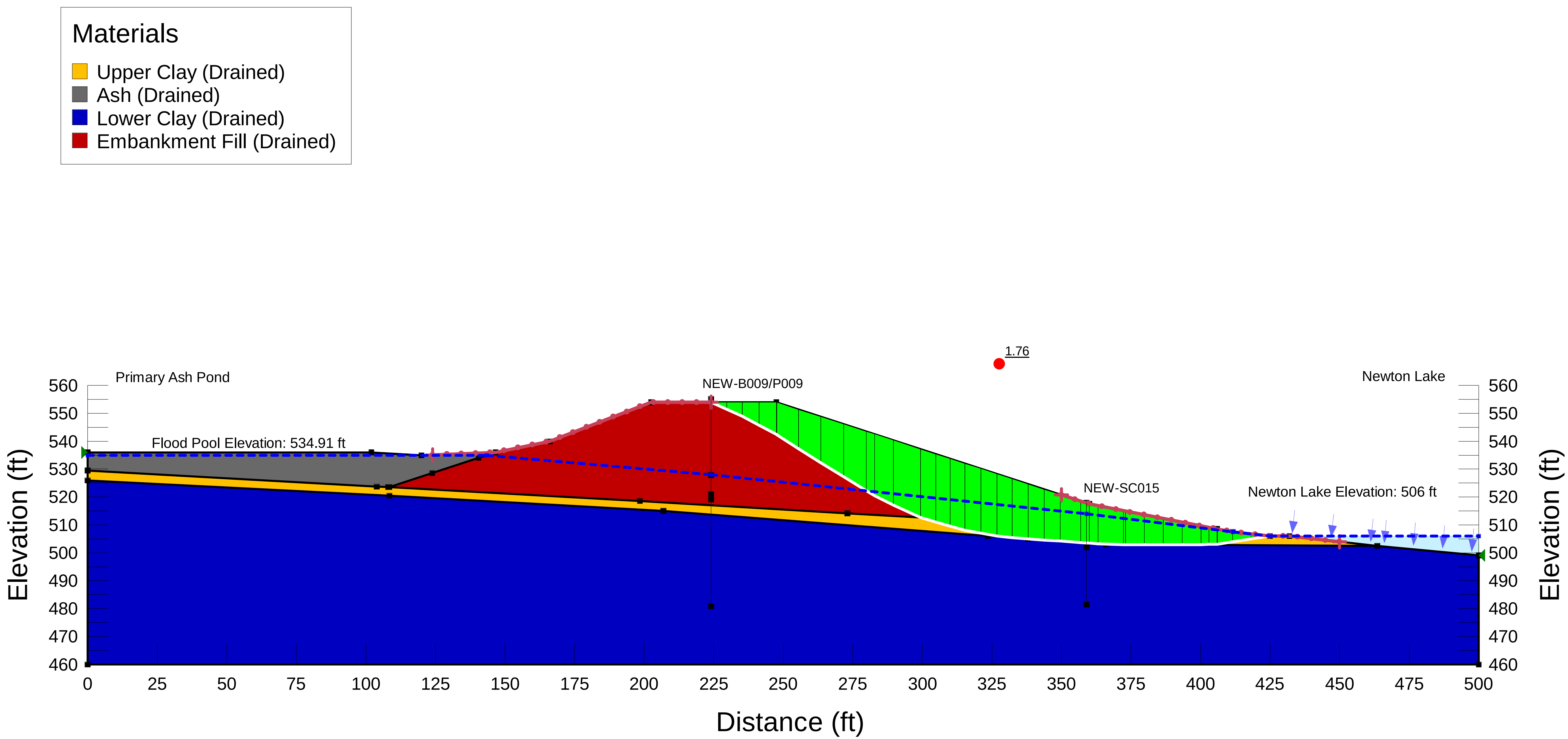
Project Name: Newton Primary Ash Pond Stability Analysis-Section D
Project Number: 60501553.02

Calculated By: MJN Date: 6/20/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Surcharge (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Ash (Drained) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 30 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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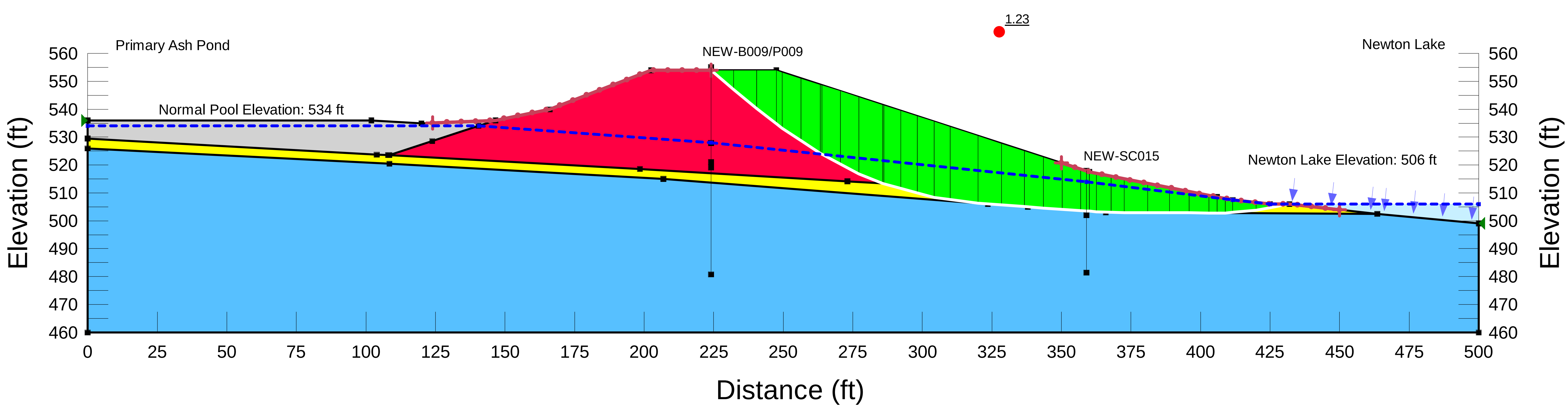
Project Name: Newton Primary Ash Pond Stability Analysis-Section D
Project Number: 60501553.02

Calculated By: MJN Date: 6/20/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Pseudostatic (Undrained)
Horizontal Seismic Coefficient = 0.153g

Name: Upper Clay (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Upper Clay (Undrained)
Name: Embankment Fill (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Embankment Fill (Undrained)
Name: Lower Clay (Undrained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 5,000 psf Phi': 0 °
Name: Ash (Undrained) Model: S=f(overburden) Unit Weight: 90 pcf Tau/Sigma Ratio: 0.05 Minimum Strength: 0 psf



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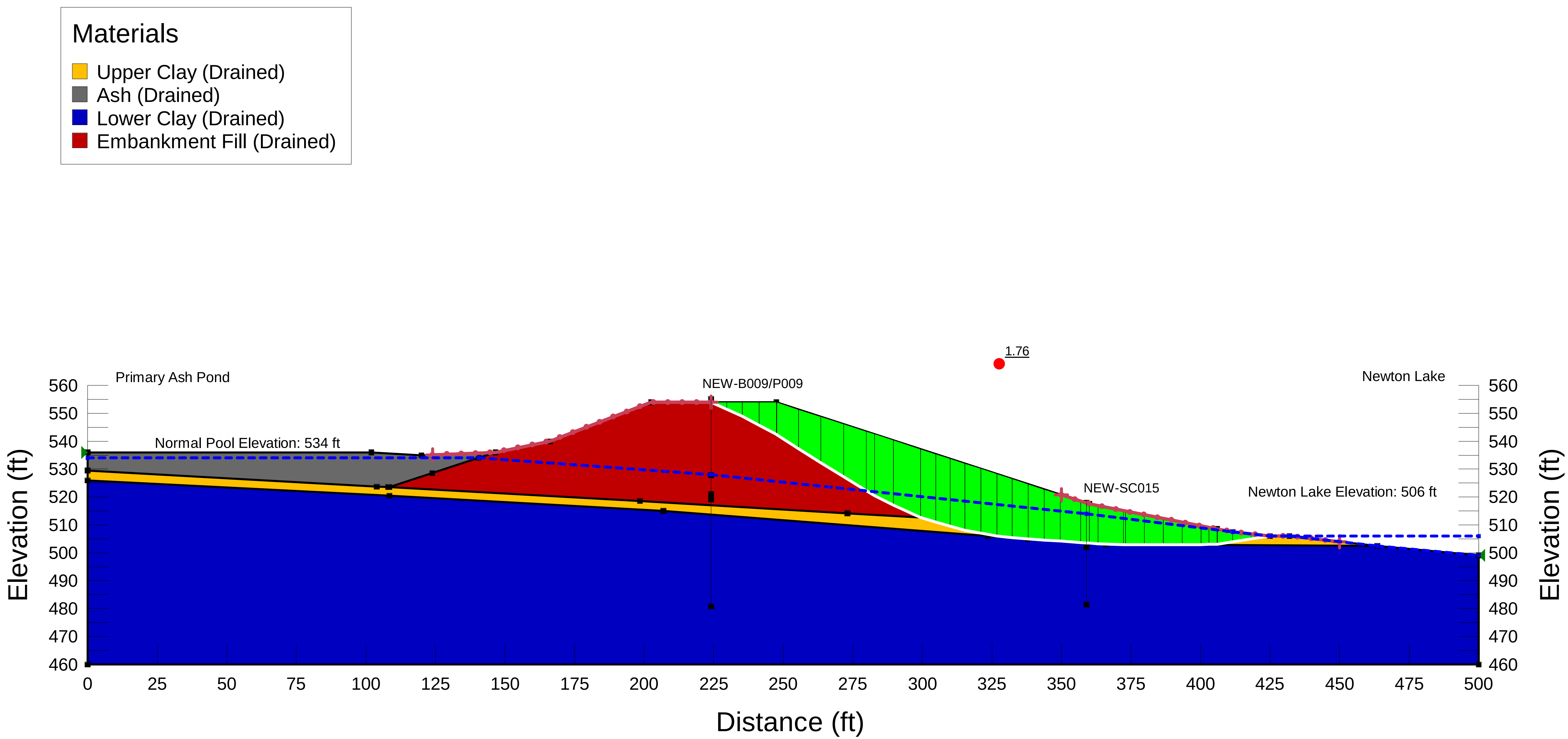
Project Name: Newton Primary Ash Pond Stability Analysis-Section D
Project Number: 60501553.02

Calculated By: MJN Date: 6/20/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Rapid Drawdown

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 ° Cohesion R: 470 psf Phi R: 22 ° Piezometric Line After Drawdown: 2
Name: Ash (Drained) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 30 ° Cohesion R: 0 psf Phi R: 0 ° Piezometric Line After Drawdown: 2
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 ° Cohesion R: 0 psf Phi R: 0 ° Piezometric Line After Drawdown: 2
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 ° Cohesion R: 500 psf Phi R: 22 ° Piezometric Line After Drawdown: 2



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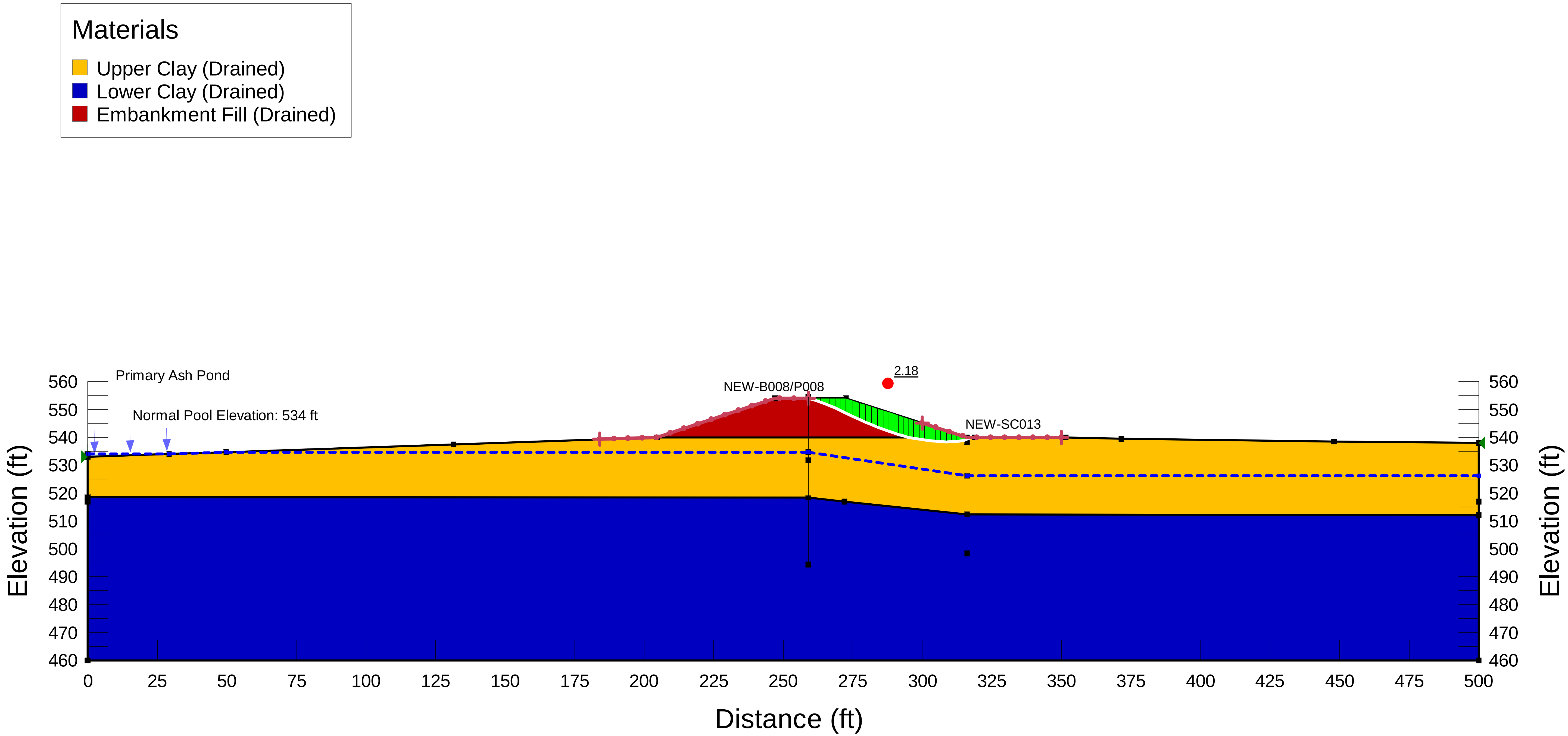
Project Name: Newton Primary Ash Pond Stability Analysis-Section E
Project Number: 60501553.02

Calculated By: MJN Date: 6/17/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Long Term (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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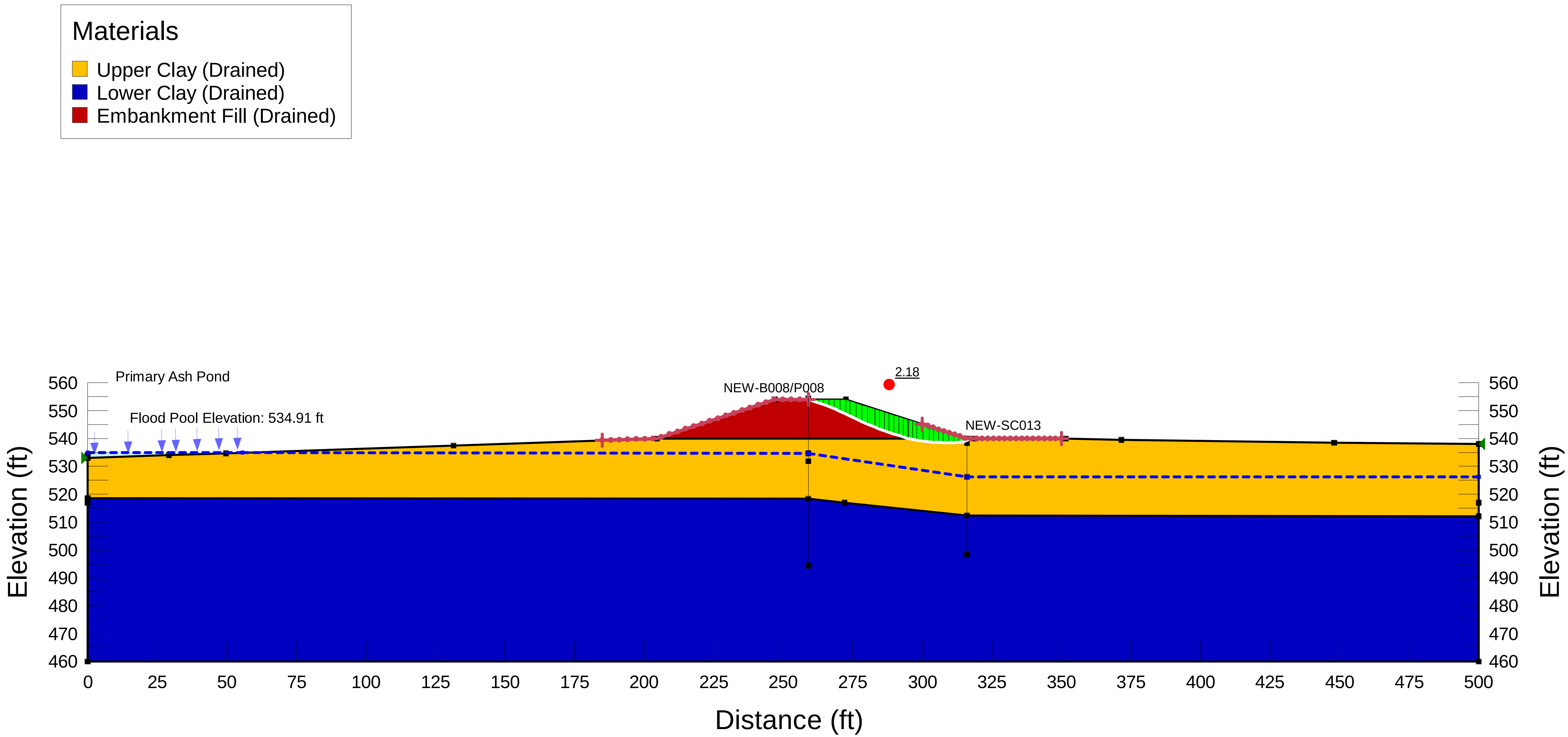
Project Name: Newton Primary Ash Pond Stability Analysis-Section E
Project Number: 60501553.02

Calculated By: MJN Date: 6/17/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Surcharge (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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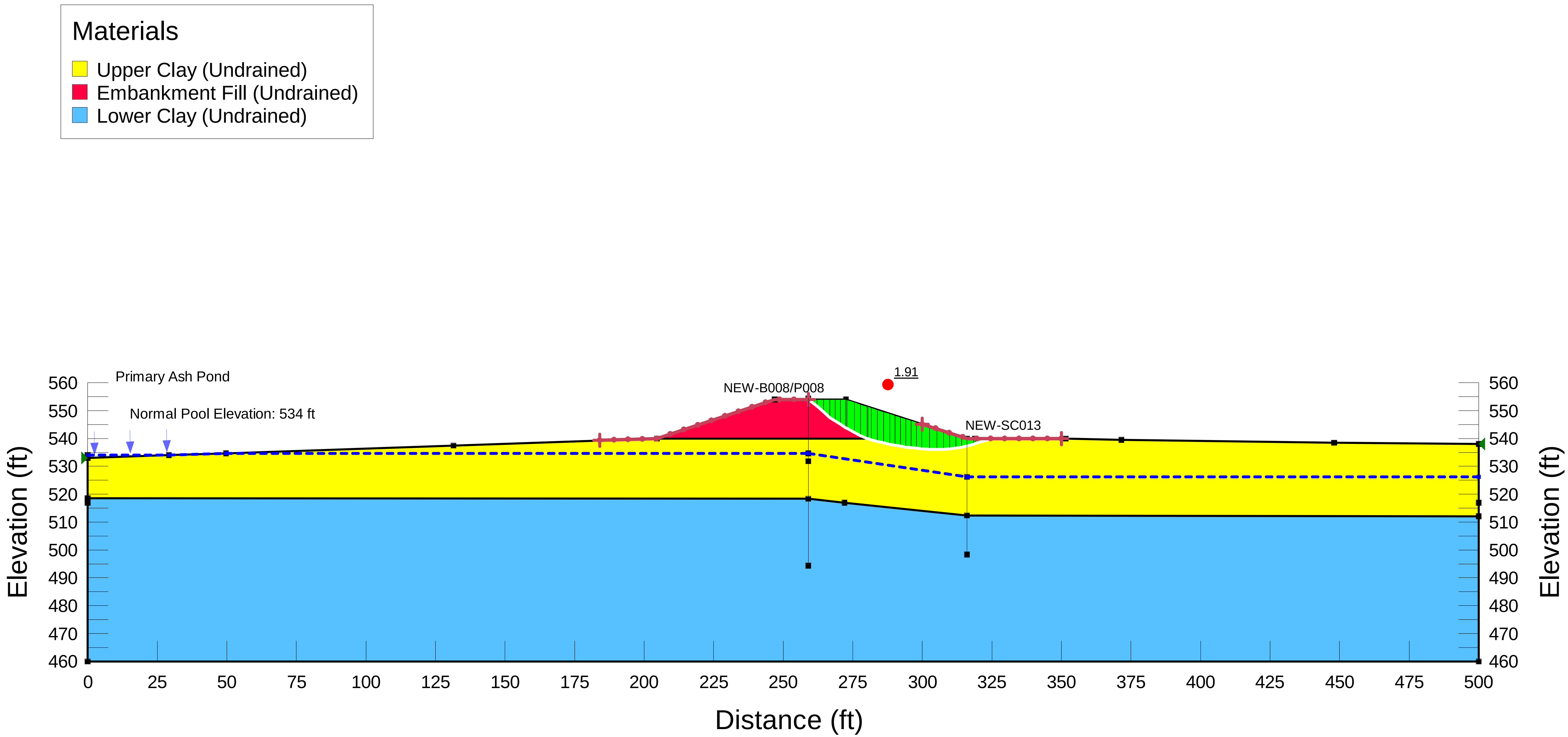
Project Name: Newton Primary Ash Pond Stability Analysis-Section E
Project Number: 60501553.02

Calculated By: MJN Date: 6/17/2016
Checked By: VMCh Date: 6/20/2016

Analysis: Pseudostatic (Undrained)
Horizontal Seismic Coefficient = 0.153g

Name: Upper Clay (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Upper Clay (Undrained)
Name: Embankment Fill (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Embankment Fill (Undrained)
Name: Lower Clay (Undrained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 5,000 psf Phi': 0 °



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Project Name: Newton Primary Ash Pond Stability Analysis-Section F
Project Number: 60501553.02

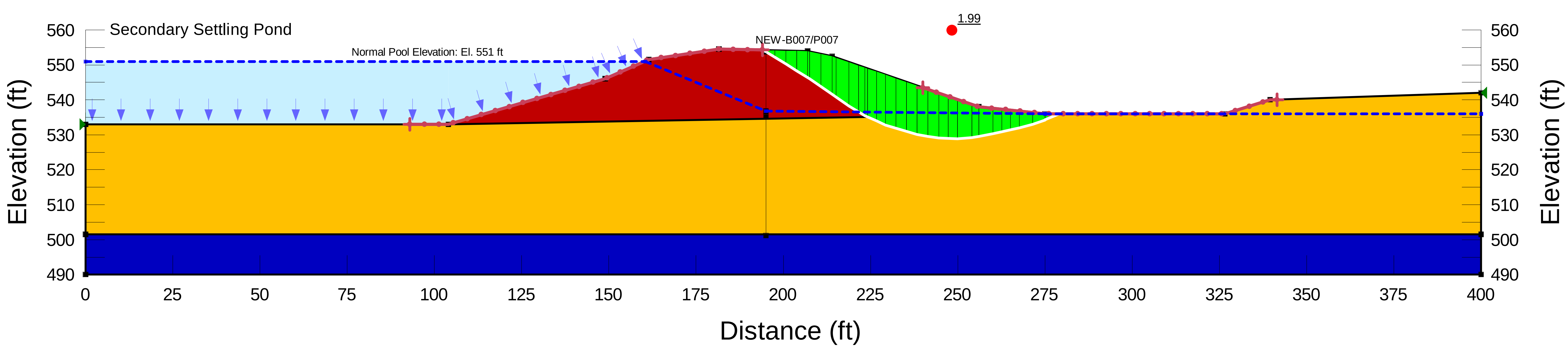
Calculated By: ZJF Date: 5/23/16
Checked By: VMCh Date: 6/16/2016

Analysis: Long Term (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °

Materials

- Upper Clay (Drained)
- Lower Clay (Drained)
- Embankment Fill (Drained)



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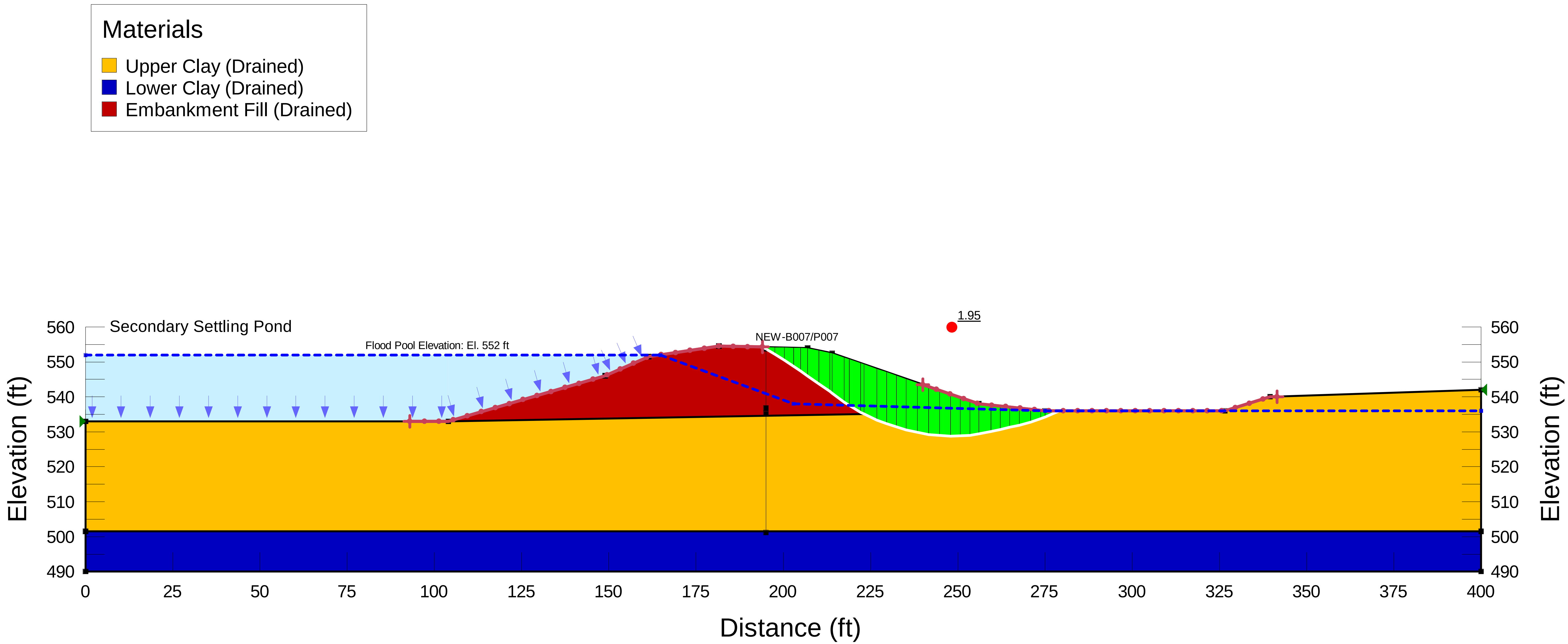
Project Name: Newton Primary Ash Pond Stability Analysis-Section F
Project Number: 60501553.02

Calculated By: ZJF Date: 5/23/16
Checked By: VMCh Date: 6/16/2016

Analysis: Surcharge (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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Project Name: Newton Primary Ash Pond Stability Analysis-Section F
Project Number: 60501553.02

Calculated By: ZJF Date: 5/23/16
Checked By: VMCh Date: 6/16/2016

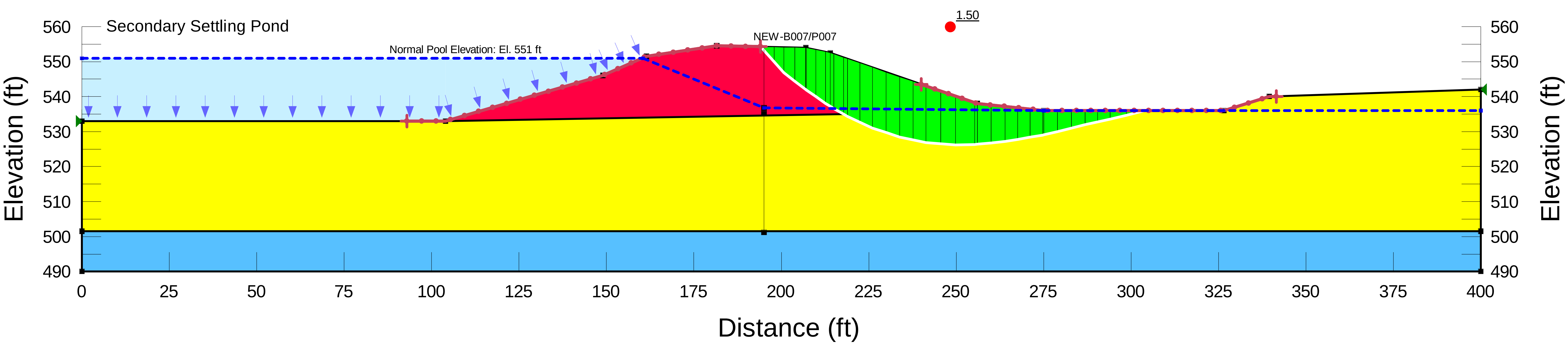
Analysis: Pseudostatic (Undrained)

Horizontal Seismic Coefficient = 0.153 g

Name: Upper Clay (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Upper Clay (Undrained)
Name: Embankment Fill (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Embankment Fill (Undrained)
Name: Lower Clay (Undrained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 5,000 psf Phi': 0 °

Materials

- Upper Clay (Undrained)
- Embankment Fill (Undrained)
- Lower Clay (Undrained)



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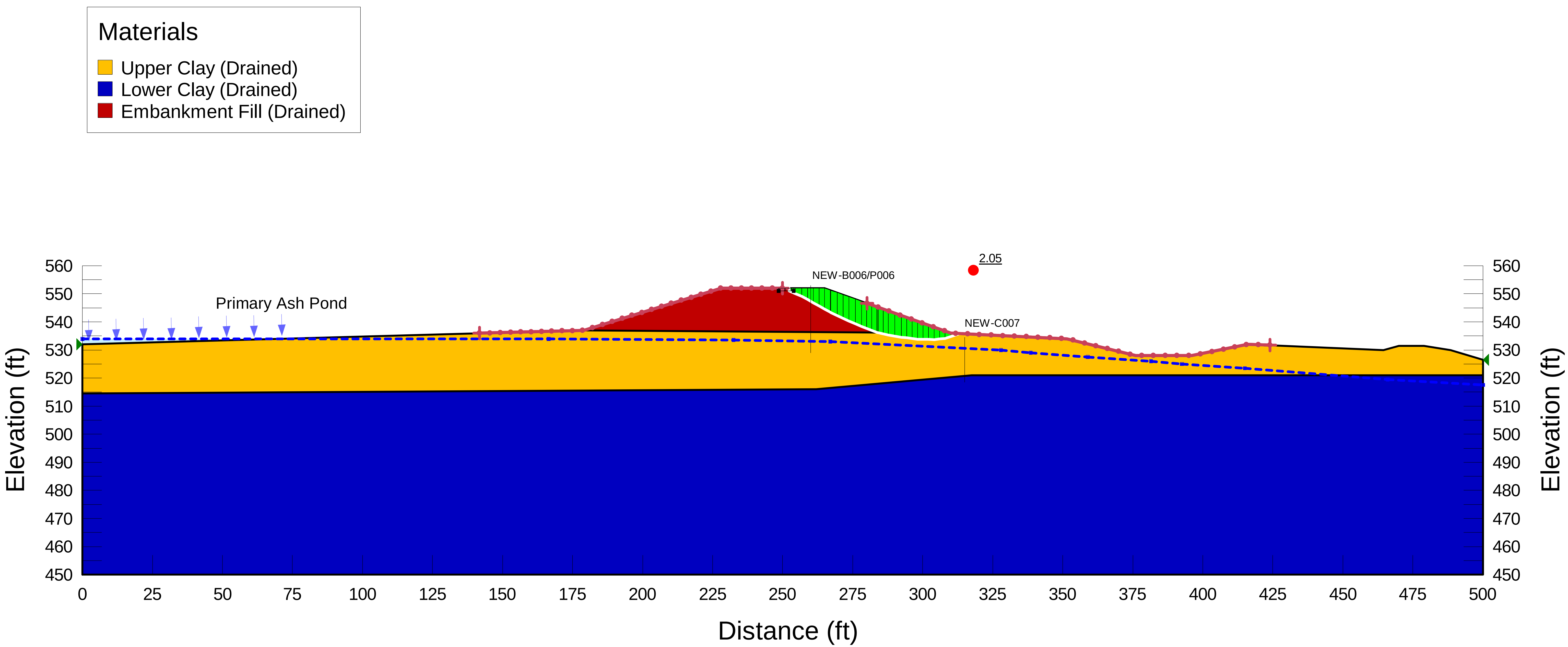
Project Name: Newton Primary Ash Pond Stability Analysis-Section G
Project Number: 60501553.02

Calculated By: ZJF Date: 5/23/16
Checked By: VMCh Date: 06/20/16

Analysis: Long Term (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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Project Name: Newton Primary Ash Pond Stability Analysis-Section G
Project Number: 60501553.02

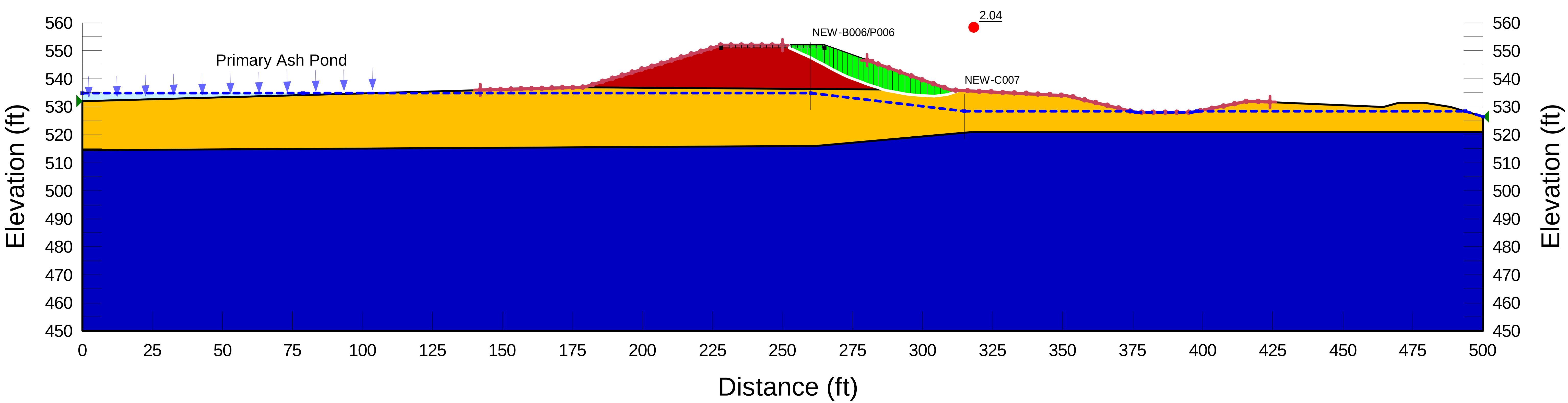
Calculated By: ZJF Date: 5/23/16
Checked By: VMCh Date: 06/20/16

Analysis: Surcharge (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °

Materials

- Upper Clay (Drained)
- Lower Clay (Drained)
- Embankment Fill (Drained)



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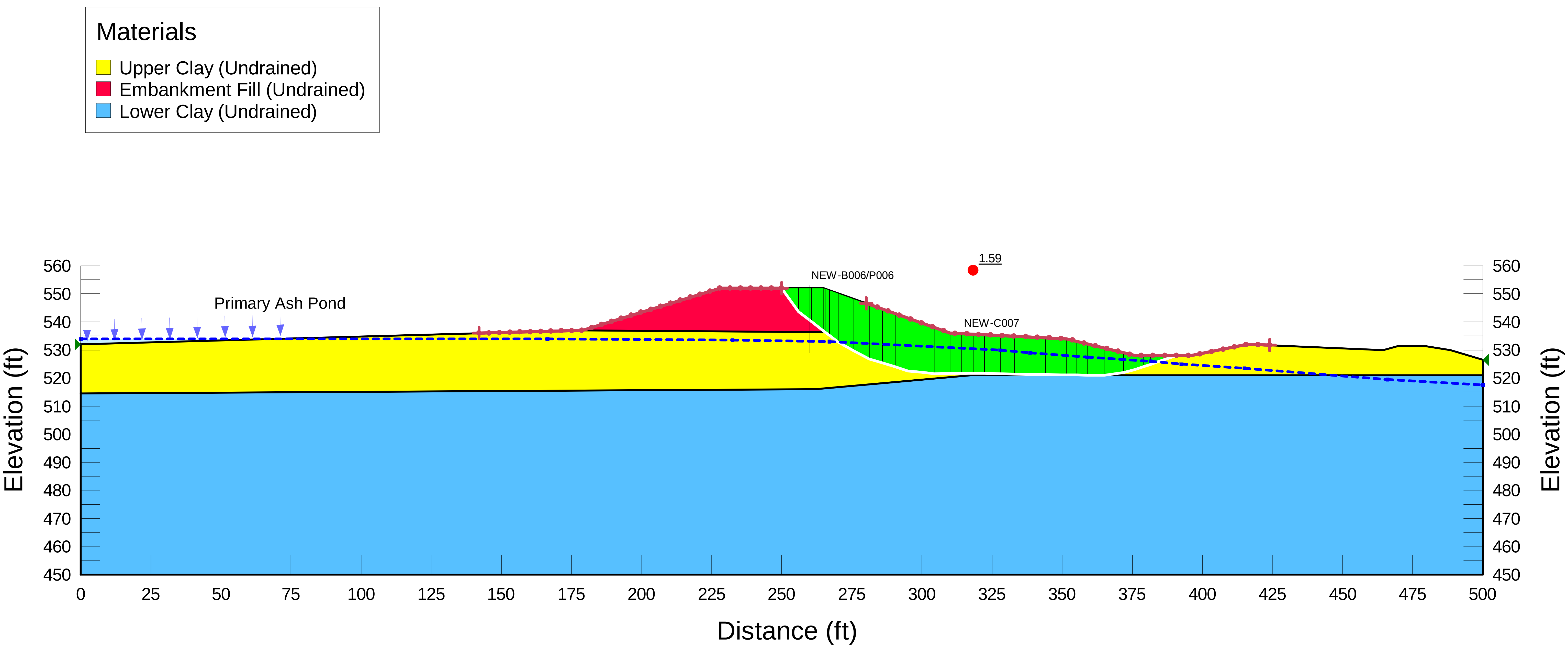
Project Name: Newton Primary Ash Pond Stability Analysis-Section G
Project Number: 60501553.02

Calculated By: ZJF Date: 5/23/16
Checked By: VMCh Date: 06/20/16

Analysis: Pseudostatic (Undrained)
Horizontal Seismic Coefficient = 0.153 g

Name: Upper Clay (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Upper Clay (Undrained)
Name: Embankment Fill (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Embankment Fill (Undrained)
Name: Lower Clay (Undrained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 5,000 psf Phi': 0 °



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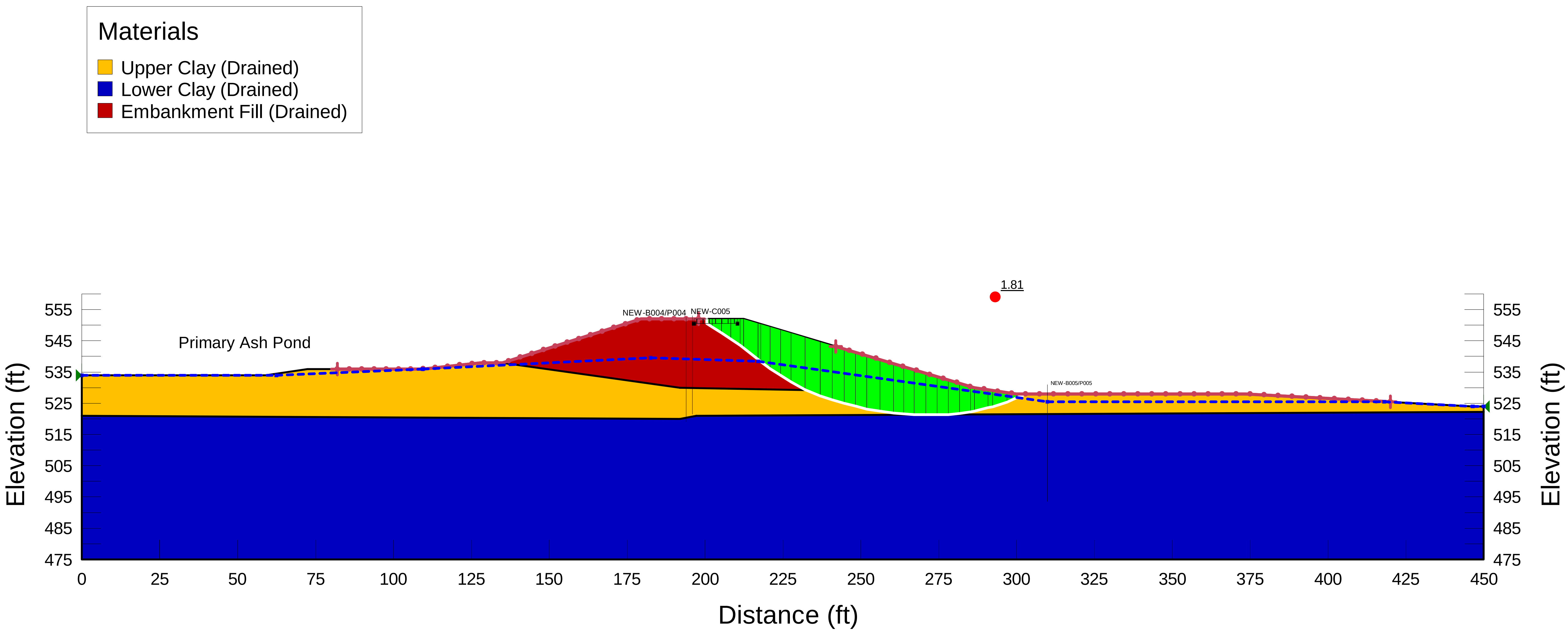
Project Name: Newton Primary Ash Pond Stability Analysis-Section H
Project Number: 60501553.02

Calculated By: ZJF Date: 5/23/16
Checked By: VMCh Date: 6/20/16

Analysis: Long Term (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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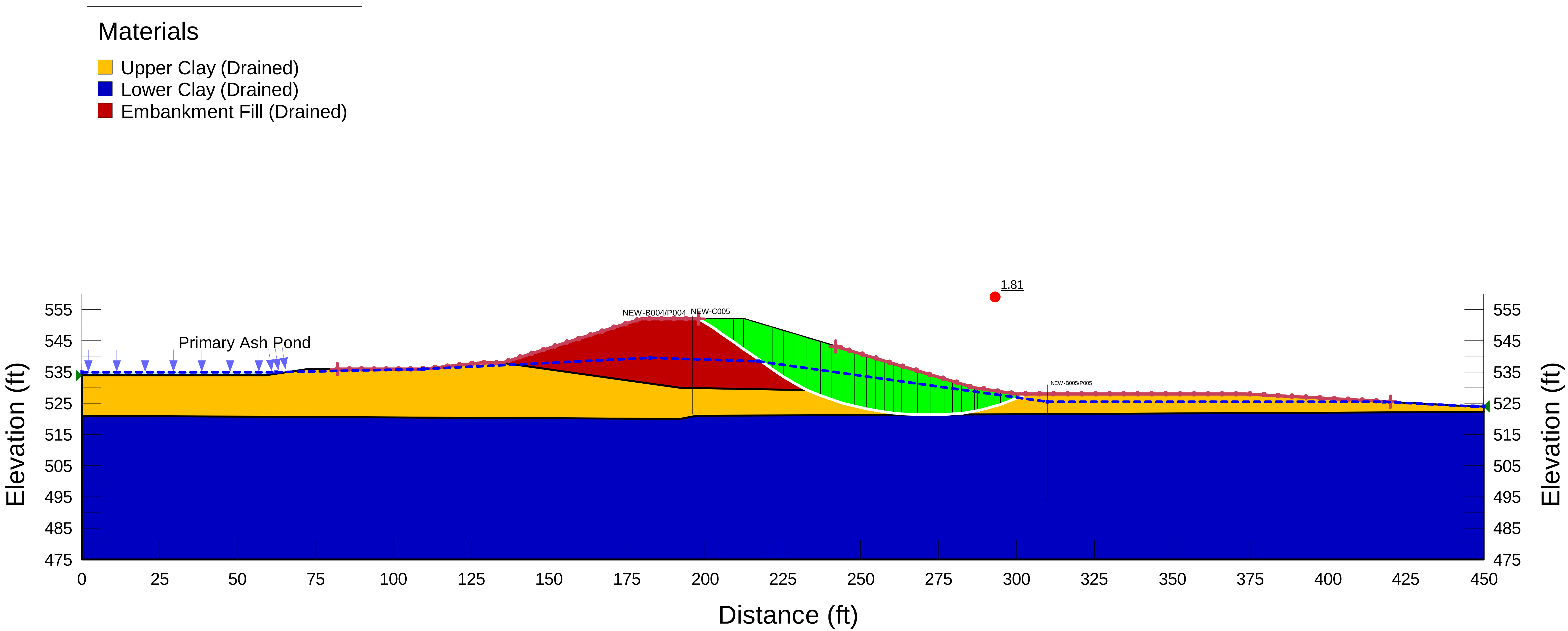
Project Name: **Newton Primary Ash Pond Stability Analysis-Section H**
Project Number: 60501553.02

Calculated By: ZJF Date: 5/23/16
Checked By: VMCh Date: 6/20/16

Analysis: Surcharge (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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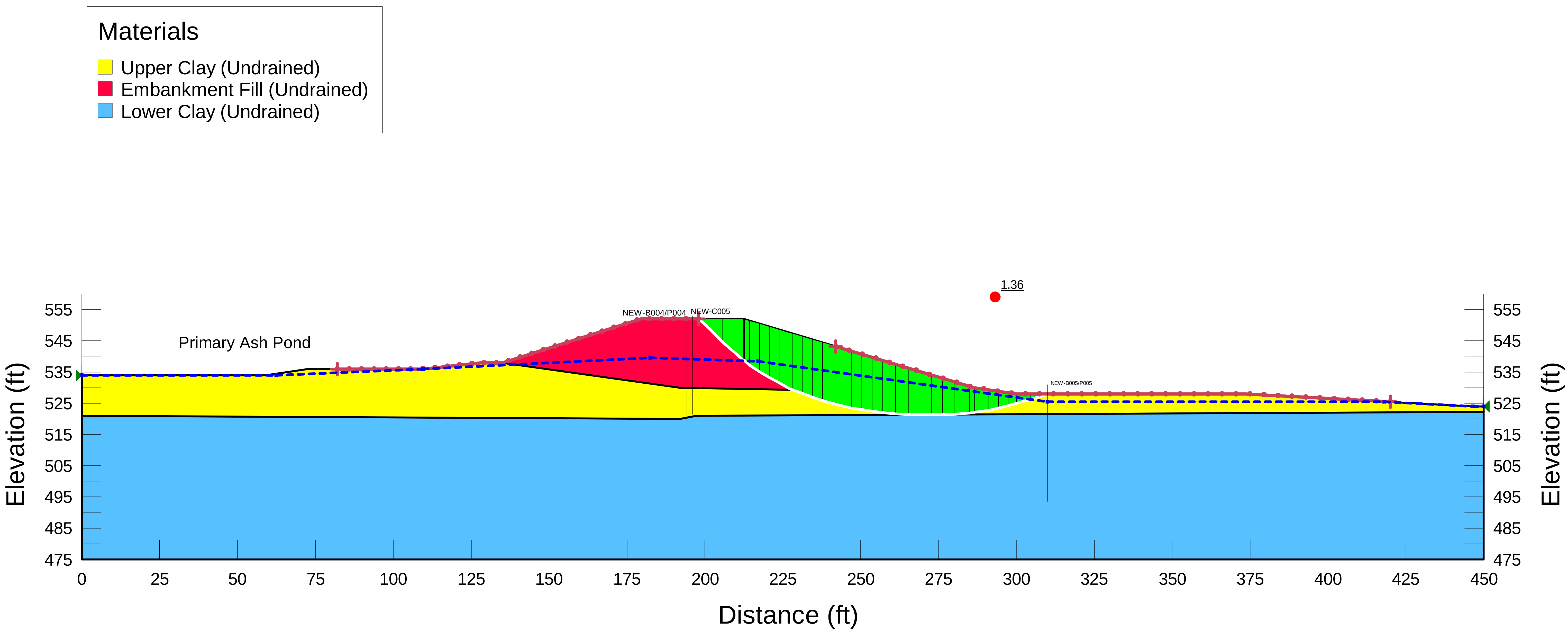
Project Name: Newton Primary Ash Pond Stability Analysis-Section H
Project Number: 60501553.02

Calculated By: ZJF Date: 5/23/16
Checked By: VMCh Date: 6/20/16

Analysis: Pseudostatic (Undrained)
Horizontal Seismic Coefficient = 0.153 g

Name: Upper Clay (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Upper Clay (Undrained)
Name: Embankment Fill (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Embankment Fill (Undrained)
Name: Lower Clay (Undrained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 5,000 psf Phi': 0 °



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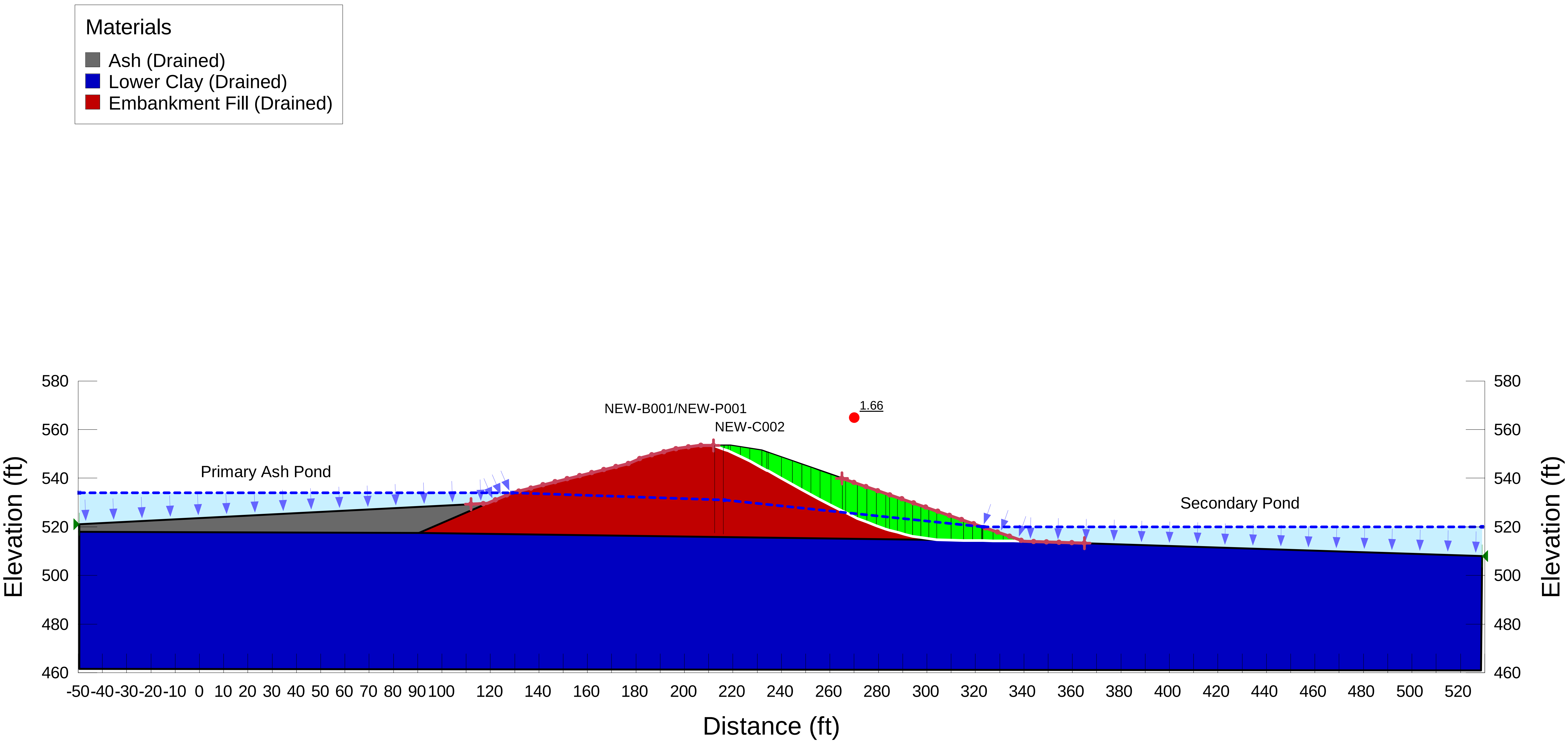
Project Name: Newton Primary Ash Pond Stability Analysis-Section I
Project Number: 60501553.02
Analysis: Long Term (Drained)

Calculated By: NDS Date: 5/25/16
Checked By: VMCh Date: 6/20/16
Updated By: MJN Date: 6/28/16

Name: Ash (Drained) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 30 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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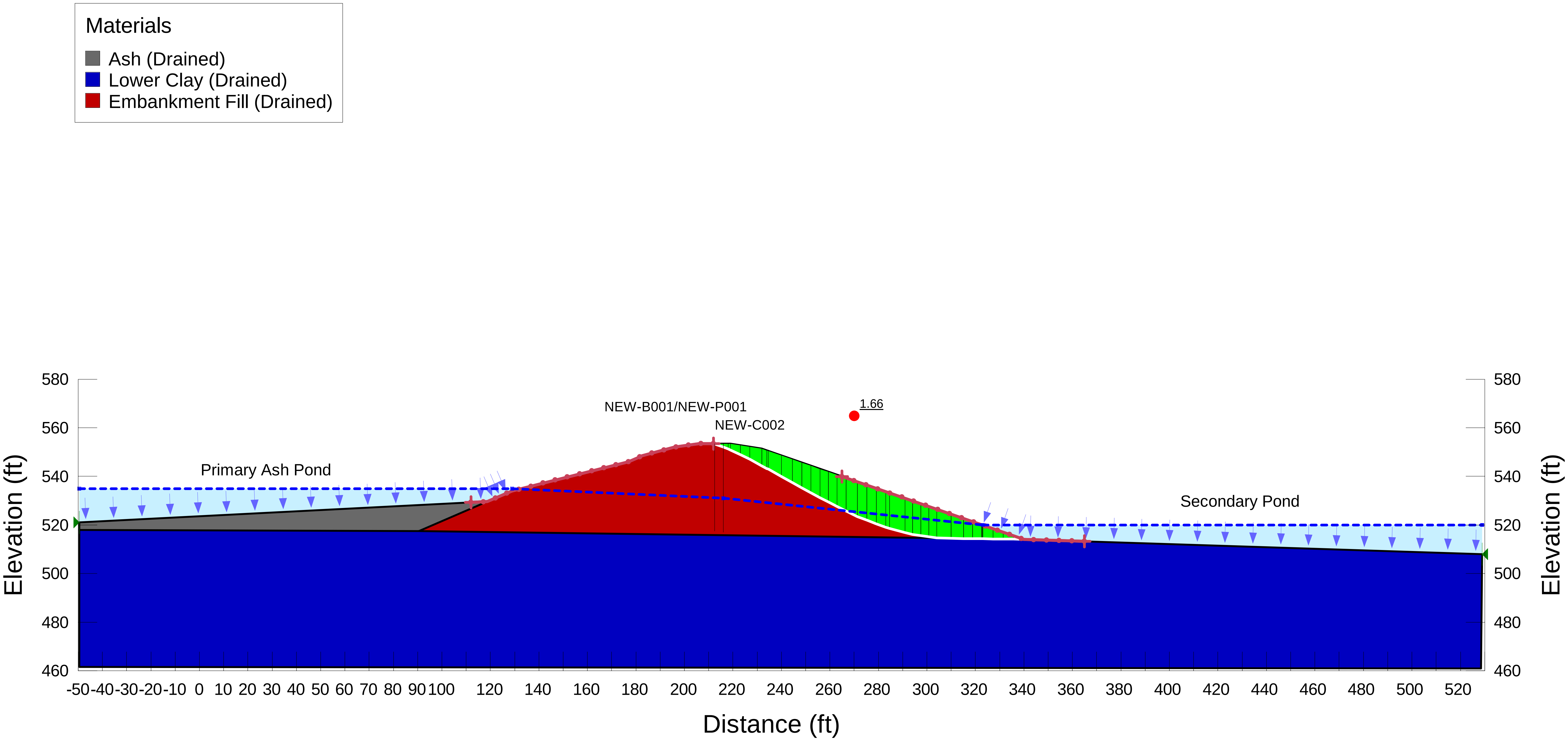
Project Name: Newton Primary Ash Pond Stability Analysis-Section I
Project Number: 60501553.02
Analysis: Surcharge (Drained)

Calculated By: NDS Date: 5/25/16
Checked By: VMCh Date: 6/20/16
Updated By: MJN Date: 6/28/16

Name: Ash (Drained) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 30 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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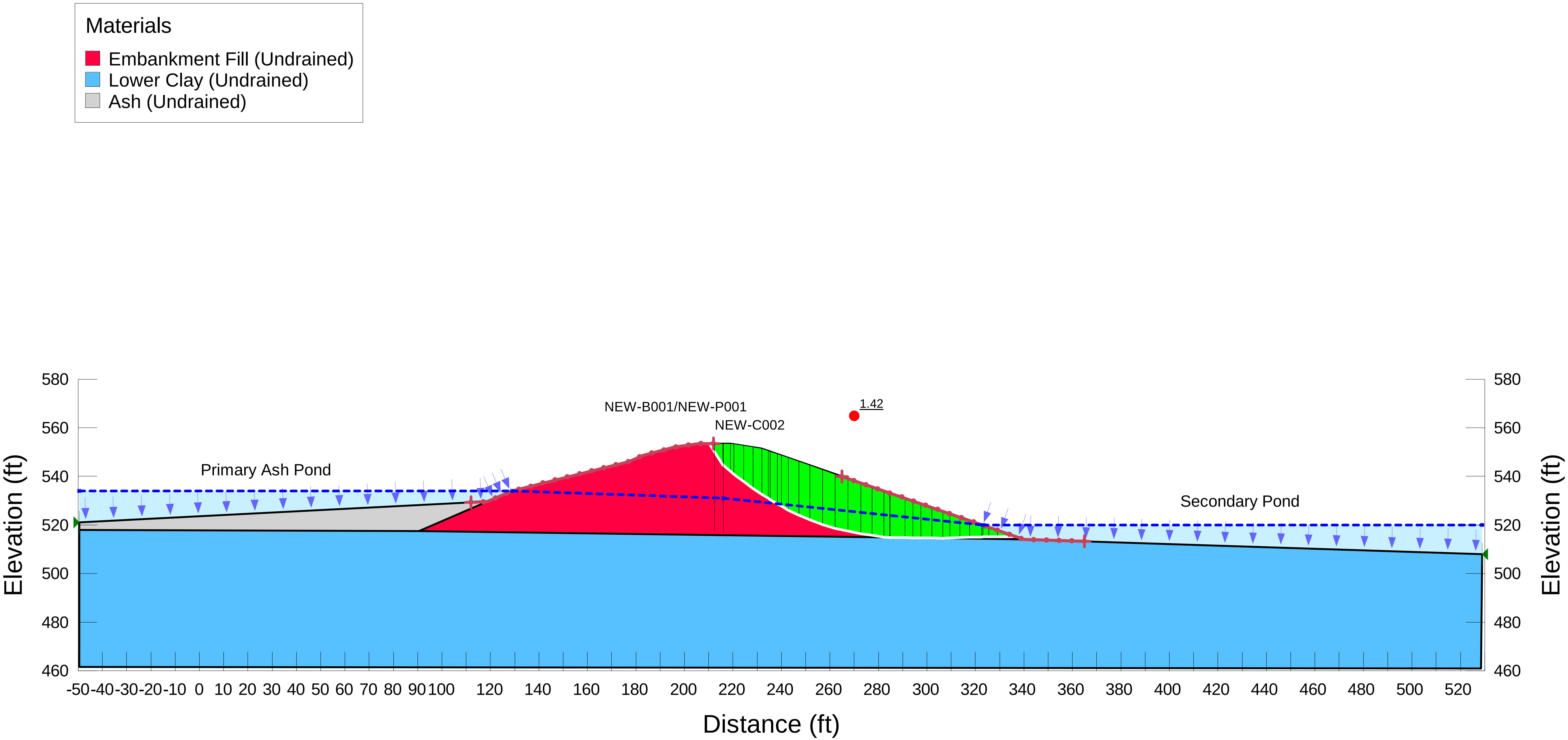
Project Name: Newton Primary Ash Pond Stability Analysis-Section I
Project Number: 60501553.02

Calculated By: NDS Date: 5/25/16
Checked By: VMCh Date: 6/20/16
Updated By: MJN Date: 6/28/16

Analysis: Pseudostatic (Undrained)

Horizontal Seismic Coefficient = 0.153 g

Name: Embankment Fill (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Embankment Fill (Undrained)
Name: Lower Clay (Undrained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 5,000 psf Phi': 0 °
Name: Ash (Undrained) Model: S=f(overburden) Unit Weight: 90 pcf Tau/Sigma Ratio: 0.05 Minimum Strength: 0 psf



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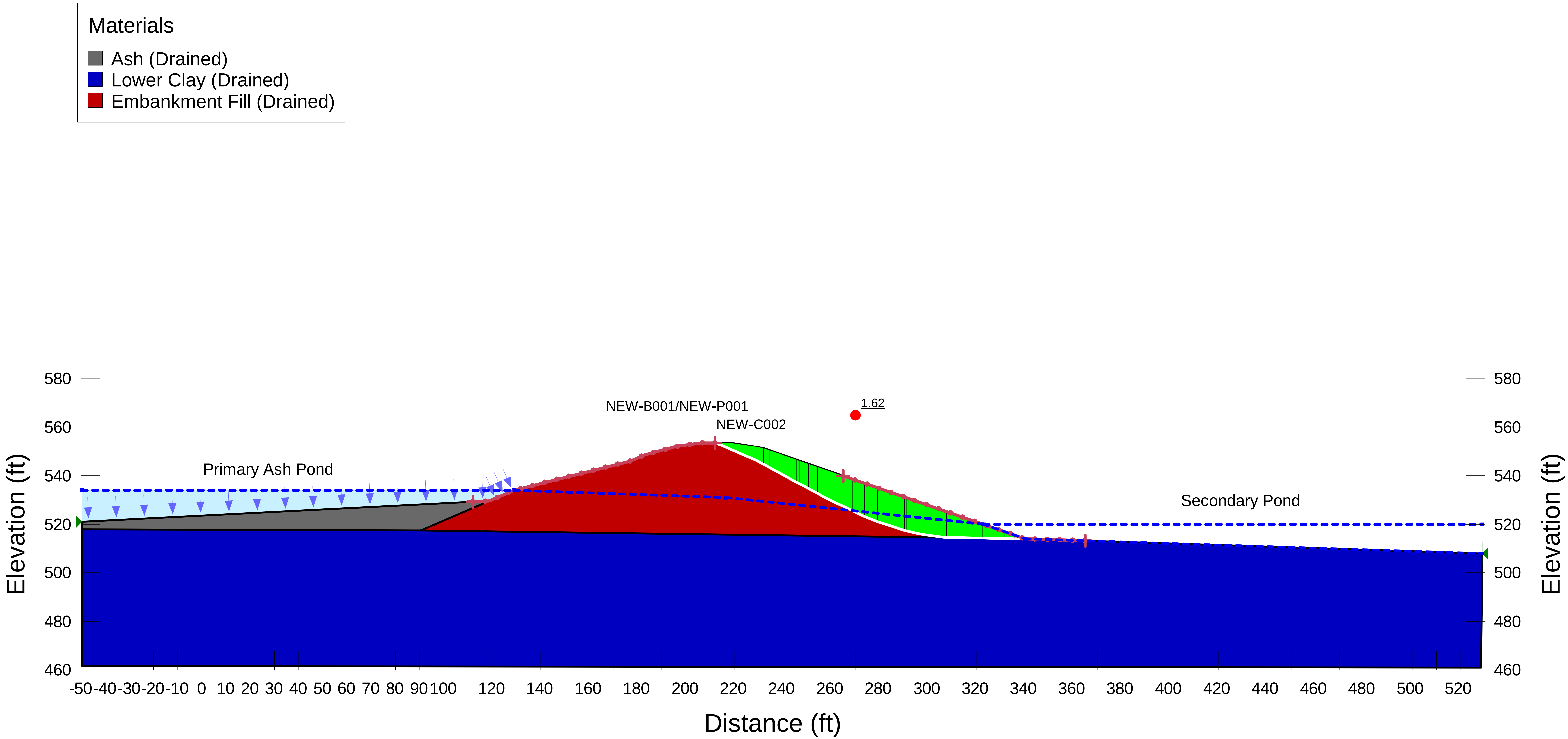
Project Name: Newton Primary Ash Pond Stability Analysis-Section I
Project Number: 60501553.02
Analysis: Sudden Drawdown

Calculated By: NDS Date: 5/25/16
Checked By: VMCh Date: 6/20/16
Updated By: MJN Date: 6/28/16

Name: Ash (Drained) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 30 ° Cohesion R: 0 psf Phi R: 0 ° Piezometric Line After Drawdown: 2
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 ° Cohesion R: 0 psf Phi R: 0 ° Piezometric Line After Drawdown: 2
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 ° Cohesion R: 500 psf Phi R: 22 ° Piezometric Line After Drawdown: 2



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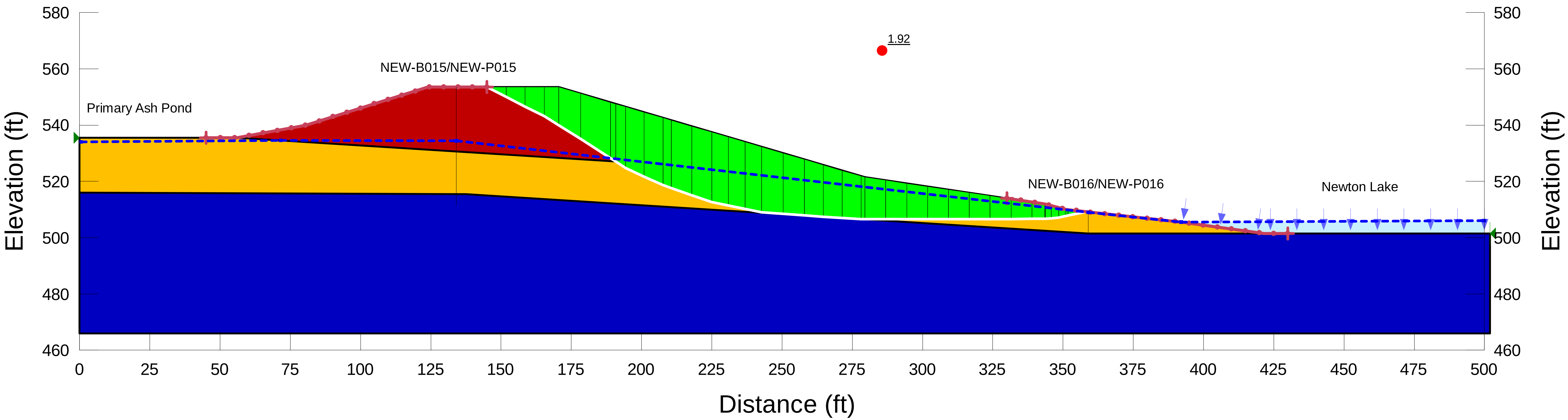
Calculated By: NDS Date: 5/31/16
Checked By: VMCh Date: 6/20/16

Project Name: Newton Primary Ash Pond Stability Analysis-Section K
Project Number: 60501553.02

Analysis: Long Term (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °

Materials
- Upper Clay (Drained)
- Lower Clay (Drained)
- Embankment Fill (Drained)



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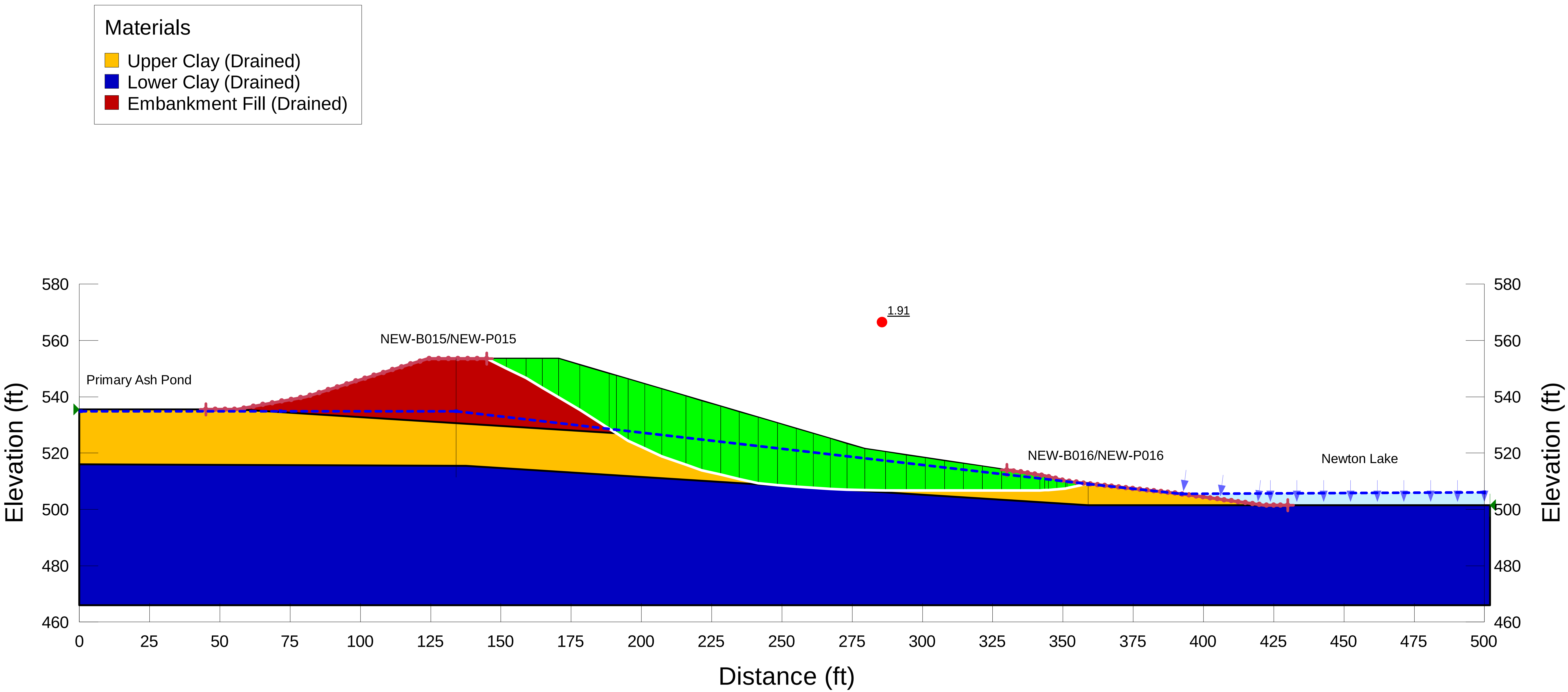
Project Name: Newton Primary Ash Pond Stability Analysis-Section K
Project Number: 60501553.02

Calculated By: NDS Date: 5/31/16
Checked By: VMCh Date: 6/20/16

Analysis: Surcharge (Drained)

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 °
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 °
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 °



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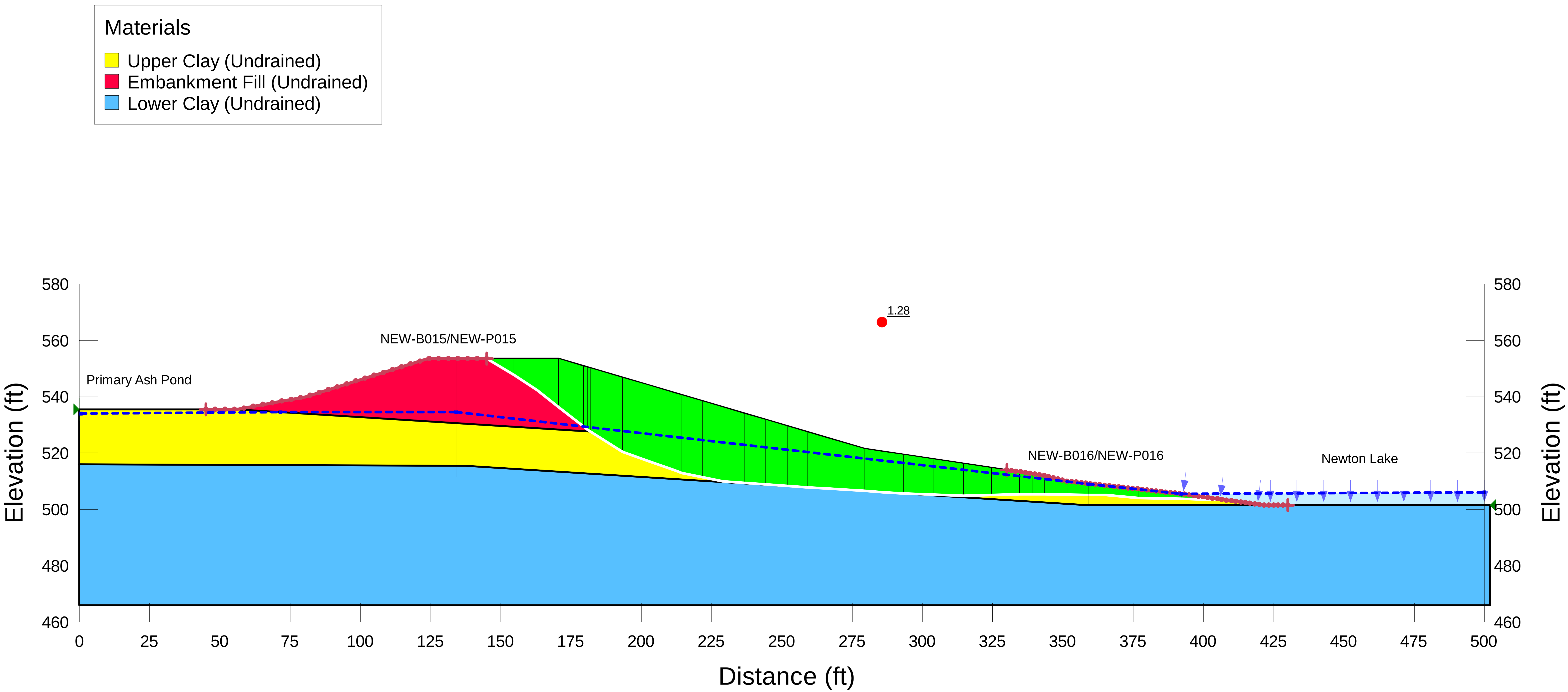
Project Name: Newton Primary Ash Pond Stability Analysis-Section K
Project Number: 60501553.02

Calculated By: NDS Date: 5/31/16
Checked By: VMCh Date: 6/20/16

Analysis: Pseudostatic (Undrained)
Horizontal Seismic Coefficient = 0.153 g

Name: Upper Clay (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Upper Clay (Undrained)
Name: Embankment Fill (Undrained) Model: Shear/Normal Fn. Unit Weight: 130 pcf Strength Function: Embankment Fill (Undrained)
Name: Lower Clay (Undrained) Model: Undrained (Phi=0) Unit Weight: 130 pcf Cohesion': 5,000 psf



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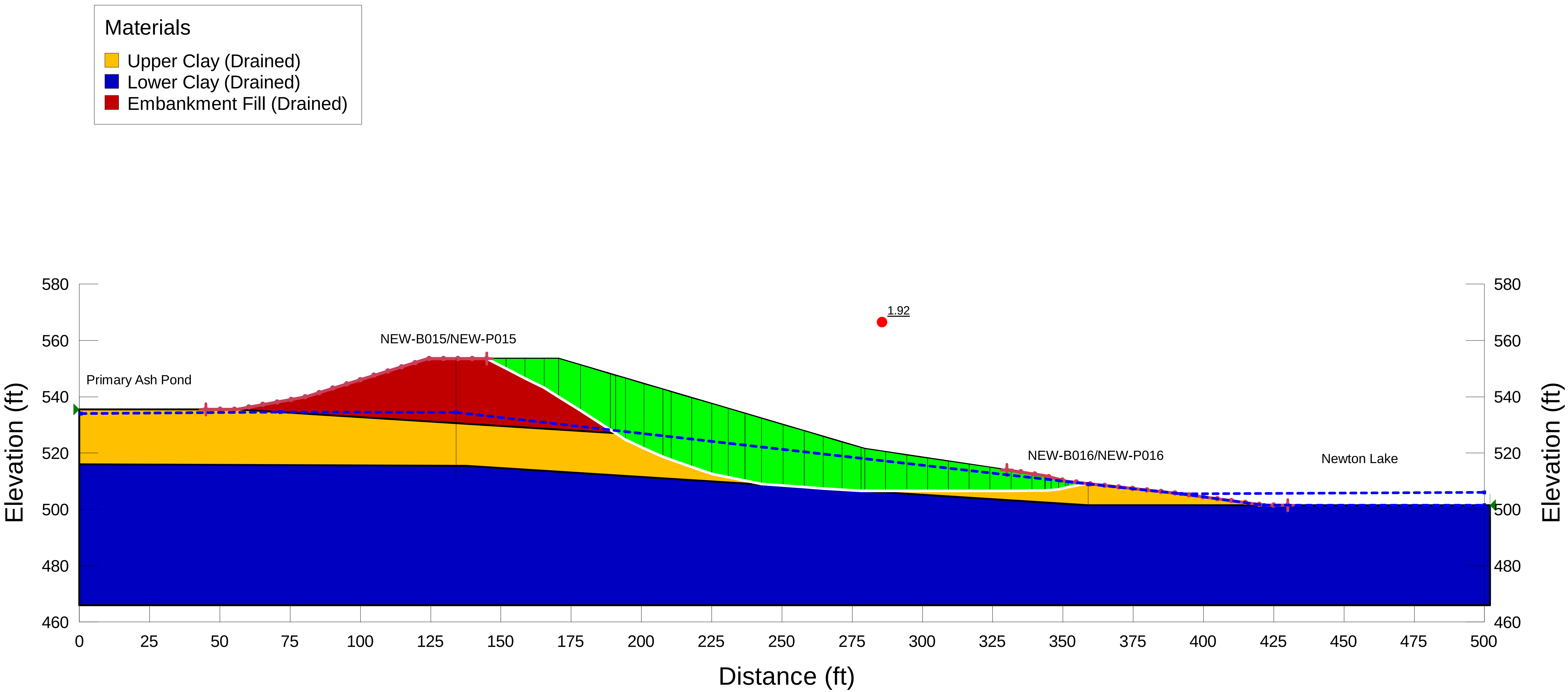
Project Name: Newton Primary Ash Pond Stability Analysis-Section K
Project Number: 60501553.02

Calculated By: NDS Date: 5/31/16
Checked By: VMCh Date: 6/20/16

Analysis: Sudden Drawdown

Name: Upper Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 29 ° Cohesion R: 470 psf Phi R: 22 ° Piezometric Line After Drawdown: 2
Name: Lower Clay (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 3,700 psf Phi': 33 ° Cohesion R: 0 psf Phi R: 0 ° Piezometric Line After Drawdown: 2
Name: Embankment Fill (Drained) Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 31 ° Cohesion R: 500 psf Phi R: 22 ° Piezometric Line After Drawdown: 2



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Attachment F: Probabilistic Seismic Hazard Analysis Report

Final Report

Site-Specific Probabilistic Seismic Hazard Analysis, Site Response Analysis and Development of Time Histories for the Newton Power Station in Southern Illinois

Prepared for

Dynegy
Houston, Texas

12 January 2016

Prepared by

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A site-specific seismic hazard analysis has been performed for the Newton Power Station in southern Illinois to develop Safety Evaluation Earthquake (SEE) ground motions for use in liquefaction and dynamic deformation analyses of the facility. The SEE ground motions consist of acceleration response spectra and time histories. The power station is located in the Midcontinent of the U.S. away from active plate boundaries but in a region that exhibits a moderate level of historical seismicity. The site is capable of experiencing strong ground shaking from moderate to large earthquakes (moment magnitude [**M**] > 6) particularly from the adjacent New Madrid Seismic Zone (NMSZ) and the Wabash Valley Seismic Zone. The New Madrid fault system (NMFS) which is located with the NMSZ produced the series of three **M** > 7 earthquakes in 1811 and 1812. These are the largest earthquakes known to have occurred in the central and eastern U.S. (CEUS).

In this study, four major tasks were performed: 1) seismic source characterization; 2) probabilistic seismic hazard analysis (PSHA); 3) site response analysis; and 4) development of the SEE ground motion parameters. The SEE ground motions are based on a probabilistic assessment of the seismic hazard at the site using the PSHA approach. The annual probability considered in this study was 1/2500 or a return period of 2,500 years. There are two major inputs into a PSHA: a characterization of all seismic sources that can generate significant ground shaking at the site and ground motion prediction models that relate primarily magnitude, distance, and site condition to levels of ground shaking at a site. For the seismic source characterization, we used the recently developed seismic source model developed for the CEUS by the Electric Power Research Institute (EPRI), the U.S. Department of Energy (DOE), and the U.S. Nuclear Regulatory Commission (NRC). This model is being used in the PSHAs for nuclear power plants and other critical facilities in the CEUS.

In a similar fashion, we used the EPRI ground motion prediction models developed in 2013 that are also being used in the PSHAs for nuclear power plants. A limitation of all existing ground motion models for the CEUS including the EPRI models is that they were developed for a hard rock site condition (shear-wave velocity [V_S] of 2,830 m/sec and greater).

The products of the PSHA are hard rock hazard curves and deaggregation information. The deaggregation indicated that the most important seismic sources to the power station site were the Illinois Basin Extended Basement Zone (IBEB) in which the site is located and the NMFS.

The power station is situated on soil and Quaternary glacial till. Hard rock (in this case Precambrian basement rock), is at a depth of greater than 1,645 m. A site response analysis was performed to estimate the ground motions at the top of the glacial till by accounting for any site effects of the geology beneath the site down to basement rock. The inputs required in a site response analysis are a best-estimate V_S profile and dynamic properties of the geologic units beneath the site. A V_S profile was developed from the ground surface down to basement rock based on available data, none of it being site-specific in nature. Dynamic properties were assigned to the unconsolidated materials and firm rock above the basement in the analysis. The hard rock hazard curves from the PSHA were adjusted to the top of the glacial till using amplification factors computed from the site response analysis.

Based on the results of the PSHA and site response analysis, a horizontal SEE Uniform Hazard Spectrum (UHS) was calculated. The SEE UHS is provided in the table below. The SEE peak horizontal ground acceleration (PGA) at the site is 0.18 g. Three sets of two-component horizontal time histories were spectrally matched to the SEE UHS.

2,500-Year Return Period Mean UHS at the Top of Glacial Till

Period (sec)	SA (g)
0.01 (PGA)	0.18
0.02	0.21
0.03	0.23
0.04	0.24
0.10	0.41
0.20	0.40
0.40	0.21
1.0	0.12
2.0	0.07
3.0	0.06
4.0	0.05
5.0	0.04

At the request of Dynegy, a site-specific probabilistic seismic hazard analysis (PSHA) and site response analysis has been performed for the Newton Power Station in southern Illinois to develop Safety Evaluation Earthquake (SEE) ground motions (Figure 1). The SEE ground motions will be used to evaluate the seismic design of the station. Both horizontal acceleration response spectra and acceleration time histories were developed. The hazard was defined at the top of the Quaternary till beneath the site and will be used in liquefaction and deformation analyses of the power station.

The Newton Power Station is located in the Midcontinent region of the U.S. away from active plate boundaries in a region that exhibits a moderate level of historical seismicity (Figure 1). There have been six known earthquakes larger than moment magnitude (**M**) 5.0 within 200 km of the site. The region is capable of experiencing strong ground motions from moderate to large earthquakes (**M** > 6) particularly from the New Madrid Seismic Zone (NMSZ) to the south of the site and the Wabash Valley Seismic Zone (WVSZ) to the east of the site (Figure 1). In 1811 to 1812, a series of three **M** > 7 earthquakes occurred along the New Madrid fault system (NMFS), which is located within the NMSZ.

This report presents the results of the site-specific PSHA, the site response analysis, and development of the horizontal acceleration time histories consistent with the 2,500-year return period SEE Uniform Hazard Spectrum (UHS) at the ground surface.

1.1 SCOPE OF WORK

In site-specific seismic hazard analyses, the available geologic and seismologic data are used to evaluate and characterize (1) potential seismic sources, (2) the likelihood of earthquakes of various magnitudes occurring on those sources, and (3) the likelihood of the earthquakes producing ground motions over a specified level. Based on a site-specific PSHA and site response analysis, SEE spectra and time histories were developed. The following tasks were performed:

Task 1 – Seismic Source Characterization

Seismic source parameters that are needed in order to characterize an active (seismogenic) fault for ground motion hazard assessments include: the geometry and rupture dimensions of the fault; the size of the maximum earthquake; the nature (style) and amount of slip on the fault expected for the maximum earthquake; and the rate and nature of earthquake recurrence. These parameters should be estimated for all significant seismic sources. In addition to the known active faults located in the region that can impact the site, the hazard from buried and unknown faults must also be accounted for. Hence, seismic sources will consist of active and potentially active faults and regional seismic source zones, which account for buried and unknown faults. In this study, we utilized the recently developed seismic source model developed for the central and eastern U.S. (CEUS) by the Electric Power Research Institute (EPRI), the U.S. Department of Energy (DOE), and the U.S. Nuclear Regulatory Commission (NRC). This model is being used in the seismic hazard analyses for nuclear power plants and other critical structures/facilities in the CEUS.

Task 2 – Probabilistic Seismic Hazard Analysis

Site-specific probabilistic ground motions were calculated for the project site for a 2,500-year return period. The PSHA methodology allows for the explicit inclusion of the range of possible interpretations in components of the seismic hazard model, including seismic source characterization and ground motion estimation. Uncertainties in models and parameters were incorporated into the hazard analysis through the use of logic trees. State-of-the-art ground motion prediction models were selected for the types of seismic sources considered in the PSHA. In this case, the EPRI (2013) models for hard rock and the CEUS were used in the PSHA. Hard rock is defined by a V_S30 (time-averaged shear-wave velocity [V_S] in the top 30 m) greater than 2,830 m/sec.

Task 3 – Site Response Analysis

Site response analyses were performed consistent with NUREG/CR-6728 (McGuire *et al.*, 2001) to adjust the hard rock hazard to site-specific free-field ground surface conditions. The inputs into the analyses were V_S profiles representative of the site and non-linear dynamic properties. The V_S profiles were randomized using a correlation model to capture the variability in V_S across the site. A site response analysis was performed to calculate a suite of amplification factors at selected spectral frequencies i.e., PGA, 0.2 and 1.0 sec spectral acceleration and input motions. A state-of-the-art random-vibration-theory (RVT) methodology based on an equivalent-linear approach was used.

Task 4 – Development of SEE Ground Motion Parameters and Final Report

Horizontal SEE response spectra for a 2,500-year return period were developed and provided for the soil-structure interaction (SSI) analysis. A total of three time histories were developed. A final report was produced that describes and summarizes the above analyses.

1.2 ACKNOWLEDGMENTS

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The PSHA approach used in this study is based on the model developed principally by Cornell (1968). The occurrence of earthquakes on a fault is assumed to be a Poisson process. The Poisson model is widely used and is a reasonable assumption in regions where data are sufficient to provide only an estimate of average recurrence rate (Cornell, 1968). The occurrence of ground motions at the site in excess of a specified level is also a Poisson process, if (1) the occurrence of earthquakes is a Poisson process, and (2) the probability that any one event will result in ground motions at the site in excess of a specified level is independent of the occurrence of other events.

The probability that a ground motion parameter "*Z*" exceeds a specified value "*z*" in a time period "t" is given by:

$$p(Z > z) = 1 - e^{-\nu(z) \cdot t} \qquad (2\text{-}1)$$

where $\nu(z)$ is the annual mean number (or rate) of events in which Z exceeds z. It should be noted that the assumption of a Poisson process for the number of events is not critical. This is because the mean number of events in time t, $\nu(z) \bullet t$, can be shown to be a close upper bound on the probability $p(Z > z)$ for small probabilities (less than 0.10) that generally are of interest for engineering applications. The annual mean number of events is obtained by summing the contributions from all sources, that is:

$$\nu(z) = \sum_n \nu_n(z) \qquad (2\text{-}2)$$

where $\nu_n(z)$ is the annual mean number (or rate) of events on source n for which Z exceeds z at the site. The parameter $\nu_n(z)$ is given by the expression:

$$\nu_n(z) = \sum_i \sum_j ß_n(m_i) \bullet p(R=r_j|m_i) \bullet p(Z>z|m_i,r_j) \qquad (2\text{-}3)$$

where:

$ß_n(m_i)$ = annual mean rate of recurrence of earthquakes of magnitude increment m_i on source n;

$p(R=r_j|m_i)$ = probability that given the occurrence of an earthquake of magnitude m_i on source n, r_j is the closest distance increment from the rupture surface to the site;

$p(Z > z|m_i,r_j)$ = probability that given an earthquake of magnitude m_i at a distance of r_j, the ground motion exceeds the specified level z.

The calculations were made using the computer program HAZ38CEUS. The basic program (HAZ38) has been validated in the Pacific Earthquake Engineering Research (PEER) Center-sponsored "Validation of PSHA Computer Programs" Project (Thomas *et al.*, 2010). Modifications were made to HAZ38 to incorporate the CEUS-SSC model and the resulting revision, HAZ38CEUS, was validated by comparing hazard results with the test case results contained in EPRI/DOE/NRC (2012).

The following is a general overview of PSHA methodology used by AECOM. For this study, we have adopted the EPRI/DOE/NRC (2012) seismic source model, which required modifications to our general approach. For a detailed description, see EPRI/DOE/NRC (2012). A sample logic tree is shown on Figure 2. Logic trees such as shown on Figure 3 are used in the EPRI/DOE/NRC (2012) model.

2.1 SEISMIC SOURCE CHARACTERIZATION

Three types of earthquake sources are characterized in the CEUS-SSC model: (1) known fault sources; (2) seismotectonic zones; and (3) Mmax zones. Fault sources are modeled as three-dimensional fault surfaces and details of their behavior are incorporated into the source characterization. The inventory of fault sources in the CEUS is small and undoubtedly incomplete. Given this shortcoming, the historical seismicity is used as a proxy to address the hazard from those buried or unknown faults. The spatial density of the historical seismicity was assumed to be stationary; in this model the recurrence rates per area for each small area were smoothed using a Gaussian filter.

The geometric source parameters for faults include fault location, segmentation model, dip, and thickness of the seismogenic zone (Figure 3). The recurrence parameters include recurrence model, recurrence rate (slip rate or average recurrence interval for the maximum event), slope of the recurrence curve (*b*-value), and maximum magnitude. Clearly, the geometry and recurrence are not totally independent. For example, if a fault is modeled with several small segments instead of large segments, the maximum magnitude is lower, and a given slip rate requires many more small earthquakes to accommodate a cumulative seismic moment. For areal source zones, only the area, seismogenic thickness, maximum magnitude, and recurrence parameters (based on the historical earthquake record) need to be defined (Figure 2).

Uncertainties in the CEUS-SSC source parameters are modeled using logic trees. In this procedure, values of the source parameters are represented by the branches of logic trees with weights that define the distribution of values. Sample logic trees are shown on Figures 2 and 3. In general, three or five values for each parameter were weighted and used in the analysis. Note that the weights associated with the percentiles are not equivalent to probabilities for these values, but rather are weights assigned to define the distribution.

2.1.1 Source Geometry

In the PSHA, it is assumed that earthquakes of a certain magnitude may occur randomly along the length of a given fault or segment. The distance from an earthquake to the site is dependent on the source geometry, the size and shape of the rupture on the fault plane, and the likelihood of the earthquake occurring at different points along the fault length. The distance to the fault is defined to be consistent with the specific ground motion prediction model used to calculate the ground motions. The distance, therefore, is dependent on both the dip and depth of the fault plane, and a separate distance function is calculated for each geometry and each ground motion prediction model. The size and shape of the rupture on the fault plane are dependent on the magnitude of the earthquake, with larger events rupturing longer and wider portions of the fault plane. For a given magnitude, the associated rupture surface is uniformly distributed along the fault length and width. Ruptures are constrained to occur entirely on the defined fault plane.

The rupture dimensions are modeled using magnitude-rupture area and rupture width relationships.

2.1.2 Fault Recurrence

The recurrence relationships for faults are generally modeled using the exponentially truncated Gutenberg-Richter, characteristic earthquake, and the maximum moment (magnitude) recurrence models. These models are weighted to represent judgment on their applicability to the sources. For the areal source zones, only a truncated exponential recurrence relationship is assumed appropriate.

The general approach of Molnar (1979) and Anderson (1979) is often used to arrive at the recurrence for the exponentially truncated model. The number of events exceeding a given magnitude, *N(m)*, for the truncated exponential relationship is

$$N(m) = \alpha(m^o)\frac{10^{-b(m-m^o)} - 10^{-b(m^u-m^o)}}{1 - 10^{-b(m^u-m^o)}} \qquad (2\text{-}4)$$

where $\alpha(m^o)$ is the annual frequency of occurrence of earthquake greater than the minimum magnitude, m^o; *b* is the Gutenberg-Richter parameter defining the slope of the recurrence curve; and m^u is the upper-bound magnitude event that can occur on the source. A m^o of **M** 5.0 was used for the hazard calculations; this value is also used by the USGS in the National Hazard Maps (Frankel *et al*., 1996; Petersen *et al*., 2008).

A popular model often used in PSHA is where faults rupture with a “characteristic” magnitude on specific segments; this model is described by Aki (1983) and Schwartz and Coppersmith (1984). For the characteristic model, the numerical model of Youngs and Coppersmith (1985) is often used. In the characteristic model, the number of events exceeding a given magnitude is the sum of the characteristic events and the non-characteristic events. The characteristic events are distributed uniformly over a ± 0.25 magnitude unit around the characteristic magnitude and the remainder of the moment rate is distributed exponentially up to the characteristic range using the above equation (Youngs and Coppersmith, 1985).

The maximum moment model can be regarded as an extreme version of the characteristic model. The model proposed by Wesnousky (1986) is often used when there is no exponential portion of the recurrence curve, i.e., no events can occur between the minimum magnitude of **M** 5.0 and the distribution about the maximum magnitude.

The recurrence rates for the fault sources are defined by either the slip rate or the average return time for the maximum or characteristic event and the recurrence *b*-value. The slip rate is used to calculate the moment rate on the fault using the following equation defining the seismic moment:

$$M_o = \mu A D \qquad (2\text{-}5)$$

where M_o is the seismic moment, μ is the shear modulus, A is the area of the rupture plane, and D is the slip on the plane. Dividing both sides of the equation by time results in the moment rate as a function of slip rate:

$$\dot{M}_o = \mu A S \tag{2-6}$$

where $\dot{M}_o$ is the moment rate and S is the slip rate. M_o has been related to moment magnitude, **M**, by Hanks and Kanamori (1979):

$$\mathbf{M} = 2/3 \log M_o - 10.7 \tag{2-7}$$

Using this relationship and the relative frequency of different magnitude events from the recurrence model, the slip rate can be used to estimate the absolute frequency of different magnitude events.

The average return time for the characteristic or maximum magnitude event defines the high magnitude (low likelihood) end of the recurrence curve. When combined with the relative frequency of different magnitude events from the recurrence model, the recurrence curve is established.

2.2 GROUND MOTION PREDICTION

To characterize the ground motions at a specified site as a result of the seismic sources considered in the PSHA, we used ground motion prediction models for spectral accelerations (Figure 2; Section 4.2). Ground motion prediction models have at a minimum the variables of magnitude, distance, and site condition (e.g., rock, soil).

The uncertainty in ground motion models was included in the PSHA by using the log-normal distribution about the median values as defined by the standard deviation associated with each model. This distribution was truncated at five standard deviations above the median value predicted by the each model. We have tested our approach using the five sigma truncation against the test cases contained in EPRI/DOE/NRC (2012) where sigma was untruncated. The differences are insignificant.

In this section, we describe the seismotectonic setting and historical seismicity of the site region and the site geology.

3.1 SEISMOTECTONIC SETTING

Newton Power Station is located in southern Illinois, about 30 km west of the WVSZ and 190 km north of the NMSZ (Figure 4). Although the site is located within the continental interior and far from active plate boundaries, the preexisting structures formed in earlier tectonic settings are still capable of generating seismicity that can pose a hazard to the region. This seismicity has included several large historical earthquakes in the region (**M** > 7), e.g., the 1811 and 1812 New Madrid earthquakes (Figure 1).

The CEUS is part of a broad mid-plate compressive stress province that also includes most of Canada (Zoback and Zoback, 1991). Over this large region, the stress field is oriented with a relatively uniform east-northeast direction of maximum horizontal compression. This compression direction corresponds well to the direction of absolute plate motion of the North American Plate, which suggests that a far-field tectonic source such as ridge-push or basal drag at the Mid-Atlantic Ridge may be the primary source of stress in the mid-plate region (Zoback and Zoback, 1991).

3.2 HISTORICAL SEISMICITY

The following is a discussion of the historical seismicity and significant earthquakes in the region surrounding the Newton Power Station.

3.2.1 Historical Seismicity Catalog

A historical seismicity catalog was derived mainly from the CEUS Seismic Source Characterization (CEUS-SSC) catalog (EPRI/NRC/DOE, 2012) (Figure 4). This catalog includes data primarily from the catalog compiled by the U.S. Geological Survey (USGS) for the National Seismic Hazard Mapping Project (Mueller *et al*., 1997; Petersen *et al*., 2008) and from the Geological Survey of Canada (GSC) catalog for seismic hazard analyses (Adams and Halchuk, 2003). The main source for the USGS catalog was the NCEER-91 catalog (Seeber and Ambruster, 1991) which updated the original EPRI-SOG (EPRI 1988) catalog. The catalog was then updated using the National Earthquake Information Center's (NEIC) Preliminary Determination of Epicenters (PDE) and data from the National Earthquake Database (NEDB) of Canada. Researchers reviewed original catalogs and special earthquake studies to verify and if needed update original entries, and regional catalogs were incorporated into the continental scale catalogs described above (see EPRI/NRC/DOE, 2012 for details of special study references and list of regional catalogs used). The CEUS-SSC catalog spans the time period of 1568 to 2008. We updated this catalog with more recent data (up to May 2015) from the Advanced National Seismic System (ANSS) catalog as shown on Figure 1.

All of the events in the USGS catalog used to compile the CEUS-SSC catalog have body-wave (m_b) magnitude values, which were converted to **M** using the equations of Atkinson and Boore (1995):

$\mathbf{M} = -0.39 + 0.98Mn$ for magnitudes ≤ 5.5

$\mathbf{M} = 2.715 - 0.277Mn + 0.127(Mn^2)$ for magnitudes > 5.5

and Johnston (1996):

$\mathbf{M} = 1.14 + 0.24\, m_b + 0.0933\, m_b^2$

Mn (Nuttli magnitude) was considered to be equivalent to m_b. All events in the ANSS catalog that we used to update the CEUS-SSC catalog were Mn or M_D. We converted the ANSS Mn magnitudes to **M** using the average of Atkinson and Boore (1995) and Johnston (1996). For the M_D values, we used the same conversion used in the CEUS-SSC catalog to convert them to **M** values for the Midcontinent U.S. east of 100º W (EPRI/DOE/NRC, 2012).

$\mathbf{M} = 0.869 + 0.762\, M_D$

3.2.2 Significant Earthquakes

The most significant earthquakes to have occurred in the CEUS are the 1811-1812 **M** 7 to 8 New Madrid earthquake sequence and the 1886 **M** 6.8 Charleston, South Carolina, earthquake (Figure 1). The New Madrid earthquake sequence occurred over the winter of 1811-1812 in southeastern Missouri/northeastern Arkansas. This sequence, which was felt as far away as the East Coast (Figure 5), consisted of three principal events on 16 December 1811, 23 January 1812, and 7 February 1812 (referred to as NM1, NM2, and NM3, respectively in Hough *et al*., 2000) (Figure 6). Because the epicentral region was sparsely populated at the time of the events, little structural damage occurred, and the maximum Modified Mercalli (MM) intensity is IX (NM1) as reinterpreted by Hough *et al.* (2000). The power station site probably underwent strong ground shaking of MM VI to VIII in the 16 December 1811 mainshock (Figure 5). The NMSZ is currently the most seismically active area in the CEUS (Figure 1).

The Wabash Valley, which encompasses southern Illinois and southwestern Indiana and is 30 km east of the site, has historically been seismically active with several earthquakes of **M** 4.5 and larger (Figure 4). Hence, the site has been strongly shaken numerous times after the 1811-1812 and 1886 earthquakes. An event on 27 September 1891 occurred near Mt. Vernon, Illinois, which caused chimney damage in the epicentral area (Stover and Coffman, 1993). The size of the earthquake was estimated to be a body-wave magnitude (m_b) 5.8 and the event was felt widely in several states (Figure 7). Shaking at the site could have been as strong as MM V.

On 31 October 1895, an earthquake of estimated surface wave magnitude (M_S) 6.7 struck the northern end of the NMSZ (Figures 1 and 8). This is the largest earthquake to have occurred in the central Mississippi Valley since 1811-1812 (Stover and Coffman, 1993). The event caused extensive damage in the town of Charleston, Missouri. Sand blows due to liquefaction were also reported in the epicentral area (Stover and Coffman, 1993). In the area of the site, the ground shaking was probably MM V (Figure 8).

On 9 November 1968, a m_b 5.5 earthquake struck southern Illinois and neighboring states with a maximum reported MM VII (Figures 1 and 9). Damage consisted of damaged chimneys, broken windows, cracked or fallen plaster, cracked foundations, and scattered instances of collapsed parapets (Stover and Coffman, 1993). The site was probably subjected to MM V ground shaking from this event. Another notable earthquake was the 18 April 2008 **M** 5.4 Southern Illinois earthquake southeast of the site (Figure 1).

On 27 July 1980, a **M** 5.1 earthquake struck the area near Sharpsburg, Kentucky. This event, the strongest in the history of Kentucky, occurred approximately 390 km east of the site and caused over $1 million in property damage (Stover and Coffman, 1993). The site was probably subjected to intensities of MM I to III (Figure 10).

3.3 SITE GEOLOGY

The site lies in the east-central portion of the Illinois Basin, a northwest-southeast oriented regional-scale structural depression that includes Illinois, Indiana, Kentucky and portions of Tennessee and Missouri. The bedrock in the site area dips gently to the southeast toward the center of the Illinois Basin which lies in southern Illinois. Underlying the region is thousands of meters of sedimentary bedrock deposited from Cambrian to Pennsylvanian periods. More recent Quaternary deposits of glacial, loess, and alluvial soils cover the bedrock at depths ranging from tens to hundreds of feet.

The regional bedrock consists of sequences of shale, siltstone, sandstone, coal, and limestone overlying Precambrian crystalline basement rock. The thickness of the sedimentary bedrock units varies and is controlled by depositional environment and geologic structure. The total thickness of the sedimentary rocks in the region is reported to be about 2,000 m based upon oil test borings and seismic profiles (Horberg, 1950).

Pleistocene-aged glacial and loess deposits cover the bedrock at the site. Glacial till deposits from the Illinoian Stage glaciation form dense, compact silts, sand, clay, and gravel mixtures (Frye *et al.*, 1968; Jacobs and Lineback, 1969). Windblown loess, silts blown from river valleys, cover the glacial deposits and are interbedded in select areas with modern alluvium. At the Newton site these unconsolidated deposits are approximately 70 ft at their maximum thickness.

Underlying the Quaternary deposits at the site is a ~1,892 foot-thick section of the Pennsylvanian System that includes sandstone, siltstone, shale, limestone, coal, and clay (Treworgy *et al.*, 1994; Treworgy and Whitaker, 1990). The Pennsylvanian System lies unconformably above the Mississippian strata, which are comprised mainly of limestones and siltstone and to a lesser extent shale, with a total thickness of ~2,200 ft (Treworgy *et al.*, 1994; Treworgy and Whitaker, 1990). A siltstone member of the Mississippian, the Borden Siltstone was interpreted to have lower strength than surrounding limestone rock and was assigned as a separate sub-unit. The Borden Siltstone was estimated from cross-section to be approximately 200 ft thick at the Newton site.

The Devonian System beneath the Mississippian only consists of the Lower Devonian Series at the Newton site: a sequence of carbonate limestone and chert deposits approximately 700 ft in thickness (Treworgy *et al.*, 1994; Treworgy and Whitaker, 1990). Beneath the Devonian, the Silurian System contains a reddish argillaceous limestone to calcareous siltstone, a homogeneous limestone, and a cherty limestone and is estimated to be 400 ft thick at the Newton site (Treworgy *et al.*, 1994; Treworgy and Whitaker, 1990).

Underlying the Silurian, the Ordovician System, approximately 700 ft thick at the site, contains several major groups: the Maquoketa Group, the Galena Group, the Platteville Group and the Joaquim Dolomite (Treworgy *et al.*, 1994; Treworgy and Whitaker, 1990; Horberg, 1950). Formations within these groups consist of the St. Peter Sandstone, the Galena-Platteville

Limestone and Dolomite, and the Maquoketa Shale. The St. Peter Sandstone is a distinct, very well-sorted fine- and medium-grained quartz sandstone. The Galena-Platteville Group is comprised of numerous dolomite and limestone formations of varying composition. The Maquoketa Group, ~300 ft thick at the site, consists of three shale formations and one limestone formation. The Maquoketa Group was estimated to have lower strength than the surrounding dolomite and limestone rock and accordingly this group was assigned as a separate sub-unit of the Ordovician System for the site stratigraphy.

The Cambrian System rocks, primarily siltstone, shale sandstone, and dolomite, are projected to be approximately 3,950 ft thick. Below the rocks of the Cambrian system lie stronger crystalline basement rocks, predominately granite with associated granodiorite and rhyolite.

The following section discusses the two major inputs into the PSHA: the seismic source model and the ground motion prediction models.

4.1 SEISMIC SOURCE MODEL

Seismic source characterization is concerned with three fundamental elements: (1) the location, geometry, and characteristics of significant sources of future earthquakes; (2) the maximum size of these earthquakes; and (3) the rate at which different size earthquakes occur. Two types of seismic sources were considered in this PSHA: discrete fault or fault zone sources and regional seismic source zones.

The seismic source characterization presented here is adopted from the comprehensive seismic source characterization of the CEUS, developed for nuclear facilities by EPRI/DOE/NRC (2012). Two zonation models that account for earthquakes associated with buried or generally unknown faults (background) were characterized and included in the PSHA; these models include multiple zones, many having alternative geometries (Figures 11 and 12). In addition, the source parameters for several fault sources or RLMEs (repeated large magnitude earthquakes) (Figure 11) were characterized for input into the PSHA.

A major challenge in understanding the earthquake potential in the CEUS has been associating the observed seismicity with specific geologic structures. Few active faults are known east of the Rocky Mountains. Thus the traditional approach in addressing the seismic hazard in the CEUS has been to rely on the historical earthquake record in conjunction with seismic source zones that separate regions of different seismotectonic characteristics and hence possibly different earthquake potential. Each seismic source zone is defined and characterized according to geologic, tectonic, and seismicity data. The zones comprise regions having a common geologic history that distinguishes them from neighboring areas. They may have a similar structure (e.g., faults or fractures of similar age, type, orientation), a similar pattern of seismicity, and/or a homogeneous stress regime. The EPRI/DOE/NRC (2012) model retains this methodology by dividing the CEUS into numerous “seismotectonic zones”, defined by differences in various seismic source assessment criteria such as style of faulting, earthquake recurrence, maximum magnitude, seismogenic thickness, etc. The model includes an alternative approach to dividing the CEUS into source zones, which is based solely on the expected maximum magnitude in the zone. This alternative zonation approach divides the study area into “Mmax zones” (Figure 12). The seismotectonic zone approach receives slightly higher weight, 0.6, than the Mmax zone approach, 0.4.

Figures 11 and 12 show the locations of the seismotectonic and Mmax zones, respectively. There are three Mmax zones and 12 seismotectonic zones in the EPRI/DOE/NRC model. The Mmax zones and some seismotectonic zones have one or more alternate geometries. Table 1 summarizes the source zone parameters used in the analysis. (Not all seismic source zones are shown on Figure 11.) The station lies in the Illinois Basin Extended Basin Zone (IBEB) zone, 30 km from the Wabash Valley RLME, 195 km from the Commerce fault zone and 190 km from the New Madrid North fault (NMN) (Figures 6 and 11).

Table 1
Seismic Source Zones Incorporated Into Analysis

Source Zone	Symbol	Mmax (M)[1]	Seismogenic Depth[2] (km)	Area (km^2)
Seismotectonic Zones				
Atlantic Highly Extended Crust	AHEX	6.0 6.7 7.2 7.7 8.1	8 (0.5) 15 (0.5)	177683
Extended Continental Crust–Atlantic Margin Zone	ECC-AM	6.0 6.7 7.2 7.7 8.1	13 (0.4) 17 (0.4) 22 (0.2)	881480
Extended Continental Crust–Gulf Coast	ECC-GC	6.0 6.7 7.2 7.7 8.1	13 (0.4) 17 (0.4) 22 (0.2)	1239288
Gulf Highly Extended Crust	GHEX	6.0 6.7 7.2 7.7 8.1	8 (0.5) 15 (0.5)	509090
Great Meteor Hotspot Zone	GMH	6.0 6.7 7.2 7.7 8.1	25 (0.5) 30 (0.5)	32250
Illinois Basin Extended Basin Zone	IBEB	6.5 6.9 7.4 7.8 8.1	13 (0.4) 17 (0.4) 22 (0.2)	114526
Midcontinent Craton Zone (all alternatives)	MidC	5.6 6.1 6.6 7.2 8.0	13 (0.4) 17 (0.4) 22 (0.2)	4258598 4246625 4025001 4013028
Northern Appalachian Zone	NAP	6.1 6.7 7.2 7.7 8.1	13 (0.4) 17 (0.4) 22 (0.2)	378331
Oklahoma Aulacogen Zone	OKA	5.8 6.4 6.9 7.4 8.0	15 (0.5) 20 (0.5)	53583

Source Zone	**Symbol**	**Mmax (M)[1]**	**Seismogenic Depth[2] (km)**	**Area (km^2)**
Paleozoic Extended Crust (Narrow and Wide alternatives)	PEZ	5.9 6.4 6.8 7.2 7.9	13 (0.4) 17 (0.4) 22 (0.2)	365395 598992
Reelfoot Rift Zone	RR	6.2 6.7 7.2 7.7 8.1	13 (0.4) 15 (0.4) 17 (0.2)	69479
Reelfoot Rift with Rough Creek Graben Zone	RR and RR_RCG	6.1 6.6 7.1 7.6 8.1	13 (0.4) 15 (0.4) 17 (0.2)	81452
St. Lawrence Rift Zone	SLR	6.2 6.8 7.3 7.7 8.1	25 (0.5) 30 (0.5)	329322
Mmax Zones				
Mesozoic and Younger Extended Crust - Narrow	MESE-N	6.4 6.8 7.2 7.7 8.1	13 (0.4) 17 (0.4) 22 (0.2)	3616923
Mesozoic and Younger Extended Crust - Wide	MESE-W	6.5 6.9 7.3 7.7 8.1	13 (0.4) 17 (0.4) 22 (0.2)	4342413
Non-Mesozoic and Younger Extended Crust - Narrow	NMESE-N	6.4 6.8 7.1 7.5 8.0	13 (0.4) 17 (0.4) 22 (0.2)	4792101
Non-Mesozoic and Younger Extended Crust - Wide	NMESE-W	5.7 6.1 6.6 7.2 7.9	13 (0.4) 17 (0.4) 22 (0.2)	4066611
Study Region	Study Region	6.5 6.9 7.2 7.7 8.1	13 (0.4) 17 (0.4) 22 (0.2)	8409024

Notes:

1 Weights for all magnitude distributions are 0.101/0.244/0.310/0.244/0.101, a discrete five-point approximation to an arbitrary continuous distribution (EPRI/DOE/NRC, 2012).

2 Weights for depth in parentheses

The EPRI/DOE/NRC (2012) model includes sources defined based on RLMEs rather than only fault sources. Many of the RLMEs correlate with identified geologic faults, but some are defined solely by geographically clustered paleoliquefaction events that suggest a localized source even if the responsible fault has not been identified and characterized. The site lies adjacent to the Wabash Valley RLME. Although quite distant from the site, we include the Charleston source (Figure 11) in the PSHA because its maximum earthquakes and relatively high activity rates often dominate the hazard in the CEUS, particularly at long-period ground motions. Tables 2 and 3 summarize the RLME (fault) source parameters used in the analysis.

4.1.1 Seismotectonic Zones

This section describes the seismotectonic characteristics of the most significant seismotectonic zones to the site, the basis for delineating the zones and for defining the model values for style of faulting, geometry, seismogenic depth, and Mmax. Recurrence for the zones is discussed in Section 4.1.3.

Illinois Basin Extended Basement Zone (IBEB)

The Illinois Basin Extended Basement Zone (IBEB) encompasses southwestern Indiana and southeastern Illinois; the site is located in the IBEB (Figure 11). Southern Indiana and southern Illinois are characterized by several moderate-sized paleoearthquakes and by higher rates of seismicity than adjacent craton regions (Figure 4). Several characteristics combine to support the delineation of IBEB as a separate seismotectonic zone. The southern part of the Illinois basin is one of the most structurally complex areas of the Midcontinent (McBride *et al.*, 2002), with a crust distinct from that of the neighboring craton. Numerous moderately dipping reflectors interpreted to be faults are present in the basement. Moderate-sized historical earthquakes that appear to be spatially associated with Precambrian basement faults and with Paleozoic faults suggest continued reactivation of older basement features as well as younger Paleozoic structures (McBride *et al*., 2002). Stresses induced by Mesozoic rifting possibly extend into the southern Illinois basin causing the reactivation of deep structures (Braile *et al*., 1984). The IBEB is defined to characterize sources of moderate- to large-magnitude earthquakes (excluding those attributed to the Wabash Valley RLME source) that may occur on deep structures in the Precambrian basement and as Paleozoic faults that extend into the overlying Paleozoic sedimentary rocks (EPRI/DOE/NRC 2012).

Fault dips are generalized based on sense of slip, with strike-slip ruptures assigned steep dips between 70° and 90° and reverse ruptures assigned moderate dips between 40° and 70°. Seismogenic thickness ranges from 13 to 22 km, the default values for the entire study area (EPRI/NRC/DOE, 2012). The seismogenic thickness is based on reported depths of seismicity within the IBEB. The deepest well-constrained earthquake hypocenters in the deep part of the Illinois basin, are located at depths of 20 to 22 km (McBride *et al.*, 2002; Yang *et al*., 2009). However, the average depth throughout the IBEB based on other historical earthquakes may be less (EPRI/DOE/NRC, 2012).

Table 2
New Madrid Fault System RLME Source Model

Cluster?	wt	Localizing Structures	Southern Fault Geometry	wt	Northern Fault Geometry	wt	Central Fault Geometry	wt	Thickness (km)	wt	Mmax	wt	Recurrence method	wt	Recurrence Data	wt	Earthquake Recurrence Model	wt	Repeat Time Coefficient of Variation	wt	Rate (yrs)	wt
All In	0.9	NMS NMN RFT	BA-BL	0.6	NMN-S	0.7	RFT-S	0.7	13	0.4	NMS, RFT, NMN 7.9, 7.8, 7.6	0.167	Intervals	1.0	1811-1812, 1450, and 900 AD	1.0	Poisson	0.75	NA		167	0.101
																					270	0.244
																					417	0.310
																					714	0.244
																					1613	0.101
											7.8, 7.7, 7.5	0.167	same as above				Renewal	0.25	0.3	0.2	286	0.101
											7.6, 7.8, 7.5	0.25									909	0.244
											7.2, 7.4, 7.2	0.085									3125	0.310
											6.9, 7.3, 7.0	0.25									15625	0.244
											6.7, 7.1, 6.8	0.085									212766	0.101
									15	0.4	same as above								0.5	0.5	208	0.101
									17	0.2											455	0.244
							RFT-L	0.3	same as above												1124	0.310
					NMN-L	0.3	same as above														3846	0.244
																					32258	0.101
			BA-BFZ	0.4	same as above														0.7	0.3	227	0.101
																					455	0.244
																					1000	0.310
																					2941	0.244
																					21277	0.101
All out except RFT	0.05	RFT	NA		NA		RFT-S	0.7	13	0.4	7.8	0.167	Intervals	1.0	2000 BC and 1000 AD	1.0	Poisson	1.0	NA		769	0.101
																					1389	0.244
																					2381	0.310
																					4545	0.244
																					12500	0.101
											7.7	0.167	same as above									
											7.8	0.25										
											7.4	0.085										
											7.3	0.25										
											7.1	0.085										
									15	0.4	same as above											
									17	0.2												
							RFT-L	0.3	same as above													
All Out	0.05	None	Revert to background																			

Table 3
RLME (Fault) Sources Incorporated Into Analysis

Fault	Geometry	Style of Faulting[1]	Mmax (M)	Dip (deg)	Seismogenic Thickness (km)	Recurrence Data[2]	Recurrence Interval (yr)[3]
Reelfoot Rift - Eastern Rift Margin Fault (ERM)							
ERM-N	ERM-N (1.0)	SS	6.7 (0.3) 6.9 (0.3) 7.1 (0.3) 7.4 (0.1)	90	13 (0.3) 15 (0.5) 17 (0.2)	1 event in 12-35 kyr (0.9)	3448 6667 12500 25000 71429
						2 events in 12-35 kyr (0.1)	2564 4545 7692 13889 31250
ERM-S	ERM-SCC (0.6)	SS	6.7 (0.15) 6.9 (0.2) 7.1 (0.2) 7.3 (0.2) 7.5 (0.2) 7.7 (0.05)	90	same as above	2 events in 17.7-21.7 kyr (0.333)	2857 4762 7143 12500 27778
						3 events in 17.7-21.7 kyr (0.334)	2326 3571 5263 8333 16129
						4 events in 17.7-21.7 kyr (0.333)	2000 2941 4167 6250 11111
	ERM-SRP (0.4)	same as above	same as above	same as above	same as above	same as above	same as above
Reelfoot Rift-Marianna In cluster (0.5) [Out of cluster (0.5) - default to background]	Marianna NW-strike (0.5)	SS	6.7 (0.15) 6.9 (0.2) 7.1 (0.2) 7.3 (0.2) 7.5 (0.2) 7.7 (0.05)	90	13 (0.3) 15 (0.5) 17 (0.2)	3 events in 9.6-10.2 kyr	1449 2381 3704 6250 13889
						4 events in 9.6-10.2 kyr	1190 1818 2703 4167 8333
	Marianna NE-strike (0.5)	same as above	same as above	same as above	same as above	same as above	same as above

Fault	Geometry	Style of Faulting[1]	Mmax (M)	Dip (deg)	Seismogenic Thickness (km)	Recurrence Data[2]	Recurrence Interval (yr)[3]
Reelfoot Rift - Commerce Fault Zone	Commerce fault (1.0)	SS	6.7 (0.15) 6.9 (0.35) 7.1 (0.35) 7.3 (0.1) 7.7 (0.05)	90	13 (0.3) 15 (0.5) 17 (0.2)	2 events in 18.9-23.6 kyr	4000 7143 12500 25000 71429
						3 events in 18.9-23.6 kyr	3030 5000 7692 13158 29412
Wabash Valley	Wabash Valley zone (1.0)	SS	6.75 (0.05) 7 (0.25) 7.25 (0.35) 7.5 (0.35)	90		2 events in 11-13 kyr	2273 4000 7143 13889 41667
Charleston	Local (0.5)	SS	6.7 (0.1) 6.9 (0.25) 7.1 (0.3) 7.3 (0.25) 7.5 (0.1)	90	13 (0.4) 17 (0.4) 22 (0.2)	2,000-yr record (0.8) 4 events in 2 kyr (1.0)	213 323 476 769 1471
						5,500-yr record (0.2) 4 events in 5.5 kyr (0.2)	213 323 476 769 1471
						5 events in 5.5 kyr (0.3)	370 526 769 1136 2000
						5 events in 5.5 kyr (0.2)	526 769 1086 1562 2941
						6 events in 5.5 kyr (0.3)	455 667 909 1282 2174
	Narrow (0.3)	SS	same as above	90	same as above	same as above	same as above
	Regional (0.2)	SS	same as above	90	same as above	same as above	same as above
New Madrid Fault System (NMFS)	see Table 2						

Note: Values in parentheses are weights. All faults are modeled with the Characteristic recurrence model

[1] SS Strike-slip

[2] "Recurrence Data" describes datasets used to calculate recurrence intervals.

[3] Weights for all distributions are: 0.101/0.244/0.310/0.244/0.101.

The largest earthquakes in the IBEB include an August 1891 **M** 5.5 event, a September 1891 **M** 5.0 event in eastern Nebraska, and a 2008 **M** 5.3 event. Four prehistoric earthquakes inferred from the paleoliquefaction studies have estimated magnitudes (**M** 6.2 to 6.3) that are larger than the historical earthquakes (EPRI/DOE/NRC, 2012). Maximum magnitudes modeled in the IBEB range from **M** 6.5 to 8.1, with a value of **M** 7.4 being preferred.

Reelfoot Rift Zone (RR)

The Reelfoot Rift Zone (RR) is a north-northeast-trending major crustal rift located within the Mississippi Embayment of the south-central United States (Figure 11). The RR originally formed in late Precambrian to early Paleozoic time during the breakup of Rodinia and Iapetan rifting (Bond *et al*., 1971; Hildenbrand, 1985; Thomas, 2006), but experienced middle to late Paleozoic uplift and Mesozoic extension and deposition (Kolata and Nelson, 1991). Geologic evidence for faulting from post-Cretaceous to Holocene time in the RR and adjacent areas includes shallow seismic reflection data (Koffi *et al*., 1997; Schweig and Van Arsdale, 1996; Sexton *et al*., 1996); faulting and fault-related deformation exposed in exploratory trenches (Kelson *et al*., 1996); and regional paleoliquefaction features (Tuttle and Schweig, 1995; Tuttle *et al*., 1996a and 1996b; Tuttle and Schweig, 1996; Wolf *et al*., 1996).

The RR contains several RLME sources in the EPRI/DOE/NRC source model, including the NMFS, the Eastern Rift Margin (ERM), Marianna zone (MAR), and Commerce fault zone (CFZ) (Figure 6). The NMFS is discussed in detail in Section 4.1.4 because of its relatively high rate of activity.

The RR is characterized by having experienced Mesozoic extension and having a higher rate of seismicity than the surrounding MidC cratonic seismotectonic zone, as well as containing a unique concentration of Quaternary active faults. The RR has two alternative geometries, based on inclusion or exclusion of the east-west-trending Rough Creek graben. The Rough Creek graben was formed as part of the late Proterozoic-Cambrian Iapetan intracontinental rifting episode that created the RR. Some structures may have been reactivated during the Appalachian-Ouachita Orogeny (Kolata and Nelson, 1991) like the RR. However, due to the lack of associated igneous rocks, Wheeler (1997) infers that deeply penetrating faults were not reactivated. This coupled with the different strike of the major faults in the RCG compared to those in the RR leads EPRI/DOE/NRC (2012) to put lower weight (0.33) on the combined RR-RCG zone; rather, they prefer to include the RCG in the MidC zone.

The largest historical earthquakes in the RR are the 1811-1812 **M** 7.5 to 8 events, which are included in the characterization of the NMFS RLME (Figure 6). Large magnitude paleoseismic events are also included in nearby RLME characterizations. The largest non-RLME historical earthquakes include two approximately **M** 6 events in 1843 and 1895. The Mmax distribution for the RR ranges from **M** 6.1 to **M** 8.1, with a preferred value of **M** 7.1 (Table 1). Seismogenic depth in the RR, based on seismicity, ranges from 13 to 17 km.

Midcontinent-Craton Zone (MidC)

The MidC zone occupies most of the CEUS study area, dominating the central United States and encompassing most of the Great Plains area (Figure 11). The MidC includes those regions of the continent that have not occupied the Phanerozoic continental margin, specifically Precambrian basement rocks of the Canadian shield and the platform (EPRI/DOE/NRC, 2012). The craton was formed by Paleoproterozoic accretion and now forms a cold, strong crustal core to the continent. Two orthogonal sets of structures, northeast-striking ductile shear zones and northwest-striking brittle-ductile faults dominate the Precambrian basement structure (Sims *et al*., 2005). Numerous geophysical anomalies have been observed within the MidC zone and may represent zones of crustal weakness that could localize future seismicity. Seismicity in the MidC zone is spatially variable and includes a few concentrations of activity that constitute seismic zones within the greater seismotectonic zone, such as the Anna seismic zone and Northeast Ohio seismic zone in Ohio, and the Nehama Ridge seismic zone in Kansas.

The fundamental distinguishing characteristic of the MidC is that it contains crust that has not experienced Mesozoic or younger extension, and generally not Paleozoic extension either. The characterization of the seismotectonic zone includes four alternative geometries, based on the inclusion or exclusion of smaller Midcontinent regions. These smaller zones include a northeast-trending band of crust along the Appalachian Mountains that is included either within the PEZ or within the MidC zone, and the Rough Creek Graben, which is included either in the RR or in the MidC zone (Figure 11).

The largest earthquakes in the MidC include a 1909 **M** 5.7 event in eastern Montana, an 1877 **M** 5.5 event in eastern Nebraska, and a 1964 **M** 4.8 earthquake in eastern Ontario. Maximum magnitudes have a broader distribution in the MidC than most other seismotectonic zones, ranging from **M** 5.6 to 8.0, with a value of **M** 6.6 being preferred.

Few data exist to characterize independently the deep Precambrian structures within the intracratonic MidC region on which future earthquakes might be preferentially located. Thus the characterization of the MidC region is equivalent to what EPRI/DOE/NRC (2012) calls the "default" seismotectonic characteristics, representative of the entire study region. Thus both strike-slip and reverse mechanisms are included, with a 2/3 weight on strike-slip, reflecting the occurrence of both mechanisms in focal mechanism data, the state of stress, and the orientation of existing geologic structures in the region. Strikes include northwest, north-south, northeast and east-west orientations, determined based on focal mechanism data, tectonic stress, and structural grain within the study area. The dips are generalized based on sense of slip, with strike-slip ruptures assigned steep dips between 60° and 90° and reverse ruptures assigned moderate dips between 30° and 60°. Seismogenic thickness ranges from 13 to 22 km.

4.1.2 Mmax Zones

The Mmax zones are based on the observation that within the global catalogue of earthquakes within stable continental regions, there is little to distinguish any of them in a statistically significant way except that larger earthquakes seem to occur more commonly within those parts of the stable continental regions that have undergone extension, especially Mesozoic or younger extension (Johnston *et al*., 1994). Consequently, the zonation model is based on using global analogues to characterize the maximum magnitudes, with regions divided into extended and cratonic categories, each with a different distribution of maximum magnitudes. We adopt the zone boundaries and maximum magnitude distribution of EPRI/DOE/NRC (2012). The maximum magnitude distributions are used for the background seismicity.

The EPRI/DOE/NRC statistical analysis of the global database of earthquakes in stable continental regions (SCR) showed that the distinction between Mesozoic extended crust and non-extended crust noted by Johnston *et al*. (1994), while present, is only marginally significant. Therefore, within the Mmax zonation approach, two models are included: 1) the CEUS is divided into two Mmax zones, each with its own Mmax distribution, based on the presence or absence of Mesozoic-extended crust, and 2) the CEUS can be described by a single Mmax zone with a single Mmax distribution (Figure 12). The former model has slightly higher weight because of the marginally significant difference observed in the statistical analyses.

Mesozoic and Younger Extended Crust (MESE)

The Mesozoic extended zone (MESE) includes areas that underwent Paleozoic and Mesozoic or younger extension and includes the Atlantic and Gulf coastal regions as well as the failed rifts in the central U.S. (including the RR and southern Oklahoma aulocogen) (Figure 12). The site is located within the MESE-W and the NMESE-N (Figure 12).

Non-Mesozoic and Younger Extended Crust (NMESE)

The Non-Mesozoic and Younger extended crust (NMESE) includes that part of the CEUS stable continental region that has not undergone Mesozoic or younger extension. This includes primarily interior cratonic regions and overlaps significantly with the MidC seismotectonic zone (Figure 12).

The boundaries between the extended and non-extended Mmax zones have two alternatives, reflecting uncertainty in the geographic extent of extended crust (Figure 12). The MESE-N (N = “narrow”) zone includes regions that have definitively experienced Mesozoic extension as inferred based on the presence of certain distinguishing characteristics. These may include: Mesozoic grabens and rift basins, Mesozoic and younger plutons, Mesozoic and younger uplift and unroofing associated with normal faulting (EPRI/DOE/NRC, 2012). Generally, regions that meet most of these criteria are considered to be extended and are assigned to the MESE-N zone. Regions with less compelling evidence, such as localized Mesozoic and younger reactivation of older structures or the presence of structures favorably oriented for reactivation, are less certainly extended and are assigned to the MESE-W (W = “wide”) zone. The NMESE-N and NMESE-W zones include the rest of the CEUS region outside the MESE-N and MESE-W zones, respectively (Figure 12). The narrow boundary, dividing definitively extended crust from the rest of the craton receives most of the weight (0.8) due to the lack of clear evidence for extension in the MESE-W zone.

The narrow and wide geometry for each zone has its own maximum magnitude distribution for this region, based on the largest historical earthquake known in each zone. These appear in Table 1 (Table 6.3.2-1 in EPRI/DOE/NRC, 2012).

Study Region

The single-zone alternative of the Mmax zone model includes the Study Region (StudyR) source zone (Figure 12), which encompasses the entire study area, which is represented by a single Mmax distribution. The distributions for seismogenic depth and Mmax for this zone appear in Table 1.

4.1.3 Recurrence for Seismic Zonation

The CEUS-SSC model is based on the spatial stationarity of seismicity, which is defined from small- to moderate-magnitude earthquakes that have occurred during a relatively short historical and instrumental record (EPRI/DOE/NRC, 2012).

For the seismotectonic and Mmax source zones, the seismicity rates are determined from the historical seismicity catalog. All dependent earthquakes were removed from the catalog, and earthquakes associated with the RLME sources were also removed to avoid double-counting. The cell size for all seismotectonic source zones except MidC was 0.25 degrees; the cell size for MidC was set to 0.5 degrees. The spatial smoothing operation, a penalized-likelihood function, is based on calculations of earthquake recurrence within each cell. Both *a*- and *b*- values are allowed to vary, but the degree of variation has been optimized such that *b*-values vary little across the study region, and the *a*-values are neither too smooth or spikey. Also, the recurrence calculations consider weighting of magnitudes in the recurrence rate calculations, with moderate events assigned more weight than smaller events.

Five alternative cases were considered for weights, which affect the degree of smoothing, for various magnitude bins; Cases A, B, C, D, and E (EPRI/DOE/NRC, 2012). Case C was dropped as it is very similar to Case B, and Case D was considered too extreme. Thus for each source zone three magnitude weighted cases were used: A, B, and E, with weights of 0.3, 0.3, and 0.4, respectively.

Furthermore, more than point estimates of the recurrence parameters are needed as modern PSHA requires an assessment of the epistemic uncertainty associated with these estimates, including correlations between the recurrence parameters of cells in the same geographical region, which may jointly affect the hazard at one site. The approach used to generate alternative maps of the recurrence parameters uses a technique known as Markov Chain Monte Carlo (MCMC) (EPRI/DOE/NRC, 2012).

This resulted in eight alternative maps representing the uncertainty in recurrence parameters that result from the limited duration of the catalog. If the smoothing parameters are treated as uncertain and estimated objectively from the data, the eight alternative maps also include the uncertainty about the appropriate values of the smoothing parameters. The eight realizations are equally weighted. For computational efficiency, the mean of the eight realizations was utilized in these calculations.

4.1.4 RLME

The following describes the Wabash Valley and New Madrid fault system RLMEs, which are the most significant RLMEs to the site.

Wabash Valley Fault Zone

The north-northeast-trending Wabash Valley fault system (WVFS) consists of numerous high-angle oblique-slip faults that comprise a broad 80-km-long zone located within the limits of the Grayville graben. The Wabash Valley RLME as defined in the CEUS-SSC model is significantly longer than the WVFS proper and extends north to include the Vincennes, Indiana area (Figures 6 and 11). The Grayville graben formed during Iapetan rifting (Hildenbrand and Ravat, 1997;

EPRI/DOE/NRC, 2012). Direct evidence for neotectonic activity, including exposures of Quaternary displacement, was documented along the WVFS by Woolery (2005). He interpreted offset of a reflector, identified as a late Quaternary (ca 37,000 years old) sand, revealed in high-resolution seismic reflection profiles as due to displacement across the Hovey Lake fault at the south end of the WVFS. More recent work by Counts *et al*. (2009) and Van Arsdale *et al*. (2009) has identified Holocene deformation across the Uniontown scarp, part of the Hovey Lake fault. Van Arsdale *et al*. (2009) excavated a trench exposing 3500-year-old Ohio River alluvium that had been folded in a monocline with a 3-m amplitude, and also observed fractures within a younger unit that indicate possible activity within the last 295 years. For the most part, activity of the WVFS is indicated by historical seismicity and the aforementioned paleoliquefaction features. The historic seismicity includes five slightly damaging earthquakes of body-wave magnitude (mb) 5.0 to 5.8 during 200 years of historical time (Figure 4).

The maximum magnitude estimates adopted from the EPRI/DOE/NRC (2012) CEUS source characterization of the Wabash Valley RLME are based on analysis of paleoliquefaction features in the vicinity of the lower Wabash Valley of southern Illinois and Indiana. The magnitude of the largest paleoearthquake in the lower Wabash Valley (the Vincennes-Bridgeport earthquake), which occurred 6,011 ± 200 yr BP, was estimated to be ≥ **M** 7.5 using the magnitude-bound method (Obermeier, 1998). Use of a more recently developed magnitude-bound curve for the CEUS gives a lower estimate of **M** 7.1 to 7.3 (Olsen *et al*. (2005). The lower-bound relationship developed by Castilla and Audermard (2007) from a worldwide database gives a range of **M** 7.0 to 7.3. Estimates based on a suite of geotechnical analyses (cyclic stress and energy stress methods) range from **M** 7.5 to 7.8 (summarized in Obermeier *et al*., 1993). The next largest earthquake, the Skelton paleoearthquake, occurred 12,000 ± 1,000 yr BP (Obermeier, 1998). Lower and upperbound magnitude range from **M** 6.3 to 7.3 based on estimates by Munson *et al*. 1997, Olsen *et al*., 2005 and Castilla and Audemard (2007). The magnitude distribution of the EPRI/DOE/NRC (2012) CEUS source model (Table 3) incorporates the range of estimated sizes of the Vincennes-Bridgeport and Skelton paleoearthquakes as representative of both the aleatory variability in the size of individual Wabash Valley RLMEs and the epistemic uncertainty in the approaches and data used to estimate the magnitudes of prehistoric earthquakes.

The recurrence rates for the Wabash Valley RLME (Table 3) are based on the estimated ages for the Vincennes-Bridgeport and Skeleton paleoearthquakes using a Poisson model (EPRI/DOE/NRC, 2012).

New Madrid Fault System (NMFS) RLME

The New Madrid Seismic Zone (NMSZ) is the most likely site of the 1811-1812 New Madrid earthquake sequence, which includes three of the largest earthquakes to have occurred within the North American plate in historical times (Johnston and Shedlock, 1992) (Figure 6). The pattern of seismicity and surface uplift is generally interpreted as delineating a left-stepping, right-lateral, strike-slip fault system (Cox *et al*., 2001; Johnston and Schweig, 1996). Johnston and Schweig (1996) developed faulting models for the 1811-1812 sequence based on geological, geophysical, seismological, and historical data. They concur with the commonly held assumption that the current seismicity is illuminating the most active faults; i.e., those that ruptured in 1811–1812 and also prior to 1811.

Schweig and Ellis (1994) and Johnston and Schweig (1996) provide summaries of the seismological, geodetic, and paleoseismologic data that have been used to assess the repeat times of large-magnitude events in the New Madrid region. In addition, Wheeler and Perkins (2000) provide additional information from the 2002 USGS National Hazard Maps for the CEUS. Correlation of dated liquefaction features suggest that widespread liquefaction occurred within the zone in A.D. 1811-1812, 1450, 900, 300 as well as about 2350 B.C. (Tuttle *et al*., 2005). Liquefaction deposits can constrain the ages of prehistoric events but not the causative faults. However, several of the prehistoric liquefaction deposits are composite, indicating they were formed in multiple episodes within a short period and thus may have occurred in a rapid sequence of large earthquakes similar to the 1811-1812 sequence.

The occurrence of two large events in A.D. ~900 and 2500-1400 B.C. is supported by recent studies of Mississippi River channel morphology that suggest that the Mississippi River changed its course in response to a sudden localized change in base level at those times (Holbrook *et al*., 2006). That change in base level is attributed to uplift of the downstream side of the channel across the Reelfoot reverse fault (described below).

These paleoseismic results indicate a recurrence interval of about 500 years for large earthquakes or earthquake sequences in the NMSZ over the past 2,000 years. The absence of paleoseismic evidence for earthquakes between 300 A.D. and 2200-2350 B.C. has been cited as indicative of temporal clustering of earthquakes in the NMSZ, with large earthquakes or earthquake sequences happening every few hundred years over a period of time followed by a long hiatus in activity (Holbrook *et al*., 2006). However, at this point it remains uncertain if the lack of events documented between A.D. 300 and 2200 B.C. in New Madrid is due to clustering or an incomplete paleoseismic record.

The possibly clustered behavior in the NMSZ, coupled with the discovery of paleoliquefaction features in the RR (indicative of large earthquakes between about 5,000 and 7,000 years ago but not during the New Madrid cycles), has led to the suggestion that the locus of earthquake activity moves around the RR on time scales of 5 to 15 kyr. In this model, the New Madrid region is the current, or most recent, locus of activity, but other areas have been so in the past, and the locus may shift again.

In the seismic source model, the elevated seismicity in the NMSZ is included in the RR seismotectonic zone, whereas large historical and paleoseismic events that likely occurred on the structures that ruptured in 1811-1812 are modeled as part of the NMFS RLME, in keeping with the CEUS-SSC model. The source zone accommodates the hazard from background seismicity; the NMFS contributes an additional hazard (Tables 1 and 2). In the seismic source model, the NMFS comprises three distinct fault zones, located within the NMSZ source zone (Figure 6). The three NMFS faults, defined after the models of Van Arsdale (2000) and Johnston and Schwieg (1996), include: 1) the southern section (NMS), comprising the Blytheville arch (BA), extending into the Blytheville fault zone (BFZ) and Bootheel lineament (BL) area, 2) the central section, comprising the Reelfoot reverse fault (RFT), and 3) the northern section, comprising the New Madrid North fault and the Northwestern Seismicity Arm (NMN) (Figure 6; Table 2). Each of these sections ruptured to produce the 1811 and 1812 earthquakes.

The faults of the NMFS are defined primarily based on concentrations of seismicity as geomorphic expression of faulting is poor; only the RFT is well expressed as a definitively tectonic feature. Several different geologic faults have been postulated as the source of the events but there remains considerable uncertainty in defining the causative faults. The southern and northern sections of the fault system are northeast-striking features that are probably ancient faults related to rifting that have been reactivated in the modern stress regime as primarily right-lateral strike-slip faults. Focal mechanisms from these areas are consistent with predominantly dextral motion. The RFT strikes northwest and dips southwest; earthquakes associated with it have a variety of focal mechanisms. The fault has been described as a cross-structure in a compressional left step between right-lateral strike-slip faults.

Van Arsdale (2000) reports that the first of the 1811 and 1812 earthquakes, the NM1 event in December 1811, occurred on the southern section (NMS), which extends about 110 km (69 mi) from northeastern Arkansas to the southeastern bootheel of Missouri (EOI, 2008). The rupture occurred along the Blytheville arch, a 10 to 15-km wide northeast-trending Paleozoic upwarp that lies along the axis of the RR, and extended northeast of the arch proper. Van Arsdale (2000) considers that the event may have resulted from rupture of the 65-km long, steeply dipping to vertical, dextral-oblique Cottonwood Grove-Ridgely fault. Johnston and Schweig (1996) assign the northern extension of the rupture to the Blytheville fault, a 55-km long structure that continues on trend with the Blytheville arch and lies about 4 km east of the Cottonwood Grove fault. However, they suggest the Blytheville fault and the Cottonwood Grove fault may be essentially the same structure.

Johnston and Schweig (1996) propose two alternative rupture scenarios for the December earthquake: (1) the Blytheville Arch region ruptured along with its extension to the northeast, the Blytheville fault (NMS: BA-BFZ) and (2) the Blytheville Arch ruptured, but the rupture branched onto the Bootheel lineament and ruptured the northernmost 70 km of that structure (NMS: BA-BL) (Figure 6). In each scenario, the structure that did not rupture in the main event was the source of one of more of the large aftershocks, which have been proposed as smaller mainshocks (Johnston and Schweig, 1996). In other words, the Bootheel lineament and Blytheville fault sustained the aftershocks in the first and second scenarios, respectively.

The second mainshock of the New Madrid 1811-1812 sequence was the NM2 earthquake, in January 1812, on the northern margin of the fault system (NMN; Figure 6). The source of this event is also uncertain. The region is delineated by a line of seismicity, the Northwestern Seismicity Arm. Concentrated seismicity extends about 40 km, with more sparse seismicity extending another 20 km to near the Illinois border. This seismicity has been postulated to be correlated with the New Madrid North fault (sometimes the East Prairie fault), which has been seen in the subsurface, geomorphically, and in trench exposures (Baldwin *et al*., 2005; Johnston and Schweig, 1996). That fault is at least 30 km long; the seismicity extends beyond the known fault. Wheeler (1997) postulated that the structure continued still farther north to merge with the Rough Creek graben in western Kentucky; he considered this extent, about 100 km, to be the maximum extent of RR faults. There is little in the sparse distribution of seismicity and lack of significant Quaternary faulting in the northern extent to support that assertion, and based on surface and subsurface expression as well as focal mechanisms, this fault is likely a steeply dipping dextral fault (DTEE, 2011).

The last of the three 1811-1812 mainshocks, NM3, occurred in February 1812, on the central section, the RFT, the proposed cross-structure in a compressional step-over between the dextral southern and northern sections of the system (Figure 6). The RFT is a south-dipping blind reverse fault that has a dip that varies laterally and down dip. The dip can be as steep as 45°-75° in the upper few kilometers and as shallow as 25°-30° at depth (Mueller and Pujol 2001; Csontos and Van Arsdale, 2008). This fault is well-expressed geomorphically with a pronounced scarp, but its extent is also uncertain because seismicity extends beyond the scarp in both directions, beyond the strike-slip faults of the postulated stepover. Johnston and Schweig (1996) define three distinct fault segments: (1) the central RFT, defined by its mapped surface extent of about 32 km (Van Arsdale *et al*., 1995); (2) the Reelfoot South seismicity trend, extending 35 km east of the RFT; and (3) the New Madrid West seismicity trend, extending about 40 km west of the RFT. Their proposed rupture scenarios include rupture of the RFT with one or the other of the flanking seismicity trends in the NM3 mainshock.

The third event may have served to accommodate the strain produced by the previous two bounding events (Van Arsdale, 2000). Van Arsdale (2000) also suggests that this sequence of multiple, temporally-clustered events may not be unusual for the NMFS. He cites evidence from subsurface analyses that suggests that these three faults may have identical displacement histories since the Late Cretaceous. Thus, he suggests that the paleoseismic history for the RFT can serve as a proxy for the other two faults. Trench exposures of the RFT indicate that deformation occurs primarily as folding rather than faulting at the surface and that the structure has experienced at least three earthquakes in the past 2400 years at times consistent with those determined from regional paleoliquefaction studies (Kelson *et al*., 1996). This interpretation is supported by paleoliquefaction studies, which indicate that large magnitude earthquakes on the faults of the New Madrid system have occurred in clusters like those of 1811-1812 (e.g., Tuttle *et al*., 2002; 2005).

There is significant uncertainty regarding the exact identification and geometry of the faults that ruptured in the 1811-1812 and earlier earthquakes, and some models of rupture (e.g., EPRI/DOE/NRC, 2012; STNOC 2011; USNRC, 2006) include weighted alternative geometries for each of the three faults. We adopt the characterization of EPRI/DOE/NRC (2012; Table 2). We include two alternative geometries for the northern extent of the southern section, the Blytheville fault zone (NMS: BA-BL), weighted 0.4, and the Bootheel Lineament (NMS: BA-BFZ), weighted 0.6. For the central and northern sections, we include two alternatives: short and long (RFT-S, RFT-L, NMN-S, NMN-L). The short central section (RFT-S) includes only that part of the RFT that is defined by the Reelfoot scarp and extends from the Blytheville fault to the New Madrid North fault; the long alternative (RFT-L) extends both east and west, based on continued seismicity. The short alternative for the New Madrid north fault (NMN-S) is the fault as defined by Johnston and Schweig (1996); the long alternative (NMN-L) extends the source along northward continuations of seismicity identified by Wheeler (1997). Because the causative faults are not well understood, the dips are not well constrained. The northern and southern sections of the system are modeled as vertical. The RFT is modeled with a 40-degree southwest dip.

The EPRI/DOE/NRC (2012) characterization also addresses the apparent clustering of activity along the NMFS faults using the approach of Toro and Silva (2001). The rate of earthquakes and geomorphic expression of faulting on the RFT in the late Holocene suggests that the system is or has recently been in a cluster. However, geodetic data gathered over the last decade or so suggest that little or no interseismic deformation is occurring across the NMSZ, which some researchers have interpreted as evidence that the system is shutting down and entering an inter-cluster period of quiescence (e.g., Calais *et al*., 2005; Calais and Stein, 2009). The EPRI/DOE/NRC model strongly favors the interpretation that the system is currently in a cluster (0.9), based on the recent history of activity and the unlikelihood that we have just happened upon the exact moment the system is shutting down. However, they, and we, give some weight to two alternative models: 1) only the RFT is currently in a cluster, and the other faults are quiescent (0.5), and 2) the entire system is out of a cluster (0.5) (Table 3). In the former case, the RFT is active, but at a lower rate than the in-cluster case; in the latter case, no faults are active and the system defaults to the RR background zone characterization.

Several recent hazard analyses have developed source characterizations for the New Madrid faults. The USGS National Seismic Hazard Maps (Petersen *et al*., 2008) compiled recent data to develop a model with lower weighted mean magnitudes for the faults than in previous models, and with a recurrence model reflecting possibly clustered timing of events. Their magnitudes range from **M** 7.3 to 8.0 for the southern and central sections, with a preferred magnitude of **M** 7.7 and weighted mean of **M** 7.6, and from **M** 7.1 to 7.8 for the northern section, with a preferred value of **M** 7.5 and weighted mean of **M** 7.4. Models developed for the Site Safety Analysis for Exelon Generation Company in Illinois (USNRC, 2006) include a lower magnitude distribution, with **M** 7.2 to 7.9 (weighted mean **M** 7.5), **M** 7.4 to 7.8 (weighted mean of **M** 7.6), and **M** 7.0 to 7.6 (weighted mean of **M** 7.3) for the southern, central, and northern faults, respectively. EPRI/DOE/NRC (2012) include distributions for the NMS, RFT, and NMN sections of the NMFS of **M** 6.7 to 7.9, **M** 7.1 to 7.8, and **M** 6.8 to 7.6, respectively. In our model, we adopt the EPRI/DOE/NRC distribution of maximum magnitudes. The preferred values and weighted means are similar to those developed in the nuclear studies described above.

4.2 EPRI GROUND MOTION PREDICTION MODELS

Several factors control the level and character of earthquake ground shaking. These factors are in general: (1) rupture dimensions, geometry, and orientation of the causative fault; (2) distance from the causative fault; (3) magnitude of the earthquake; (4) the rate of attenuation of the seismic waves along the propagation path from the source to site; and (5) site factors, including the effects of near-surface geology, particularly from soils and unconsolidated sediments. Other factors, which vary in their significance depending on specific conditions, include slip distribution along the fault, rupture process, footwall/hanging-wall effects, and the effects of crustal structure such as basin effects.

Several parameters may be used to characterize earthquake ground motions. The common parameters include: peak ground acceleration, velocity, and displacement; response spectral accelerations or velocities, duration, and time histories in acceleration, velocity, or displacement. In this analysis, we have estimated peak horizontal ground acceleration (PGA) and horizontal spectral accelerations (SA) at 0.04, 0.1, 0.2, 0.4, 1.0, and 2.0 sec.

Crustal ground motion prediction models for tectonically active regions like the western U.S. are empirical in nature and derived from strong motion data from such areas as California, Taiwan, Japan, and Italy. In contrast, few useable strong motion records exist for earthquakes in the Central and Eastern North America (CENA). Thus ground motion prediction models for the CENA have been developed, in large part, using seismological-based numerical models. During the past decade, ground motion models for the CENA have been derived using three different approaches: the stochastic method, the Green's function method, and the complex/empirical source method.

Recent efforts have been made to update the ground motion models for the CENA. One project is called the Next Generation of Attenuation (NGA) – East sponsored by Pacific Earthquake Engineering Research (PEER) Center. The objective of the project is to develop a new suite of ground motion prediction model for the CENA. The median ground motion models were just released but no standard deviations for the models were specified. There are 20 new NGA-East models and we expect it will be several months before the models become vetted.

In a second project, EPRI (2013) updated the 2004/2006 EPRI models in the near-term so that preliminary Ground Motion Response Spectra (GMRS) could be developed for existing nuclear power plant sites as required by the NRC's Recommendation 2.1 pending completion of the NGA East Project. The models were used in this study. The EPRI Ground-Motion Model (GMM) Review Project (EPRI, 2013), an enhanced SSHAC Level 2 assessment process, established a methodology to evaluate the existing 2004 EPRI GMM and determine if it should be updated. After reviewing the current literature and conducting interviews and convening a workshop with ground-motion experts and seismologists it was decided to update the 2004 GMM because (1) seven of the thirteen developers of the 2004 EPRI GMM recommended that their models be replaced; (2) three new models have been developed for the CENA by ground-motion experts; (3) 80% of the earthquake records in a new ground-motion database provided by the NGA-East Project are from earthquakes that occurred after the development of the 2004 EPRI GMM; (4) comparisons to the updated CENA database indicate the 2004 EPRI GMM overpredicts ground motions at some magnitude-distance and structural frequency ranges that are important to nuclear power plant PSHA; and (5) the models used to develop the aleatory portion of the 2006 EPRI GMM have been superseded.

The 2013 EPRI GMM retains the structure of the 2004 EPRI GMM, grouping the candidate individual models into four clusters according to their seismological characteristics, weighting the models within each cluster according to their consistency with the data, representing each cluster by three fitted relationships (5^{th} percentile, median, and 95^{th} percentile), and assessing cluster weights based on consistency with observed data and seismological attributes of the models within each cluster. The GMM Review Project identified new candidate models for the updated GMM clusters, models and weights, as shown in Table 4; a summary of the overall elements of the model are listed in Table 5.

For reference, the ground motion prediction models used by the USGS to develop the 2014 National Seismic Hazard Maps include Toro *et al.* (1997), Frankel *et al.* (1996), Silva *et al.* (2002), Atkinson and Boore (2006), Atkinson (2008), Campbell (2003), Tavakoli and Pezeshk (2005), Pezeshk *et al.* (2011), and Somerville *et al*. (2001). The versions of Atkinson and Boore (2006) and Atkinson (2008) in the EPRI study have been updated with Atkinson and Boore (2011). All the ground motion prediction models are for hard rock characterized by a time-averaged shear-wave (V_S) in the top 30 m (V_S30) of 2,800 m/sec. There are no vetted CENA GMMs for soil at present.

Comparisons indicate that the 2013 GMM is somewhat lower than 2004 EPRI GMM when the two models are taken as a whole, but these differences are moderate, given the broad uncertainty range spanned by both GMMs. The greater differences occur at low frequencies. For PGA the bulk of the curves are consistent between the two GMMs. In addition, there is a substantial overlap in the 10 to 200 km range indicating that the updated GMM does not represent a radical departure from the 2004 EPRI GMM. The observed differences are the result of possessing and using substantially more data and having acquired additional insights from other regions over a period of nearly 10 years.

The 2006 EPRI model for aleatory uncertainty (sigma) was based on preliminary NGA-West1 models for sigma from active tectonic regions, adjusted to account for differences in properties of the earth's crust between active (western North America [WNA]) and stable tectonic regions (i.e., CENA) (EPRI, 2006). The EPRI GMM Review Project updated the model to incorporate the nearly final NGA-West 2 aleatory models, with the same adjustments for differences between WNA and CENA. The updated sigma model is frequency and magnitude dependent, with inter-event and intra-event components. There is additional aleatory variability for distances of $R_{JB} <$ 20 km. The updated aleatory variability model has higher values of total sigma than the 2006 EPRI model for **M** 5 earthquakes, and lower values for **M** 6 and 7 earthquakes for motions at 2.5 Hz and higher. At 1 Hz, the values of sigma are comparable in the two models and at 0.5 Hz, the updated GMM has slightly higher sigma than the 2006 EPRI model.

Table 4

EPRI (2013) GMM Clusters and Models

Cluster	Model Types and Cluster Weights (repeated large-magnitude earthquake sources/area earthquake sources)	Models
1	Single-corner Brune source (0.15/0.185)	Silva *et al*. (2002) – SC-CS-Sat[1] Silva *et al*. (2002) – SC-VS[1] Toro *et al*. (1997) Frankel et al. (1996)
2	Complex/Empirical Source ~R^{-1} geometrical spreading (0.31/0.383)	Silva *et al*. (2002) – DC-Sat Atkinson (2008) with 2011 modifications (A08′)
3	Complex/Empirical Source ~$R^{-1.3}$ geometrical spreading (0.35/0.432)	Atkinson-Boore (2006) with 2011 modifications (AB06′) Pezeshk *et al*. (2011)
4	Finite-source /Green’s function (0.19/0)	Somerville *et al*. (2001); slightly different models for rifted and nonrifted (not used for distributed seismicity sources with large contribution from **M** < 6)

SC = single-corner; DC = double-corner; CS = constant stress; VS = variable stress; Sat = saturation.
[1] Treated as one model for calculation of weights.

Table 5

Elements of the CENA Ground Motion Models

Feature	Attribute
Ground Motion Measure	Peak ground acceleration Spectral acceleration at frequencies of 0.5, 1, 2.5, 5, 10, 25 Hz
Site Conditions	Hard rock (V_S 2.8 km/sec, 9200 ft/sec)
Regions	Midcontinent (includes east coast) Gulf Coast
Ground Motion Model Types	Four types included: • Single-corner Brune source • Complex/empirical source ~R^{-1} geometrical spreading • Complex/empirical source ~$R^{-1.3}$ geometrical spreading • Finite-source/Green's function
Aleatory Variability	Magnitude and frequency dependent Includes additional variability for distances of R_{JB} < 20 km

4.3 SITE CONDITIONS

4.3.1 Development of Site Stratigraphy

Subsurface investigations for the site have been limited to shallow soil borings in the upper Quaternary soils. Stratigraphic profiles for bedrock at the site were developed by researching available information which included data provided by Dynegy, geologic and mining reports, and various structural, isopach, lithofacies, and bedrock geology maps collected from the Illinois Geologic Survey (ISGS).

Specifically, the thickness of overlying soil (overburden) was determined from geotechnical soil borings completed by AECOM in 2015 and others (Hanson, 2008), drilled water well logs, and the nearest referenced 7.5 minute geologic quad map. Geotechnical borings met with refusal from 40 to 70 feet below ground surface where weathered shale bedrock was encountered, marking the top of the Pennsylvanian system rock. Bedrock stratigraphy was developed primarily using detailed cross sections compiled by the ISGS utilizing data from drilled oil exploration wells (Treworgy and Whitaker, 1990; Treworgy *et al*., 1994). Based on the cross-sections, structural contours identified using the compiled topography of the Mt. Simon Sandstone (MGSC, 2005) were projected to the Newton site. The nearest oil exploration test hole along the contour interval was used to measure the thicknesses of bedrock units and the proper scaled thicknesses of bedrock units were then projected to the site. These thicknesses and projections were cross-checked using known depths to specific coal seams in Pennsylvanian bedrock, particularly the Herrin Coal, and matching the depth(s) to the information in the cross sections (Treworgy and Whitaker, 1990; Treworgy *et al*., 1994). Errors in estimates of bedrock thickness due to structural variations and map projection are likely in the range of 100 to 200 feet, and may compound with increasing depth or in areas of greater subsurface topography.

Site response analysis requires detailed information on subsurface stratigraphy and accurate representation of V_S characteristics for rock and soil. Shear wave velocities were measured in the overburden soil materials to refusal depths ranging from 40 to 70 feet below ground surface using seismic CPT (SCPT). *In situ* measurements of V_S of deeper material and deep exploration of bedrock at the site were not within the scope of this project. A summary of V_S data collected from the Clinton Nuclear Power Station (130 km to the north) (Exelon, 2014) was used to correlate V_S velocities for bedrock units at the site. Measurements at the Clinton site consisted of refraction, uphole, and downhole surveys as well as recent ESP measurements of unspecified proximity to the site. The measured velocities for lithofacies reported from the Clinton site were assigned to the same rock and soil units at the Newton site with thicknesses developed using the methods described above. Table 6 illustrates a set of estimated bedrock thicknesses and V_S for specific rock types at the site used to develop the V_S profile.

Based on Table 6, the mean basecase V_S profile used in the site response analysis (Section 6) was developed by combining layers of identical V_S (Figure 13). The mean value in the V_S ranges given in Table 6 were adopted for the mean basecase profile and the variability (factor of 1.57; Section 6.1.2) about that mean value was considered in developing the lower-range and upper-range basecase models.

Classification for site stratigraphy was based on the Nuclear Power Station report (Exelon, 2014), where rock groups were aggregated and classified according to geologic systems that each contain various rock types with thicknesses. Ranges for V_S are given to reflect the range of rocks included in each geologic system. In cases where weaker rock is thought to have an appreciable thickness that could affect the site response model, the layer was reported separately in the geologic system and assigned the lower range of values for V_S.

Table 6
V_S Profile

Formation Bottom Depth at Site* (ft)	Thickness of Unit/Formation at Site* (ft)	Age- System	Soil/Rock Description	Estimated V_S (ft/sec)[1]
0-38	38	**Quaternary**	Modern Site soil	800-1900
38-108[2]	70		Undifferentiated TILL (Glasford / Banner Fm)	1100-3300
108-2000	1892	**Pennsylvanian**	limestone, shale, sandstone, coal, and siltstone	3250-5700
2000-4000	2000	**Mississippian**	limestone, wlth lesser siltstone and shale	4500-6500
4000-4200	200		Siltstone[3]	4500[3]
4200-4900	700	**Devonian**	shale and limestone	4500-8500
4900-5300	400	**Silurian**	carbonates	4500-8500
5300-5600	300	**Ordovician**	shale, calcareous shales, and interbedded limestone	6500[3]
5600-6250	650		dolomite, sandstone, limestone and shales	6500-10500
6250-10200	3,950	**Cambrian**	siltstone, shale, sandstone and dolomite	6500-10500
>10200		**Pre-Cambrian**	igneous rocks, dominantly granite with associated granodiorite, rhyolite	> 9200

***** Depths and thicknesses of bedrock statigraphic units are estimated from structural maps and cross-sections for the Illinois Basin (ISGS) and considered accurate within 200-400 ft

[1] V_S taken from Sesmic Hazard Screening Report data Clinton Station below 70 ft

[2] V_S value estimated from SCPT information in 2015 borings

[3] V_S estimated to be the lower bound limit of recorded velocity at Clinton Station

The results of the PSHA are presented in terms of ground motion for hard rock site conditions as a function of annual frequency of exceedance (AFE). AFE is the reciprocal of the average return period. Figure 14 shows the mean, median (50th percentile), 5th, 15th, 85th, and 95th percentile hazard curves for PGA. (PGA is defined as the 0.01 sec spectral acceleration [SA].) These fractiles indicate the range of epistemic uncertainties about the mean hazard. The uncertainties are large due to both the large uncertainties in the ground motion prediction models and the source parameters of the controlling seismic source. The 1.0 sec horizontal SA hazard is shown in Figure 15. The 2,500 year return period mean PGA is 0.21 g (Table 7).

The contributions of the various seismic sources to the mean PGA hazard are shown on Figure 16. The PGA hazard at the site is dominated by the IBEB zone (Figures 16 and 17). At a return period of 2,500 years, the IBEB, NMESE and StudyR zones contribute 46, 13 and 11 percent of the PGA hazard, respectively, with the NMFS and Wabash Valley RLMEs at 14 and 10 percent, respectively (Figure 18). At 1.0 sec SA, the NMFS RLME relative contribution increases to 59 percent of the hazard at 2,500 years compared to the IBEB zone at 15 percent and the Wabash Valley RLME at 12 percent (Figures 18 and 19).

By deaggregating the PGA and 1.0 sec SA hazard by magnitude, distance and epsilon bins, we can illustrate the contributions by events at a return period of 2,500 years (Figures 20 and 21). Epsilon is the difference between the logarithm of the ground motion amplitude and the mean logarithm of ground motion (for that M and R) measured in units of the standard deviation (σ) of the logarithm of the ground motion. As shown on Figure 20, a majority of the PGA hazard at the site is coming from background events (**M** 5.0 to 6.25 within 50 km); the Wabash Valley RLME (**M** 7.0 to 7.75 at 50 to 75 km) and the NMFS RLME (**M** 7.25 to 8.0 at 175 to 350 km are also contributing to the PGA hazard. As shown on Figure 21, most of the 1.0 sec SA hazard at the site is coming from the NMFS RLME (**M** 7.0 to 8.25 at 175 to 350 km) with some contribution from background events (**M** 5.0 to 6.25 within 50 km).

The deaggregation shown in Figures 20 and 21 also provides the modal magnitude M*, modal distance D*, and modal epsilon ε*, which represent the largest contributor to the hazard at the defined return period. The M* and D* for the 2,500-year return period for PGA and 1.0 sec horizontal SA are listed in Table 8.

A horizontal Uniform Hazard Spectrum (UHS) on hard rock computed at 7 spectral periods for the 2,500-year return period is shown on Figure 22. A UHS shows the hazard across all periods for the same annual exceedance probability or return period. The SA hazard has been calculated at 0.01 (PGA), 0.04, 0.1, 0.2, 0.4, 1.0 and 2.0 sec. These are the spectral periods specified in the EPRI (2013) ground motion models.

Table 7

2,500-Year Return Period Mean UHS for Hard Rock

Period (sec)	SA (g)
0.01 (PGA)	0.212
0.04	0.435
0.10	0.363
0.20	0.249
0.40	0.158
1.00	0.074
2.00	0.043

Table 8

Modal M* and D* at 2,500-year Return Period

	M*	D* (km)
PGA	5.1	12.5
1.0 Sec SA	7.9	325

The PSHA results are for hard rock and so we performed a site response analysis to adjust the ground motions to the top of glacial till. Traditionally in the estimation of site-specific probabilistic ground motions for a soil site, a rock ground motion is calculated and modified by deterministic site response analyses derived for the soil column to arrive at the ground motions at the soil surface. In doing so, the annual exceedance probability of that soil motion is generally unknown, varies with period, and may be of a higher probability than the control (rock) motion. If a risk analysis is desired, the surface motions must be hazard consistent, i.e., the annual exceedance probability of the soil ground motion should be the same as the rock ground motion.

In NUREG/CR-6728 (McGuire *et al.*, 2001), several site response approaches are recommended to produce soil motions consistent with the rock outcrop hazard. The approaches also incorporate the aleatory variabilities in the soil properties into the soil motions. McGuire *et al.* (2001) identified four basic approaches for determining the ground motions at a soil site. The approaches range from a PSHA using ground motion prediction models for the specific site (or location) of interest (Approach 4) to scaling the rock motion on the basis of a site response analysis using a broadband input motion (Approach 1). Conceptually, Approach 4 is the ideal approach and other approaches are approximations to it. However, Approach 4 is seldom used because rarely are data sufficient to develop site-specific ground motion models.

To compute the ground motions for the Coffeen Station site, we implemented Approach 3 as it is called (McGuire *et al.*, 2001; Bazzurro and Cornell, 2004). Approach 3 is a fully probabilistic analysis procedure which moves the site response, in an approximate way, into the hazard integral. The approach is described by Bazzurro and Cornell (2004) and NUREG/CR-6769 (McGuire *et al*., 2002). In this approach, the hazard at the surface is computed by integrating the site-specific hazard curve at generic rock or soil level with the probability distribution of the amplification factors (Lee *et al*., 1998; 1999). The site-specific amplification, relative to a reference rock, in this case hard rock, is characterized by a suite of frequency-dependent amplification factors that can account for nonlinearity in soil/rock response. Approach 3 involves approximations to the hazard integration using suites of transfer functions, which result in complete hazard curves at the ground surface for specific ground motion parameters (e.g., spectral accelerations) and a range of frequencies.

The basis for Approach 3 is a modification of the standard PSHA integration:

$$P[A_S>z] = \iiint P\left[AF > \frac{z}{a}\middle|m,r,a\right] f_{M,R|A}\,(m,r;a) f_A(a)\,dm\,dr\,da \qquad (6\text{-}1)$$

where A_S is the random ground-motion amplitude on soil at a certain natural frequency; z is a specific level of A_S; m is earthquake magnitude; r is distance; a is an amplitude level of the random rock ground motion, A, at the same frequency as A_S; $f_A(a)$ is derived from the rock hazard curve for this same frequency (namely it is the absolute value of its derivative); and $f_{M,R|A}$ is the deaggregated hazard (i.e., the joint distribution of M and R, given that the rock amplitude is level a). AF is an amplification factor defined as:

$$AF = A_S/a \qquad (6\text{-}2)$$

where AF is a random variable with a distribution that can be a function of m, r, and a. To accommodate epistemic uncertainties in site dynamic material properties, multiple suites of AF may be used and the resulting hazard curves combined with weights to properly reflect mean hazard and fractiles.

The ground surface response is controlled primarily by the level of rock motion and m, so Equation 6-1 can be approximated by:

$$P[A_S>z] = \int\int P[AF > \frac{z}{a}(m,a)] f_{M|A}(m;a) f_A(a) dm da \quad (6\text{-}3)$$

where r is dropped because it has an insignificant effect in most applications (McGuire *et al.*, 2001). To implement Equation 6-3, only the conditional magnitude distribution for relevant amplitudes of a is needed. $f_{M|A}(m;a)$ can be represented (with successively less accuracy) by a continuous function, with three discrete values or with a single point, (e.g., $m^1(a)$, the mean magnitude given a). With the latter, Equation 6-3 can be simplified to:

$$P[A>z] = \int\int P[AF > \frac{z}{a} | a, m^1(a)] f_A(a) da \quad (6\text{-}4)$$

where, $f_{M|A}(m;a)$ has been replaced with m^1 derived from deaggregation. With this equation, one can integrate over the rock acceleration, a, to calculate $P[A_S>z]$ for a range of surface amplitudes, z.

6.1 IMPLEMENTATION OF APPROACH 3

In Approach 3, the following steps were performed:

- Randomization of base case site-dynamic material properties to produce a suite of velocity profiles as well as G/Gmax and hysteretic damping curves that incorporate site randomness.
- Computation of transfer functions (hereafter termed amplification factors) as characterized by a mean and distribution for each set of base case site properties using the RVT-based equivalent-linear site response model.
- Full integration of the fractile and mean hazard curves for the generic site condition in this case hard rock and amplification factors to arrive at a distribution of site-specific hazard curves.

Specifically, the suites of rock hazard curves are first combined into a single suite and site-specific amplification factors applied using Approach 3. Combining the empirical hazard curves, rather than applying Approach 3 to each suite independently, results in the same mean hazard—the desired product—but does not properly preserve the full epistemic variability in the fractile estimates. As a result, the range in probability reflected in the resulting fractiles is likely somewhat underestimated. Although the fractiles are likely not significantly in error since the differences in hazard fractiles between the empirical relations are not large, the site-specific hazard fractiles should not be used for hazard or risk assessment.

Approach 3 is implemented through a number of computer programs. The computation of the amplification factors is the first phase of the calculations and is similar to what is done in other site-response approaches.

6.1.1 RVT-Based Equivalent-Linear Site Response Approach

The conventional site response approach in quantifying the effects of soil and other unconsolidated sediments on strong ground motions involves the use of time histories compatible with the specified outcrop response spectra to serve as control (input) motions. The control motions are then used to drive a nonlinear computational formulation to transmit the motions through the profile.

The computational formulation that has been most widely employed to evaluate 1D site response assumes vertically-propagating plane S-waves. Departures of soil response from a linear constitutive relation are treated in an approximate manner through the use of the equivalent-linear formulation. The equivalent-linear formulation, in its present form, was introduced by Idriss and Seed (1968). A stepwise analysis approach was formalized into a 1D, vertically propagating S-wave code called SHAKE (Schnabel *et al*., 1972). Subsequently, this code has become the most widely used and validated analysis package for 1D site response calculations.

The computational scheme employed to compute the amplification factors in this study uses an alternative approach employing RVT (Silva and Lee, 1987). In this approach, as embodied in the computer program RASCALS, the control motion power spectrum is propagated through the 1D soil profile using the plane-wave propagators of Silva (1976). The power spectrum is derived from the uniform hazard spectrum by spectral matching assuming the controlling earthquake. In this formulation only SH waves are considered. Arbitrary angles of incidence may be specified. In this case, vertical incidence was assumed.

Inputs to RASCALS are as follows:

- Location of input and output motions within the site profile.
- Input (control) motions characterized by earthquake power spectra.
- Incidence angles of input motion.
- A vertical profile consisting of homogeneous layers with specified thickness, seismic velocity, and density.
- Dynamic properties of the material at the site, consisting of strain-dependent shear modulus and damping curves for each layer.

Control motions (power spectral density) must be calculated for input into the site response analysis that are representative of the earthquake magnitude and distance dominating the hazard at the desired rate of exceedance. The basis for the control motions are the magnitude and distances specified by the hazard deaggregation.

Evaluation of site-response using the equivalent-linear site response model is based on convolution of appropriate control motions through randomized velocity profiles combined with randomized G/Gmax and hysteretic damping curves. The randomized profiles and curves are generated from base case velocity and nonlinear dynamic properties. The convolutions yield amplification factors for 5%-damped response spectra and peak ground velocity (PGV).

6.1.2 Inputs and Analysis

To perform the site response analysis, representative V_S profiles of the site and shear modulus (G/Gmax) reduction and damping curves are required.

For the computation of spectra for a site with uncertain properties and exhibiting a degree of lateral variability, a best-estimate (mean) basecase velocity profile (or profiles) (Table 9; Figure 13) is developed and used to simulate a number of V_S profiles. To address the epistemic uncertainty in the basecase V_S profile, an upper-range and lower-range basecase profiles were computed by using a factor of 1.57 (Figure 13). This factor was adopted from EPRI (2013) for sites where there are no site-specific V_S data. The upper-range basecase V_S profile was constrained to not exceed 2,800 m/sec (hard rock). Additionally, strain-dependent shear modulus and hysteretic damping are also randomized about best-estimate basecases. A large number of simulations can be required to achieve stable statistics on the response. To achieve statistical stability, 30 randomizations were produced using the velocity correlation models for each basecase velocity profile and each basecase nonlinear dynamic property curve. In order to randomly vary the V_S profile, a profile randomization scheme has been developed which varies both layer velocity and thickness. The randomization is based on a correlation model developed from an analysis of variance on about 500 measured V_S velocity profiles (EPRI, 1993; Silva *et al.*, 1996). Profile depth (depth to competent material) is also varied on a site-specific basis using a uniform distribution. The depth range is generally selected to reflect expected variability over the structural foundation as well as uncertainty in the estimation of depth to competent material.

Associated with each of the 30 randomized profiles was also a set of randomized dynamic material property curves. For the dynamic material properties, the EPRI (1993) and Peninsular Range curves for cohesionless soils (Silva *et al.*, 1996) were used to approximate a nonlinear response over the top 250 ft, with linear response below (Silva *et al.*, 1996). To accommodate the large uncertainty in nonlinear dynamic material properties, two sets of curves were used in the site-specific analyses. In addition to the EPRI (1993) curves, a subset of the EPRI (1993) curves was also used for each profile to account for the possibility that the site may behave more linearly. The second set, termed Peninsular Range curves, use the EPRI (1993) 51 to 120 ft curves for 0 to 50 ft and the 501 to 1,000 ft curves for deeper materials and reflect much more linear response than the EPRI curves. The two sets of curves were given equal weights and are considered to cover the range in nonlinear dynamic material properties.

Based on the RASCALS runs for the 30 V_S profiles for the three base case profiles, a probability distribution of amplification factors was calculated. Input control motions are computed using RASCALS for each set of 30 V_S profiles and dynamic property curves. RASCALS is used for horizontal spectra using normally-incident and inclined SH-waves. For each control motion, mean and standard deviation are computed from the 30 response spectra (from 30 randomized profiles). Thirty realizations result in stable estimates. The mean response spectrum from the 30 convolutions is divided by the mean (log) spectrum for hard rock spectrum to produce the amplification factors. The amplification factors include the effects of the inherent aleatory variability (randomness) of the site properties about each base case and any possible effects of magnitude of the control motions. Epistemic variability (uncertainty) is captured in consideration of alternate base case (mean) profiles and properties.

Table 9
Simplified V_S Profile Used in Analysis

Depth (ft)	Lithology	V_S (ft/sec)
0 – 70	Till	2,200
70 – 2,000	Limestone, shale, sandstone	4,500
2,000 – 4,000	Limestone	5,500
4,000 – 4,200	Siltstone	4,500
4,200 – 5,600	Shale, limestone	6,500
5,600 – 10,250	Dolomite, sandstone, limestone	8,500
> 10,250	Precambrian basement	> 9,200

RASCALS was used to generate control motions and acceleration power response spectra for two earthquakes, **M** 5.5 and 7.5, which approximately represents the range of magnitudes for events contributing to the hazard at the site at short- and long-period ground motions. The events were placed at a suite of distances to produce expected median rock peak accelerations of 0.01, 0.05, 0.10, 0.20, 0.30, 0.40, 0.50, 0.75, 1.00, 1.25 and 1.50 g. The amplification factors (the ratios of the response spectra at the top of the site profiles to the hard rock profiles) are a function of the reference (hard rock) peak acceleration (or SA), spectral frequency, and nonlinear soil response.

6.2 SITE-SPECIFIC HORIZONTAL RESULTS

The hard rock hazard curves derived from the PSHA and the amplification factors relative to hard rock were multiplied to arrive at site-specific amplified hazard curves. The hazard curves calculated using the amplification factors from the **M** 5.5 and 7.5 earthquakes were weighted based on their contributions to the hazard at each spectral frequency. The uncertainty or epistemic variability in seismic hazard is typically represented by a set of weighted hazard curves. Using these sets of curves as discrete probability distributions, they can be sorted by the frequency of exceedance at each ground-motion level and summed into a cumulative probability mass function. When the cumulative probability mass function for a particular exceedance frequency equals or exceeds fractile y, then the exceedance frequency represents the y^{th} fractile. The weighted-mean hazard curve is the weighted average of the exceedance frequency values. This approach is a standard practice in PSHA.

Figure 23 shows the UHS for the return period of 2,500 years at the ground surface (top of till) resulting from the site response analysis (Table 10). Also shown is the input hard rock UHS for the same return period. The amplification is significant at spectral periods greater than about 0.1 seconds.

6.3 COMPARISON WITH USGS NATIONAL HAZARD MAPS

In 1996, the USGS released a “landmark” set of NSHMs for earthquake ground shaking, which was a significant improvement from previous maps they had developed (Frankel *et al.*, 1996). These maps were the result of the most comprehensive analyses of seismic sources and ground motion prediction ever undertaken on a national scale. The maps are the basis for the NEHRP

Maximum Considered Earthquake (MCE_R) maps, which are used in the International Building Code. The maps are for NEHRP site class B/C (firm rock) (V_S30 760 m/sec).

For a 2,500-year return period, the 2014 NSHMs indicate firm rock (site class B/C) PGA, 0.2 sec SA and 1.0 sec SA values of 0.23, 0.40, and 0.13 g, respectively (USGS website). The site-specific ground surface values of 0.18, 0.40, and 0.12 g for PGA, 0.2 and 1.0 sec SA, respectively, are comparable. The V_S30 for the site is about 790 m/sec based on the simplified V_S profile.

Table 10

2,500-Year Return Period Mean UHS for the Ground Surface

Period (sec)	SA (g)
0.01 (PGA)	0.18
0.02	0.21
0.03	0.23
0.04	0.24
0.10	0.41
0.20	0.40
0.40	0.21
1.0	0.12
2.0	0.07
3.0	0.06
4.0	0.05
5.0	0.04

Three sets of two-component time histories were spectrally-matched to a 2,500-year return period ground surface UHS. At short periods, the 2,500-year hazard is primarily from background events, and at long periods, the hazard is from large events on the NMFS (Figures 20 and 21). Hence, one set of time histories was selected to represent a **M** ≤ 6.5 event at a distance less than 50 km and two sets to represent a large NMFS event at greater distances (Table 11).

Because the response spectrum of a time history has peaks and valleys that deviate from the design response spectrum (target spectrum), it is necessary to modify the motion to improve its response spectrum compatibility. The procedure proposed by Lilhanand and Tseng (1988), as modified by Al Atik and Abrahamson (2010) and contained in the computer code RSPMatch09 (Fouad and Rathje, 2012), was used to develop the acceleration time histories through spectral matching to the target (seed) spectrum. This time-domain procedure has been shown to be superior to previous frequency-domain approaches because the adjustments to the time history are only done at the time at which the spectral response occurs resulting in only localized perturbations on both the time history and the spectra (Lilhanand and Tseng, 1988).

To match the design (target) spectrum, seed time histories should be from events of similar magnitude and distance (for duration) and most importantly, spectral shape as the earthquake dominating the spectrum. Figure 24 shows the spectra from the seed time histories scaled to the target spectrum at PGA. The seed acceleration time history series are shown on Figures 25 to 27. The spectral matches and resulting time histories are shown on Figures 28 to 39. Arias intensities and durations of the spectrally-matched time histories are provided in Table 12.

Table 11

Seed Time Histories

Record Sequence Number	Year	Earthquake Name	Station Name	Earthquake Magnitude (M)	ClstD (km)	V_S30 (m/sec)	Comp	PGA(g)	PGV (cm/sec)	PGD (cm)	5-95% AI (m/sec)	5-95% Dur (sec)
172	1979	Imperial Valley	El Centro Array #1	6.5	21.7	237.3	140	0.141	16.06	9.82	0.287	15.02
							230	0.136	10.98	7.10	0.224	19.53
1404	1999	Chi-Chi, Taiwan	PNG	7.6	110.3	465.9	E	0.029	1.52	0.47	0.030	31.99
							N	0.034	2.27	0.66	0.033	28.10
2112	2002	Denali, Alaska	TAPS Pump Station #08	7.9	104.9	424.9	049	0.046	4.62	2.15	0.049	30.78
							319	0.036	4.22	2.52	0.043	36.28

ClstD Closest distance
Comp Component
PGA peak horizontal ground acceleration
PGV peak horizontal ground velocity
PGD peak horizontal ground displacement
AI Arias intensity
Dur Duration

Table 12

Spectrally-Matched Time Histories

Record Sequence Number	Year	Earthquake Name	Station Name	Earthquake Magnitude (M)	ClstD (km)	V_S30 (m/sec)	Comp	PGA(g)	PGV (cm/sec)	PGD (cm)	5-95% AI (m/sec)	5-95% Dur (sec)
172	1979	Imperial Valley	El Centro Array #1	6.5	21.7	237.3	140	0.174	18.73	11.25	0.387	20.65
							230	0.182	17.30	16.72	0.389	20.58
1404	1999	Chi-Chi, Taiwan	PNG	7.6	110.3	465.9	E	0.181	12.63	6.24	0.856	34.04
							N	0.179	11.30	6.52	0.727	29.65
2112	2002	Denali, Alaska	TAPS Pump Station #08	7.9	104.9	424.9	049	0.180	12.28	11.24	0.525	35.57
							319	0.183	15.62	11.63	0.783	39.73

ClstD Closest distance
Comp Component
PGA peak horizontal ground acceleration
PGV peak horizontal ground velocity
PGD peak horizontal ground displacement
AI Arias intensity
Dur Duration

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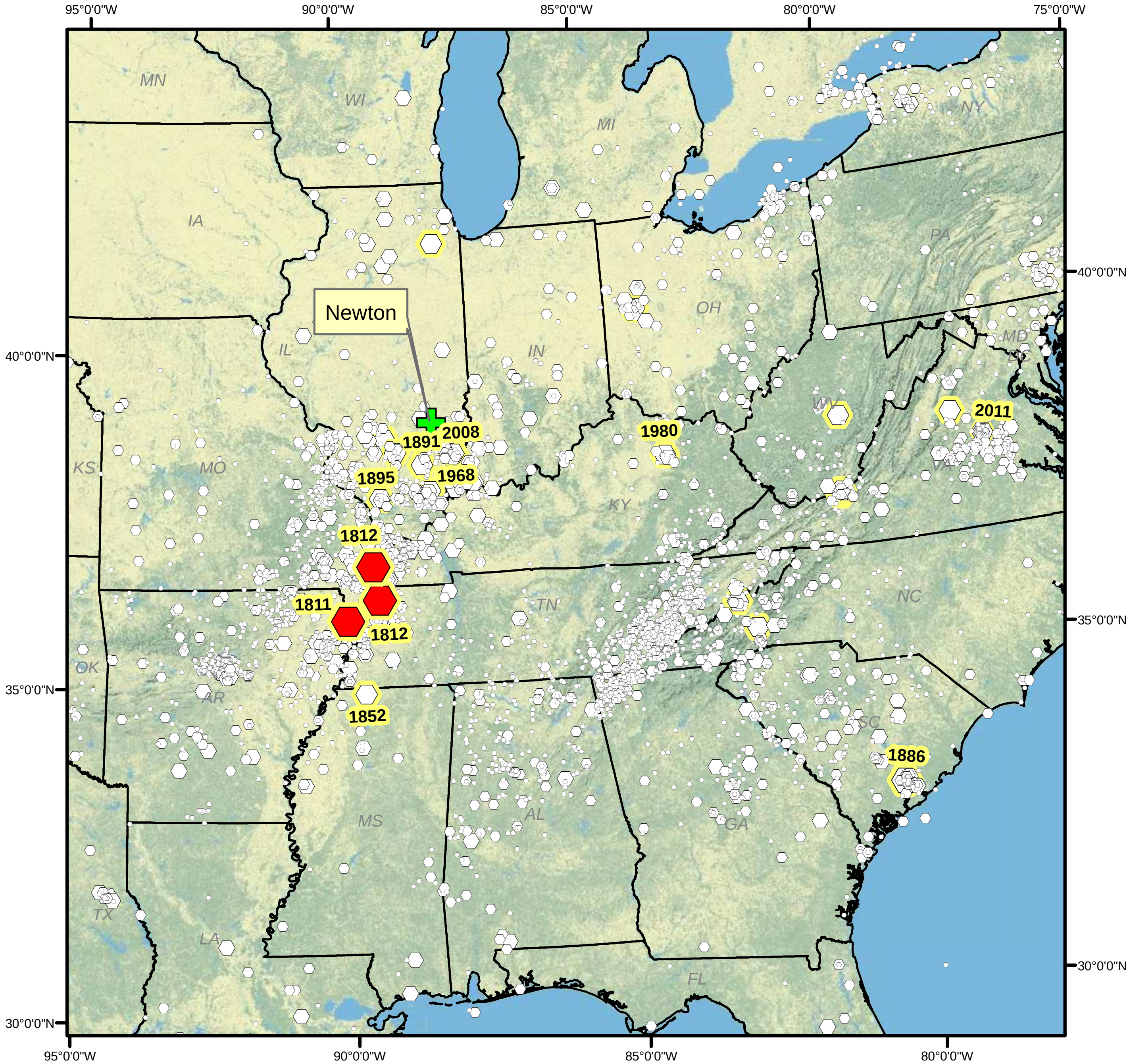

Magnitude Mw

- <= 3.0
- 3.0 - 4.0
- 4.1 - 5.0
- 5.1 - 6.0
- 6.1 - 7.0
- > 7.0

Data Sources: 1699 to 2008 from EPRI/DOE/NRC (2012)
2009 to May 2015 from ANSS

0 55 110 220 330 440 Kilometers

0 40 80 160 240 320 Miles

N

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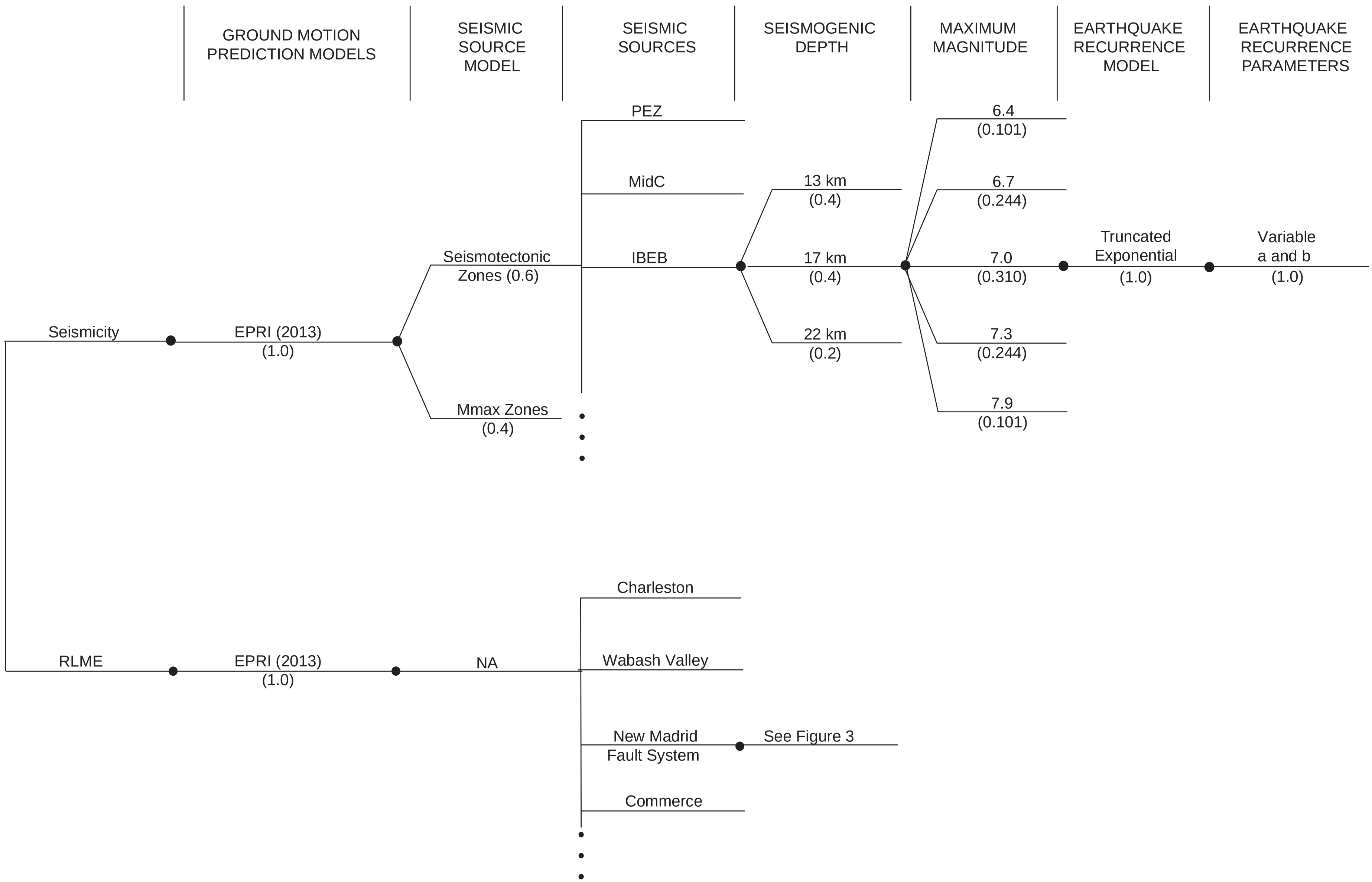
Project No. 60440378	HISTORICAL SEISMICITY OF THE CENTRAL AND EASTERN UNITED STATES (1699 - 2015)	Figure
Newton Power Station Dynegy		1



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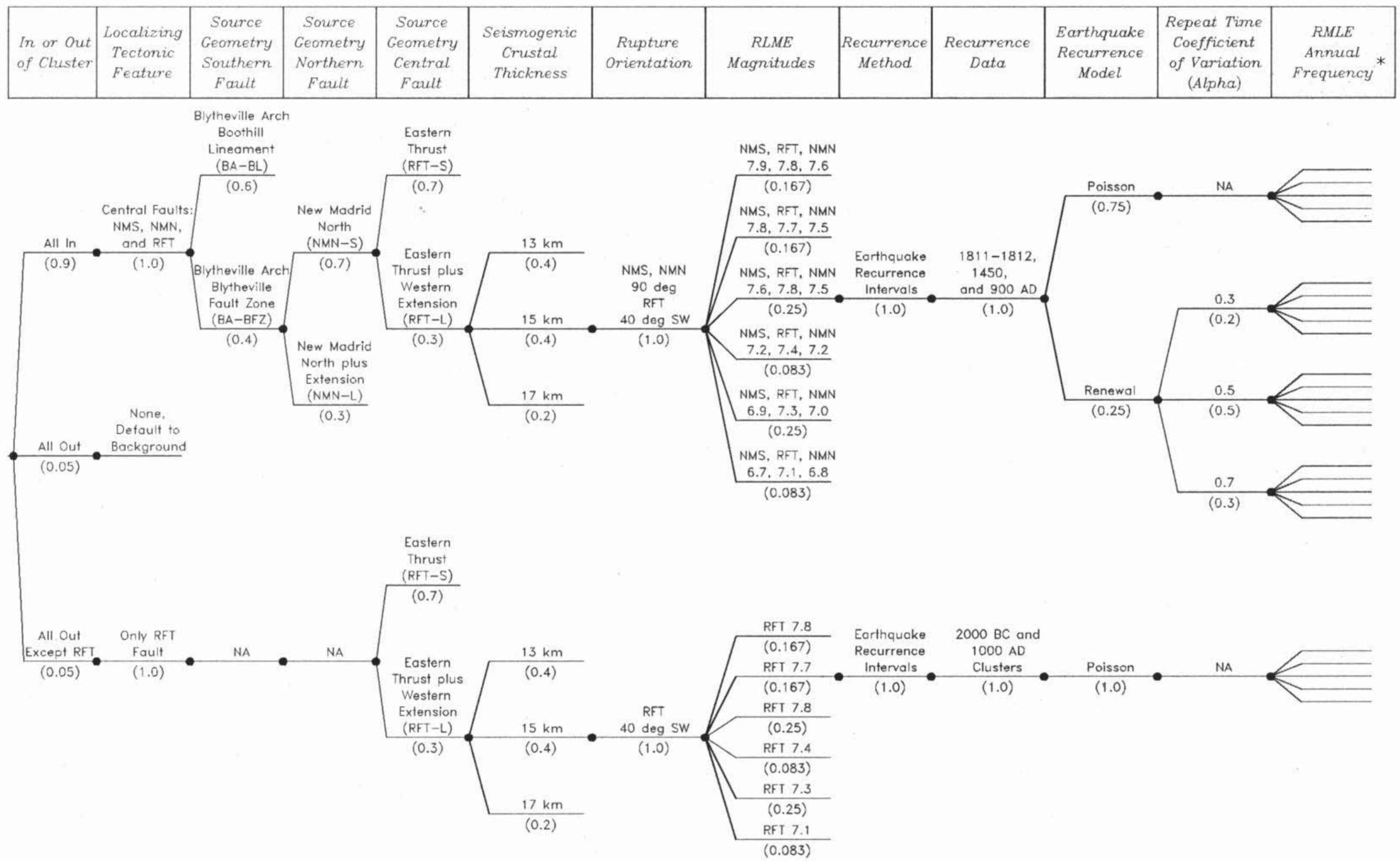
Project No. 60440697

Newton Power Station
Dynegy

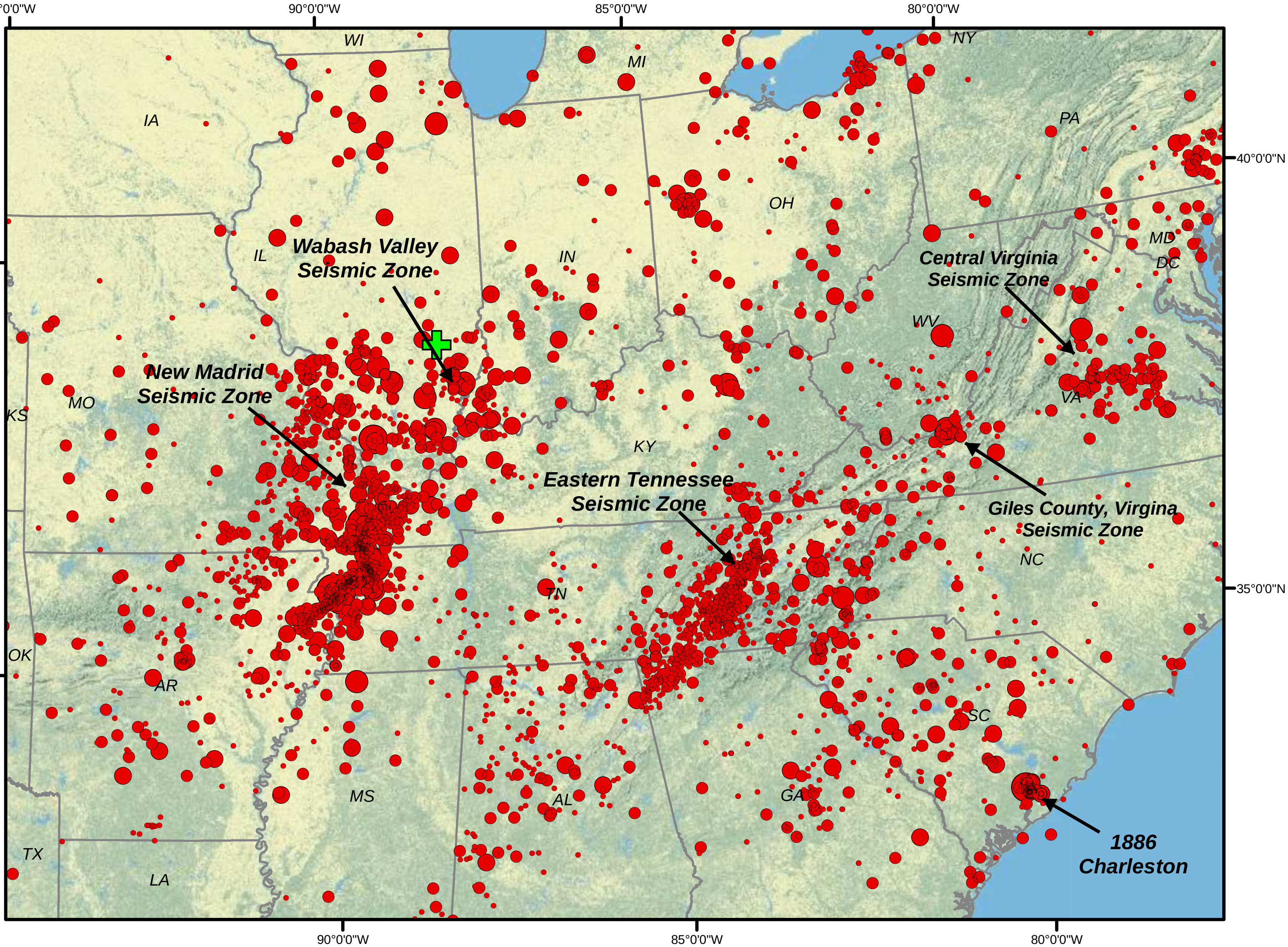
EXAMPLE SEISMIC HAZARD MODEL LOGIC TREE

Figure 2



* See EPRI/DOE/NRC (2012)

AECOM	Project No. 60440697 Newton Power Station Dynegy	NEW MADRID RLME LOGIC TREE	Figure 3

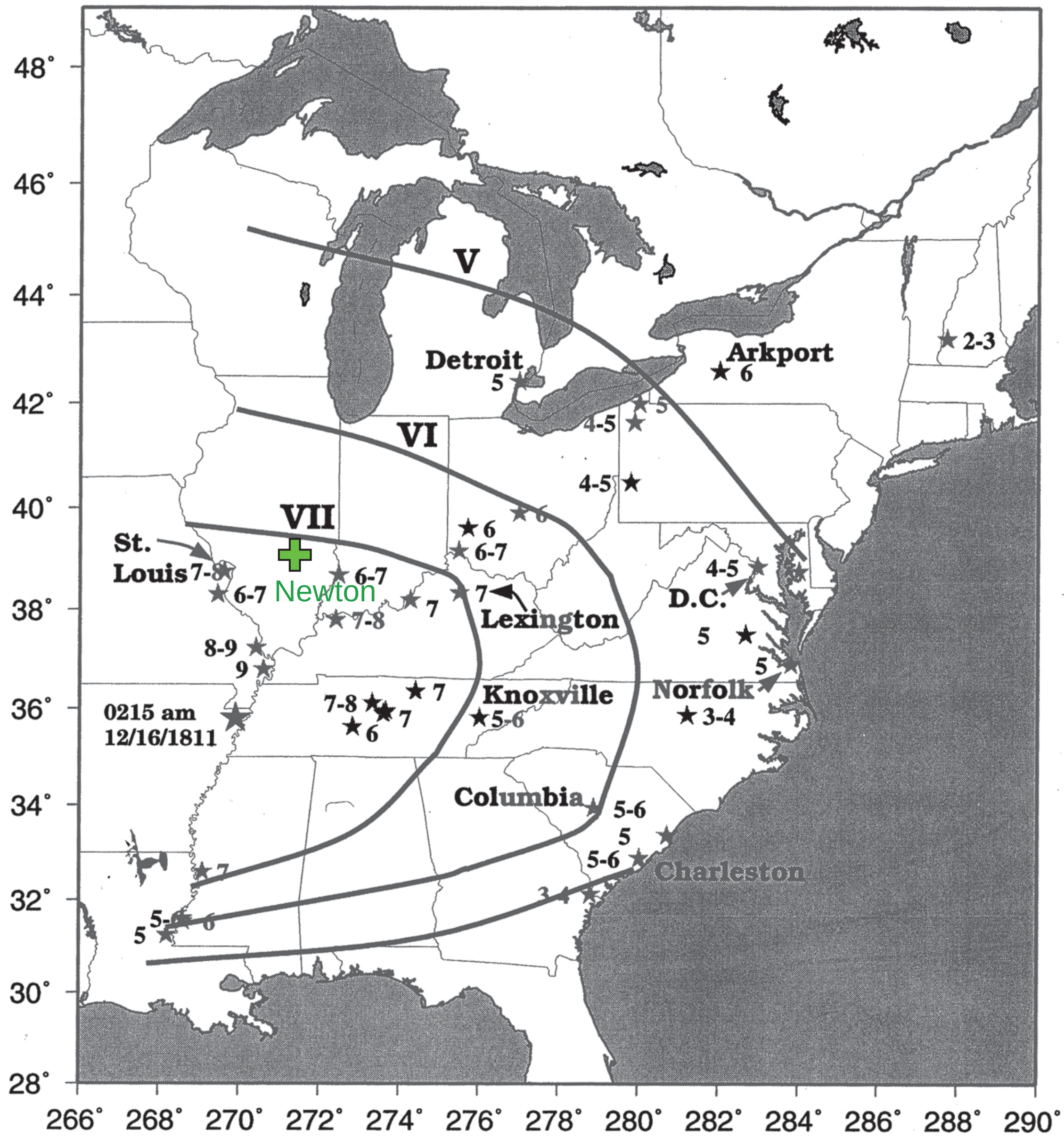


Project Site

Earthquake Epicenters

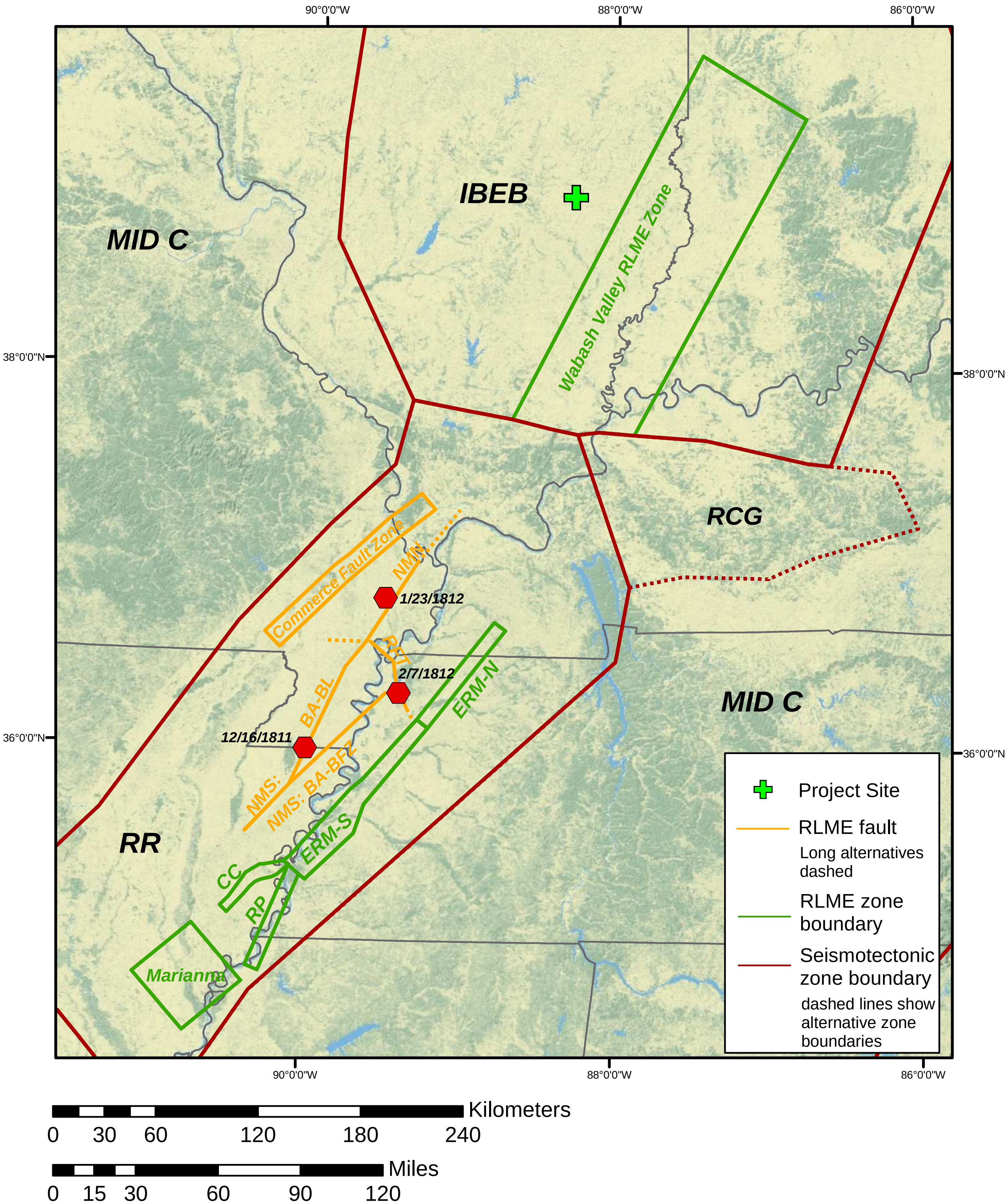
Seismicity from:
EPRI/DOE/NRC (2012)

AECOM	Project No. 60440378 Newton Power Station Dynegy	HISTORICAL SEISMICITY AND SEISMIC ZONES IN EASTERN U.S.	Figure 4

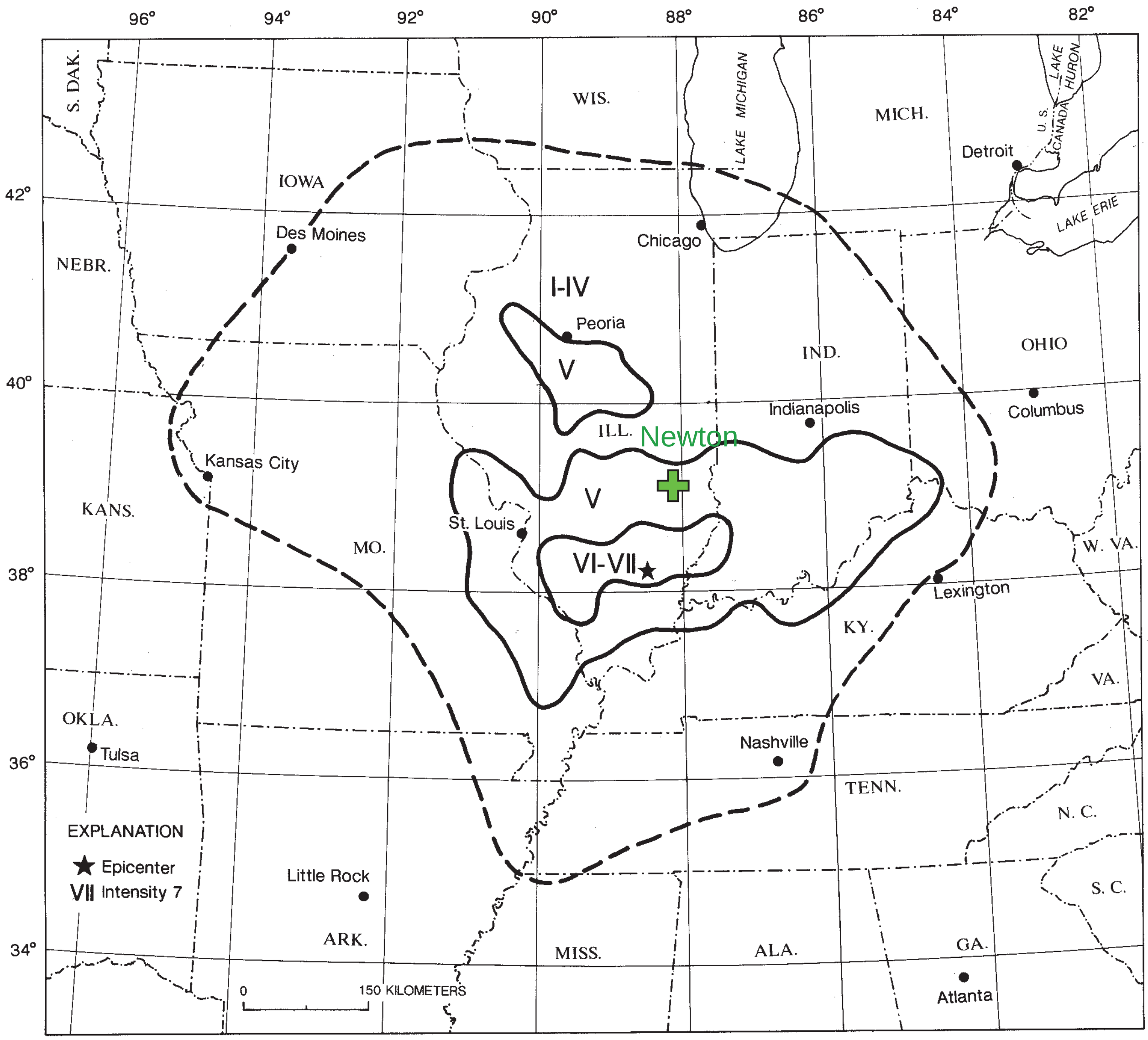


Source: Hough *et al*. (2000)

AECOM	Project No. 60440697 Newton Power Station Dynegy	ISOSEISMAL MAP OF THE 16 DECEMBER 1811 **M** 7.2-7.3 NEW MADRID EARTHQUAKE	Figure 5

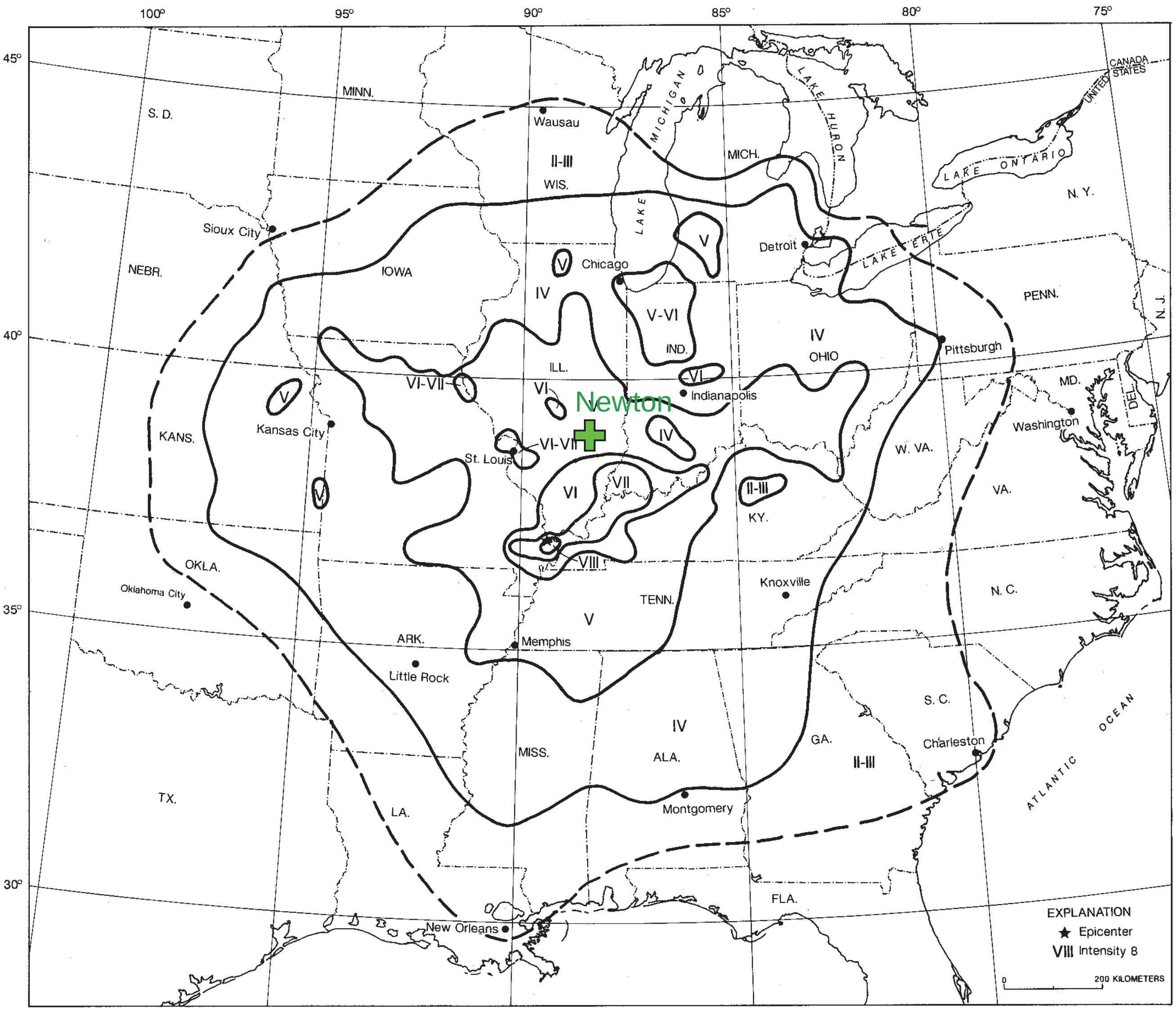


AECOM	Project No. 60440378 Newton Power Station Dynegy	NEW MADRID FAULT SYSTEM, 1811-1812 NMFS EARTHQUAKES, AND NEIGHBORING RLMEs	Figure 6



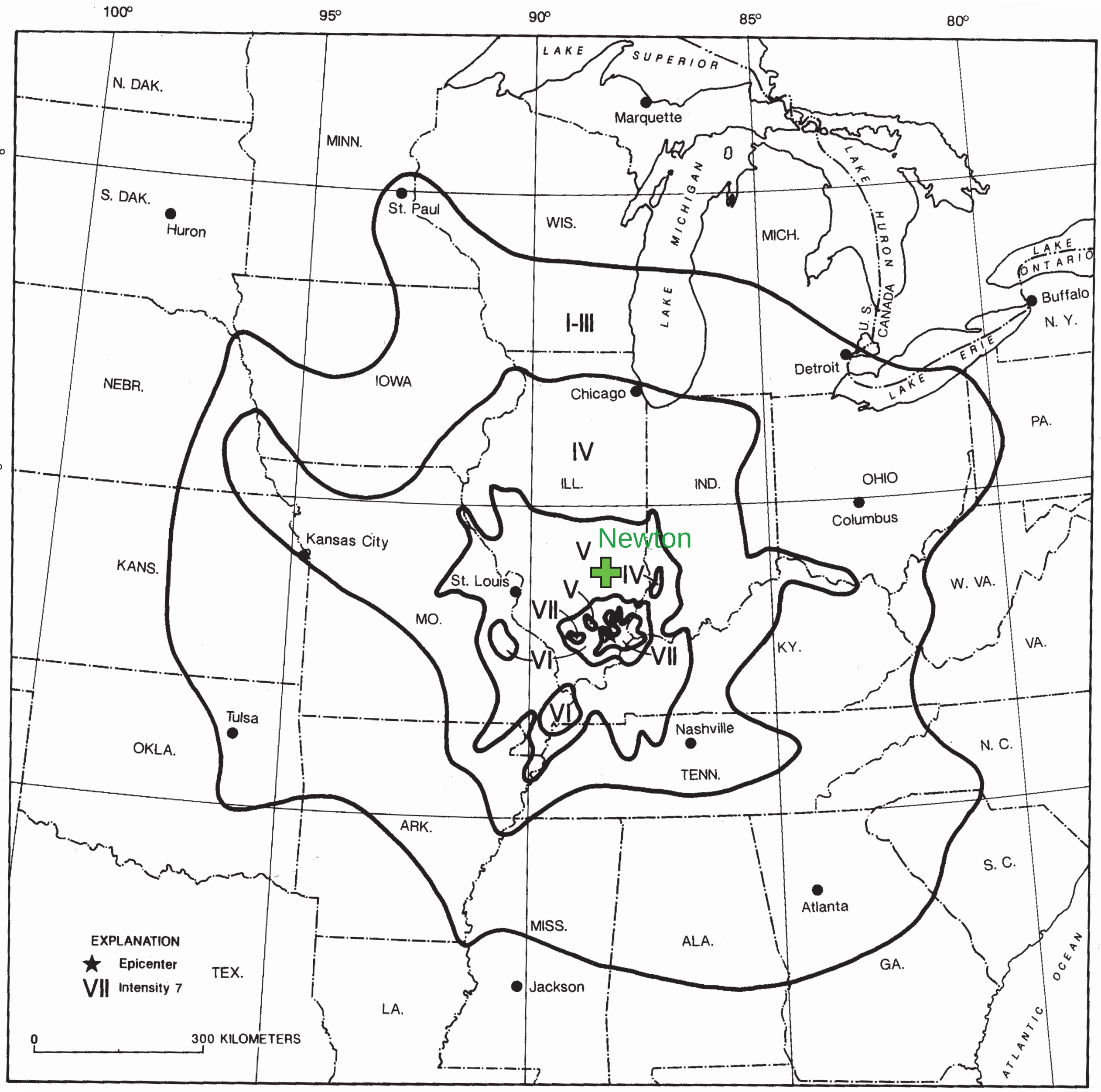
Source: Stover and Coffman (1993)

AECOM	Project No. 60440697 Newton Power Station Dynegy	ISOSEISMAL MAP OF THE 27 SEPTEMBER 1891 m_b 5.8 SOUTHERN ILLINOIS EARTHQUAKE	Figure 7



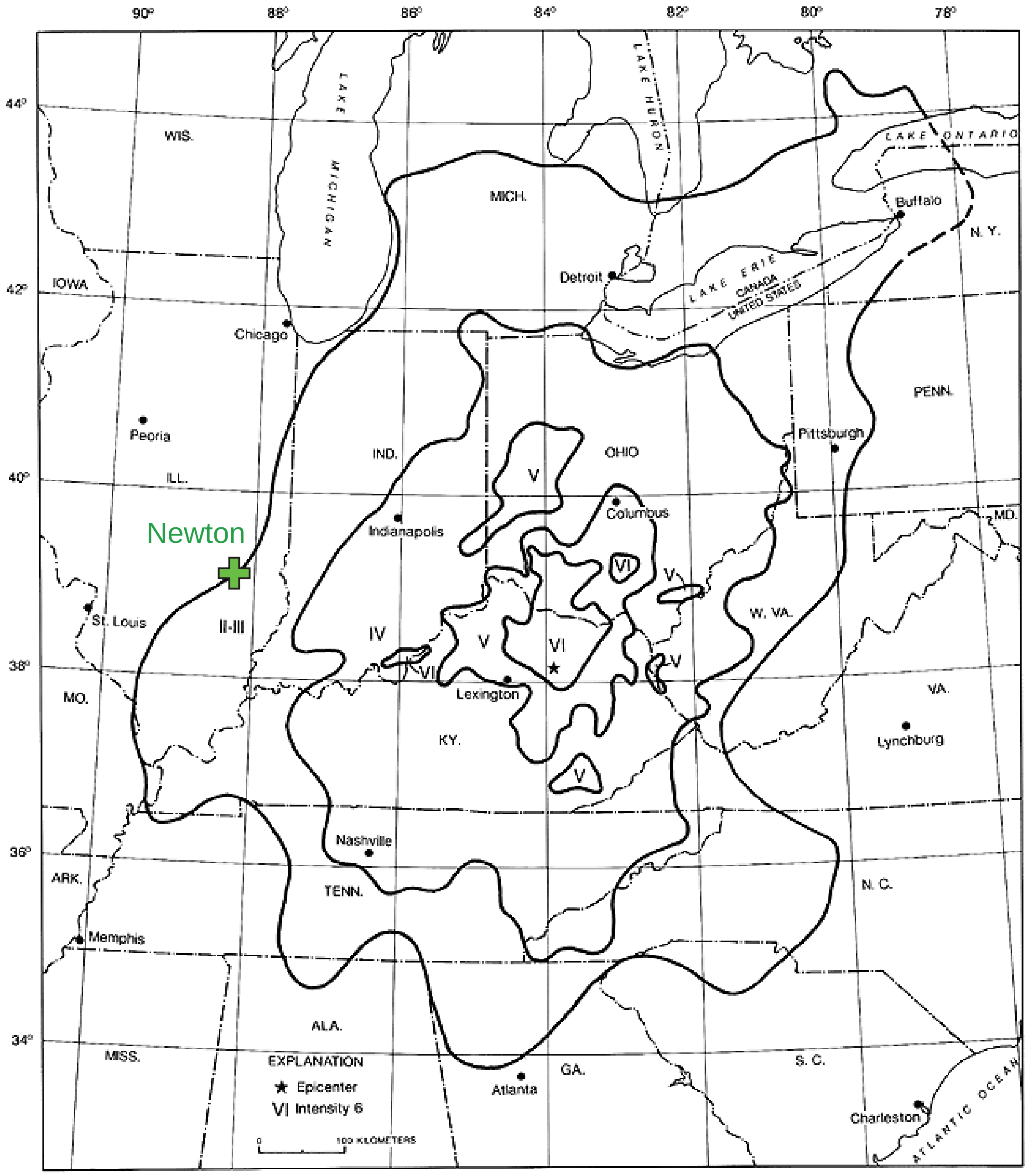
Source: Stover and Coffman (1993)

AECOM	Project No. 60440697 Newton Power Station Dynegy	ISOSEISMAL MAP OF THE 31 OCTOBER 1895 M_S 6.7 CHARLESTON, MISSOURI EARTHQUAKE	Figure 8



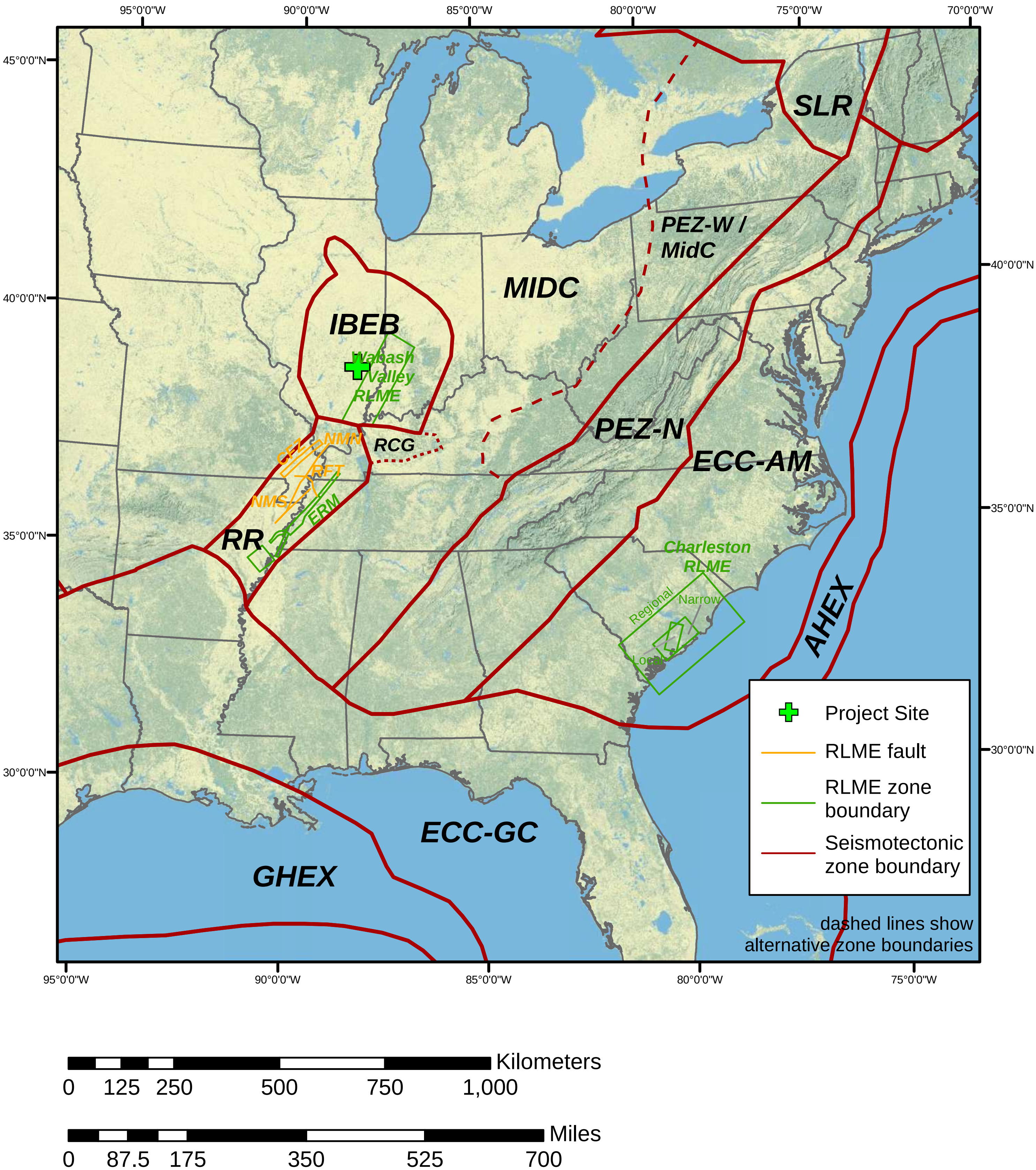
Source: Stover and Coffman (1993)

AECOM	Project No. 60440697	ISOSEISMAL MAP OF THE 9 NOVEMBER 1968 m_b 5.5 SOUTHERN ILLINOIS EARTHQUAKE	Figure 9
	Newton Power Station Dynegy		



Source: Stover and Coffman (1993)

AECOM	Project No. 60440697 Newton Power Station Dynegy	ISOSEISMAL MAP FOR THE 27 JULY 1980 M 5.1 SHARPSBURG, KENTUCKY EARTHQUAKE	Figure 10



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Project No. 60440378

Newton Power Station
Dynegy

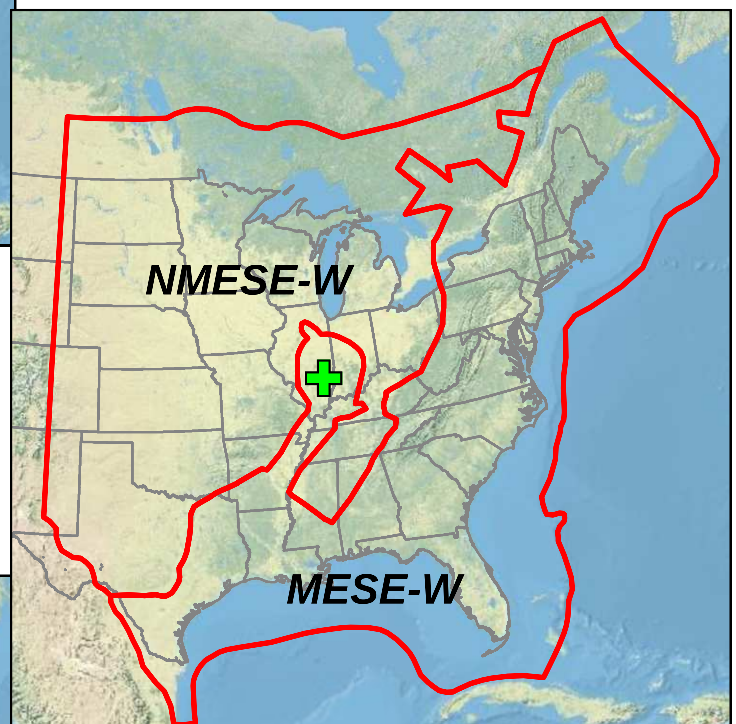
SEISMOTECTONIC ZONES AND RLMES

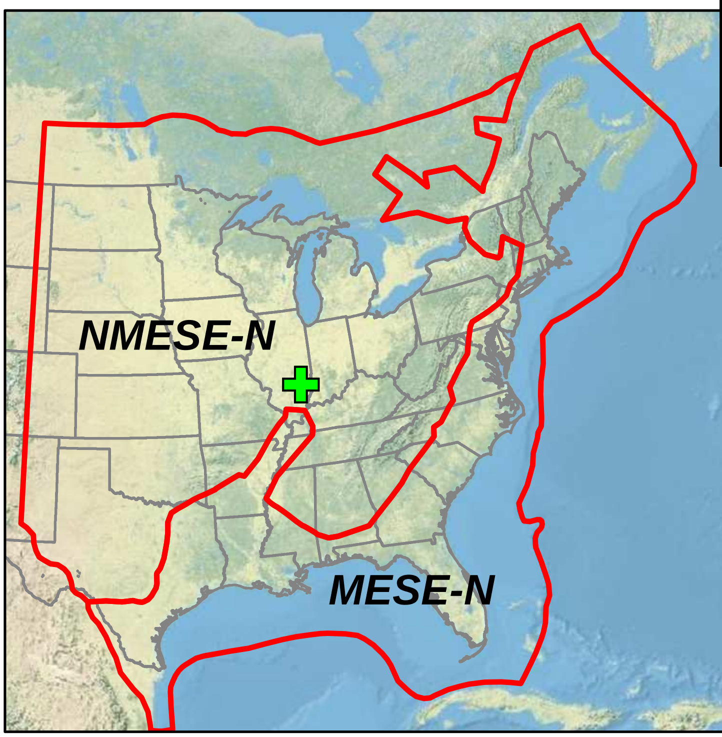
Figure

11

1-Zone Mode

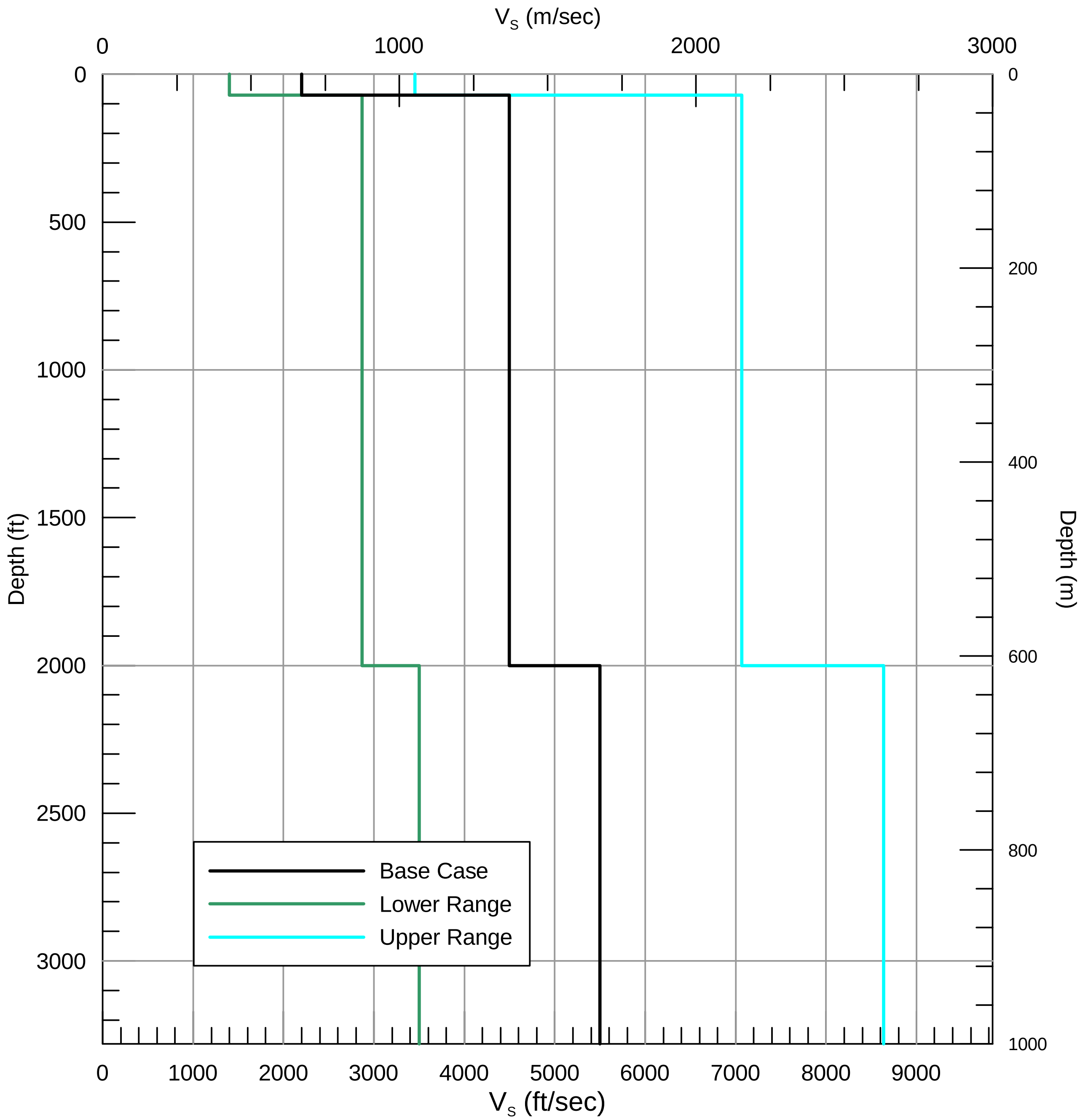
2-Zone Model
MESE-Wide



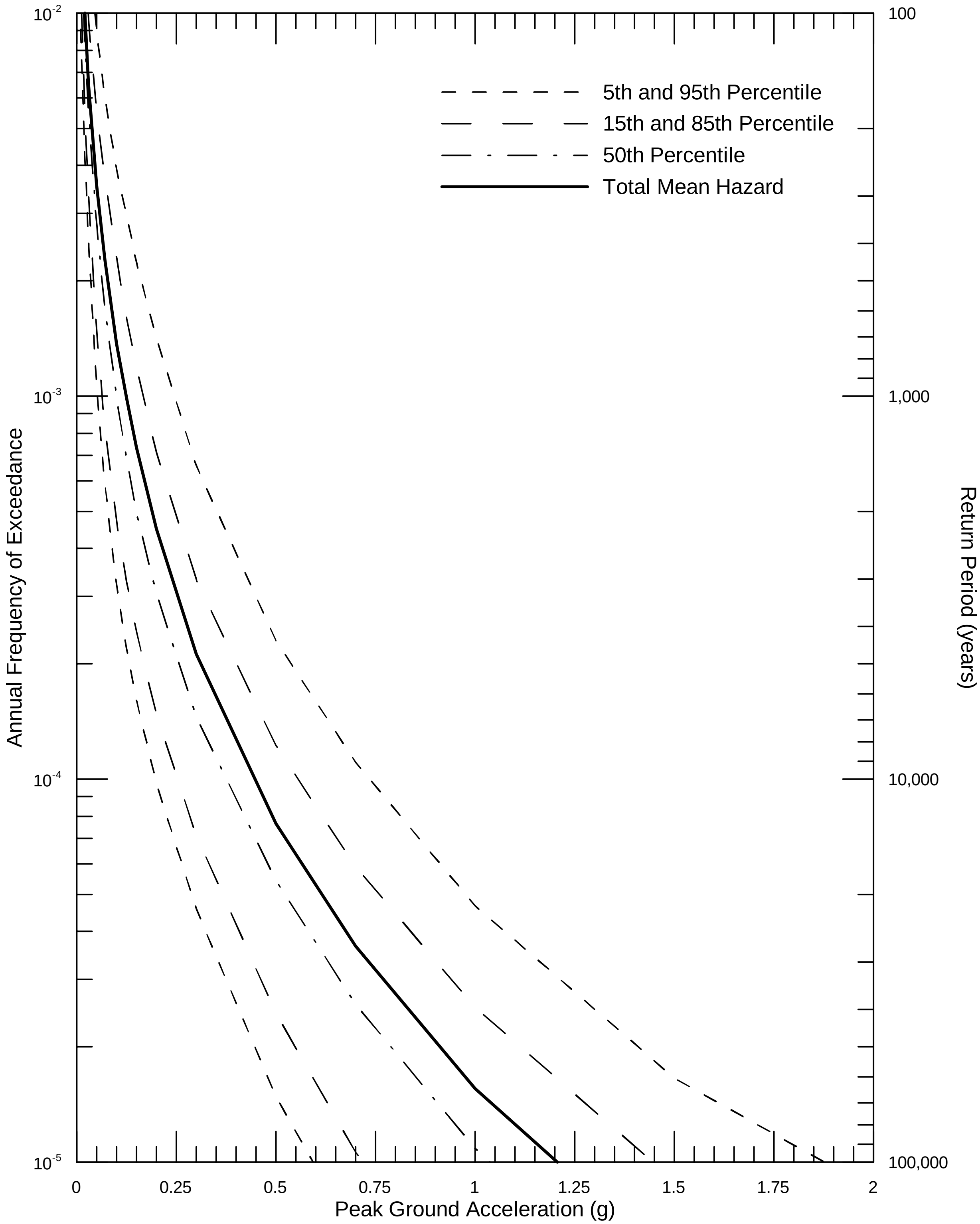


2-Zone Model
MESE-Narrow

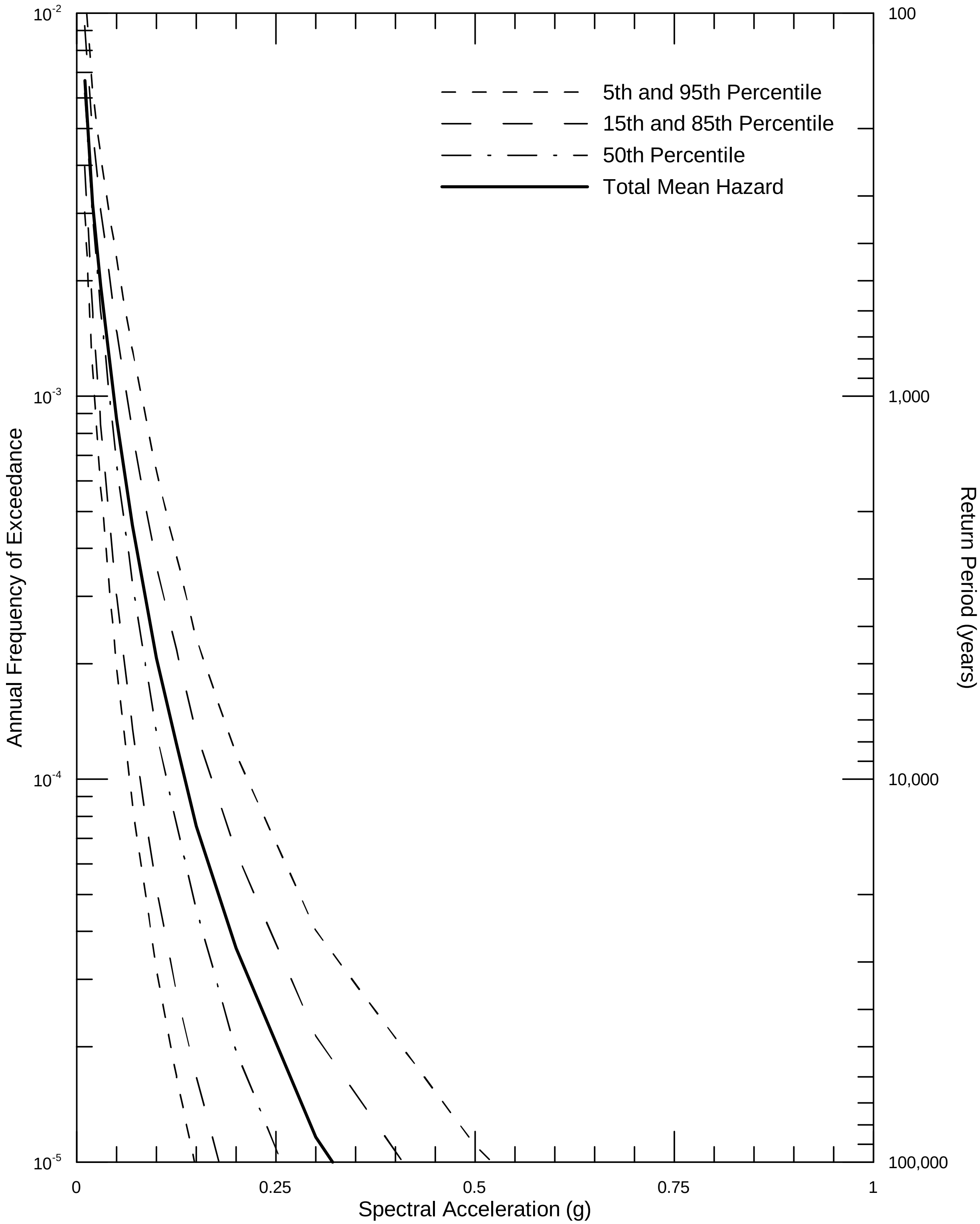
AECOM	Project No. 60440378	Mmax ZONES	Figure
	Newton Power Station Dynegy		12



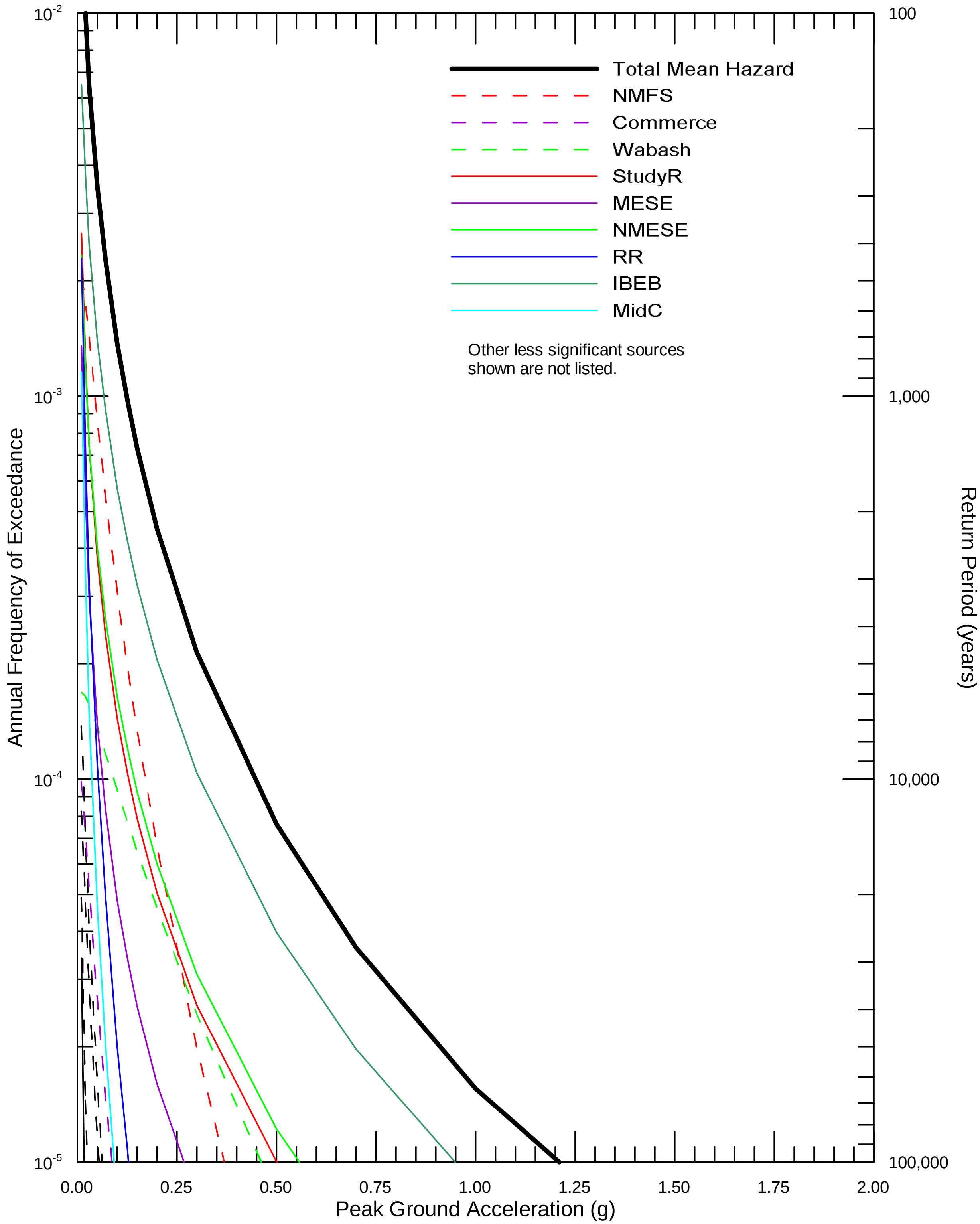
AECOM	Project No. 60440378	SITE RESPONSE VELOCITY PROFILES	Figure 13
	Newton Power Station Dynegy		



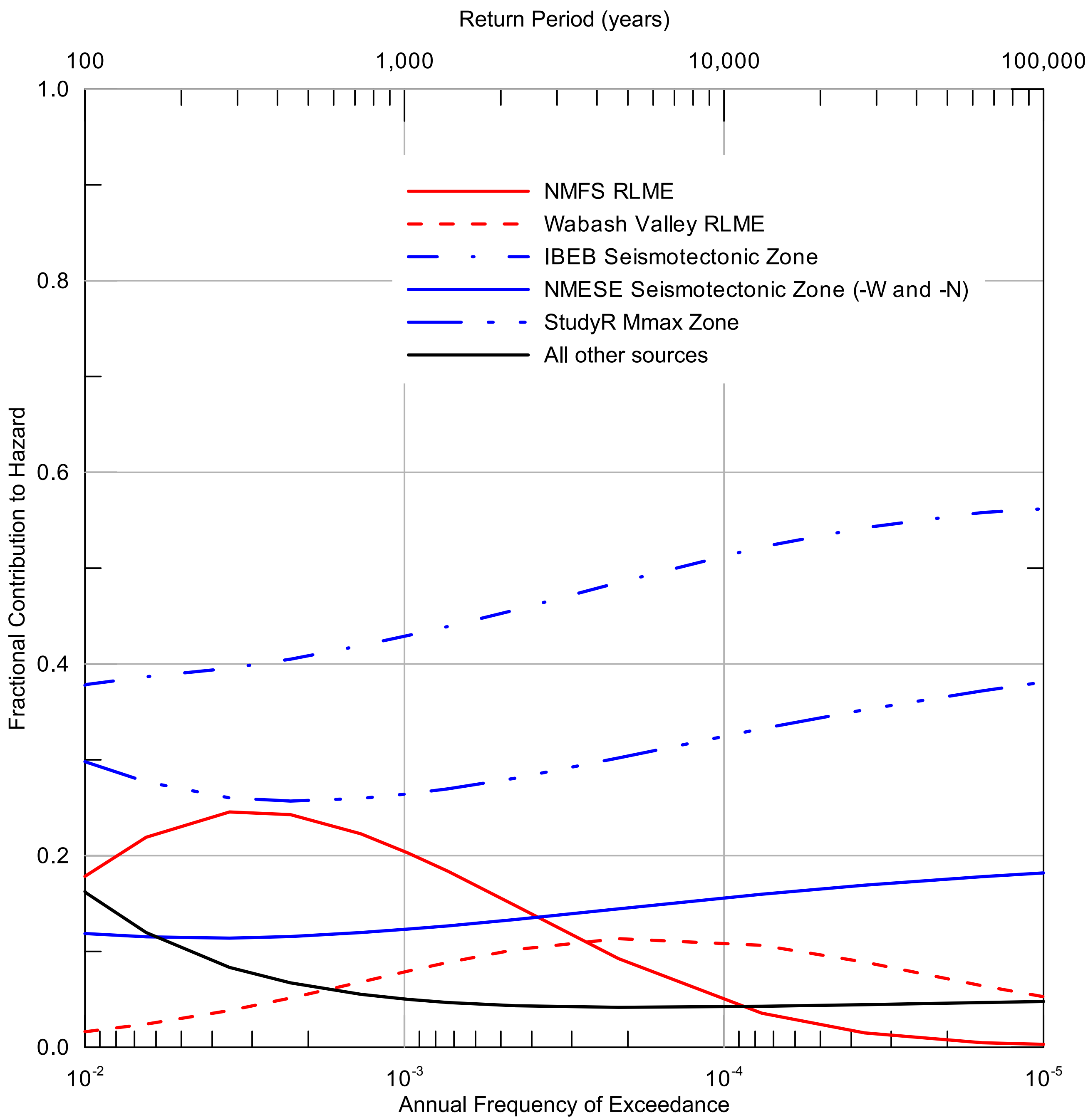
AECOM	Project No. 60440378 Newton Power Station Dynegy	SEISMIC HAZARD CURVES FOR PEAK HORIZONTAL ACCELERATION ON HARD ROCK	Figure 14



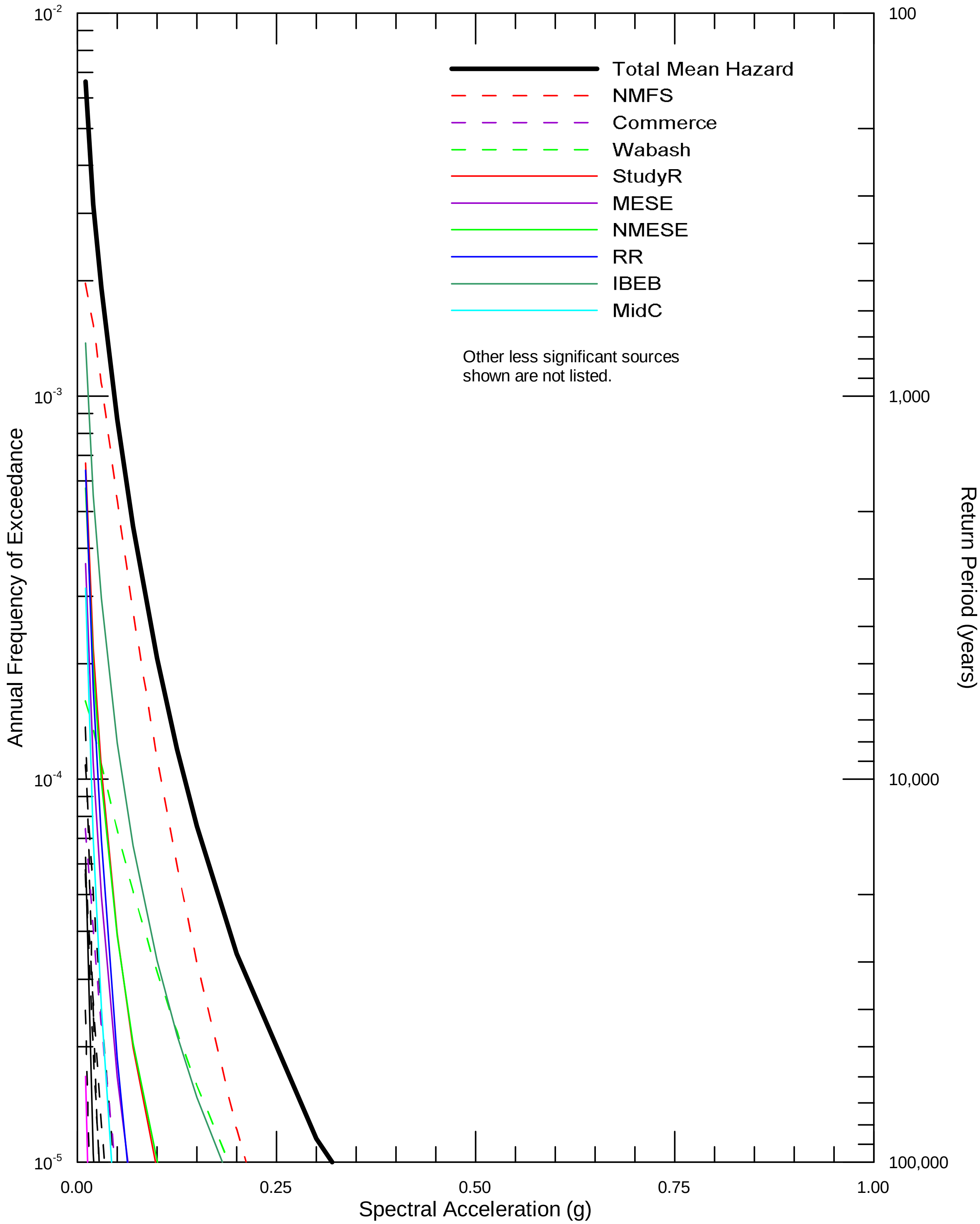
AECOM	Project No. 60440378 Newton Power Station Dynegy	SEISMIC HAZARD CURVES FOR 1.0 SEC HORIZONTAL SPECTRAL ACCELERATION ON HARD ROCK	Figure 15



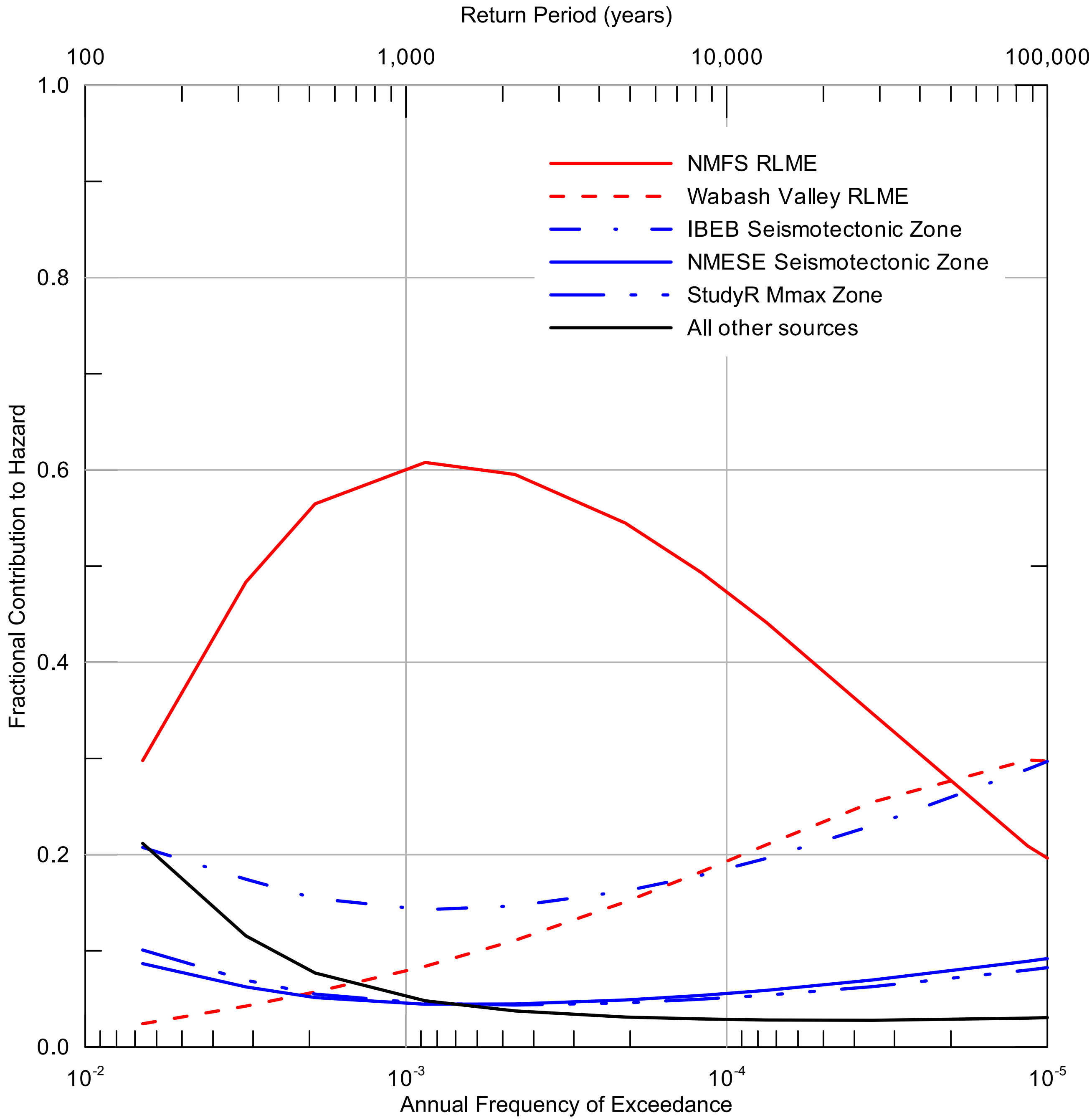
AECOM	Project No. 60440378 Newton Power Station Dynegy	SEISMIC SOURCE CONTRIBUTIONS TO MEAN PEAK HORIZONTAL ACCELERATION HAZARD ON HARD ROCK	Figure 16



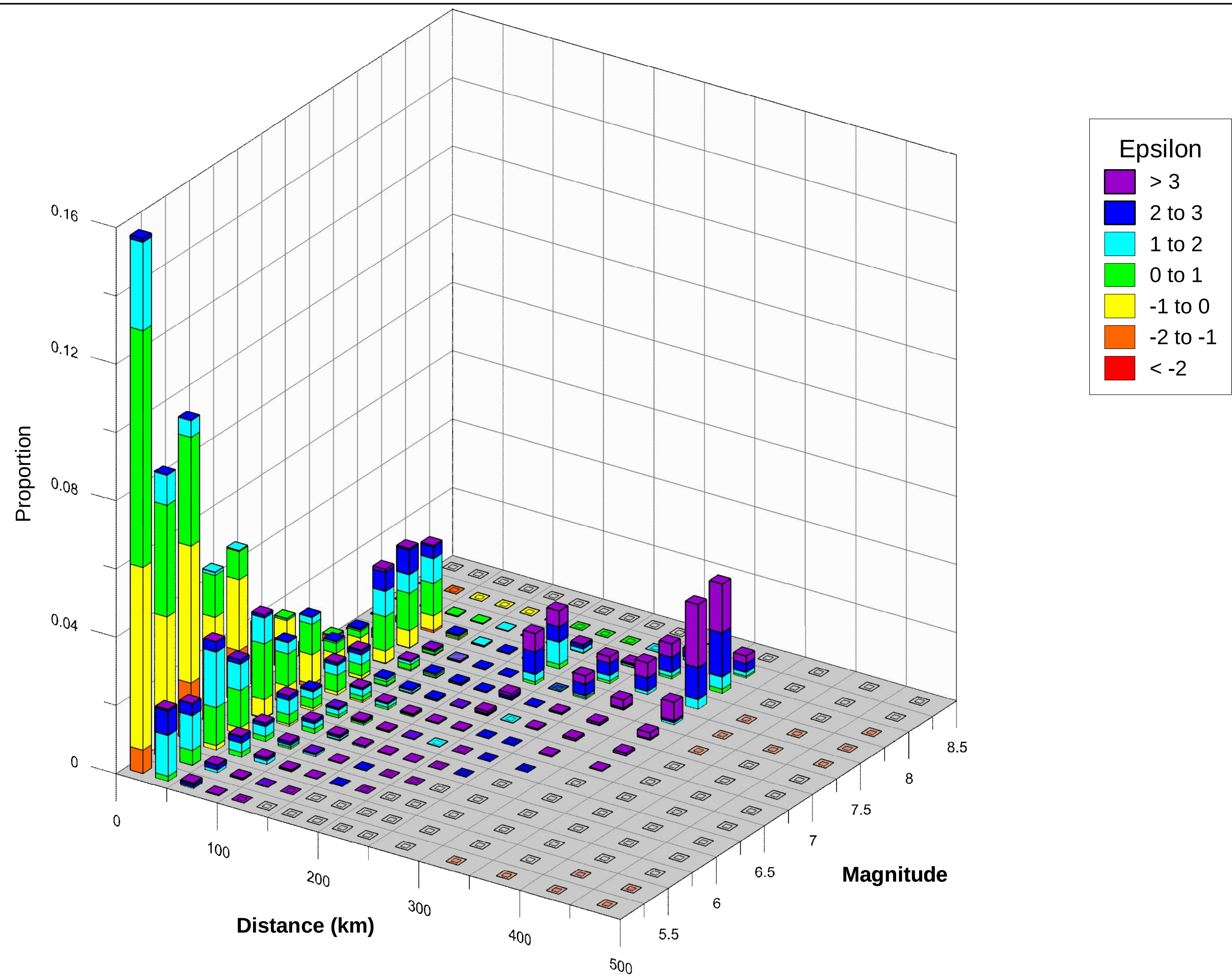
AECOM	Project No. 60440378 Newton Power Station Dynegy	SEISMIC SOURCE FRACTIONAL CONTRIBUTION TO MEAN PEAK HORIZONTAL ACCELERATION HAZARD ON HARD ROCK	Figure 17



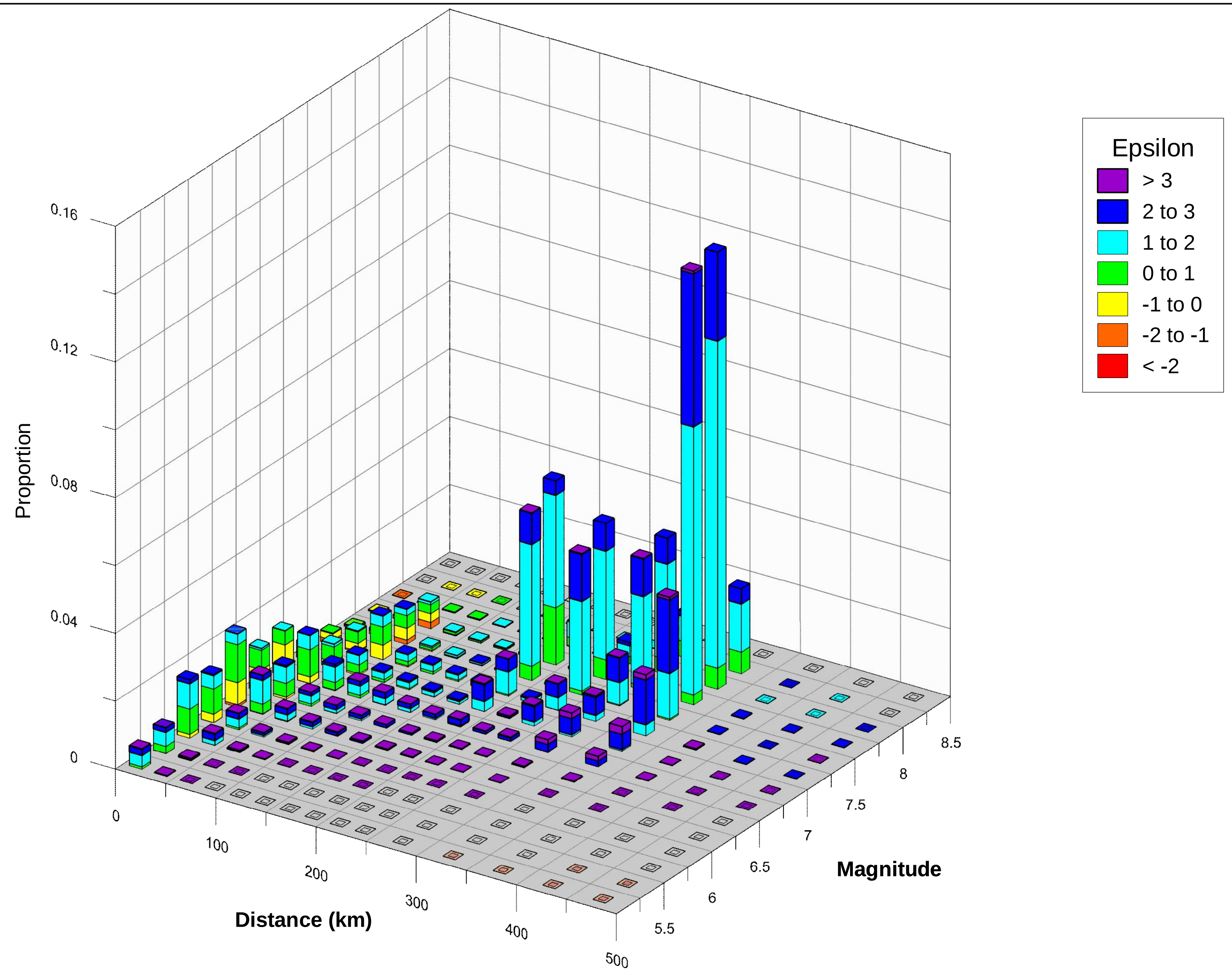
AECOM	Project No. 60440378 Newton Power Station Dynegy	SEISMIC SOURCE CONTRIBUTIONS TO MEAN 1.0 SEC HORIZONTAL SPECTRAL ACCELERATION HAZARD ON HARD ROCK	Figure 18



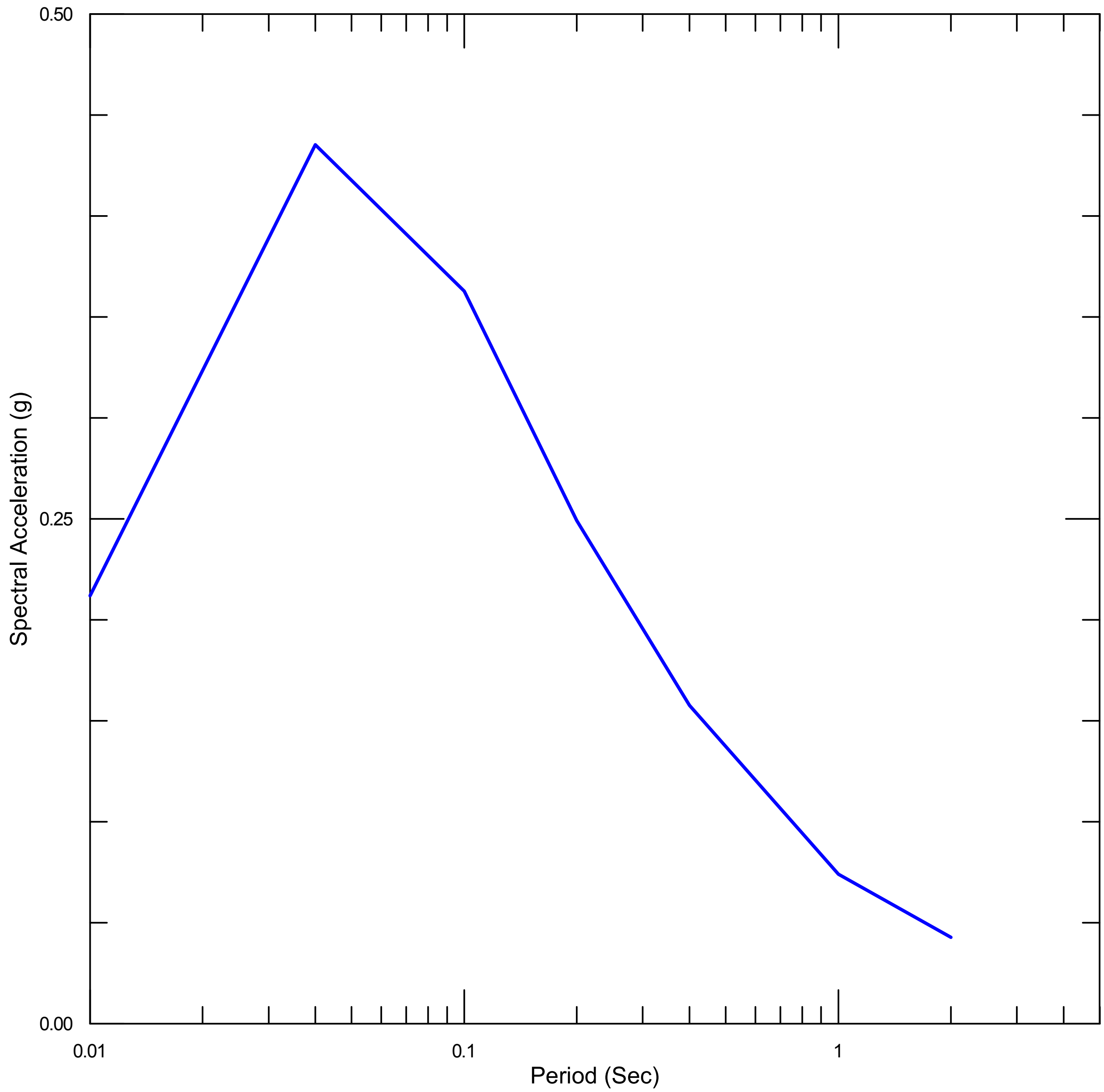
AECOM	Project No. 60440378 Newton Power Station Dynegy	SEISMIC SOURCE FRACTIONAL CONTRIBUTION TO MEAN 1.0 SEC HORIZONTAL SPECTRAL ACCELERATION HAZARD ON HARD ROCK	Figure 19



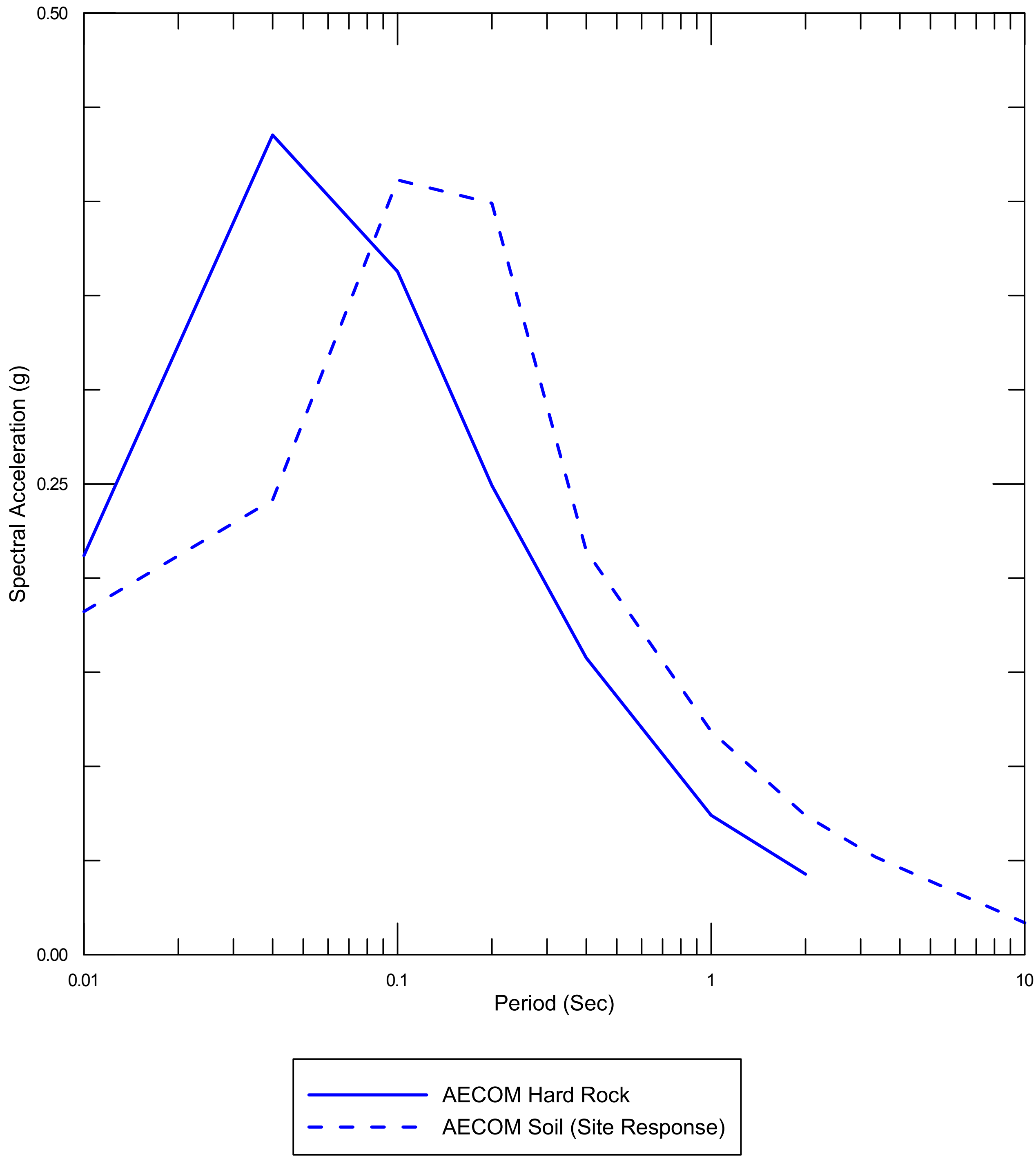
AECOM	Project No. 60440378 Newton Power Station Dynegy	MAGNITUDE, DISTANCE AND EPSILON CONTRIBUTIONS TO THE MEAN PEAK HORIZONTAL ACCELERATIONHAZARD AT 2,475-YEAR RETURN PERIOD ON HARD ROCK	Figure 20



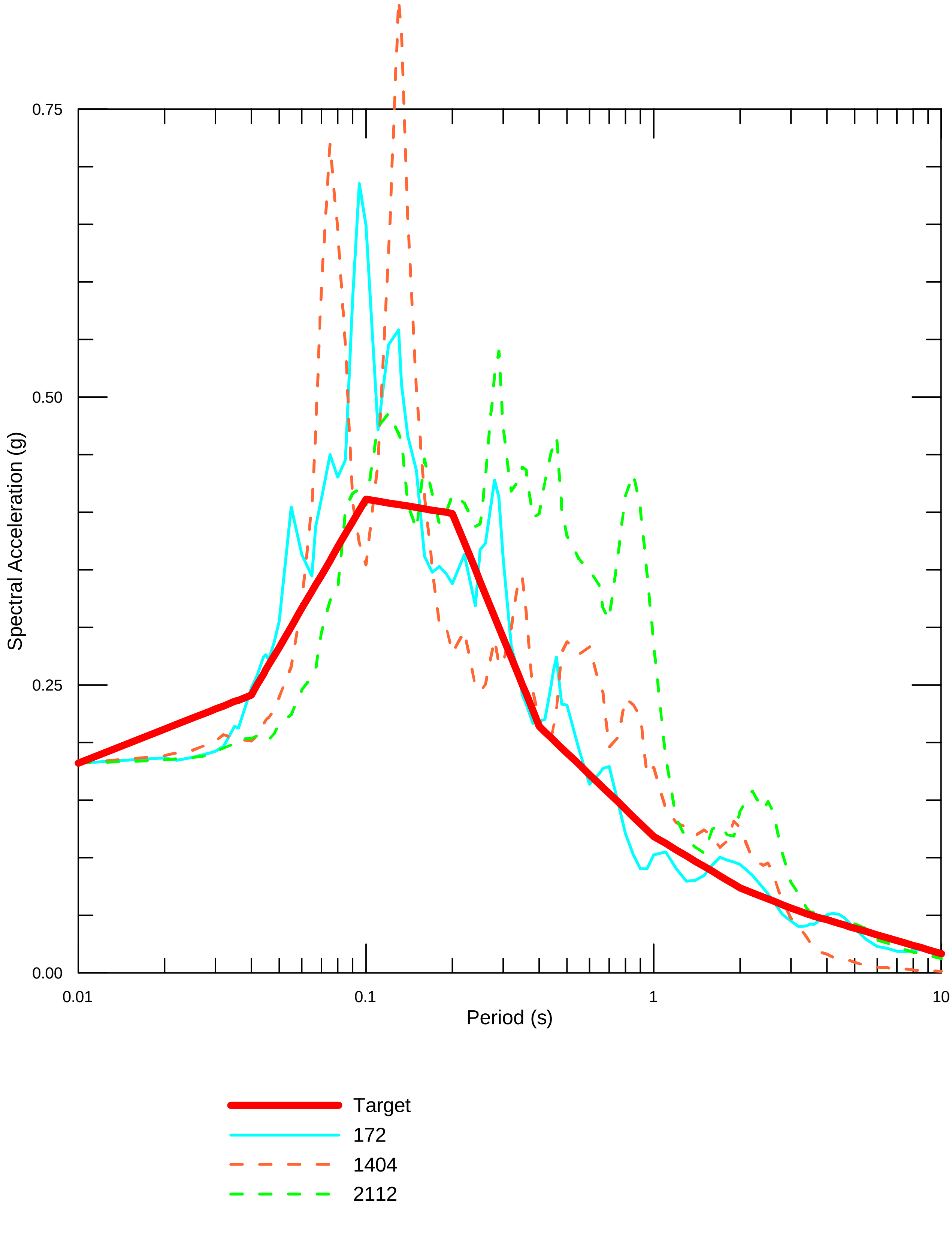
AECOM	Project No. 60440378 Newton Power Station Dynegy	MAGNITUDE, DISTANCE AND EPSILON CONTRIBUTIONS TO THE MEAN 1.0 SEC HORIZONTAL SPECTRAL ACCELERATIONHAZARD AT 2,475-YEAR RETURN PERIOD ON HARD ROCK	Figure 21



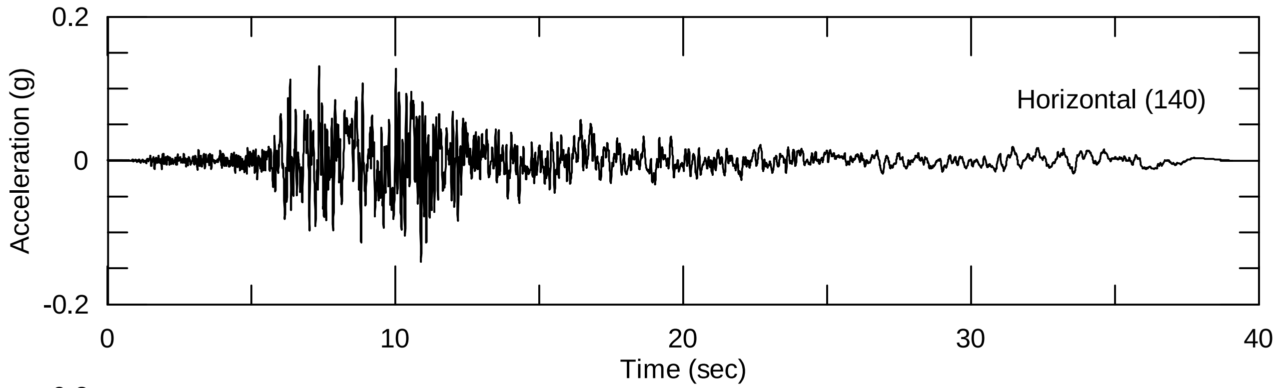
	Project No. 60440378	5%-DAMPED MEAN HORIZONTAL UHS ON HARD ROCK AT 2,500-YEAR RETURN PERIOD	Figure 22
AECOM	Newton Power Station Dynegy		

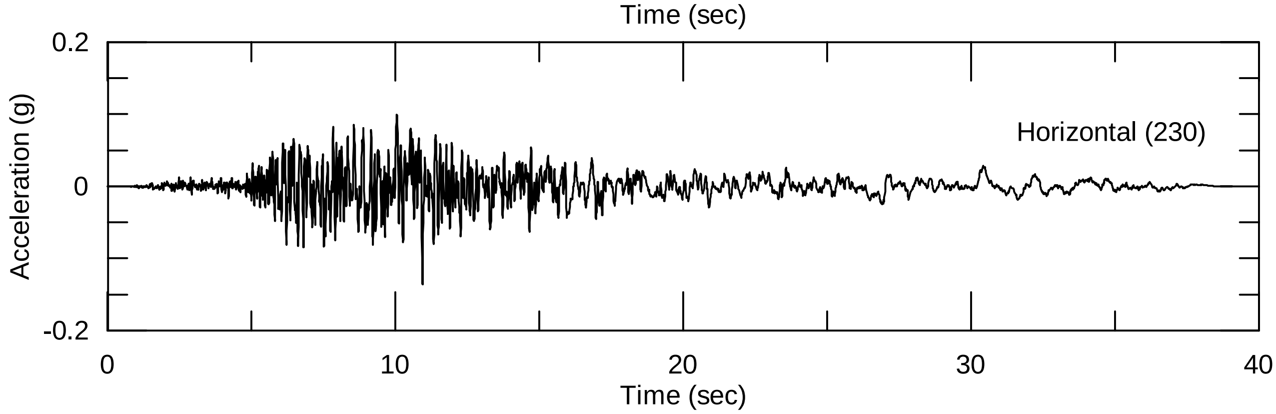


AECOM	Project No. 60440378	COMPARISON OF HORIZONTAL MEAN UHS ON HARD ROCK AND GROUND SURFACE AT 2,500-YEAR RETURN PERIOD	Figure 23
	Newton Power Station Dynegy		

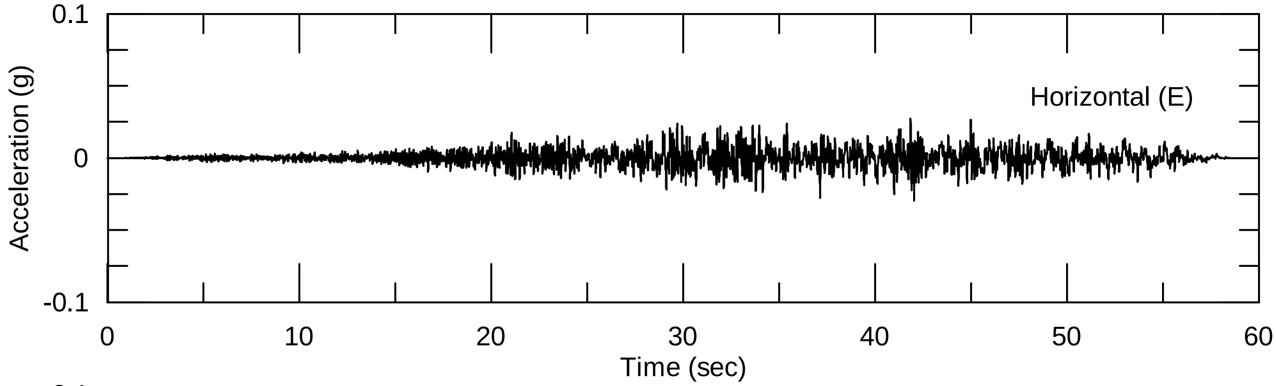


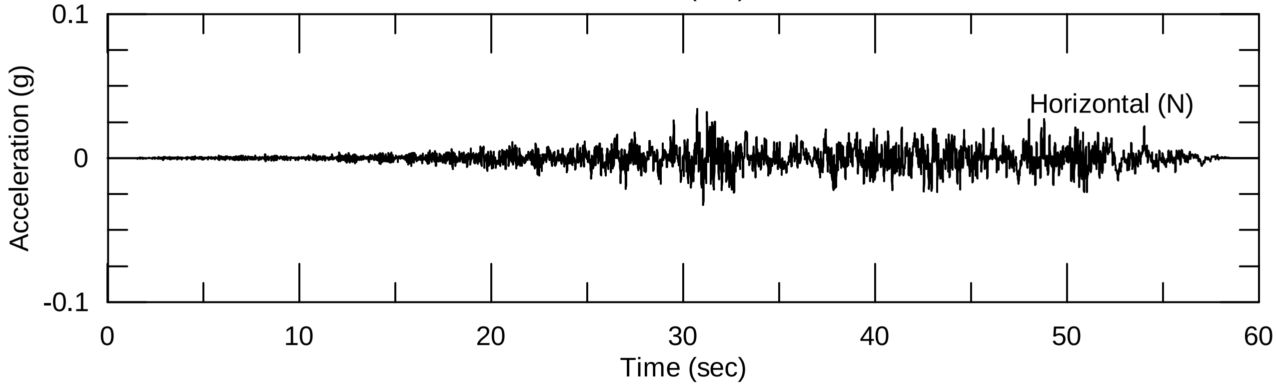
Project No. 60440378	HORIZONTAL TARGET AND SELECTED SEED RESPONSE SPECTRA	Figure 24
Newton Power Station Dynegy		



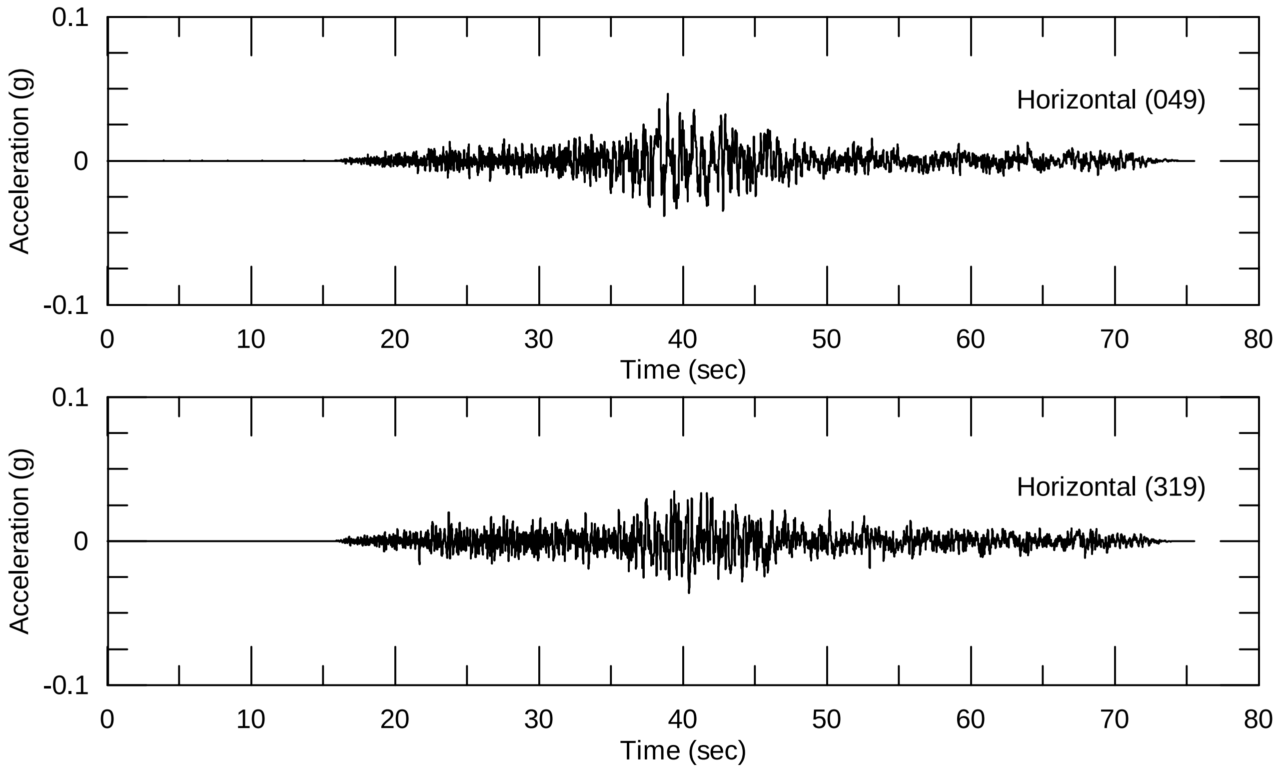


AECOM	Project No. 60440378 Newton Power Station Dynegy	SEED TIME HISTORIES RSN0172 - 1979 IMPERIAL VALLEY EL CENTRO ARRAY #1	Figure 25

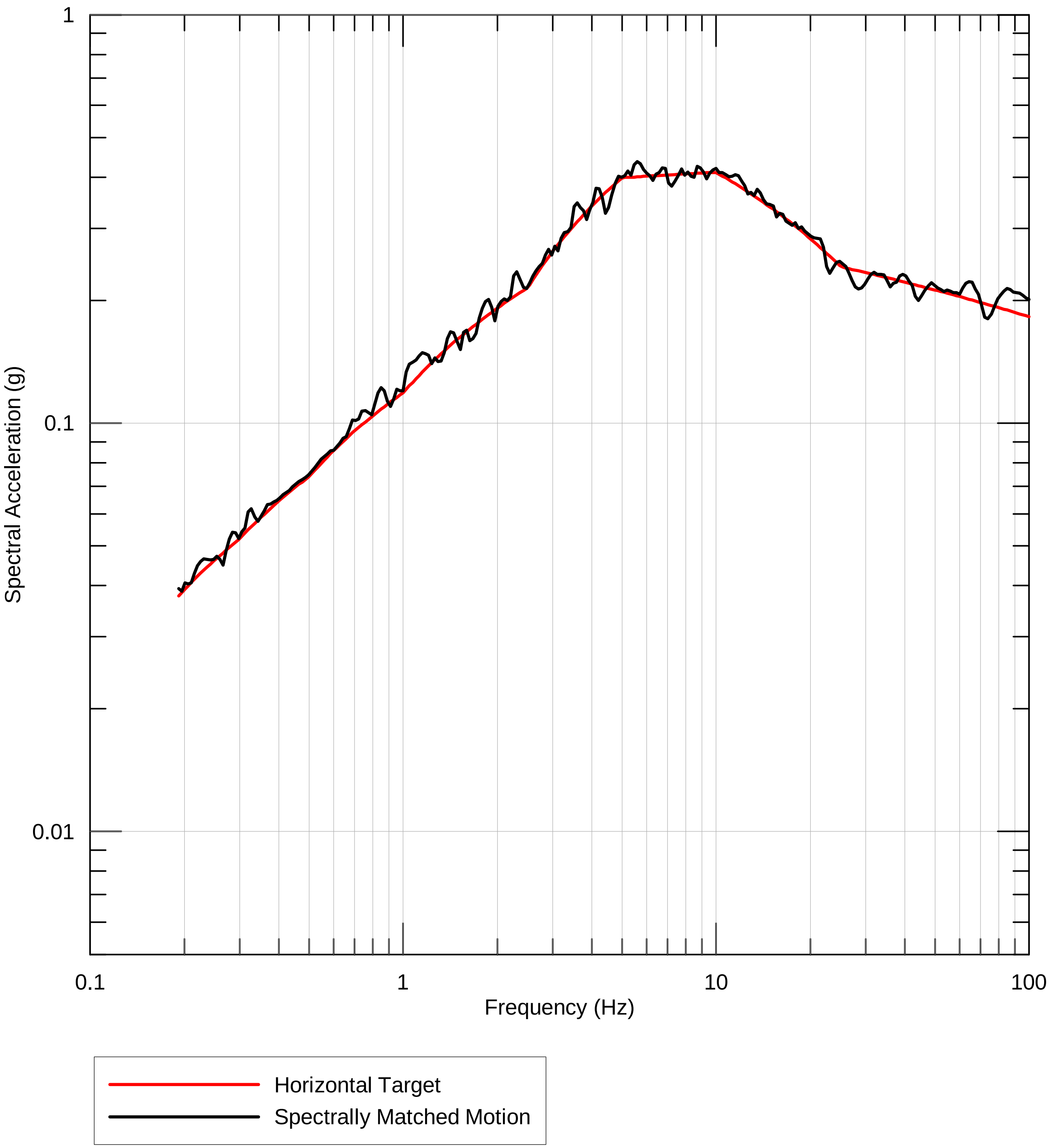




AECOM	Project No. 60440378 Newton Power Station Dynegy	SEED TIME HISTORIES RSN1404 - 1999 CHI CHI PNG	Figure 26

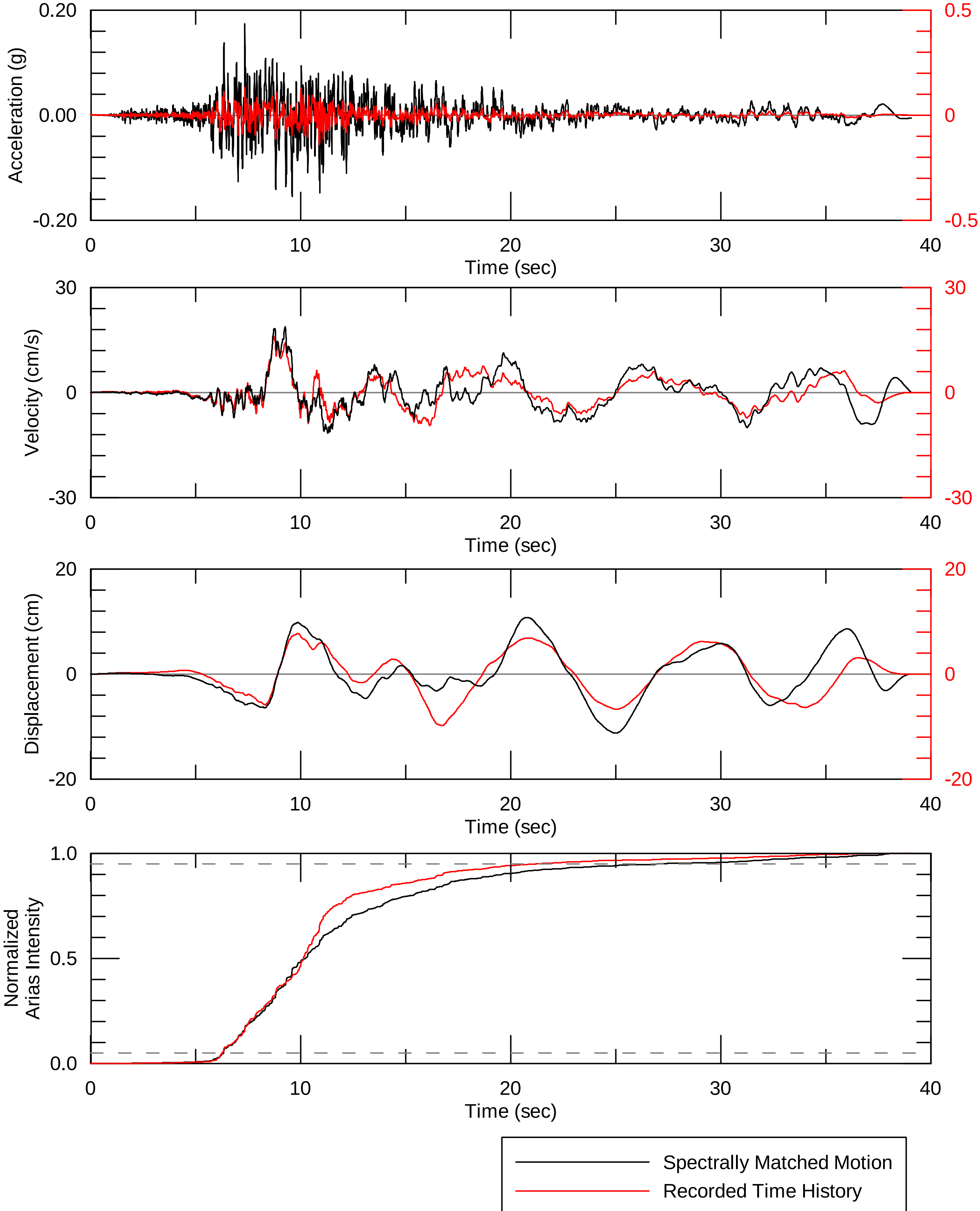


AECOM	Project No. 60440378 Newton Power Station Dynegy	SEED TIME HISTORIES RSN2112 - 2002 DENALI TAPS PUMP STATION #08	Figure 27



SEED: PEER RSN0172

AECOM	Project No. 60440378 Newton Power Station Dynegy	RESPONSE SPECTRA FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1979 IMPERIAL VALLEY - ECA #1 (140) SEED	Figure 28



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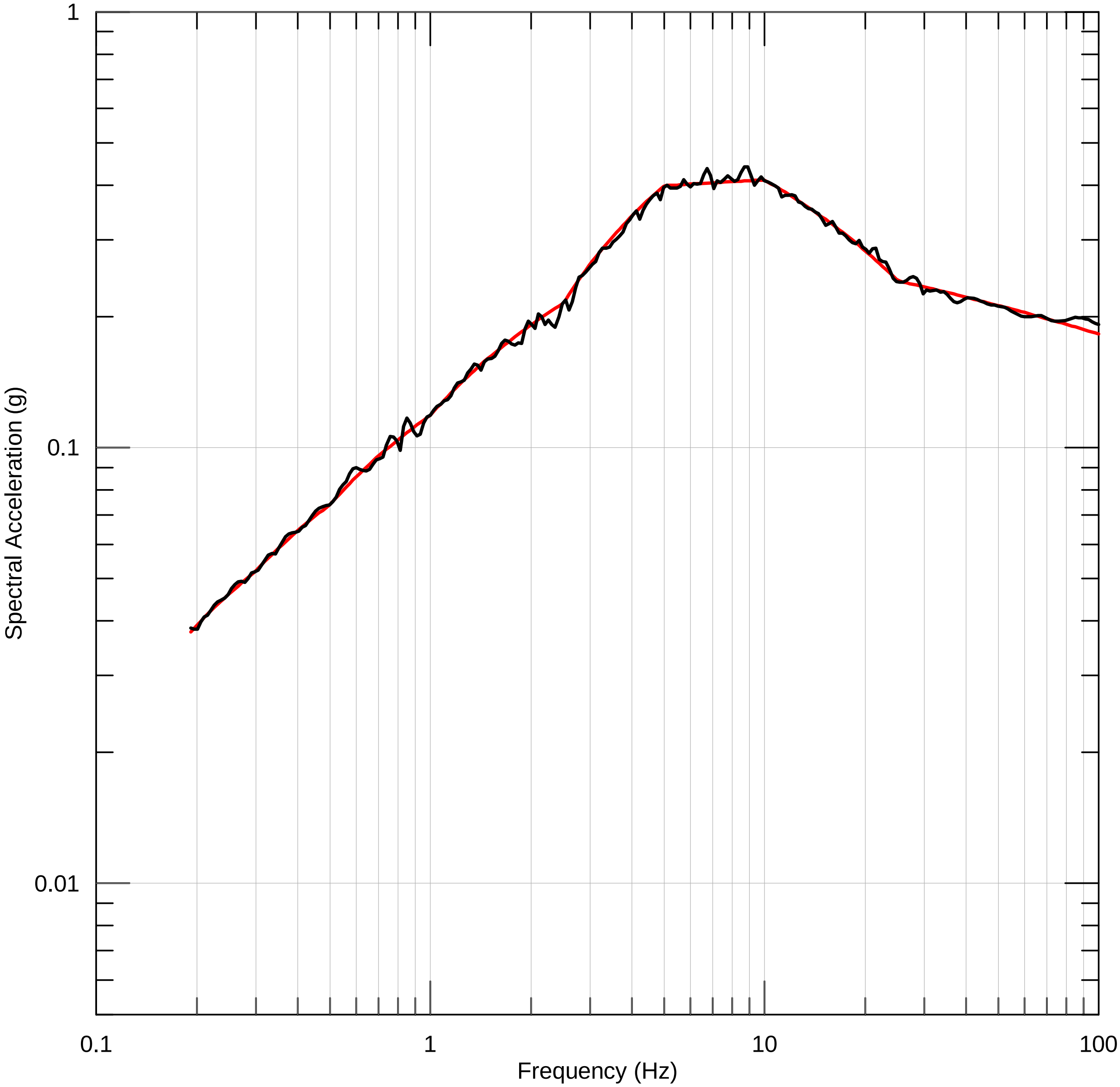
AECOM	Project No. 60440378 Newton Power Station Dynegy	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1979 IMPERIAL VALLEY - ECA #1 (140) SEED	Figure 29



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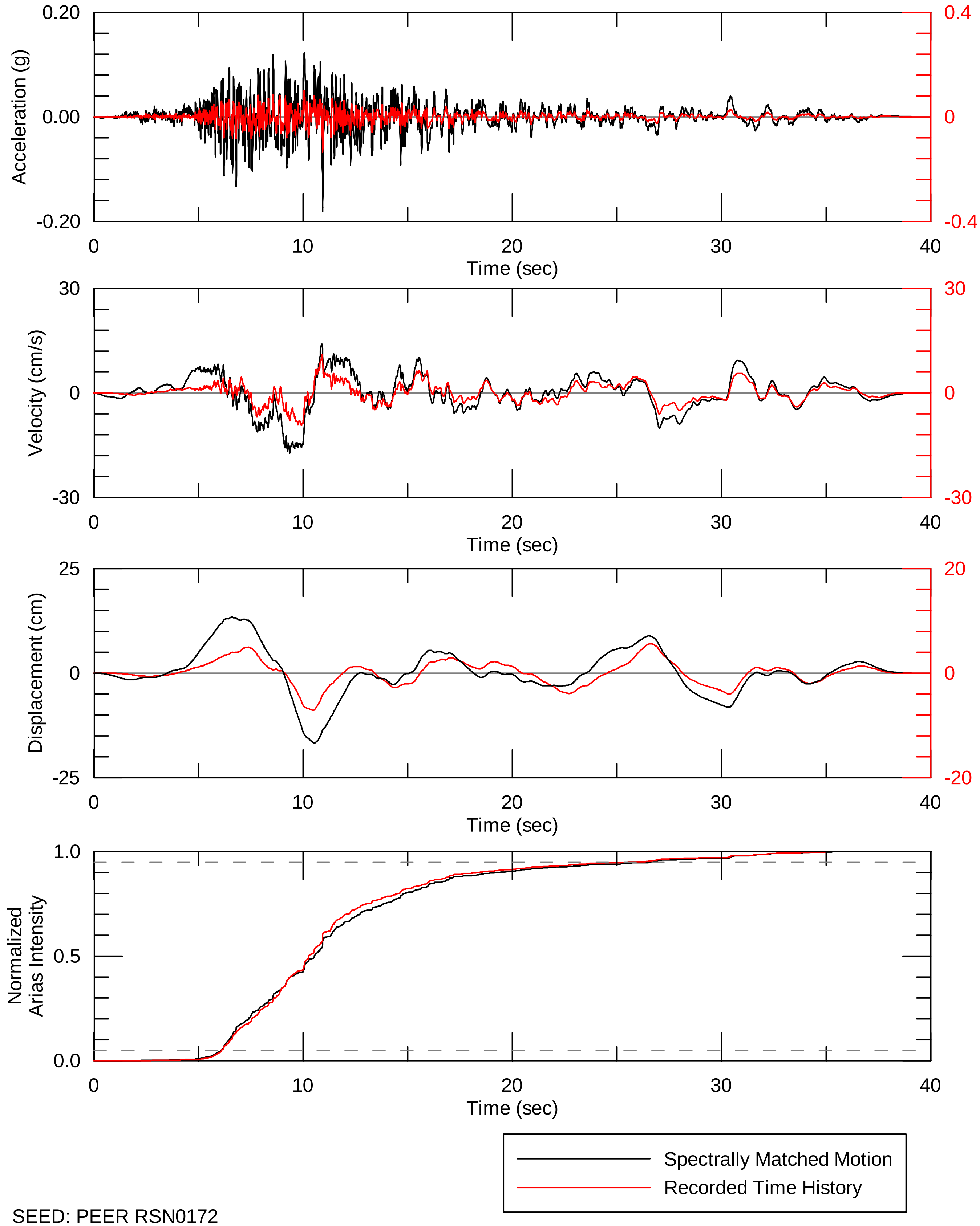
AECOM	Project No. 60440378 Newton Power Station Dynegy	RESPONSE SPECTRA FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1979 IMPERIAL VALLEY - ECA #1 (230) SEED	Figure 30



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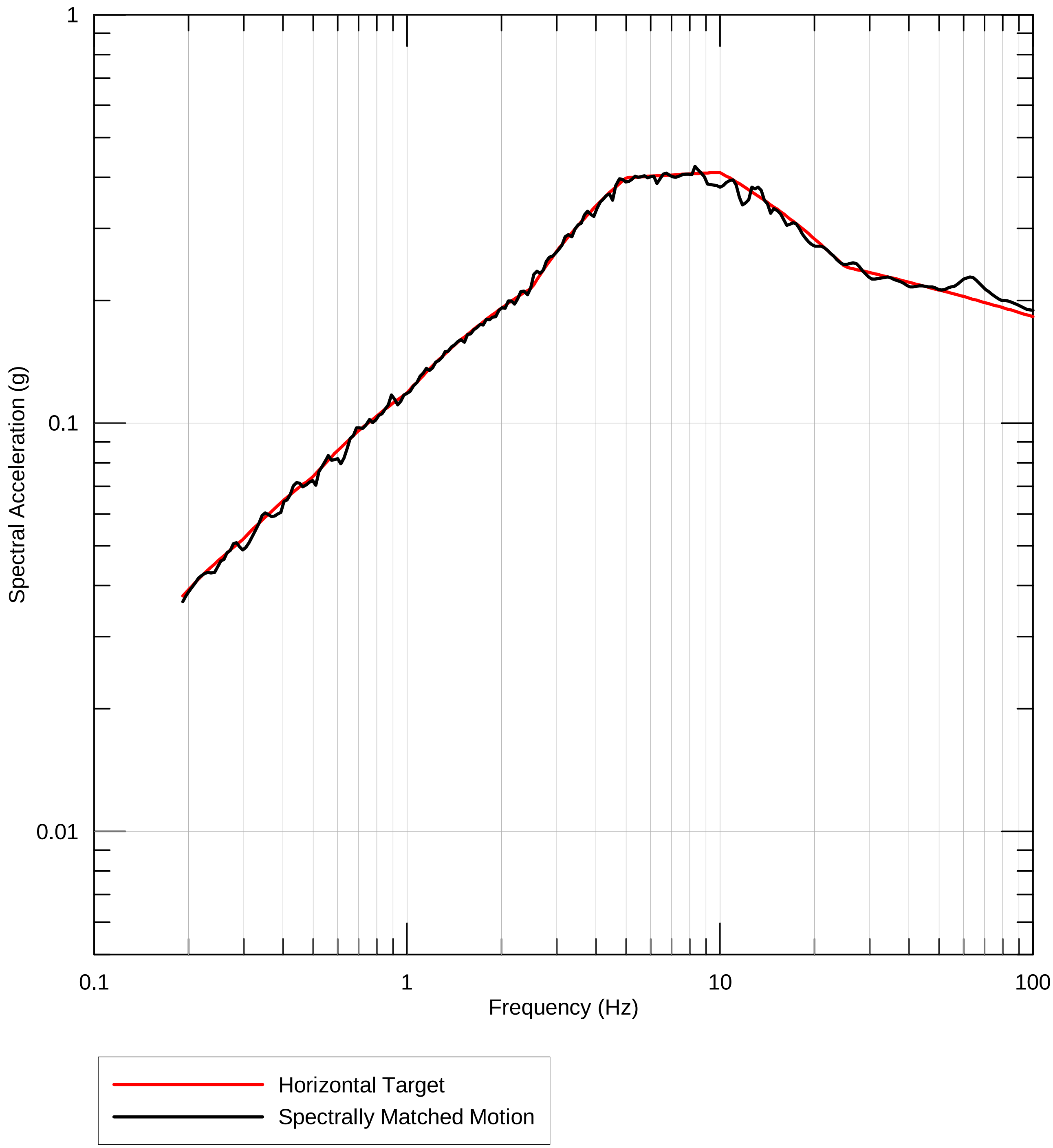
AECOM	Project No. 60440378 Newton Power Station Dynegy	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1979 IMPERIAL VALLEY - ECA #1 (230) SEED	Figure 31



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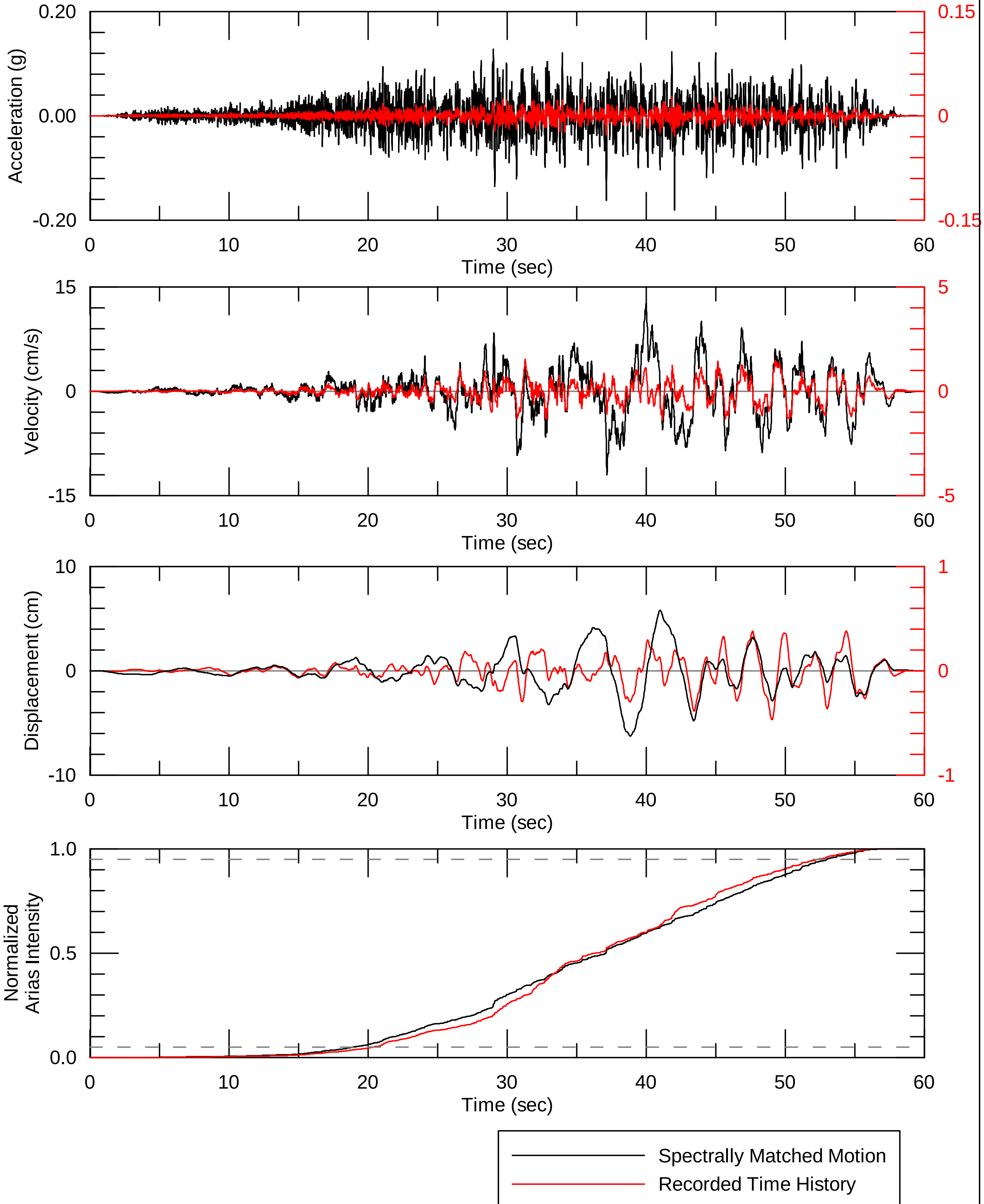
AECOM	Project No. 60440378 Newton Power Station Dynegy	RESPONSE SPECTRA FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1999 CHI CHI - PNG (E) SEED	Figure 32



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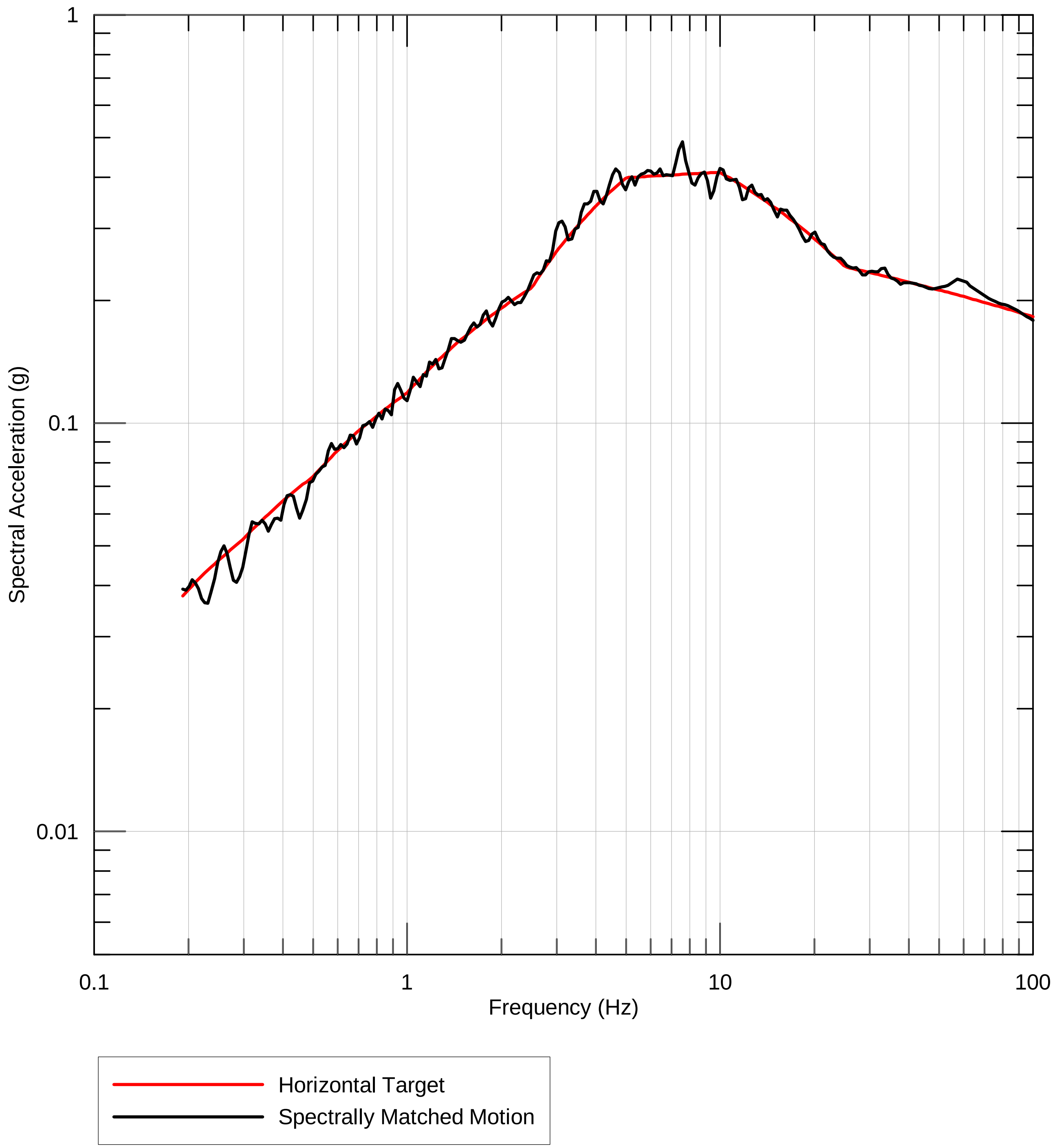
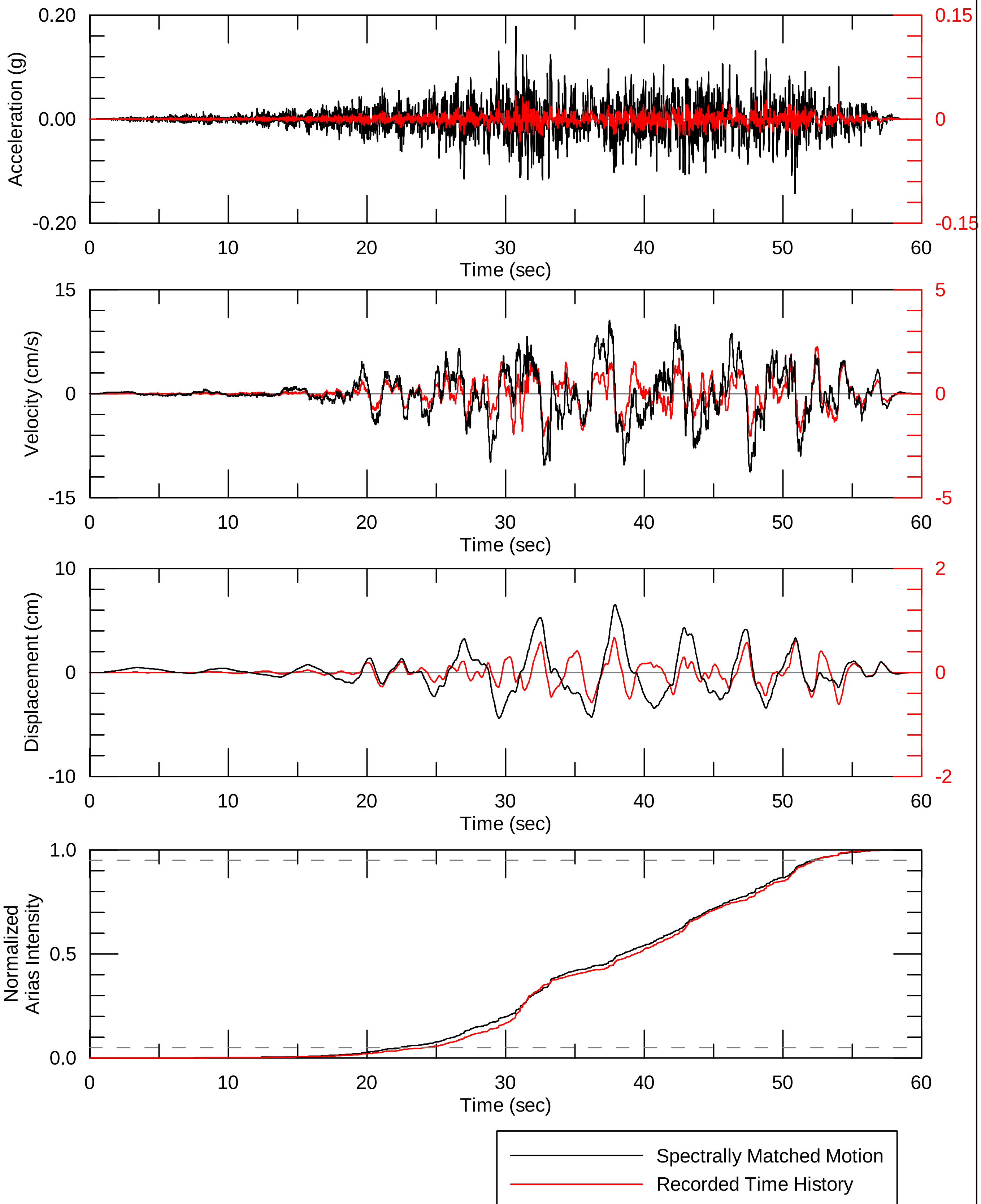
AECOM	Project No. 60440378 Newton Power Station Dynegy	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1999 CHI CHI - PNG (E) SEED	Figure 33



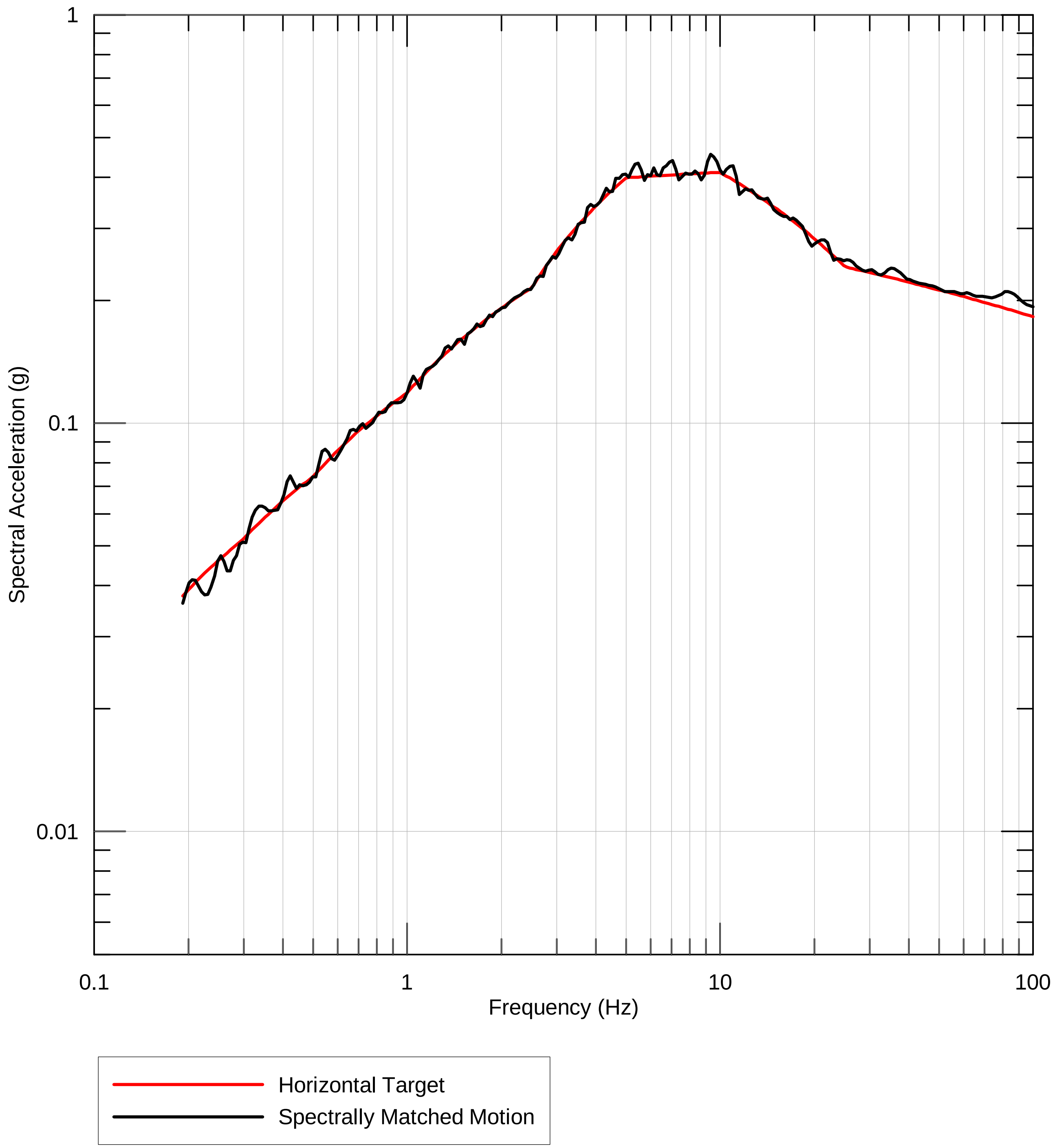
SEED: PEER RSN1404

AECOM	Project No. 60440378 Newton Power Station Dynegy	RESPONSE SPECTRA FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1999 CHI CHI - PNG (N) SEED	Figure 34



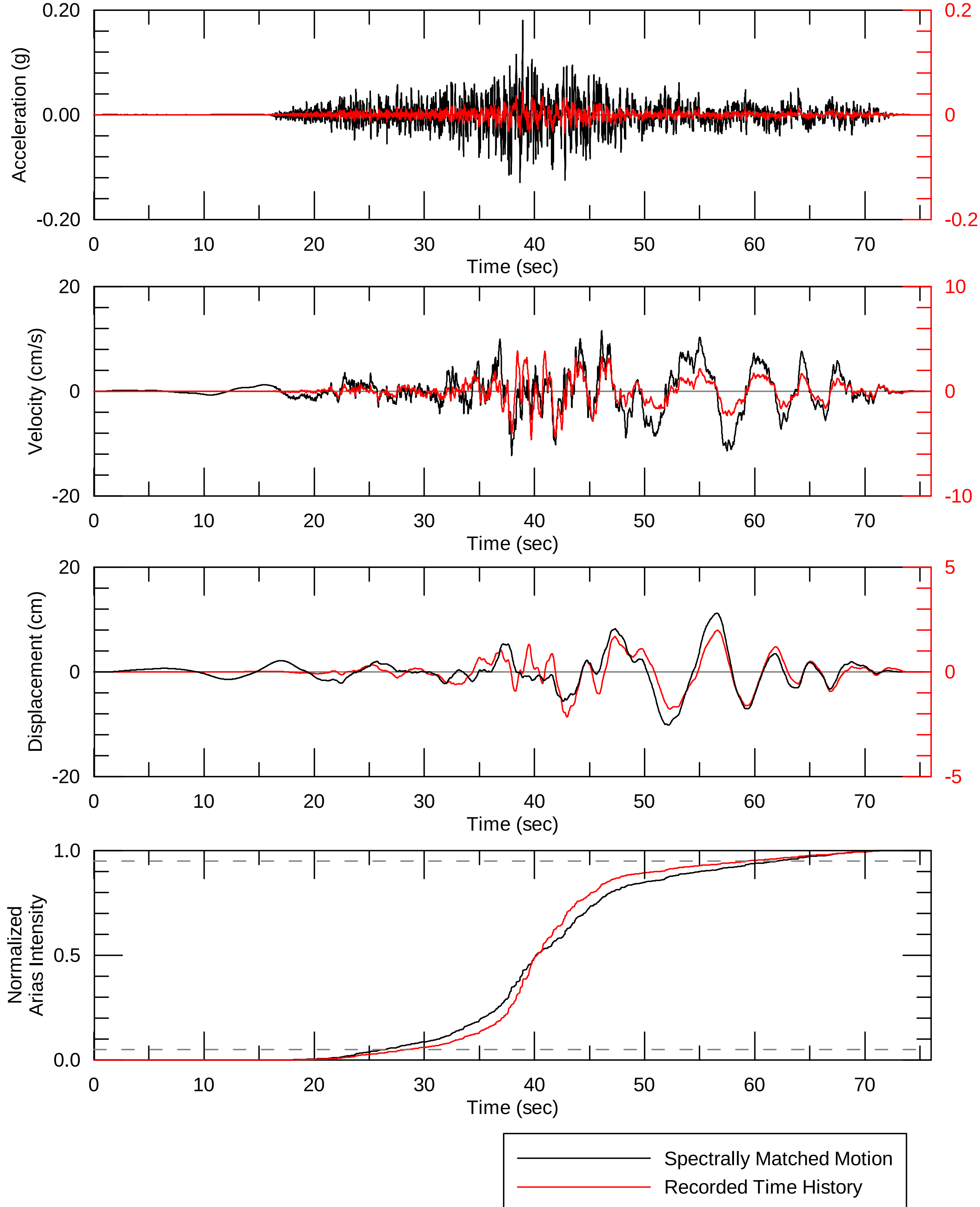
SEED: PEER RSN1404

AECOM	Project No. 60440378 Newton Power Station Dynegy	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1999 CHI CHI - PNG (N) SEED	Figure 35



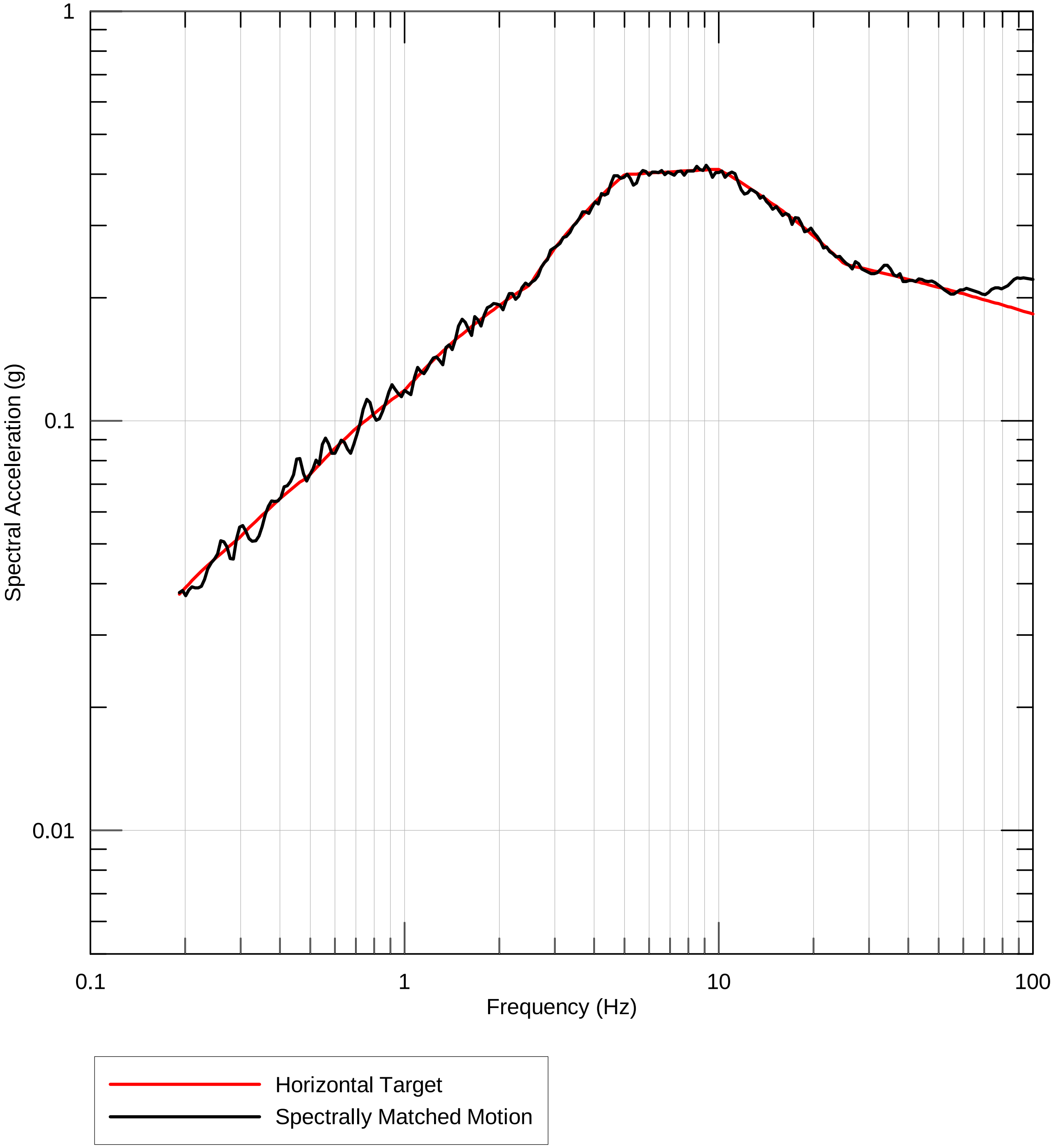
SEED: PEER RSN2112

AECOM	Project No. 60440378 Newton Power Station Dynegy	RESPONSE SPECTRA FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2002 DENALI - TAPS PUMP STATION #8 (049) SEED	Figure 36



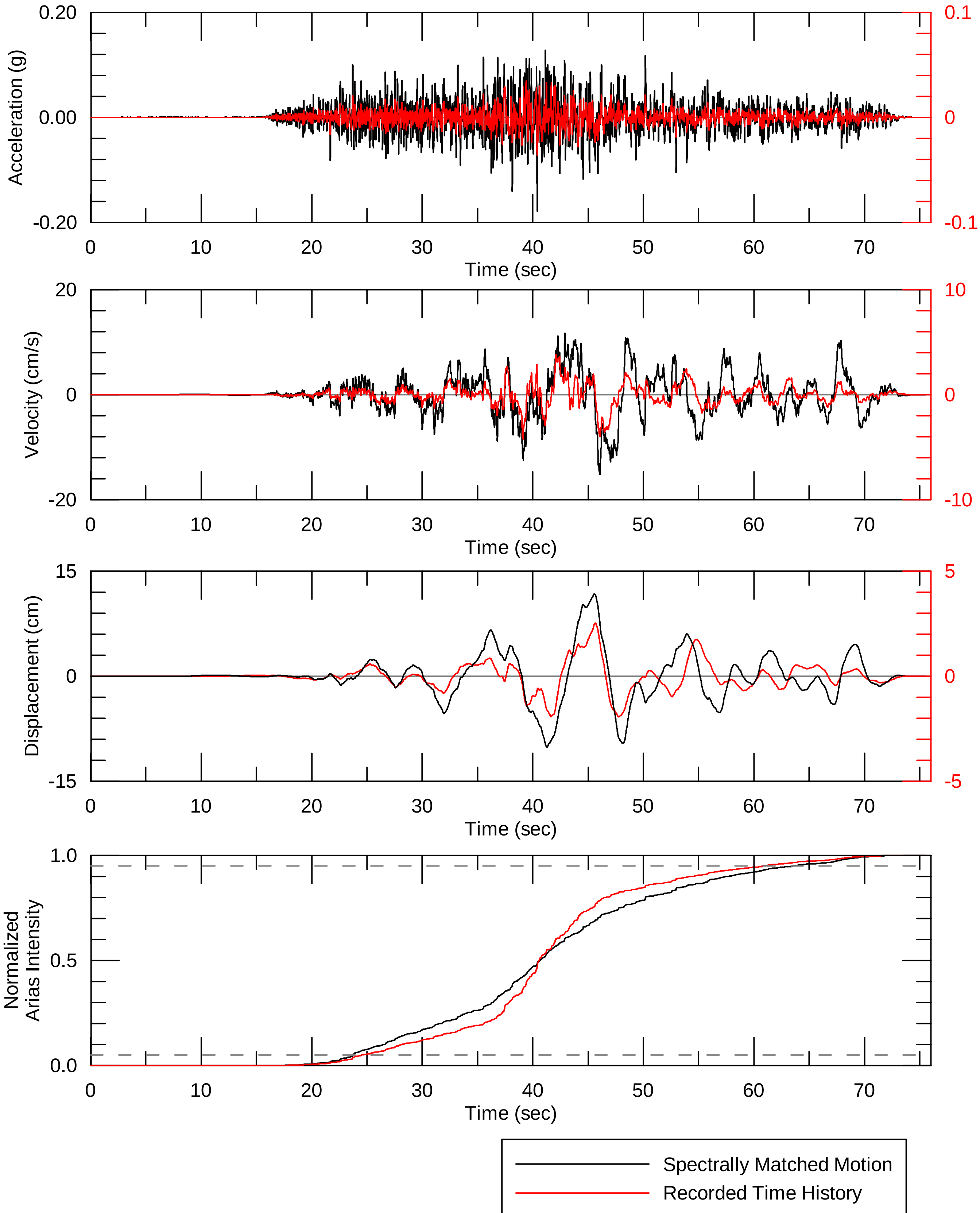
SEED: PEER RSN2112

AECOM	Project No. 60440378 Newton Power Station Dynegy	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2002 DENALI - TAPS PUMP STATION #8 (049) SEED	Figure 37



SEED: PEER RSN2112

AECOM	Project No. 60440378 Newton Power Station Dynegy	RESPONSE SPECTRA FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2002 DENALI - TAPS PUMP STATION #8 (319) SEED	Figure 38



SEED: PEER RSN2112

AECOM	Project No. 60440378 Newton Power Station Dynegy	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2002 DENALI - TAPS PUMP STATION #8 (319) SEED	Figure 39

Appendix C. Hydrologic and Hydraulic Report

AECOM

AECOM
1001 Highlands Plaza Drive West
Suite 300
St. Louis, MO 63110-1337
www.aecom.com

314.429.0100 tel
314.429.0462 fax

October 7, 2016

Mr. Matt Ballance, PE
Senior Project Engineer
Dynegy Inc.
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

RE: Hydrologic and Hydraulic Summary Report
Newton Power Station
Primary Ash Pond

Dear Mr. Ballance:

AECOM is pleased to provide this Summary Report of Hydrologic and Hydraulic Modeling for the Illinois Power Generating Company (IPGC) Newton Primary Ash Pond Coal Combustion Residual (CCR) Unit. This analysis was performed to demonstrate that the facility meets the requirements of 40 CFR §257.82(a) with regard to the Inflow Design Flood Control Plan. Based on AECOM's analysis, the Primary Ash Pond meets all hydraulic requirements for certification per 40 CFR §257.82(a).

AECOM looks forward to providing continued support to IPGC and working together on this important program. Please do not hesitate to call Ron Hager at 314-429-0100 (office) / 440-591-7868 (mobile), if you have any questions.

Sincerely,

AECOM

Victor Modeer, PE
Site Manager
victor.modeer@aecom.com

Ronald Hager
Program Manager
ronald.hager@aecom.com

cc: Mark Rokoff, PE – AECOM

Attachments:

A. Location Map
B. Site Plan
C. Hydrologic and Hydraulic Calculations

1. INTRODUCTION

1.1. *Purpose of This Memorandum*

This report presents the results of the hydrologic and hydraulic analysis prepared by AECOM for the Illinois Power Generating Company (IPGC)[1] Primary Ash Pond Coal Combustion Residual (CCR) unit at the Newton Power Station, located approximately 7.5 miles southwest of Newton, Illinois in Jasper County (See Attachment A for Location Map and Attachment B for Site Plan). This analysis was completed in accordance with the Environmental Protection Agency (EPA) 40 CFR §257, Subpart D, regulations for the disposal of CCR. As required by §257.82(a), by October 17, 2016 owners and operators of existing CCR surface impoundments must develop an Inflow Design Flood Control Plan that documents how the inflow design flood control system has been designed and constructed to meet the following requirements:

- *(40 CFR § 257.82 (a)(1)* - The inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood.
- *(40 CFR § 257.82 (a)(2)* - The inflow design flood control system must adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood.

The Primary Ash Pond has a significant hazard potential, based on the initial hazard potential classification assessment performed by Stantec in 2016 in accordance with §257.73(a)(2). The “Significant Hazard” category indicated that the inflow design flood is the 1,000-year storm event. This event is the basis for AECOM certification.

1.2. *Brief Description of Impoundments*

The Newton Primary Ash Pond is an active, approximately 400-acre CCR surface impoundment that receives sluiced ash and wastewater from the Newton Power Station. The Primary Ash Pond discharges to a smaller, approximately 12-acre non-CCR Secondary Pond through a concrete riser structure with a primary 28-inch inside diameter sliplined corrugated metal pipe (CMP) culvert at an elevation of 512 feet (unless otherwise noted, all elevations in this report are in the NAVD88 datum). A secondary outlet structure is located above the primary outlet structure, but is located nearly 20 feet higher than the primary outfall structure for use in potential future operational conditions at a much higher level. Therefore, this secondary outlet structure is not included in the analysis. The Secondary Pond has a concrete riser structure with one sliplined CMP culvert that is 28 inches in inside diameter with an inlet invert elevation of 505 feet and discharges to Newton Lake. Although the Secondary Pond is not a CCR unit, it is hydraulically connected to the Primary Ash Pond so the two ponds must be analyzed together.

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[1] Although the Newton Power Station and the Primary Ash Pond are owned and operated by IPGC, Dynegy Administrative Services Company (*Dynegy*) contracted AECOM to develop with Hydrologic and Hydraulic Summary Report. Therefore, “Dynegy” is referenced in materials attached to the hydrologic and hydraulic report.

2. POND CAPACITY / IMPOUNDMENT COMPUTATIONS

2.1. *Primary Ash Pond*

The elevation/areas for the Primary Ash Pond were determined using topographic and bathymetric surveys completed in 2015 by Weaver Consultants. Please refer to Attachment C for further details.

2.2. *Secondary Pond*

The elevation/areas for the Secondary Pond above water were determined by analyzing the 2012 topographic survey and elevations/areas below water were estimated using available design data. The 2015 Weaver Consultants topographic and bathymetric survey did not include the Secondary Pond.

3. HYDROLOGIC AND HYDRAULIC ANALYSIS OF NEWTON PONDS

3.1. *Rainfall Data*

The rainfall information used in the modeling was based on the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 1, Version 5 which provides rainfall data for storm events with average recurrence intervals ranging from 1 to 1,000 years and durations ranging from 5 minutes to 60 days. The design storm rainfall depth, obtained from the NOAA website, is 9.01 in for the 24-hour, 1,000-year storm. The Soil Conservation Service (SCS) Type II storm used by AECOM is appropriate to use for storms up to the 1,000-yer flood at the project site.

3.2. *Runoff Computations*

The HydroCAD Version 10.0 computer model, by HydroCAD Software Solutions, LLC, was used to model pond and outlet structure capacities during peak discharges. The Primary Ash Pond was modeled with a starting water surface elevation of 534.0 feet (based on the pool elevation from the 2015 Weaver Consultants survey) and the Secondary Pond was modeled with a starting water surface elevation of 520.0 feet. The model evaluated pond capacities, hydraulics of the ponds considering details of the between-pond discharge structures, and the final outlet structure during peak discharges.

Attachment C includes a layout of the system as modeled in HydroCAD. The Primary Ash Pond Watershed and Secondary Pond Watershed encompass the area inside the pond embankment. There are no additional watersheds that drain to the Primary Ash Pond or Secondary Pond. Please refer to Attachment C for detailed HydroCAD calculations.

3.3. *Additional In-Flows to System*

The Primary Ash Pond receives flows of sluiced ash (3.88 cfs), wastewater (11.64 cfs), and other miscellaneous small discharges (1.54 cfs). The quantity of these flows is stated in the Ash Pond Retention Time Estimate Report (AMEC 2012).

4. CONCLUSIONS

The inflow design flood control system for the Newton Primary Ash Pond adequately manages flow into and out of the Primary Ash Pond during and following the peak discharge of the 1,000-year storm event inflow design flood. Results of the model are summarized in Table 4.1.

Table 4.1
Newton Summary of Hydrologic and Hydraulic Analysis,
1,000-Year, 24-Hour Storm

CCR Unit	Beginning WSE[1] (ft)	Peak WSE (ft)	Minimum Crest Elevation (ft)
Primary Ash Pond	534.0	534.9	552.7

Notes:
[1] WSE = Water Surface Elevation

The Newton Primary Ash Pond meets the requirements for certification, per §257.82(a).

5. LIMITATIONS

Background information, design basis, and other data, which AECOM used in preparing this report have been furnished to AECOM by IPGC. AECOM has relied on this information as furnished, and is not responsible for the accuracy of this information. Our recommendations are based on available information from previous and current investigations. These recommendations may be updated as future investigations are performed.

The conclusions presented in this report are intended only for the purpose, site location, and project indicated. The recommendations presented in this report should not be used for other projects or purposes. Conclusions or recommendations made from these data by others are their responsibility. The conclusions and recommendations are based on AECOM's understanding of current plant operations, maintenance, stormwater handling, and ash handling procedures at the station, as provided by IPGC. Changes in any of these operations or procedures may invalidate the findings in this report until AECOM has had the opportunity to review the changes, and revise the report if necessary.

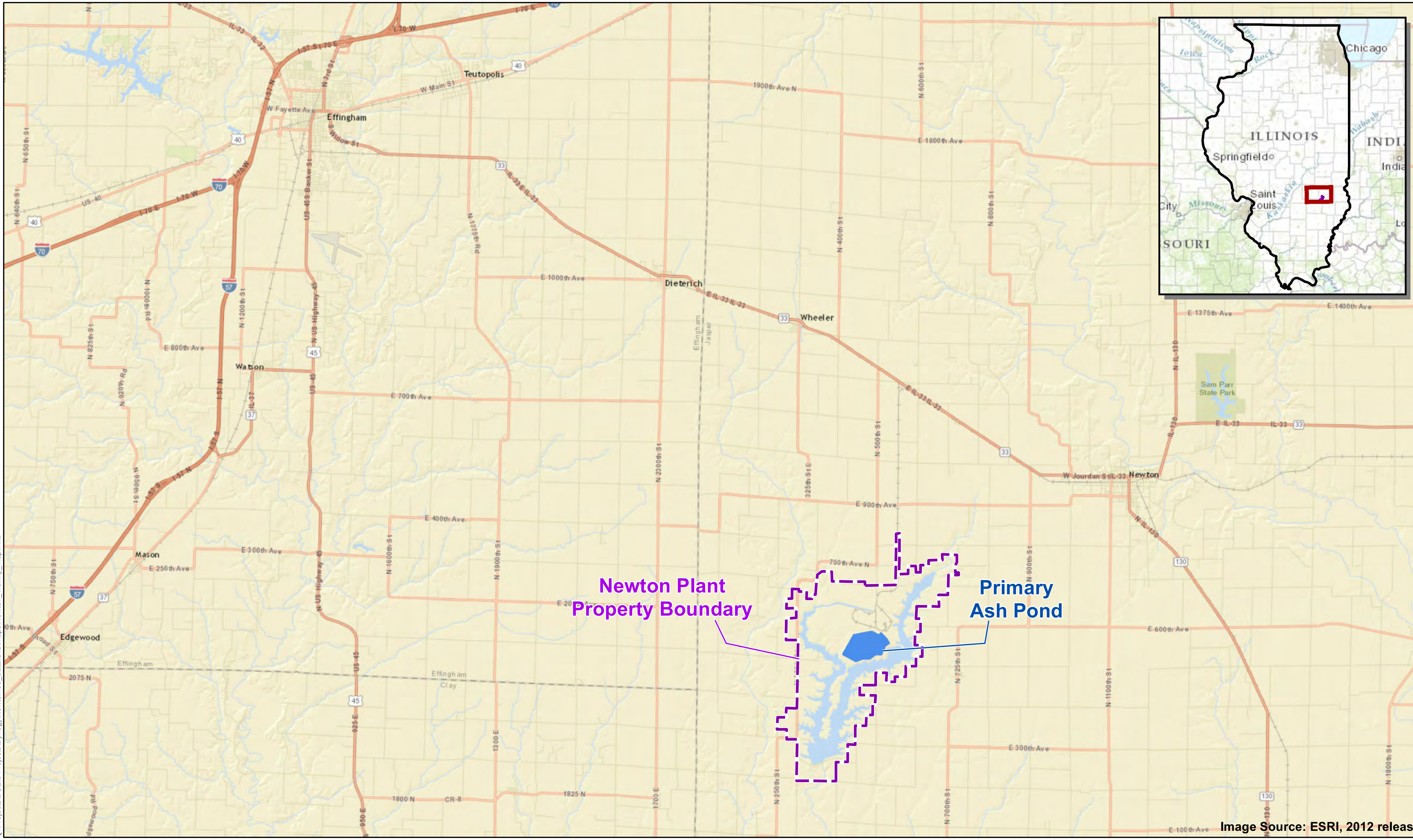
This hydrologic and hydraulic analysis was performed in accordance with the standard of care commonly used as state-of-practice in our profession. Specifically, our services have been performed in accordance with accepted principles and practices of the engineering profession. The conclusions presented in this report are professional opinions based on the indicated project criteria and data available at the time this report was prepared. Our services were provided in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation is intended.

6. REFERENCES

AMEC, (2012), *Newton Power Station Ash Pond Retention Time Estimate,* Ameren Services, St. Louis, MO.

NOAA (2014). NOAA Atlas 14 Point Precipitation Frequency Estimates, Volume 1, Version 5, http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=il.

Attachment A
Location Map



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Legend

Primary Ash Pond Boundary

Newton Plant Property Boundary

N W E S

2 0 2 4 Miles

DYNEGY

Attachment A
Vicinity Map
Newton Power Station
Jasper County, Illinois

AECOM

Attachment B
Site Plan

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Figure 01
Site Plan
Newton Power Station
Jasper County, Illinois

DYNEGY

AECOM

Attachment C
Hydrologic and Hydraulic Calculations

Objective: **This analysis describes the independent investigation and design calculations and considerations of the on-site hydrology and hydraulics for continued use of the Primary Ash Pond as required by the Environmental Protection Agency's (EPA's) Final Coal Combustion Residuals (CCR) Rule. In particular, the analysis investigates the performance of the existing Primary Ash Pond during the 1000-year, 24-hour storm event as required by CCR Rule. AECOM evaluated how the onsite hydraulics will be affected by the existing conditions of the Primary Ash Pond. In addition, the analyses evaluate how large flows from off-site affect the station's operations.**

- **Design Basis**

The watershed was estimated as the area contained to the top of the pond's berms as no other areas drain directly to the ponds. In addition to precipitation, other inflows as shown in Table 3-1 of the Ash Pond Retention Time Estimate report (AMEC 2012) were accounted for in the HydroCAD model.

The Primary Ash Pond was modeled using an elevation-area curve developed using topographic contours and a bathymetric survey. The outlet weir box geometry and pipe data were modeled based on the original design drawings (S-50 & S-70) and survey data. The inside pipe diameters were modeled as 28 inches rather than 30 inches to account for the in-situ form slip-lining that occurred in 2009.

The hydrologic model represents the present operating configuration (elevation 534 feet-NAVD88). The 1,000-year storm event was modeled to comply with the CCR Rule.

- **Data**

2012 Newton Power Station Primary Ash Pond Retention Time Estimate Report (AMEC 2012) Newton Pond Design Drawings (S-50, S-69, & S-70)
NOAA Atlas 14, Volume 2, Version 3; NOAA HMR 51, Figure 20
2015 Topographic and Bathymetric Survey, Weaver Consultants Group

- **Method**

HydroCAD Version 10.0 Stormwater Modeling software was used to model the Primary Ash Pond, Secondary Pond, their outlet structures, and other direct inflows.

Watershed Characteristics

The following watershed characteristics were used as inputs for the HydroCAD model.

	PRIMARY ASH POND	SECONDARY SETTLING POND
Drainage Area (ac)	411.52	12
Time of Concentration (min)	16.7	5
Curve Number	98	98

Elevation/Area Tables for Primary Ash Pond and Secondary Settling Pond

The following Primary Ash Pond elevation/area relationship was used as an input in the HydroCAD model. This relationship was developed using Newton 2015 topographic contours and bathymetric surveys.

Elevation (ft)	Area (ac)
495	0.778
500	1.79
505	3.66
510	8.43
515	19.9
520	49.4
525	96.4
530	134
533.5	162
535	183
540	304
545	363
550	386
552	392

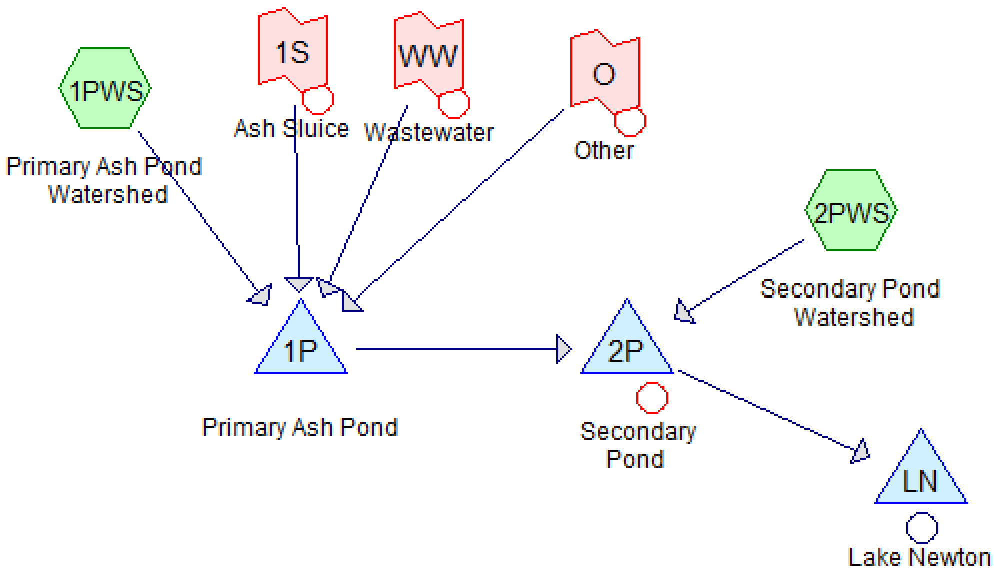
The Secondary Pond elevation/area relationship was used as an input in the HydroCAD model. This relationship was developed using available 2012 survey data for the site and historic design drawings as 2015 survey data of this pond is not available.

Elevation (ft)	Area (ac)
505	0.014
510	4.16
515	7.35
520	7.50
526	8.31
530	9.02
532	9.41

AECOM

Job	**Newton Power Station**	Project No.	**60428794**	Sheet	3 of 4
Description	**Site H&H Analysis**	Computed by	**PE**	Date	**06/15/16**
	Primary Ash Pond Certification	Checked by	**SE**	Date	**06/15/16**

Model Layout



The sluiced ash, plant wastewater, and other incoming flows were modeled as links in HydroCAD. These flows were based on the Ash Pond Retention Time Estimate report (AMEC 2012) Table 3-1:

Table 3-1. Summary of Primary Ash Pond Flows

Flow Component	Rate	Description
Plant Process Water Inputs:		
Ash Sluice	2.52 MGD (3.88 cfs)	2 pumps; each pump 3,000 gpm (4.32 MGD); pump operation 14 hours/day (total) under full load
Wastewater	7.56 MGD (11.64 cfs)	5 pumps; each pump 2,100 gpm (3.024 MGD); under full load, 60 pump hours per day
Other	1.0 MGD (1.54 cfs)	Miscellaneous small discharges

The system was analyzed using the Soil Conservation Service (SCS) Type II Distribution over a 24 hour period. The rainfall depth for the 1,000-year storm as indicated by the National Oceanographic and Atmospheric Administration (NOAA) Atlas14, Volume 2, Version 3 is 9.01 inches.

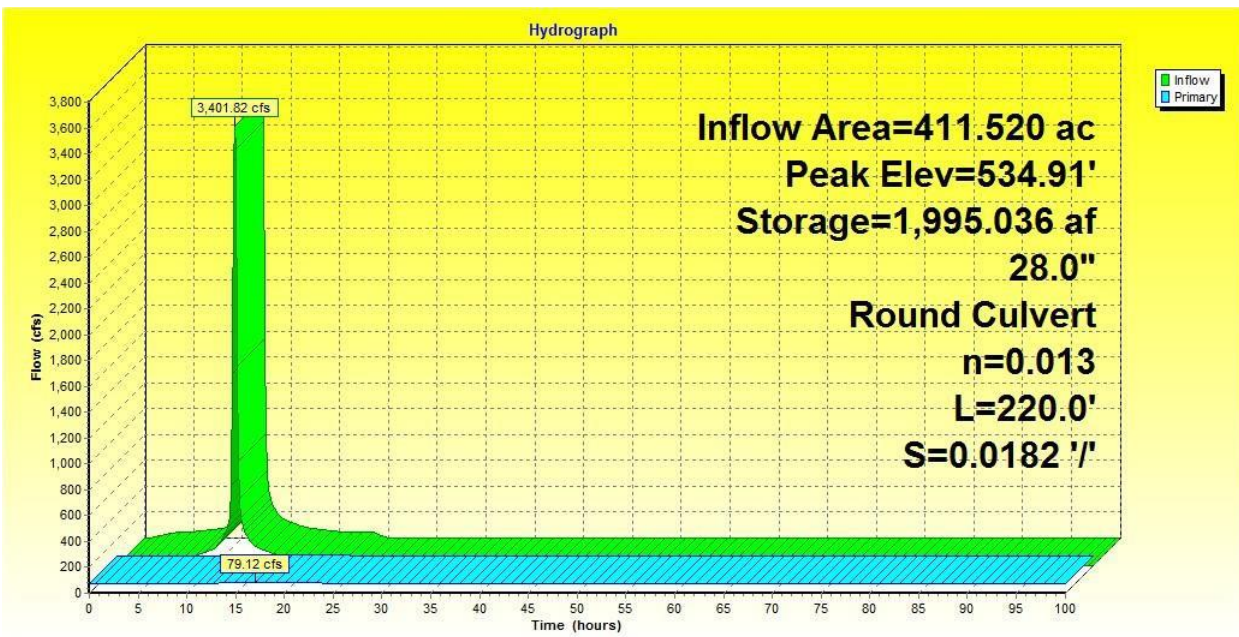
Model Run

The modeling run shows the inflow and outflow peaks that occur for the Primary Ash Pond and the Secondary Pond.

Model Output Summary

The HydroCAD model results indicate that the water surface elevation (WSE) in the Primary Ash Pond raises about 1 foot (534.91 feet-NAVD88) and has a peak discharge of 79.12 cfs for the 1,000-year storm event. The top of the Primary Ash Pond is approximately 552.7 feet-NAVD88, which is about 19ft higher than the peak WSE suggesting there is adequate storage and management of inflow design flood per the regulations.

Primary Ash Pond HydroCAD Output



Summary for Pond 1P: Primary Ash Pond

Inflow Area = 411.520 ac,100.00% Impervious, Inflow Depth = 8.77" for 1000-year Type II 24 hour event
Inflow = 3,401.82 cfs @ 12.08 hrs, Volume= 300.740 af
Outflow = 79.12 cfs @ 16.99 hrs, Volume= 635.446 af, Atten= 98%, Lag= 294.3 min
Primary = 79.12 cfs @ 16.99 hrs, Volume= 635.446 af

Routing by Stor-Ind method, Time Span= 0.00-100.05 hrs, dt= 0.15 hrs
Starting Elev= 534.00' Surf.Area= 169.000 ac Storage= 1,835.600 af
Peak Elev= 534.91' @ 16.99 hrs Surf.Area= 181.728 ac Storage= 1,995.036 af (159.436 af above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= 2,222.6 min (2,968.1 - 745.5)

Volume	Invert	Avail.Storage	Storage Description
#1	495.00'	7,547.100 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
495.00	0.780	0.000	0.000
500.00	1.790	6.425	6.425
505.00	3.660	13.625	20.050
510.00	8.430	30.225	50.275
515.00	19.900	70.825	121.100
520.00	49.400	173.250	294.350
525.00	96.400	364.500	658.850
530.00	134.000	576.000	1,234.850
533.50	162.000	518.000	1,752.850
535.00	183.000	258.750	2,011.600
540.00	304.000	1,217.500	3,229.100
545.00	363.000	1,667.500	4,896.600
550.00	386.000	1,872.500	6,769.100
552.00	392.000	778.000	7,547.100

Device	Routing	Invert	Outlet Devices
#1	Primary	512.00'	**28.0" Round Culvert** L= 220.0' Ke= 0.820 Inlet / Outlet Invert= 512.00' / 508.00' S= 0.0182 '/' Cc= 0.900 n= 0.013, Flow Area= 4.28 sf

Primary OutFlow Max=79.12 cfs @ 16.99 hrs HW=534.91' TW=508.00' (Fixed TW Elev= 508.00')
↑—**1=Culvert** (Inlet Controls 79.12 cfs @ 18.50 fps)

Summary for Pond 2P: Secondary Pond

[79] Warning: Submerged Pond 1P Primary device # 1 INLET by 14.23'

Inflow Area = 423.520 ac,100.00% Impervious, Inflow Depth > 18.25" for 1000-year Type II 24 hour event
Inflow = 202.48 cfs @ 11.95 hrs, Volume= 644.216 af
Outflow = 74.66 cfs @ 84.19 hrs, Volume= 596.032 af, Atten= 63%, Lag= 4,334.3 min
Primary = 74.66 cfs @ 84.19 hrs, Volume= 596.032 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-100.05 hrs, dt= 0.15 hrs
Starting Elev= 520.00' Surf.Area= 7.500 ac Storage= 76.335 af
Peak Elev= 526.23' @ 84.19 hrs Surf.Area= 8.350 ac Storage= 125.642 af (49.307 af above start)

Plug-Flow detention time= 1,118.3 min calculated for 519.218 af (81% of inflow)
Center-of-Mass det. time= 136.4 min (3,074.1 - 2,937.7)

Volume	Invert	Avail.Storage	Storage Description
#1	505.00'	176.855 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
505.00	0.014	0.000	0.000
510.00	4.160	10.435	10.435
515.00	7.350	28.775	39.210
520.00	7.500	37.125	76.335
526.00	8.310	47.430	123.765
530.00	9.020	34.660	158.425
532.00	9.410	18.430	176.855

Device	Routing	Invert	Outlet Devices
#1	Primary	505.00'	**28.0" Round Culvert** L= 226.0' Ke= 0.820 Inlet / Outlet Invert= 505.00' / 504.42' S= 0.0026 '/' Cc= 0.900 n= 0.013, Flow Area= 4.28 sf
#2	Secondary	528.50'	**5.0' long Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 Coef. (English) 2.65 2.65 2.65 2.65 2.65 2.65 2.65 2.65 2.65

Primary OutFlow Max=74.66 cfs @ 84.19 hrs HW=526.23' TW=504.42' (Fixed TW Elev= 504.42')
└─**1=Culvert** (Barrel Controls 74.66 cfs @ 17.46 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=520.06' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

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About AECOM

AECOM (NYSE: ACM) is a global provider of professional technical and management support services to a broad range of markets, including transportation, facilities, environmental, energy, water and government. With nearly 100,000 employees around the world, AECOM is a leader in all of the key markets that it serves. AECOM provides a blend of global reach, local knowledge, innovation, and collaborative technical excellence in delivering solutions that enhance and sustain the world's built, natural, and social environments. A Fortune 500 company, AECOM serves clients in more than 100 countries and has annual revenue in excess of $19 billion.

More information on AECOM and its services can be found at www.aecom.com.

Attachment C

35 I.A.C. § 845 SAFETY AND HEALTH PLAN

DECEMBER 29, 2023

NEWTON POWER PLANT PRIMARY ASH POND

CONTENTS

APPENDICES

ACRONYMS & ABBREVIATIONS

%	Percent
§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
29 C.F.R.	Title 29 of the Code of Federal Regulations
ACGIH	American Conference of Governmental Industrial Hygienists
CCR	Coal Combustion Residual
CDC	Centers for Disease Control and Prevention
HAZWOPER	Hazardous Waste Operations and Emergency Response
ID	identification
IDLH	Immediately Dangerous to Life and Health
IEPA	Illinois Environmental Protection Agency
IPGC	Illinois Power Generating Company
kV	kilovolt
NID	National Inventory of Dams
NIOSH	National Institute for Occupational Safety and Health
No.	number
NPP	Newton Power Plant
OSHA	Occupational Safety and Health Administration
PAP	Primary Ash Pond
Part 845	35 I.A.C. Part 845: Residuals in Surface Impoundments
PEL	Permissible Exposure Level
PFAS	Per- and polyfluoroalkyl substances
PFD	Personal Flotation Device
PNOR	particulates not otherwise recognized
POC	Point of Contact
PPE	personal protective equipment
ppm	parts per million
SDS	Safety Data Sheet
Site	NPP PAP
STEL	Short Term Exposure Limit
TLV	Threshold Limit Value
TWA	time-weighted averages
USCG	United States Coast Guard

REVISION SUMMARY

Revision Date	**Description of Changes** (Section title or number – description)
12/30/2022	1.2 – Updated facility personnel contact information 2.1 – Removed reference to COVID screening 2.6 – Removed duplicative bullet point about hand held radios 3.8 – Revised to follow CDC guidelines 4.6 – Added the table found in 29 C.F.R. § 1926.1408(h) 5.1 – Updated PEL for iron oxide and TLV for titanium dioxide 6.4 – updated first sentence to say "In the case of an emergency, site personnel will contact 618-783-0344" Appendix D – Removed COVID-19 Vistra Site Guidelines Appendix E – Moved Safety Data Sheets to Appendix D
12/29/2023	Annual update as required by 35 I.A.C. § 845.530 1.2 – Updated POC 3.0 – Included additional information regarding storage of training records and summary of training program 3.1 – Added "that informs them of the hazards at the facility" to the first sentence 3.4 – Updated procedure number 3.9 – Updated location for document retention 6.1 – Updated incident notification contact

PREFACE

Illinois Power Generating Company (IPGC) has prepared this Safety and Health Plan in accordance with requirements set forth in Title 35 of the Illinois Administrative Code (35 I.A.C.) Part 845: Residuals in Surface Impoundments (Part 845), Section (§) 845.530. IPGC assessed health and safety hazards of its coal combustion residual (CCR) surface impoundments to develop and update this Safety and Health Plan.

This document describes the minimum anticipated protective measures necessary for worker health and safety at the Newton Power Plant (NPP) Primary Ash Pond (PAP; Vistra identification [ID] number [No.] 501, Illinois Environmental Protection Agency [IEPA] ID No. W0798070001-01, National Inventory of Dams [NID] No. IL50719), herein referred to as the Site. Employees of IPGC, contract workers, and third-party contractors must read and comply with the contents of this document. The contents of this document are not intended to cover all situations that may arise nor to waive any provisions specified in Federal, State, and local regulations or site owner / contractor health and safety requirements.

Third-party contractors are accountable for the health and safety of their employees. Third-party contractors are required to prepare a Safety and Health Plan that meets the minimum requirements herein. However, no requirements or provisions within this plan shall be construed as an assumption of IPGC of their legal responsibilities as an employer.

This Safety and Health Plan will be reviewed and updated annually, at a minimum. The Safety and Health Plan will also be updated if facility operations change, or a new hazard is identified.

1. INTRODUCTION

This Safety and Health Plan has been developed to outline the requirements to be met by employees of IPGC, contract workers, and third-party contractors while performing any activity to construct, operate, or close the PAP. This Safety and Health Plan has been developed to meet the requirements of 35 I.A.C. § 845.530 and describes the responsibilities, training requirements, protective equipment, and safety procedures necessary to minimize the risk of injury, fires, explosion, chemical spills, material damage incidents, and near misses related to CCR activities. This Safety and Health Plan incorporates by reference the Occupational Safety and Health Administration (OSHA) regulations contained in Title 29 of the Code of Federal Regulations (29 C.F.R.) § 1910 and 29 C.F.R. § 1926.

The requirements and guidelines in this Safety and Health Plan are based on a review of available information and data, and an evaluation of identified on-site hazards. This Safety and Health Plan will be reviewed with persons assigned to work at the PAP and will be available on-site.

1.1 Site Description/History

The NPP is located in Jasper County in the southeastern part of central Illinois, approximately 7 miles southwest of the town of Newton. The PAP is located in Section 26 and the western half of Section 25, Township 6 North, Range 8 East. The PAP is located south of the power plant and situated in a predominantly agricultural area and is surrounded by Newton Lake on the west, south, and east. Beyond the lake is additional agricultural land. The Phase 1 Landfill is located northwest and west of the PAP, and the Phase 2 Landfill is located to the west (Appendix A).

1.2 Facility Personnel

The following table outlines key IPGC personnel with respect to facility operations and health and safety. The Plant Control Room is the first point of contact for plant communication, including emergencies.

Name	Position	Phone Number
Tanner Lewis	Point-of-Contact (POC) / Safety Specialist	618-783-0352
Security		618-783-0302
Control Room		618-783-0302
James Marshall	Plant Manager	618-783-0351
Plant Shift Supervisor (24/7)		618-783-0344
Terry Hanratty	Environmental and Chemistry Manager	618-783-0388
Matt Ballance	Engineering Manager	618-792-7274 (mobile)
Jason Campbell	Dam Safety Manager	271-753-8904 (Springfield) 217-622-3491 (mobile)
Stu Cravens	Senior Technical Expert	217-390-1503 (mobile)
Vic Modeer	Engineering Manager	618-541-0878

1.3 Responsibilities

The following persons have responsibilities associated with communicating and implementing the Safety and Health Plan for the PAP.

1.3.1 IPGC Point of Contact

The IPGC Point of Contact (POC) is a management-level person who is requiring employees, contract workers, or third-party contractors to enter the PAP. The IPGC POC is responsible to communicate Safety and Health Plan information and requirements to employees, contract workers, and third-party contractors, and oversee work performed in the PAP to the extent necessary to confirm implementation of Safety and Health Plan requirements.

1.3.2 IPGC Employees

IPGC employees are directly hired by IPGC. They are required to implement and/or follow Safety and Health Plan requirements as applicable to their work and exercise their "stop work authority" if safety requirements are unclear or unanticipated site conditions or hazards are observed.

1.3.3 Contract Workers

Contract workers are those hired by IPGC through an agency firm. Similar to IPGC employees, contract workers are required to implement and/or follow Safety and Health Plan requirements as applicable to their work and exercise their "stop work authority" if safety requirements are unclear or unanticipated site conditions or hazards are observed.

1.3.4 Third-Party Contractor Employees

Third-party contractor employees work for firms under contract to IPGC. Third-party contractors include prime contractors and all of their lower tier subcontractors. Similar to IPGC employees, third-party contractors are required to implement Safety and Health Plan requirements as applicable to their work and exercise their "stop work authority" if safety requirements are unclear or unanticipated site conditions or hazards are observed.

1.3.5 Third-Party Contractor Safety Competent Person

Third-party contractors will be required to designate a Safety Competent Person. The Safety Competent Person must be in a management position (*e.g.,* superintendent, foreman, etc.) with OSHA 30-hour construction safety certification who may perform other duties, unless IPGC requires a dedicated Safety Competent Person. A Safety Competent Person must be on site at all times when the subcontractor has employees performing work for IPGC and must possess a sound working knowledge of pertinent OSHA regulations, this Safety and Health Plan, and other applicable safety requirements related to the scope of work. Third-party contractors must also designate a backup Safety Competent Person that possesses the same authority and training. The competent person will ensure timely correction of safety deficiencies identified by IPGC. The Safety Competent Person is responsible to ensure Safety and Health Plan requirements have been communicated to lower-tier subcontractors and enforce Safety and Health Plan requirements.

2. SITE ACCESS & CONTROL

This section outlines requirements for ensuring that only authorized personnel and visitors are permitted at the Site.

2.1 Facility Security

Elements of site control include restricting access to the Site to persons until they have met the training requirements outlined in this Safety and Health Plan and have been authorized to do so by NPP POC or their representative.

Upon arrival to the Site, all IPGC employees, contract workers, and third-party contractors must check in/out at Security.

2.2 Third-Party Contractor Management

Prior to working at the PAP, all third-party prime contractors must maintain an active registration with ISNetworld and maintain a grade of A or B. Lower tier subcontractors are currently not required to be registered in ISNetworld, but this requirement may change at the discretion of IPGC.

All third-party contactor supervisors must meet with their specified Contract Coordinator/Plant Contact prior to beginning work.

2.3 Third-Party Contractor Safety and Health Plan

Prior to being authorized to conduct work at PAP, third-party contractors must develop and submit a Safety and Health Plan. The third-party contractor's Safety and Health Plan must be specific to the scope of work that they will be performing at the PAP. The third-party contractor's Safety and Health Plan must meet or exceed all the requirements in this Safety and Health Plan, other IPGC requirements, and applicable regulations. All lower tier subcontractors of third-party contractors must meet the requirements in this Safety and Health Plan as well as the requirements outlined in the Safety and Health Plan of the third-party with whom they are contracted.

2.4 Authorized Personnel

At a minimum, authorized personnel who will be granted unescorted access to the project include IPGC employees, contract workers, and third-party contractors that meet the following:

- Reviewed this Safety and Health Plan and other applicable safety planning documentation
- Have completed all the training, medical surveillance, and drug screen and background investigation requirements as outlined in Section 3 of this Safety and Health Plan.
- Have completed the NPP Site Orientation Training

2.5 Visitors

Visitors must be escorted by Authorized Personnel through the PAP if they have not reviewed this Safety and Health Plan or completed the training requirements outlined in Section 3 of this Safety and Health Plan. Visitors may not undertake any activity to construct, operate, or close a CCR surface impoundment.

2.6 Communication

Communication between workers and emergency services must be maintained at all times. Cellular service is not consistently available and cannot be relied upon to summon emergency services. In lieu of using mobile phones, the following will be implemented:

- Hand held radios will be used to communicate to a central location where a landline or reliable cellular service is available.

3. TRAINING & MEDICAL REQUIREMENTS

Project personnel must be properly trained for the type of work being performed and in accordance with 35 I.A.C. § 845.530, 29 C.F.R. § 1926 and 29 C.F.R. § 1910, and IPGC policies. Additionally, personnel working in areas regulated by the OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) standards (29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65) must have current medical surveillance. All employees, contractors, and third-party contractors must complete the following prior to beginning any activity to construct, operate, or close the PAP.

The facility maintains an outline of the training programs used and a brief description of training program updates. Training records are located in the Safety Specialist's Office in accordance with 35 I.A.C. § 845.530(c)(1).

The training program ensures that employees, contract workers, and third-party contractors understand and are able to respond effectively to the following as outlined in 35 I.A.C. § 845.530(c)(2):

A) Procedures for using, inspecting, repairing, and replacing facility emergency and monitoring equipment (see Section 3.4);

B) Communications or alarm systems (see Section 3.5);

C) Response to fires or explosions (see Section 6.5);

D) Response to a spill or release of CCR (see Sections 6.7 and 6.8);

E) The training under the Occupational Safety and Health Standards in 29 CFR 1910.120, 29 CFR 1926.65, and the OSHA 10-hour or 30-hour construction safety training (see Sections 3.1 and 3.2);

F) Information about chemical hazards and hazardous materials identified in subsection (b) (see Section 5.3); and

G) The use of engineering controls, administrative controls, and personal protective equipment (see Section 4).

3.1 HAZWOPER Training

35 I.A.C. § 845.530(c)(2)(E) requires that all employees, contract workers, and third-party contractors be trained in accordance with 29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65 that informs them of the hazards at the facility. The following training will be completed as required by job function:

- **OSHA 40-Hour Training** per 29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65, for those personnel who are expected to have extensive contact with contaminated materials and/or may be required to wear a respirator.
- **OSHA 24-Hour Training** per 29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65, for those personnel who are expected to have minimal contact with contaminated materials and will NOT be required to wear a respirator.
- **OSHA 8-hour Supervisor Training** per 29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65, for Site Supervisors, Foremen, Superintendents, and others who will be directing and managing site activities.
- **OSHA 8-hour Refresher** per 29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65, completed within 12 months of initial 40-hour or 24-hour training and annually thereafter.

The following matrix outlines HAZWOPER training requirements based on typical job functions at the PAP. It is not intended to be all inclusive, new job functions must be evaluated per 29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65.

Training	Job Function
OSHA 40-hour	Ash handlers
OSHA 24-hour	Personnel not required to handle CCR materials
OSHA 8-hour Supervisor Training	Third-Party Contractor Safety Competent Persons
OSHA 8-hour refresher	All personnel

3.2 OSHA Construction Outreach Training

35 I.A.C. § 845.530(c)(2)(E) requires that all employees, contract workers, and third-party contractors complete an OSHA 10-hour or 30-hour construction safety training. These trainings will be completed as follows:

- All employees, contract workers, and third-party contract employees: OSHA 10-hour or 30-hour construction outreach training.
- Supervisors, superintendents, foreman and safety professionals: OSHA 30-hour construction outreach training.

3.3 PAP Safety and Health Plan Review

Pursuant to 35 I.A.C. § 845.530(d)(e), before beginning any activity at the PAP, and annually thereafter, all IPGC employees, contract workers, and third-party contractors must review the content of this HASP. After reviewing this Safety and Health Plan all personnel will understand the following:

- Procedures for using, inspecting, repairing, and replacing facility emergency and monitoring equipment
- Communications or alarm systems outlined in Section 6
- Response to fires and explosions outlined in Section 6
- Response to a spill or release of CCR
- Information about chemical hazards and hazardous materials outlined in Section 5
- The use of engineering controls, administrative controls, and personal protective equipment (PPE) outlined in Section 4

All personnel will acknowledge this HASP by signing the *Safety and Health Plan Acknowledgment Form (Appendix B).*

3.4 Emergency and Monitoring Equipment Training

All IPGC employees, contract workers, and third-party contractors must be aware of how to respond to alarms and other emergencies as outlined in Section 6 of this plan. Individuals may only use facility emergency and monitoring equipment if they have been trained in their use and authorized to do so by the designated POC. Additionally, a written release may need to be completed as required by Vistra Corporate Procedure CL-SAF-0037.

Individual IPGC employees and contract workers may be responsible for using, inspecting, repairing and replacing facility emergency monitoring equipment. These individuals will be trained in accordance with procedures identified by IPGC. These individuals will review and adhere to the manufacturer’s instructions, where applicable.

Third-party contractors are responsible for inspecting, repairing, and replacing any owned emergency (*i.e.*, fire extinguishers) and monitoring equipment (*i.e.*, air monitoring equipment). Third-party contractors will maintain procedures for using, inspecting, repairing, and replacing owned emergency and monitoring equipment that is consistent with the manufacturer’s requirements. Third-party contractor employees who are responsible for this equipment will be trained in procedures for using, inspecting, and repairing owned equipment by their employer.

3.5 Hazard Communication

All employees, contract workers, and third-party contractors must be trained in chemical hazards (if any) associated with their work in accordance with 29 C.F.R. § 1910.1200. Work tasks performed on the PAP may include exposure to compounds identified in the Hazard Communication section of this Safety and Health Plan and is included as part of the Safety and Health Plan Review outlined in Section 3.3.

3.6 Medical Surveillance

All employees, contract workers, and third-party contractors engaged in operations specified in 29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65 and meet one of the criteria outlined in 29 C.F.R. § 1910.120(f)(2) and 29 C.F.R. § 1926.65(f)(2) must participate in a medical surveillance program that is administered by their employer. The criteria for participating in a medical surveillance program are:

- All employees who are or may be exposed to hazardous substances at or above the established permissible exposure limit, without regard to the use of respirators, for 30 days or more a year;
- All employees who wear a respirator for 30 days or more a year; or
- All employees who are injured, become ill or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation.

The medical surveillance program must result in documentation that an individual is cleared to work on sites covered by 29 C.F.R. § 1910.120 and 20 C.F.R. § 1926.65 and is medically fit to wear a respirator when applicable.

3.7 Drug Screen and Background Investigations

IPGC requires that contract worker agencies and third-party contractors are responsible for ensuring that all personnel have completed and passed a drug and alcohol test and background investigation prior to on-site work as described in Appendix C.

3.8 COVID-19 Site Entry Guidelines

All personnel entering Vistra work sites shall review and adhere to the Centers for Disease Control and Prevention (CDC) guidelines related to COVID-19.

3.9 Document Management

IPGC will maintain employee and contract employee training and medical surveillance records. Medical surveillance and training records are located in the Safety Specialist’s Office. Third-party contractors are responsible for maintaining training and medical surveillance documentation for their employees. Third-party contractors will produce documentation upon IPGC request.

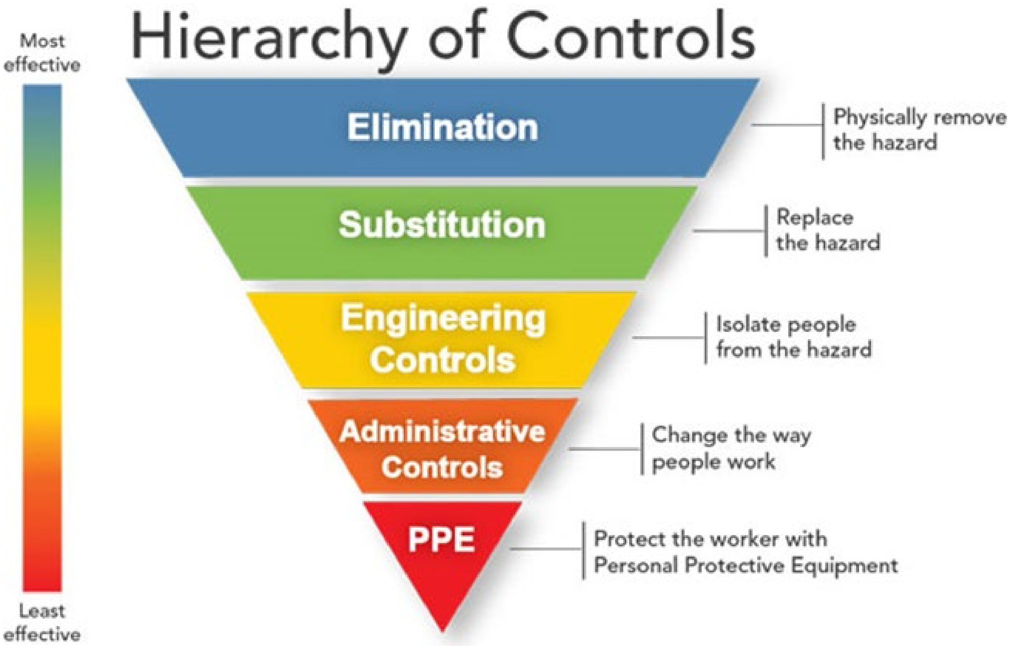
3.10 Industrial Hygiene Sampling Records

Upon receipt of exposure sampling results IPGC and third-party contractors must distribute exposure sampling results to employees within 15 business days unless otherwise required by applicable regulation. All personnel exposure sampling results and records must be maintained by the employee’s company for at least 30 years following termination of employment.

4. HAZARD & CONTROLS

The following section outlines general controls for the hazards and controls. Third-party contractors are still responsible for developing a Safety and Health Plan that incorporates requirements of this Safety and Health Plan, other safety requirements for the NPP, as well as the third-party contractor's safety policies and procedures. Safety and Health Plans developed by third-party contractors must be specific to the site and the anticipated work means and methods. Safety and Health Plans that consist of only standard operating procedures or are not otherwise specific to the work performed at the PAP will not be accepted by IPGC.

IPGC requires that a hierarchy of controls be considered when performing work at the PAP. Implement controls that favor elimination, substitution, and engineering over the use of administrative controls and PPE when feasible. See the figure below for additional guidance (courtesy of the National Institute for Occupational Safety and Health [NIOSH]).



4.1 Ash/Unstable Surfaces

Prior to working in or on an ash pond, third-party contractors must notify the facility POC. Work in or on an ash pond may not begin until the facility POC has approved the work. Upon completion of the work, third-party contractors must notify the POC that they have left the ash pond.

Additionally, Security must be notified prior to entering and upon exiting an ash pond.

When working on ash ponds or unstable surfaces the following requirements must be implemented where applicable and feasible. The following table summarizes safety controls for work performed in ash ponds and on unstable surfaces and are aligned to the hierarchy of controls:

Elimination	Substitution	Engineering	Administrative	PPE
Change the work task or work methods so that work on ash ponds is no longer required	Use the lightest available tracked equipment to reduce ground pressure	Use crane mats or other cribbing to support heavy equipment on ash ponds	Traverse compacted paths that have previously been used by heavy equipment	Use a restraint (tethering) system to prevent falls or slips into unstable ash pond surfaces or surface water that represents a drowning hazard

Elimination	Substitution	Engineering	Administrative	PPE
			If an unstable condition exists, complete a Next Level Up Pre-Job Brief prior to accessing the ash pond.	
			Approach the ash pond from the most stable direction	
			Inspect travel paths for recent terrain shifts, particularly following heavy rains or rapid dewatering	
			Working alone on ash ponds is prohibited without pre-approval from the POC.	
			When a drowning hazard exists, implement requirements for working on/near water as outlined in Section 4.4.	
			Implement an emergency response plan with trained responders for falls into (or engulfment by) ash	

4.2 Ash Inhalation/Airborne Exposure

Ash that becomes airborne due to site activities or environmental conditions may result in an exposure to its components as outlined in Section 5.1. IPGC and third-party contractors are responsible for ensuring their respective employees' and contract workers' exposures are below occupational exposure limits. Upon request, third-party contractors must demonstrate to IPGC that exposure control methods are adequate. The following table summarizes airborne exposure controls and is aligned to the hierarchy of controls:

Elimination	Substitution	Engineering	Administrative	PPE
Change the work task or work methods so that work on ash ponds is no longer required	Substitute manual work methods for those that can be completed from the cab of a vehicle	Continually wet work areas to reduce the amount of ash that becomes airborne Equip vehicles and heavy equipment cabs with filters. Clean and change filters as required	Conduct air monitoring or exposure sampling to confirm that airborne exposure is below regulatory limits	If exposure levels are above the PEL, equip employees with respirators appropriate to the level of exposure

4.3 Stuck Vehicles/Equipment

If a vehicle or piece of equipment becomes stuck, a third-party towing or wrecking company who is trained in vehicle extraction must be retained and the IPGC will be notified. Third-party contractors may extract their own vehicle if they have an approved extraction plan and a competent person is on site to implement the extraction. The extraction plan shall be included as part of the third-party contractor's reviewed and approved Safety and Health Plan. The above notifications are still required.

The hazards presented by stuck vehicles/equipment must not be underestimated. While the weight of the stuck equipment can be calculated, it's impossible to precisely calculate the other forces that are pulling against the towing vehicle which requires special training and experience to properly size towing equipment and select towing techniques. This is especially true for "complex" or high-hazard extractions involving equipment stuck at axle depth (or beyond) or sloped surfaces or any area where extraction activities could trigger shifts in the ground surface. No chains shall be used to remove stuck vehicles/equipment.

The following table summarizes safety controls related to stuck vehicles and equipment and are aligned to the hierarchy of controls:

Elimination	Substitution	Engineering	Administrative	PPE
Change the work task or work methods so that work on ash ponds is no longer required	Use the lightest available tracked equipment to reduce ground pressure Substitute tracked equipment for wheeled equipment	Use crane mats or other cribbing to support heavy equipment on ash ponds Lighten the load – Remove materials from stuck vehicles or equipment prior to extraction if possible	Only persons trained in vehicle extraction are permitted to remove stuck vehicles/equipment A professional towing/wrecking service is required Prepare for spills (damage to fuel or hydraulic systems)	All persons involved in removing stuck equipment must wear PPE that includes hard hat, safety boots, safety glasses, high visibility vests, and cut resistant gloves

4.4 Working Near/Over Water

All employees, contract workers, and third-party contractors must wear a United States Coast Guard (USCG) approved personal floatation device (PFD), when within 6 feet of water, over water, and/or wading in water where the danger of drowning exists. The PFD must be properly secured to the wearer, free of all defects including rips, tears, stress, and fading, and be kept clean and free of excessive dirt and oil.

If the possibility of falling into water has been eliminated through the use of guardrails, fall restraint, or other method, the use of a PFD is no longer required.

When performing work on water from a vessel, at least one lifesaving rescue vessel (*e.g.,* a skiff) shall be immediately available at locations where employees are working over, in, on, or adjacent to water where the danger of drowning exists. However, if the water is so shallow that rescuers could simply walk/run into the water body without endangering themselves and/or others or the work was being conducted very close to shore (*e.g.,* the length of the skiff from shore would be greater than the working distance from shore and/or the skiff would foul on the bottom), a skiff would not be required.

The following table summarizes the requirements for working over/near water where a drowning hazard exists and are aligned to the hierarchy of controls:

Elimination	Substitution	Engineering	Administrative	PPE
Change the work task or work methods so that work near a drowning hazard is no longer required		Install guardrails that separate work areas from the drowning hazard	All work to be performed by at least two people where each is equipped with proper safety gear and capable of summoning emergency rescue	All personnel are required to wear suitable PFDs
		Utilize equipment (crowd-control barricades, safety fence, etc.) that will keep personnel at least 6 feet from a drowning hazard	When working on water use of a rescue skiff as outlined above	
			Use of a ring buoy with 90 feet of braided polycarbonate (or equivalent) line	
			Ring buoys must be positioned within 100 feet of work (maximum of 200 feet spacing)	

4.5 Heavy Equipment

All heavy equipment operators must be competent and authorized to operate each piece of heavy equipment. Forklift and telehandler (*e.g.,* Lull, JLG) operators must have a license or certificate that indicates they have passed a written test and "road" test for the equipment they will be operating within the last 3 years. Third-party contractors will provide proof of qualification upon request of IPGC.

Persons working around heavy equipment must implement the “25 Foot Rule.” The 25 Foot Rule requires that persons get the operator’s attention and permission prior to approaching closer than 25 feet to heavy equipment. Persons must walk quickly through blind spots. Loitering in heavy equipment blind spots (especially to the rear) must be avoided.

Temporary fuel storage tanks will be labelled as to their content and be protected from collision by Site vehicles using solid barricades including balusters, chain link fence, or equivalent. Spill kit (55-gallon sorbent capacity contained in an overpack) and one 20-pound Type ABC fire extinguisher will be located within 45 feet of fueling areas. Tanks will be rated for above ground use and will be double walled or have secondary containment in case of a leak. Tanks and dispensing hose will be bonded and grounded. On-site filling of fuel storage tanks will be completed with trucks that have automatic over-flow shutoffs. These trucks will be properly bonded to the storage tank and meet all of the other storage tank requirements. Temporary secondary containment must be provided in the refueling area that includes the storage tank and dispensing hoses.

Elimination	Substitution	Engineering	Administrative	PPE
		Heavy equipment (and vehicles) must be equipped with backup alarms, horns, roll-over protection (when feasible)	Operators must be competent and authorized	Operators must use seatbelts when equipped
		Vehicles and heavy equipment operated at night must have headlights, tail lamps, and reflectors	Forklift operators must have a current license or certificate (within 3 years)	High visibility vests are required when working around heavy equipment
			All vehicles and equipment must be turned off when not in use	
			Operators must inspect equipment daily prior to use	
			Persons working near heavy equipment must follow the "25 Foot Rule" and avoid lingering in blind spots as outlined above	
			Always obey site speed limits – 15 mph unless otherwise posted	

4.6 Overhead Powerlines

All overhead powerlines must be assumed to be energized until confirmed otherwise. The minimum clearance distance for equipment working near energized power lines must be in accordance with the table of minimum clearance distances shown on the following page, as found in 29 C.F.R. § 1926.1408(h).

Voltage (nominal, kV, alternating current)	Minimum clearance distance (feet)
up to 50	10
over 50 to 200	15
over 200 to 350	20
over 350 to 500	25
over 500 to 750	35
over 750 to 1,000	45
over 1,000	(as established by the utility owner/operator or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution).

Note: The value that follows "to" is up to and includes that value. For example, over 50 to 200 means up to and including 200kV.

The following table summarizes safety controls for work near energized power lines:

Elimination	Substitution	Engineering	Administrative	PPE
Plan to work away from powerlines	Use heavy equipment with shorter booms/attachments to avoid coming close to power lines	Contact the utility owner to deenergize the line	Install signs to warn personnel of overhead powerlines	
		Contact the utility owner to install insulated sleeves over energized lines	Install a non-conductive distance marker to delineate minimum clearance	
			Use a dedicated spotter to ensure equipment does not enter minimum clearance distances	

4.7 Severe Weather

Severe weather conditions include but are not limited to high winds, electrical storms, heavy rain, and tornados can cause hazardous conditions at CCR surface impoundments. The primary control for severe weather is monitoring weather reports prior to beginning work and as work occurs throughout the day. In remote work areas with inconsistent cellular service, a weather radio should be used.

Monitor lightning using a commercially available mobile application if cellular service is available. When lightning is observed within 10 miles of the CCR surface impoundment, or a storm is imminent, take shelter in the nearest solid structure or fully enclosed vehicle. If possible, secure all tools, materials, and equipment prior to the storm arriving. Work may resume 30 minutes after the last lightning strike is observed within 10 miles. The severe weather shelter is located at the Service Building. The shelter location will be reviewed during the Site Orientation Training.

Do not conduct work on a CCR surface impoundment when there is a risk for tornados in the area. If on a CCR surface impoundment and a tornado forms, seek the nearest substantial shelter. The closest tornado shelter to the PAP is the Service Building (shown on Appendix A). If no shelter is available, attempt to evacuate to a shelter using a vehicle. If a tornado forms and you are not in a shelter, take one of the following actions:

- Stay in a vehicle with the seat belt on, keep your head below the windows and cover it with your hands
- If there is an area which is noticeably lower than the work area, lie in that area and cover your head with your hands.

The following table summarizes safety controls related to severe weather:

Elimination	Substitution	Engineering	Administrative	PPE
Plan outdoor tasks on days with low potential for severe weather.			Prior to beginning outdoor work monitor the day's weather.	
			Periodically monitor weather throughout the day. Use a weather app which issues alerts for severe weather and lightning, assuming cell service is available	
			Utilize a weather radio if cellular service is inconsistent	
			Stop all outdoor work and seek shelter when lightning is observed	

4.8 Heat Stress

Heat stress can be a significant hazard, especially for workers wearing protective clothing. Depending on the ambient conditions and the work being performed, heat stress can occur very rapidly, within as little as 15 minutes. Employees, contract workers, and third-party contractors will be instructed in the identification of a heat stress victim, the first-aid treatment procedures for the victim, and in the prevention of heat stress incidents.

Workers will be encouraged to immediately report any heat-related problems that they experience or observe in fellow workers. Any worker exhibiting signs of heat stress and exhaustion should be made to rest in a cool location and drink plenty of water. Emergency help by a medical professional is required immediately for anyone exhibiting symptoms of heat stroke, such as red, dry skin, confusion, delirium, or unconsciousness. Heat stroke is a life-threatening condition that must be treated immediately by competent medical authority.

4.8.1 Heat Stress Prevention

To prevent heat stress, IPGC employees, contract workers, and third-party contractors will implement heat stress prevention measures as outlined in OSHA's Heat Index (below). A summary of these precautions is described below.

Heat Index	Risk Level	Protective Measures
Less than 91°F	Lower (Caution)	Basic heat safety and planning
91°F to 103°F	Moderate	Implement precautions and heighten awareness
103°F to 115°F	High	Additional precautions to protect workers
Greater than 115°F	Very High to Extreme	Triggers even more aggressive protective measures

Know the Symptoms: Some symptoms associated with heat stress are: Employees should be aware of these symptoms with themselves and with their co-workers:

- Elevated heart rate, lack of concentration, difficulty focusing on a task, fatigue
- Irritability and/or sickness
- Cramps, rash, headache
- Loss of desire to drink water
- Fainting
- Skin clammy, moist, and pale (severe heat exhaustion)
- Skin extremely dry and red (heat stroke)

Acclimatize: When high heat stress conditions arise, employees should be exposed to the heat for short work periods followed by longer periods of work. Acclimatization usually takes five (5) days and should be provided for all new employees and employees returning from an absence of two (2) weeks or more. Contact Corporate Health and Safety for proper procedures.

Hydration & Pace of Work: Make sure all employees intake plenty of water throughout the work day (sometimes as much as a quart per worker per hour) and let employees know where the drinking water is located. Adjust your work pace and expectations on how much work can be done during periods of high heat stress. Workers cannot do as much during periods of high heat stress compared with similar periods of low heat stress. After acclimatization, workers may be able to resume a more "normal" work pace as long as fluid intake is adequate.

Work/Rest Periods: If possible, heavy work should be scheduled during the cooler parts of the day (*i.e.,* early morning) and rest periods should be taken in cool areas for longer periods.

Personal Protective Equipment (PPE): Employees using PPE (*i.e.*, Tyvek® suits or other equipment which may retain heat) can be more susceptible to heat stress due to the fact that heat/sweat often cannot escape the suits and/or the equipment. Persons wearing PPE that contributes to heat stress require more hydration, longer rest periods, or a reduced pace of work. Also, more careful monitoring of each person's health status is required by co-workers and management.

The following table summarizes safety controls for heat related illnesses:

Elimination	Substitution	Engineering	Administrative	PPE
Perform outdoor, strenuous, tasks at cooler times of day/year	Use mechanized equipment in place of manual labor	Install fans or air conditioning units in the work area	Train all personnel to know the signs of heat stress/stroke and how to prevent it	Implement the use of cooling vests or other similar PPE
		Install a canopy to provide shade to work areas	Allow workers to acclimatize to the work environment	
		Provide cool, shaded break areas	Adjust work pace to allow for the effects of heat	
			Implement work/rest periods	

4.9 Cold Stress

The four environmental conditions that cause cold-related stress are low temperatures, high/cool winds (wind chill), dampness, and cold water. One, or any combination of these factors, can cause cold-related hazards. Cold stress, including frostbite and hypothermia, can result in severe health effects. Employees, contract employees, and third-party contractors will be instructed in the identification of a cold stress victim, the first-aid treatment procedures for the victim and in the prevention of heat stress incidents.

A dangerous situation of rapid heat loss may arise for any individual exposed to high winds and cold temperatures. Major risk factors for cold-related stresses include:

- Wearing inadequate or wet clothing thus increasing the effects of cold on the body.
- Taking certain drugs or medications such as alcohol, nicotine, caffeine, and medication thus inhibiting the body's response to the cold and/or impairing judgment.
- Having a cold or certain disease, such as diabetes, heart, vascular and thyroid problems, and thereby increasing susceptibility to the winter elements.
- Lower body-fat composition or other physiological differences. Statistics show that men experience far greater death rates due to cold exposure than women, potentially attributable to participation in risk-taking activities, lower body-fat composition and/or other physiological differences.
- Becoming exhausted or immobilized, especially due to injury or entrapment, thus speeding up the effects of cold weather.

The following table provides the resulting equivalent chill temperature to exposed skin because of increasing wind speeds at decreasing actual temperatures. Personnel shall be aware of predicted weather conditions before beginning site work and stay apprised of changes.

TABLE 2. Cooling Power or Wind on Exposed Flesh Expressed as Equivalent Temperature (under calm conditions)*

Estimated Wind Speed (in mph)	Actual Temperature Reading (°F)											
	50	40	30	20	10	0	−10	−20	−30	−40	−50	−60
	Equivalent Chill Temperature (°F)											
calm	50	40	30	20	10	0	−10	−20	−30	−40	−50	−60
5	48	37	27	16	6	−5	−15	−26	−36	−47	−57	−68
10	40	28	16	4	−9	−24	−33	−46	−58	−70	−83	−95
15	36	22	9	−5	−18	−32	−45	−58	−72	−85	−99	−112
20	32	18	4	−10	−25	−39	−53	−67	−82	−96	−110	−121
25	30	16	0	−15	−29	−44	−59	−74	−88	−104	−118	−133
30	28	13	−2	−18	−33	−48	−63	−79	−94	−109	−125	−140
35	27	11	−4	−20	−35	−51	−67	−82	−98	−113	−129	−145
40	26	10	−6	−21	−37	−53	−69	−85	−100	−116	−132	−148
(Wind speeds greater than 40 mph have little additional effect.)	LITTLE DANGER In < hr with dry skin. Maximum danger of false sense of security				INCREASING DANGER Danger from freezing of exposed flesh within one minute.				GREAT DANGER Flesh may freeze within 30 seconds.			
	Trenchfoot and immersion foot may occur at any point on this chart.											

*Developed by U.S. Army Research Institute of Environmental Medicine, Natick, MA.

[shaded] Equivalent chilll temperature requiring dry clothing to maintain core body tempearture above 36°C (96.8°F) per cold stress TLV

The following table summarizes safety controls for preventing cold stress:

Elimination	Substitution	Engineering	Administrative	PPE
Perform work during warm parts of the day or warmer parts of the year		Install heaters in enclosed work areas	Train all personnel on the symptoms of cold stress and how to prevent it	All personnel must wear multiple layers of clothing
		Provide a warm break area	Implement work/rest schedule	Utilize hand/foot warmers when required

An additional hazard in cold weather conditions is the increased risk for slips from the accumulation of ice and snow in general work areas, ruts where water is accumulated, and heavy equipment. The following table outlines controls that may be used for preventing slips:

Elimination	Substitution	Engineering	Administrative	PPE
Perform work during warm parts of the day or in areas free of accumulated areas		Clear snow in work areas		Use traction control devices (*i.e.,* YakTrax) on work boots to provide additional traction.
		Apply salt/sand to icy areas		
		Use equipment to access work areas		

4.10 Biological Hazards

The following are biological hazards that may be present at the PAP.

4.10.1 Ticks (Lyme Disease) & Mites

Although Lyme disease has been detected throughout the continental United States, it is prevalent primarily in certain areas in New England, the Mid-Atlantic and the northern Midwest states.

Although Lyme disease is the most common tickborne illness, other tickborne illnesses include southern tick-associated rash illness, Rocky Mountain spotted fever, ehrlichiosis, and tularemia. More information on Lyme disease and other tickborne illnesses can be found from the CDC.

Prevention

- Standard field gear (work boots, socks, and light colored coveralls) provides good protection against tick bites, particularly if the joints are taped. However, even when wearing field gear, the following precautions shall be taken when working in areas that might be infested with ticks:
  - Wear long pants and long-sleeved shirts that fit tightly at the ankles and wrists, tape cuffs if necessary
  - Wear light colored clothing so ticks can be easily spotted
  - Per- and polyfluoroalkyl substances (PFAS)-free tick repellents (DEET and Permethrin) must be used when walking in all overgrown areas. DEET (≥25 percent [%]) must be applied to skin while permethrin must be applied to clothes and allowed to dry. Spray outer clothing, particularly your pant legs and socks, BUT NOT YOUR SKIN, with an insect repellent that contains permethrin. For heavily infested tick areas, wear spun polypropylene coveralls that have been sprayed with permethrin.
  - Inspect clothing frequently
  - Inspect head and body thoroughly when you return from the field, particularly on your lower legs and areas covered with hair
  - When walking in wooded areas, wear a hard hat, and avoid contact with bushes, tall grass, or brush as much as possible

Removal

- Remove any ticks by tugging with tweezers or special tick removal tools
- Do not squeeze or crush the tick
- DO NOT use matches, a lit cigarette, nail polish, or any other type of chemical to "coax" the tick out

Treatment

- Disinfect the area with alcohol or a similar antiseptic after removal
- Notify the Safety Competent Person of the embedded tick
- For several days to several weeks after removal of the tick, look for the signs of the onset of Lyme disease, such as a rash.
- No further treatment is necessary for ticks embedded <48 hours.
- If other signs or symptoms of Lyme are observed (fever/chills, aches, and pains), then notify the Safety Competent Person and seek medical attention

The following table summarizes safety controls to reduce the hazards associated with ticks and mites.

Elimination	Substitution	Engineering	Administrative	PPE
Use mechanical equipment to remove overgrown vegetation		Remove overgrowth and excessive vegetation from walkways and work areas (provide safe access)	Train personnel on tick and mite prevention. Areas of vegetation overgrowth and/or debris piles should be considered "high risk" areas	Wear light colored long-sleeved shirt tucked into pants. Tuck pant legs into socks

Elimination	Substitution	Engineering	Administrative	PPE
			Perform frequent tick checks in the field and a thorough tick check after completing work activities	Apply Permethrin to clothes and DEET (20% or more) to exposed skin
			Call licensed pesticide contractors to remove infestations of bees, wasps, fire ants, etc.	

4.10.2 Insect Bites/Stings

Stinging/biting insects at the PAP include spiders, wasps, and bees. Contact with these insects may result in project personnel experiencing adverse health effects that range from being mildly uncomfortable to being life-threatening. Therefore, insects present a serious hazard to project personnel, and extreme caution must be exercised whenever Site and weather conditions increase the risk of encountering stinging insects. Some of the factors related to stinging insects that increase the degree of risk associated with accidental contact are as follows:

- The nests for these insects are frequently found in remote wooded or grassy areas or equipment staging areas where equipment has not been moved recently.
- Some people are hypersensitive to the toxins injected by a sting, and when stung, experience a violent and immediate allergic reaction resulting in a life-threatening condition known as anaphylactic shock. Anaphylactic shock manifests itself very rapidly and is characterized by extreme swelling of the body, eyes, face, mouth, and respiratory passages.
- The hypersensitivity needed to cause anaphylactic shock, can in some people accumulate over time and exposure, therefore even if someone has been stung previously and not experienced an allergic reaction, there is no guarantee that they will not have an allergic reaction if they are stung again
- Spider bites generally only cause localized reactions such as swelling, pain, and redness. However, bites from a Black Widow or Brown Recluse, or if you are allergic to spiders, can cause symptoms that are more serious.
- ***If a worker knows that they are hypersensitive to bee, wasp, or hornet stings, or other insects, they must inform the Safety Competent Person prior to site work. Persons who have been prescribed epi-pens by their physician must have an epi-pen on the Site.***
- Inspect any clothing or PPE that has been left for a period of time prior to putting it on. Shake out the clothing and inspect the inside of safety shoes/boots prior to putting them on
- Nests in active work areas must be eradicated. Small nests may be handled by Site personnel using consumer-type insecticide. A pest control contractor should be hired to handle large or difficult to reach nests.

The following table outlines safety controls to reduce the risk of hazards associated with stinging/biting insects.

Elimination	Substitution	Engineering	Administrative	PPE
Use mechanical equipment to remove overgrown vegetation		Remove overgrowth and excessive vegetation from walkways and work areas (provide safe access)	Train personnel on stinging/biting insect prevention. Areas of vegetation overgrowth and/or debris piles should be considered "high risk" areas	Wear light colored long-sleeved shirt tucked into pants. Tuck pant legs into socks
		Eradicate nests in the work area as outlined above.	Instruct personnel to inspect/shake out clothing and work boots that have been left for a period of time.	Apply Permethrin to clothes and DEET (20% or more) to exposed skin – NOTE this will not repel bees/wasps
			Instruct employees who are hypersensitive to insect bites/stings to carry their epi-pen while on site	

4.10.3 Venomous Snakes

There are four species of venomous snakes in Illinois, they are:

- Copperhead
- Cottonmouth Water Moccasin
- Timber rattlesnake
- Eastern Massasauga

Generally, these snakes are found in the southern one-third of the state, with the Cottonmouth Water Moccasin found mostly in the southernmost portions of Illinois. Snakes are generally found in tall grass, wood piles, or other covered areas. Snakes are generally not aggressive towards humans, but if they are encountered avoid the snake and do not provoke it. If bitten by a snake that may be venomous seek medical treatment.

The following table outlines safety controls to reduce the hazard associated with venomous snakes.

Elimination	Substitution	Engineering	Administrative	PPE
Use mechanical equipment to remove overgrown vegetation		Remove debris piles, overgrowth and excessive vegetation from walkways and work areas (provide safe access)	Train personnel on the identification of venomous snakes. Areas of vegetation overgrowth and/or debris piles should be considered "high risk" areas	If working in area with snakes cannot be avoided, wear snake chaps
			Instruct personnel to not disturb snakes if they identify one in their work area	

Elimination	Substitution	Engineering	Administrative	PPE
			Use caution when moving staged tools or materials into which snakes may have moved	

4.10.4 Poisonous Plants and Plant Hazards

Poison ivy and poison oak may be present at the Site. Poison ivy thrives in all types of light and usually grows in the form of a trailing vine; however, it can also grow as a bush and can attain heights of 10 feet or more. Poison ivy has pointed leaves that grow in clusters of three. Poison oak resembles poison ivy except that the poison oak leaves are more rounded rather than jagged like poison ivy, and the underside of poison oak leaves are covered with hair.

The skin reaction associated with contacting these plants is caused by the body's allergic reaction to toxins contained in oils produced by the plant. Becoming contaminated with the oils does not require contact with just the leaves. Contamination can be achieved through contact with other parts of the plant such as the branches, stems or berries, or contact with contaminated items such as tools and clothing. The allergic reaction associated with exposure to these plants will generally cause the following signs and symptoms:

Symptoms

- Blistering at the site of contact, usually occurring within 12 to 48 hours after contact and in many cases, persons experience almost immediate irritation.
- Reddening, swelling, itching, and burning at the site of contact.
- Pain, if the reaction is severe.
- Conjunctivitis, asthma, and other allergic reactions if the person is extremely sensitive to the poisonous plant toxin.

Prevention

- The best treatment appears to be removal of the irritating oil before it has had time to cause inflammation by wiping exposed skin with rubbing alcohol followed by washing with soap and water.
- A visual Site inspection and identification of the plants should be completed prior to starting work so that all individuals are aware of the potential exposure. Avoid contact with any poisonous plants on the Site, and keep a steady watch to identify, report, and mark poisonous plants found on the Site.
- Avoid contact with, and wash daily, contaminated tools, equipment, and clothing.
- Barrier creams (Ivy Block®) and orally administered desensitization may prove effective and should be tried to find the best preventive solution.
- Keeping the skin covered as much as possible (*i.e.*, long pants and long-sleeved shirts) in areas where these plants are known to exist will limit much of the potential exposure. PFAS-free spun polypropylene coveralls or Tyvek® may be worn to prevent contact of skin and clothes with poison ivy.

The following table outlines safety controls to mitigate the hazards associated with poisonous plants.

Elimination	Substitution	Engineering	Administrative	PPE
Use mechanical equipment to remove overgrown vegetation		Remove overgrowth and excessive vegetation from walkways and work areas (provide safe access)	Train personnel on the identification of poisonous plants	Wear pants and long sleeves when working in overgrown areas
			Instruct personnel to avoid areas where poisonous plants have been identified	Consider the use of a coverall when working in areas where these plants are present, especially for hypersensitive employees.
			Provide isopropyl alcohol along with soap and water to remove oils from skin, tools, and equipment.	

4.11 Working Alone

As outlined in Section 4.1, working alone while on the PAP must be pre-approved by the POC. Working alone is prohibited for tasks deemed to be high risk by IPGC including, but not limited to, handling highly hazardous chemicals (sulfuric acid), work over/near water, excavation and trenching, hot work (grinding, welding and torch cutting), and elevated work that requires personal fall arrest. Third-party contractors are responsible for identifying potential high-risk tasks in their Safety and Health Plan and requiring that a buddy system be implemented while high risk work is performed. The buddy must be located in a safe area but may perform other tasks that do not prevent observing the person performing high risk work. Working alone may occur on and around other parts of the PAP when there is no drowning hazard or risk of severe injury due to high-risk work.

Elimination	Substitution	Engineering	Administrative	PPE
	Modify work methods by substituting lower hazard methods for high hazard methods	Varies depending on the hazard, but for example, could include installing guardrails (temporary or permanent) which mitigates a fall hazard reducing the risk to levels where working alone may be permitted	Prohibit working alone on ash ponds and for other high hazard tasks without prior approval from the POC	
			Implement a buddy system whenever feasible (required for high hazard work)	

Elimination	Substitution	Engineering	Administrative	PPE
			Implement a worker check-in, emergency alerting, and monitoring system	

5. HAZARD COMMUNICATION

As required by 35 I.A.C. § 845.530, the OSHA HAZWOPER standards (29 C.F.R. § 1910.120 and 29 C.F.R. § 1926.65) and OSHA Hazard Communication Standard, site personnel, subcontractors, and visitors must be informed of chemical hazards associated with their work area. The information in this section is based on:

- Recommendations in the most recent "NIOSH Pocket Guide to Chemical Hazards" by the Department of Health and Human Services, Centers for Disease Control and Prevention, and the NIOSH Pocket Guide.
- Requirements set forth in the OSHA regulations from as defined in Chapter 17 of 29 C.F.R. § 1910.1200(c) for all hazards not otherwise classified.

5.1 Coal Combustion Residuals

Primary exposure to CCR is through inhalation and skin contact. CCR is typically a fine, black, grey, or tan particulate. CCR is comprised of several components. The following table outlines the components of the CCR. The exact percentage of each component will vary based on the type of ash and location at the surface impoundment.

Chemical	Percentage	PEL	IDLH	ACGIH TLV	Symptoms of Exposure & Health Effects
Crystalline Silica	20-60% (total)	0.05 mg/m^3 (respirable)	25 mg/m^3 (respirable)	0.025 mg/m^3 (respirable)	Cough, dyspnoea (breathing difficulty), wheezing; decreased pulmonary function, progressive respiratory symptoms (silicosis); irritation eyes; [potential occupational carcinogen]
Iron oxide	1-10%	10 mg/m^3	2500 mg/m^3	5 mg/m^3	Benign pneumoconiosis with X-ray shadows indistinguishable from fibrotic pneumoconiosis (siderosis)
Calcium oxide	10-30%	5 mg/m^3	25 mg/m^3	2 mg/m^3	irritation eyes, skin, upper respiratory tract; ulcer, perforation nasal septum; pneumonitis; dermatitis
Titanium dioxide	<3%	15 mg/m^3	ND	0.2 mg/m^3 (nanoscale particles) 2.5 mg/m^3 (fine-scale particles)	Lung fibrosis; [potential occupational carcinogen]
Aluminosilicates	10-60%	15 mg/m^3 (PNOR)	ND	10 mg/m^3 (PNOR)	irritation eyes, skin, throat, upper respiratory system
Magnesium oxide	2-10%				
Magnesium dioxide	<2%				
Phosphorous pentoxide	≤2%				
Sodium oxide	1-10%				
Potassium oxide	≤1%				
Bromide salt	<0.1%				

Footnotes:

All values are 8-hour time-weighted averages (TWAs) unless otherwise indicated.

- PEL: Permissible Exposure Limit, the concentration an employee may be exposed to for an 8-hour work day for a 40-hour work week for which nearly all employees may be repeatedly exposed without adverse health effects.
- IDLH: IMMEDIATELY Dangerous to Life and Health, contaminant concentration which present the possibility for severe health consequences if exposed to the IDLH concentration without the appropriate personal protective equipment (PPE).
- ACGIH TLV: American Conference of Governmental Industrial Hygienists Threshold Limit Value
- mg/m^3 = milligrams per cubic meter of air
- PNOR: Particulates Not Otherwise Regulated
- ND: Not Determined

5.2 Sulfuric Acid

Sulfuric acid is used in the PAP to control pH. Sulfuric acid is a very hazardous corrosive capable of causing immediate chemical burns to eyes and skin as well as damage to the upper respiratory tract and lungs if aerosols are inhaled. Sulfuric acid storage tanks and piping are labelled.

Immediately flush skin and eyes for 15 minutes following contact with sulfuric acid. Personnel working within the vicinity of sulfuric acid must provide a suitable, temporary or permanent, emergency shower and eyewash.

5.3 Safety Data Sheets

Pursuant to 35 I.A.C. § 845.530(b)(3), IPGC will provide Safety Data Sheets (SDSs) to all employees, contract workers, and third-party contractors for the CCR located at the Site. Third-party contractors will provide SDSs to the POC. SDSs are provided in Appendix D.

5.4 Signage

The absence of any of the following signage does not mean that a potential hazard does not exist. Signage will be posted by IPGC, but employees, contract workers, and third-party contractors must remain vigilant for changing site conditions.

To aid in hazard communication and pursuant to 35 I.A.C. § 845.530(f), IPGC will post the following signs at the PAP:

- Signs identifying the hazards of CCR, including dust inhalation when handling CCR.
- Signs identifying unstable CCR areas that make the operation of heavy equipment hazardous.
- Signs identifying the necessary safety measures and necessary precautions, including the proper use of PPE.

The following signs may also be posted at the CCR units to aid in hazard communication:

- Sulfuric acid hazard communication signs or labels on all tanks, drums, or other storage containers. "Sulfuric Acid" labels on piping.
- Overhead electrical lines that may be struck by heavy equipment of vehicles will have signs warning drivers of their presence.

6. EMERGENCY RESPONSE PLAN

This emergency response section details actions to be taken in the event of site emergencies. This section is consistent with the NPP PAP Emergency Action Plan. All personnel on site must be familiar with emergency signals and the content of this section.

6.1 Emergency Phone Numbers & Notifications

Emergency Number	
Site Address	**Emergency Phone Number**
6725 N 500th St Newton, IL	618-783-0344
Security	618-783-0302

Medical Treatment	
Local Hospital	**Phone Number**
HSHS St. Anthony's Memorial Hospital 503 N Maple St Effingham, IL 62401	217-342-2121

Incident Notifications		
Title	**Name**	**Contact Number**
Tanner Lewis	POC / Safety Specialist	618-783-0352

6.2 Evacuation Signal

The site-specific evacuation signal will be communicated during the NPP Site Orientation.

Upon hearing an evacuation signal, all personnel will leave the work area and proceed to the muster point.

6.3 Muster Point

The muster point for the PAP is located at the main gate. The muster point is shown in Appendix A. An alternative muster point may be identified based on the location of the work or the type of incident.

6.4 Calls for Emergency Support

In the case of an emergency, site personnel will contact **618-783-0344**. Security will coordinate the arrival of on-site emergency personnel. The individual calling for emergency support will briefly explain the nature of the emergency and site conditions as follows:

- Indicate his/her name
- Location of emergency
- Description of emergency conditions that may require special rescue equipment, such as confined spaces, excavations, and elevated work platforms
- Potential chemical hazards and recommended PPE

6.5 Fire & Explosion Response Plan

Trained site personnel may respond to incipient stage fires using a 20-pound Type ABC dry chemical fire extinguisher or hose. An incipient stage fire is a fire which is in the initial or beginning stage and which can be controlled or extinguished by portable fire extinguishers, Class II standpipe or small hose systems without the need for protective clothing or breathing apparatus. Personnel shall only attempt to extinguish the fire if it is safe to do so.

A fire that CANNOT be readily extinguished with a fire extinguisher will require evacuation of the work area personnel to Muster Point areas per this Safety and Health Plan. If personal injuries result from any fire or explosion, the procedures outlined in the Personal Injury Response Plan will also be followed.

All fires or explosions must be reported to the contacts outlined in Section 6.1 of this Safety and Health Plan.

6.6 Injury Response Plan

Treatment for minor injuries will be provided on site using available first aid supplies and personnel trained in first aid. All third-party contractors must have at least one individual on site who is trained in first aid, CPR, and AED use. Third-party contractors must provide their own first aid kits and AED. For minor injuries that are not life-threatening but require further medical attention, employees should be treated by occupational physicians at occupational clinics whenever possible. Treatment of minor injuries by emergency room or personal physicians should be avoided. When injured workers are released back to work with restrictions, all subcontractors are expected to accommodate those restrictions.

Emergency medical incidents include puncture wounds to the head, chest, and abdomen, serious head and spinal cord injuries, and loss of consciousness must be treated at the hospital emergency room listed in Section 6.1 of this Safety and Health Plan.

All injuries must be reported to the contacts outlined in Section 6.1 of this Safety and Health Plan.

6.7 Spill Response Plan

In general, IPGC employees, contract workers, and third-party contractors are trained and equipped to handle small spills associated with their work. Third-party contractors must include an approved spill response plan in their Safety and Health Plan. Site personnel will generally respond to spills as follows:

- Stop the leak immediately if it can be done without directly contacting the leaking material.
- Remove or stop all ignition sources (hot work, generators, etc.) that are within 25 feet of any part of the spill.
- On-site personnel should immediately secure the area to prevent unauthorized entry into the spill area.
- Although not likely given the anticipated types of spills, site personnel must immediately initiate evacuation if a spill may cause an explosion, death, or serious injury.
- Site personnel may only respond to incipient stage fires regardless of whether such fires are associated with a spill.
- PPE for spills to open areas generally requires Modified Level D PPE (poly-coat Tyvek®, nitrile gloves, and boot covers or boot decontamination). Over-boots or boot covers may also be used if persons cleaning the spill would have to walk on spilled materials. Latex gloves are not acceptable and will degrade with exposure to petroleum products.

6.8 CCR Spill or Release Response Plan

Response to minor or incidental spills of CCR will be managed as outlined in the General Spill Response Plan. An incidental release is a release of a hazardous substance which does not pose a significant safety or health hazard to employees in the immediate vicinity or to the employee cleaning it up, nor does it have the potential to become an emergency within a short time frame. Incidental releases are limited in quantity, exposure potential, or toxicity and present minor safety or health hazards to employees in the immediate work area or those assigned to clean them up. An incidental spill may be safely cleaned up by employees who are familiar with CCR. Response to major releases of CCR will be in accordance with the NPP PAP Emergency Action Plan, which can be found on the Luminant CCR website at https://www.luminant.com/ccr/.

6.9 Ash Pond Rescue

Ash ponds may be unstable and represent an engulfment hazard if persons and equipment traverse the surface, berms, or other unstable areas. Special training is required on behalf of emergency responders to retrieve persons and equipment who become trapped in unstable ash. **Untrained persons must not enter unstable areas** in an attempt to conduct rescue because of the significant potential that they will also become victims. Call the NPP emergency number and state that an "ash pond rescue" is required. The NPP emergency contact will notify the designated service to perform the ash pond rescue. On-site personnel should remain on stand-by to support the ash pond rescue team as necessary.

6.10 Incident Reporting

All incidents must be reported to the contacts outlined in Section 6.1 of this Safety and Health Plan. An Incident Report must be completed for all injuries, illnesses, spills, fire, explosion, or property damage. The absence of an injury does not preclude the need to complete an Incident Report as such incidents will be classified as "near miss" or "other." It will include, but is not limited to, the nature of the problem, time, location, and corrective actions taken to prevent recurrence.

APPENDIX A
SITE MAP

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PROJECT: 169000XXXX | DATED: 9/22/2021 | DESIGNER: STOLZSD

PART 845 REGULATED UNIT (SUBJECT UNIT)
OTHER UNIT
PROPERTY BOUNDARY

0 500 1,000 Feet

SITE MAP

PART 845 SAFETY AND HEALTH PLAN
NEWTON POWER PLANT
NEWTON, ILLINOIS

APPENDIX A

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

APPENDIX B
SAFETY AND HEALTH PLAN ACKNOWLEDGMENT FORM

SAFETY AND HEALTH PLAN ACKNOWLEDGEMENT FORM

I HEREBY CERTIFY THAT I HAVE READ AND UNDERSTOOD ALL HEALTH AND SAFETY PROCEDURES AS STATED HEREIN:

Name and Affiliation (printed)	**Signature**	**Date**

APPENDIX C
DRUG SCREEN POLICIES AND SUPPLEMENTAL TERMS

Drug and Background Investigations

Contractor is solely responsible for ensuring that all members of Contractor Project Team have completed and passed all drug and alcohol tests and background investigations required under this Attachment and under Contractor's own programs before assigning such personnel to perform Work. Contractor is also solely responsible for ensuring that such testing and investigations are performed in accordance with all applicable laws.

1. Required Investigations. Except as otherwise required by applicable law, Required Investigations shall consist of all of the following:

 1.1 a 7-panel drug screening;

 1.2 a background investigation that includes a criminal records check in all counties where the applicable person has resided for at least the last seven (7) years;

 1.3 a third-party verification of previous employment and the highest education level completed by the applicable person;

 1.4 a check of the National Sex Offender Registry and Terrorist Watch List (Denied Parties); and

 1.5 a check of Motor Vehicles Record (if work to be performed by the applicable person requires driving as part of the defined duties).

2. Notices to Tested Persons Regarding Background Checks. All background checks will be conducted in compliance with applicable provisions of the Fair Credit Reporting Act.
3. Forms and Testing Organization for Drug Tests. Except for those positions subject to Department of Transportation ("DOT") drug and alcohol testing regulations, all drug testing shall be performed using the Universal Toxicology four part "Non-DOT" Chain of Custody and Request Form with white and blue top page, and shall be conducted by an independent third-party organization.

4. Pass/Fail Standards – Background Checks. A person shall be deemed to have failed the applicable background check if:

 4.1 information is reported through the background check process indicating that such person has failed to disclose or misrepresented information requested at any time about such a person's criminal background history; or

 4.2 such person has ever committed any felony constituting a violent crime, crime against a person, sexual offense or fraud; or

 4.3 such person has committed any other felony, or has been incarcerated for a felony, within ten (10) years prior to the date of such background check (i.e., for these felonies there must be a ten (10) year lapse in time from the later of the commission and the end of any period of incarceration); or

 4.4 such person has committed any misdemeanor that:

  4.4.1 involves violence that is sexually related; or

4.4.2 consists of a DUI that is the second (or more) DUI in the last two (2) years prior to the date of the background check; or

4.4.3 consists of a theft-related offense; provided that there can be no more than one theft by check and it must have been for an amount less that $100; or

4.4.4 consists of any drug-related misdemeanor committed at any time within forty-eight (48) months prior to the date of the background check.

4.4 For purposes of both felonies and misdemeanors, a person is deemed to have committed the applicable offense if he/she is convicted or enters a plea of guilty or nolo contendere for such offense (to include, without limitation, sentences of probation and deferred adjudication).

5. Pass/Fail Standards – Drug Tests. A person shall be deemed to have failed the applicable drug test if any of the following maximum cut-off levels are exceeded, unless there is a legitimate medical explanation for the presence of a tested substance at or above the applicable cut-off level:

5.1 Amphetamines 500ng/mL

5.2 Barbiturates 150ng/mL

5.3 Benzodiazepines 150ng/mL

5.4 Cocaine 150ng/mL

5.5 Marijuana 150ng/mL

5.6 Opiates 2000ng/mL

5.7 Phencyclidine 25ng/mL

For any positions subject to DOT drug and alcohol testing requirements, testing shall be conducted according to the applicable DOT panel and cutoff levels.

6. Other Requirements.

6.1 Background checks and drug tests will be paid for by Contractor without reimbursement by Company.

6.2 Contractor will keep background checks and drug test records while the applicable persons are working pursuant to this Agreement and for three (3) years thereafter.

6.3 Upon request, Contractor will provide a certification to Company that no person required hereunder to pass a background check or drug test has failed such investigation or test. Contractor will not provide the specific results of the background check or drug test of any individual to Company.

6.4 If any person required under this Agreement to pass a background check or drug test fails such check or test, Contractor will not report the specific results of such check or test to Company and will not allow such individual to perform any Work for Company. Although such person may not be assigned to perform any Work for Company, nothing in this Attachment requires Contractor to take any other action with respect to such person’s employment with Contractor.

Supplemental Terms for Onsite Services

1. SAFETY

1.1 Contractor agrees that any safety-related assistance or initiatives undertaken by Company will not relieve Contractor while on Company Property from responsibility for the implementation of, and compliance with, safe working practices, as developed from their own experience, or as imposed by law or regulation, and will not in any way, affect the responsibilities resting with Contractor under the provisions of any agreement to which these policies are attached and to meet all safety requirements as specified by the Occupational Safety & Health Administration (OSHA), the Mine Safety Health Administration (MSHA), including the "Mining Contractor Safety Reference Handbook" located at http://www.vistraenergy.com/wp-content/uploads/2016/12/Contractors-Safety-Handbook_Final-MC-08262016.pdf, the Department of Transportation (DOT) and any other applicable state or federal safety and health laws or regulations.

1.2 In the event that a material safety data sheet, warning label, or other documentation concerning the use of hazardous chemicals at any property owned or controlled by Company or any of its affiliates (collectively, "Company Properties"), applies to any materials or equipment provided by Contractor as an aspect of the Work, such documentation will be provided by Contractor to Company prior to the commencement of any such Work.

1.3 Contractor will report to Company all accidents involving personal injuries (including death) and damage to property occurring directly or indirectly as a result of the Work performed by Contractor hereunder immediately, but in no event, no later than 24 hours after the occurrence of any such accident. Any accident or incident occurring directly or indirectly as a result of the Work which Contractor must report to a regulatory agency (e.g. OSHA, MSHA, TCEQ) must also be reported to Company immediately following notification to the regulatory agency.

2. SECURITY

2.1 It will be the affirmative duty of Contractor to ensure that Contractor Group assists in carrying out all security measures, to include reporting all information or knowledge of matters adversely affecting security to Company's designated security personnel.

2.2 Company reserves the right to exclude any of Contractor's employees from any Company Property by denial of access, suspension or revocation of access authorization, preemptory expulsion, or by any other means, without notice or cause. Former Company employees, and any of Contractor's employees who previously have been excluded from any Company Property, may be brought onto Company property or facilities only if prior approval from Company is obtained. If Contractor terminates a member of Contractor Group performing Work on Company's premises, Contractor shall inform Company immediately, but in no event, no later than twenty-four (24) hours after such employee is terminated in order for Company to remove access to Company Property for such employee.

2.3 Company measures may also include investigations, whether by Company or law enforcement officials. Contractor agrees to cooperate in such investigations and understands that Company reserves the right to require anyone in Contractor Group to authorize appropriate agencies to release his or her criminal records to Contractor as a condition of either initial or continued permission for access to any Company Property. Investigations may include searches of Contractor Group. Such searches may include searches of facilities assigned to Contractor Group, search of all Company Property areas and property at such Company Property areas, searches of including, but not limited to, offices, lockers, desks, lunch boxes, packages and motor vehicles (regardless of ownership). Without limiting the foregoing, Contractor acknowledges and agrees that all members of Contractor Group, to the extent that Company reasonably determines that such members require security badge access prior to entering onto any Company Property, shall be required to comply with Company's standard security badge requirements, including without limitation a background check to be performed by Company.

3. ISNETWORLD

3.1 Contractor agrees to maintain at Contractor's expense a subscription with ISNetworld (www.ISNetworld.com), Company's safety compliance program or any replacement program therefor, as directed by Company, for the Term of the Agreement. Contractor shall also furnish ISNetworld with any information requested by ISNetworld relating to ISNetworld's evaluation of the Contractor's safety program and practices. As a minimum, requested documents will be related to safety, health, and insurance (i.e., regulatory required training, certifications, safety plans, safe and secure workplace practices, insurance certificates, etc.), OSHA and MSHA injury rates and Experience Modification Rate (EMR).

3.2 Contractor has and during the performance of this Agreement shall continue to report full, complete and accurate information to ISNetworld concerning Contractor's employees.

4. MATERIALS, EQUIPMENT AND LABOR. Contractor will be solely responsible for the proper storage, transportation and disposal of any product or waste, other than sandblasting waste, used or generated in connection with the Work in accordance with all applicable Environmental Laws. Contractor will dispose of all waste materials, other than sandblasting waste, at an off-site disposal facility approved for such waste materials pursuant to applicable Environmental Laws and will complete and sign all waste manifests as the generator of such waste. Company will be responsible for the storage, transportation and disposal of any sandblasting waste generated during the performance of the Work.

5. CONDITIONS AFFECTING WORK

5.1 Contractor will investigate and acquaint itself with the conditions affecting the Work, including but not limited to those related to the transportation, disposal, handling and storage of materials and waste; availability of labor, water, electric power and roads; the uncertainties of weather, river stages or similar physical conditions at the site; the conformation and condition of the ground; and the character of equipment and facilities needed preliminary to and during prosecution of the Work. Contractor has satisfied itself as to the character, quality and quantity of surface and subsurface materials or obstacles to be encountered. Contractor's failure to acquaint itself with any conditions affecting the Work or any available related information will not relieve it from responsibility for properly estimating the difficulty or cost of successfully performing the Work.

5.2 Contractor assumes full responsibility for investigating conditions and determining the existence and magnitude of any hazards to the physical well-being of property of Contractor, the employees, agents, and servants of Contractor, or any other person or entity who is or may become involved in the performance of Work, and any and all other persons in the vicinity of the Work. Contractor will advise all of the above-specified persons or entities of any hazards relating to Work, and will ensure that those persons or entities are advised of and fully understand the nature of the hazards and safety precautions that can be taken to eliminate or minimize dangers relating to the hazards.

5.3 Contractor will provide information to Company regarding hazardous chemicals and/or consumable products that contain constituents listed in 40 CFR 372.65 used at any Company Property. Contractor will report the amount of such material carried on and off the site, the amount actually used and the manner of use. Contractor will provide the maximum quantity of the material stored on site at any one time and if a waste material was collected, where it was disposed of (location name and address). Contractor will provide information on the amount of material used for the previous calendar year by the first of February.

5.4 Contractor will use its best efforts to ensure that the Work is performed so as to minimize any adverse impact upon natural resources and the environment and will use best industry practices in this regard at all times.

5.5 Contractor acknowledges and agrees that all members of Contractor Group performing Work at any Company Generation or Mining Property are required to view Company's "Contractor/Visitor Safety Orientation" video (in the case of Company Generation property), when applicable, and to read and adhere to Company's "Contractor/Visitor Safety Booklet" (in the case of Company Mining property) prior to performing any Work at any Company Generation or Mining Property.

5.6 Contractor will immediately notify Company as soon as Contractor has reason to believe that Contactor, or any employee or other person performing the Work, is not or may not be performing the Work in compliance with applicable Environmental Laws. Contractor will provide Company with written notice to Company of such actual or potential non-compliance within three (3) days following the discovery thereof. Contractor will take immediate steps to ensure compliance with all applicable Environmental Laws and will, if directed by Company, cease all Work until authorized by Company to resume the Work.

5.7 Contractor will report to Company all accidents involving personal injuries (including death) and damage to property occurring directly or indirectly as a result of the Work performed by Contractor hereunder immediately, but in no event, no later than 24 hours after the occurrence of any such accident. Any accident or incident occurring directly or indirectly as a result of the Work which Contractor must report to a regulatory agency (e.g. OSHA, MSHA, TCEQ) must also be reported to Company immediately following notification to the regulatory agency.

6. WORK SITE PERMITS AND LICENSES

6.1 Subject to the following two paragraphs, Contractor will obtain, prior to the commencement of the Work, and provide to Company upon request, all permits, licenses and governmental authorizations, at its sole expense, required for the performance of the Work. Contractor will be solely responsible for maintaining compliance with such permits, licenses and governmental authorizations.

6.2 In the event that a storm water discharge permit is required for the performance of the Work, (i) Contractor will be responsible for filing a Notice of Intent with respect to the Work, in addition to any Notice of Intent that Company may be required to file, and (ii) Contractor will coordinate with

Company in the preparation and execution of a Storm Water Pollution Prevention Plan for the Work Site.

6.3 In the event that the performance of the Work involves the handling or abatement of asbestos-containing materials, Contractor will coordinate with Company in the preparation and filing of all required notification forms.

7. ACCESS. Should Contractor desire access to the Work Site over any land not controlled by Company, it will, at its sole expense, obtain all proper permits or written permission necessary for that access.

8. COMPANY FACILITIES. Contractor will not use Company's sanitary facilities, changehouses, shops, parks, storage buildings, tools, equipment or other facilities unless so directed by Company. Contractor will not discharge, without Company's prior written authorization, any product or waste used or generated in connection with the Work through any (i) Company-permitted outfall, (ii) Company-owned or operated pollution control equipment, or (iii) storm or sanitary sewer located at or in the vicinity of the Work Site. Any request for authorization to discharge will include, at a minimum, either a copy of the Material Safety Data Sheet for the product or a written description of the waste, including a list of the constituents of the waste and the relative concentrations thereof.

9. ENVIRONMENTAL

9.1 In the event that Contractor discovers during the performance of the Work any substance at the Work Site that is not the subject of the Work or has not otherwise been identified by Company for Contractor, which substance Contractor has reason to believe is or may be a Hazardous Substance that (i) has been or may be released or spilled into the soil, surface water, or groundwater or in a building or structure, or (ii) consists of asbestos-containing materials, lead-based paint, batteries, thermostats, lighting equipment, or equipment containing polychlorinated biphenyls, Contractor will immediately stop Work and notify Company of the discovery. Contractor will not resume the Work until receiving authorization from Company to do so.

9.2 The term "Hazardous Substance" means any product, waste, emission or substance defined, listed or designated as a hazardous or toxic substance, hazardous waste, hazardous material or pollutant by or pursuant to any Environmental Law and includes, but is not limited to, any petroleum-based product, substance or waste, including any additives associated therewith, pesticides, fertilizers, solvents, polychlorinated biphenyls, mercury, lead, lead-based paint, asbestos-containing material or explosives.

9.3 Contractor will immediately notify Company in the event of a spill or release of any material which Contractor knows or has reason to believe is a Hazardous Substance, whether onto the ground, into any body of water, a storm or sanitary sewer, or the air, or anywhere on property owned or controlled by Company, including within any building or structure. Contractor will be solely responsible, as may be required by applicable Environmental Laws, for, in consultation with Company, (i) notifying the appropriate governmental agencies of such spill or release caused or permitted by the acts or omissions of Contractor and (ii) for the cleanup and remediation of such spill or release.

10. PROTECTION OF HIGHWAYS AND RAILROADS. Contractor will make suitable arrangements with governmental authorities and railroads for the construction of all structures, whether underneath or over roads, railroads or rights-of-way to protect the public from accident or delay. Contractor will repair, at its

own expense, to the satisfaction of the governmental authorities or other owners, all roads, railroads and bridges that may be damaged by, or given undue wear due to the Work.

11. CLEANING UP

11.1 Contractor will at all times keep the Work Site free of waste materials or rubbish caused by the Work. After completing the Work, Contractor will remove all its waste materials, rubbish, tools, supplies, equipment and surplus materials from and about the Work Site.

11.2 If Contractor fails to keep the Work Site clean or to clean up after completing the Work, Company may do so and charge all costs of cleaning up to Contractor. Those costs may be deducted from the final payment to Contractor.

12. COLLATERAL WORK. Company and other contractors may be working at the Work Site. Company reserves the right to coordinate the performance of Contractor's Work with the work of others. Contractor will cooperate with and will not delay, impede or otherwise impair the work of others. Company does not guarantee Contractor continuous uninterrupted access to the Work Site, but will provide such access as good construction practices will allow, considering the other activities in the area.

13. ALCOHOLIC BEVERAGES, DRUGS AND WEAPONS. Contractor will inform all members of Contractor Group who may be involved in the performance of any Work of the following Company rules relating to alcoholic beverages, drugs and weapons, with which all personnel are expected to comply:

13.1 Bringing, attempting to bring, possessing, using or being under the influence of intoxicants, drugs, or narcotics while on any Company Property, including but not limited to parking areas, is prohibited. Possessing alcoholic beverages in sealed containers is permitted, however, in designated parking areas.

13.2 Prescription or over-the-counter medications that could affect the performance of safety-sensitive work are allowed on Company Property only if they have been previously cleared by Contractor. Contractor must confirm that the medication and dosage do not impair an individual's ability to perform safety-sensitive work before clearing the individual to perform such work while under the influence of the medication.

13.3 Bringing, attempting to bring, possessing or using firearms, whether classified as legal or illegal, while on any Company Property, including but not limited to buildings, parking areas, recreation facilities, equipment and vehicles, is prohibited, unless otherwise required by applicable law. Use or possession of firearms for specific situations is permitted if approved by function or higher level management of Company.

13.4 Off-the-job involvement with intoxicants, illegal drugs, or illegal narcotics that adversely affects Company's business, to include impairing the individual's ability to perform his job or the public trust in the safe operation of Company, is prohibited.

13.5 Any conduct on any Company Property which is in violation of any state or federal law or regulation is considered a violation of these rules and a breach of any agreement to which these policies are attached.

13.6 In order to enforce these rules, all individuals with access to any Company Property as well as the vehicles, offices, lockers and any personal belongings of such individuals on any Company Property are subject to search by Company and its agents, to include security representatives appointed or employed by Company. Individuals may be required to take a blood, urinalysis or Breathalyzer test, or submit to other recognized investigatory tests or procedures as are deemed appropriate or necessary by Company in the investigation of a violation of these rules.

14. TITLE AND RIGHT. Nothing in the Agreement will vest Contractor with any right of property in materials used after they have been attached to or incorporated into the Work, nor materials for which Contractor has received full or partial payment. All those materials, upon being so attached, incorporated or paid for, will become the property of Company. Any gravel, sand, stone, minerals, timber or other materials excavated, uncovered, developed or obtained in the Work, or on any land belonging to Company may be used, in the performance of the Work, provided such materials meet the requirements of this Agreement. Any objects or natural materials or animals excavated or exposed that may have historical significance or constitute a threatened or endangered species must be brought to the attention of Company.

15. PROTECTION AGAINST LIENS AND ENCUMBRANCES

15.1 Contractor will not at any time permit any lien, attachment or other encumbrance ("Encumbrance") by any person or persons whosoever or by reason of any claim or demand against Contractor to be placed or remain on the property of Company, including, but not limited to, the Work Site upon which Work is being performed or equipment and materials that are being furnished. To prevent an Encumbrance from being placed on the property of Company, Contractor will furnish during the progress of any Work, as requested from time to time, verified statements showing Contractor's total outstanding indebtedness in connection with the Work.

15.2 If Contractor allows any indebtedness to accrue to subcontractors or others and fails to pay or discharge that indebtedness within five (5) days after demand, then Company may withhold any money due Contractor until that indebtedness is paid or pay the indebtedness and apply that amount against the money due Contractor.

15.3 If Contractor allows any Encumbrances, whether valid or invalid to be placed on the property of Company, any and all claims or demands for payment to Contractor will be denied by Company until the Encumbrance is removed. If the Encumbrance is not removed immediately, Company may pay that claim or demand and deduct the amount paid, together with all related expenses, including attorneys' fees, from any further payment due Contractor, or at Company's election, Contractor will, upon demand, reimburse Company for the amount paid and all related expenses. Any payment made in good faith by Company will be binding on Contractor.

16. TERMINATION FOR DEFAULT

16.1 If a petition in bankruptcy should be filed by Contractor, or if Contractor should make a general assignment for the benefit of creditors, or if a receiver should be appointed due to the insolvency of Contractor, or if Contractor should refuse or fail to supply enough properly skilled workmen or proper equipment, materials or services or should fail to make prompt payment to subcontractors, or to pay promptly for materials or labor, or disregard laws, ordinances or the instruction of Company's Contract Coordinator, or if Contractor should refuse or fail to abide by the SOW Construction Schedule or otherwise violate any provisions of the Agreement or SOW, then Company, upon a determination by Company's Contract Coordinator that sufficient cause exists to justify such action, may, without prejudice to any other right or remedy available to it after giving Contractor seven (7) days' written notice, terminate the Agreement or the SOW and take possession of the Work Site. In the event of such a termination, Company may use all or part of Contractor's equipment and materials and may finish the Work by whatever method Company may deem expedient. In such event, Contractor will not be entitled to receive any further payment hereunder until the Work is finished. If the unpaid balance of the SOW fees will exceed the expense of finishing the Work, including compensation of Company's Contract Coordinator, other Company personnel, third party engineering companies, or other contractors for additional services, such excess will be paid to Contractor. If the expense of finishing the Work will exceed such unpaid balance, Contractor will pay the difference to Company within fifteen (15) days of receiving an invoice for same. The expenses incurred by Company herein, and the damage incurred through Contractor's default, will be determined by Company's Contract Coordinator, in its sole discretion, and such determination will be binding as between the parties.

16.2 In the event of a termination under the provisions of this Section 3, Contractor will transfer and assign to Company, in accordance with Company's instructions, all Work, all construction records, reports, permits, data and information, other materials (including all Company-supplied materials), supplies, Work in progress and other goods for which Contractor is entitled to receive reimbursement hereunder, and any and all plans, drawings, sketches, specifications, and information in connection with the Work, and will take such action as may be necessary to secure Company, at Company's sole election, the rights of Contractor under any or all orders and subcontracts made in connection with the Work.

16.3 In the event that Company so directs or authorizes, Contractor will sell at a price approved by Company, or retain at a mutually agreeable price, any such materials, supplies, Work in progress, or other goods as referred to in the preceding paragraph. In any event, Company will receive any and all records, plans, drawings, data, permits, specifications, sketches, reports, or other information relating to the Work. The proceeds of any such sale or the agreed price will be paid or credited to Company in such manner as Company may direct so as to reduce the amount payable by Company under this Section 3.

APPENDIX D
SAFETY DATA SHEETS

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*
Bromide salt (calcium)	*7789-41-5*	*See Footnote 3*	*Toxic to Reproduction Category 2*

[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.

[3]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	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. 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 (CAS# 68131-74-8)	
Toxicity to Fish	LC50 > 100 mg/L
Toxicity to Aquatic Invertebrates	Data indicates that the test substance is not toxic to *Daphnia magna* (EC50 undetermined)
Toxicity to Aquatic Algae and Plants	EC50 = 10 mg/L
Calcium oxide CAS# 1305-78-8	
Toxicity to Fish	LC50 = 50.6 mg/L The findings were closely related to the pH of the test solutions; therefore, pH is considered to be the main reason for the effects.
Toxicity to Aquatic Invertebrates	EC50 = 49.1 mg/L The findings were closely related to the pH of the test solutions; therefore, pH is considered to be the main reason for the effects.
Toxicity to Aquatic Algae and Plants	NOEC =48 mg/L @ 72 hours based on $Ca(OH)_2$ The initial pH of the test medium was not directly related to the biologically relevant effects. The formation of precipitates is likely the result of the reaction between CO_2 dissolved in the medium.

12.2 Persistence and Degradability

Not relevant for inorganic materials.

12.3 Bioaccumulative Potential

This material does not contain any compounds that would bioaccumulate up the food chain.

12.4 Mobility in Soil

No data available.

12.5 Results of PBT and vPvB Assessment

This material does not contain any compounds classified as “persistent, bioaccumulative or toxic” nor as “very persistent/very bioaccumulative”.

12.6 Other Adverse Effects

None known.

Section 13
Disposal Considerations

See Sections 7 and 8 above for safe handling and use, including appropriate industrial hygiene practices.

Dispose of all waste product and containers in accordance with federal, state and local regulations.

Section 14
Transport Information

Regulatory entity: U.S. DOT	Shipping Name:	Not Regulated
	Hazard Class:	Not Regulated
	ID Number:	Not Regulated
	Packing Group:	Not Regulated

Section 15
Regulatory Information

15.1 Safety, Health and Environmental Regulations/Legislation Specific for the Mixture

- TSCA Inventory Status

  All components are listed on the TSCA Inventory.

- California Proposition 65

  The following substances are known to the State of California to be carcinogens and/or reproductive toxicants:

  - Respirable crystalline silica
  - Titanium dioxide

- State Right-to-Know (RTK)

Component	CAS	MA[1,2]	NJ[3,4]	PA[5]	RI[6]
Ammonium bisulfate	7803-63-6	No	Yes	No	No
Ammonium sulfate	7783-20-2	Yes	No	Yes	No
Calcium oxide	1305-78-8	Yes	Yes	Yes	No
Iron oxide	1309-37-1	Yes	Yes	Yes	No
Magnesium oxide	1309-48-4	No	Yes	No	No
Phosphorus pentoxide (or phosphorus oxide)	1314-56-3	Yes	Yes	Yes	No
Potassium oxide	12136-45-7	No	Yes	No	No
Silica-crystalline (SiO_2), quartz	14808-60-7	Yes	Yes	Yes	No
Sodium oxide	1313-59-3	No	Yes	No	No
Titanium dioxide	13463-67-7	Yes	Yes	Yes	Yes

[1] Massachusetts Department of Public Health, no date
[2] 189th General Court of The Commonwealth of Massachusetts, no date
[3] New Jersey Department of Health and Senior Services, 2010a
[4] New Jersey Department of Health, 2010b
[5] Pennsylvania Code, 1986
[6] Rhode Island Department of Labor and Training, no date

Section 16
Other Information, Including Date of Preparation or Last Revision

16.1 Indication of Changes

Date of preparation or last revision: February 23, 2018

16.2 Abbreviations and Acronyms

- ACGIH: American Conference of Industrial Hygienists
- CA: California
- CAS: Chemical Abstract Services
- CCP: Coal Combustion Product
- CFR: Code of Federal Regulations
- EPA: Environmental Protection Agency
- GHS: Globally Harmonized System of Classification and Labelling
- IARC: International Agency for Research on Cancer
- LC50: Concentration resulting in the mortality of 50 % of an animal population
- LD50: Dose resulting in the mortality of 50 % of an animal population
- MA: Massachusetts
- NA: Not Applicable
- NJ: New Jersey
- NOEC: No observed effect concentration
- NIOSH: National Institute of Occupational Safety and Health
- NOx: Nitrogen oxides
- NTP: US National Toxicology Program
- OEL: Occupational Exposure Limit
- OSHA: Occupational Safety and Health Administration
- PA: Pennsylvania
- PBT: Persistent, Toxic and Bioaccumulative
- PEL: Permissible exposure limit
- PPE: Personal Protective Equipment
- REL: Recommended exposure limit
- RI: Rhode Island
- RCS: Respirable Crystalline Silica
- RTK: Right-to-Know
- SCBA: Self-contained breathing apparatus
- SDS: Safety Data Sheet
- STEL: Short-term exposure limit
- STOT-RE: Specific target organ toxicity-repeated exposure
- STOT-SE: Specific target organ toxicity-single exposure
- TLV: Threshold limit value
- TSCA: Toxic Substances Control Act
- TWA: Time-weighted average
- UEL: Upper explosive limit
- UVCB: Unknown or Variable Composition/Biological
- U.S.: United States
- U.S. DOT: United States of Department of Transportation

16.3 Other Hazards

Hazardous Materials Identification System (HMIS) Degree of hazard (0= low, 4 = extreme)							
Health:	2*	**Flammability:**	0	**Physical Hazards:**	0	**Personal protection:****	

** Chronic Health Effects*
******** *Appropriate personal protection is defined by the activity to be performed.*
See Section 8 for additional information.

DISCLAIMER:

This SDS has been prepared in accordance with the Hazard Communication Rule 29 CFR 1910.1200. Information herein is based on data considered to be accurate as of date prepared. No warranty or representation, express or implied, is made as to the accuracy or completeness of this data and safety information. No responsibility can be assumed for any damage or injury resulting from abnormal use, failure to adhere to recommended practices, or from any hazards inherent in the nature of the product.

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 (SiO_2), quartz	14808-60-7	Yes	Yes	Yes	No
Sodium oxide	1313-59-3	No	Yes	No	No
Titanium dioxide	13463-67-7	Yes	Yes	Yes	Yes

[1] Massachusetts Department of Public Health, no date
[2] 189th General Court of The Commonwealth of Massachusetts, no date
[3] New Jersey Department of Health and Senior Services, 2010a
[4] New Jersey Department of Health, 2010b
[5] Pennsylvania Code, 1986
[6] Rhode Island Department of Labor and Training, no date

Section 16
Other Information, Including Date of Preparation or Last Revision

16.1 Indication of Changes

Date of preparation or last revision: February 23, 2018

16.2 Abbreviations and Acronyms

- ACGIH: American Conference of Industrial Hygienists
- CA: California
- CAS: Chemical Abstract Services
- CCP: Coal Combustion Product
- CFR: Code of Federal Regulations
- EPA: Environmental Protection Agency

- GHS: Globally Harmonized System of Classification and Labelling
- IARC: International Agency for Research on Cancer
- LC50: Concentration resulting in the mortality of 50 % of an animal population
- LD50: Dose resulting in the mortality of 50 % of an animal population
- MA: Massachusetts
- NA: Not Applicable
- NJ: New Jersey
- NOEC: No observed effect concentration
- NIOSH: National Institute of Occupational Safety and Health
- NOx: Nitrogen oxides
- NTP: US National Toxicology Program
- OEL: Occupational Exposure Limit
- OSHA: Occupational Safety and Health Administration
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- 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:

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Attachment D

Closure Alternatives Analysis Groundwater Modeling Review at the Coffeen Power Plant, Edwards Power Plant, Newton Power Plant, and Hennepin Power Plant

Expert Report of Andrew Bittner, P.E.

Prepared by

Andrew Bittner, M.Eng., P.E.

Prepared for
ArentFox Schiff LLP
233 South Wacker Drive, Suite 7100
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January 24, 2024

GRADIENT

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List of Tables

Abbreviations

AP1	Ash Pond 1
CAA	Closure Alternatives Analysis
CBR	Closure By Removal
CCR	Coal Combustion Residual
CIP	Closure In Place
DMG	Dynegy Midwest Generation, LLC
EAP	East Ash Pond
GMF GSP	Gypsum Management Facility Gypsum Stack Pond
GMF RP	Gypsum Management Facility Recycle Pond
GWPS	Groundwater Protection Standards
HELP	Hydrologic Evaluation of Landfill Performance
ID	Identification
IEPA	Illinois Environmental Protection Agency
IPGC	Illinois Power Generating Company
IPRG	Illinois Power Resources Generating, LLC
K_d	Distribution Coefficient
mL/g	Milliliters Per Gram
NID	National Inventory of Dams
No.	Number
PAP	Primary Ash Pond
PE	Professional Engineer
SIs	Surface Impoundments
TDS	Total Dissolved Solids

1 Introduction and Background

1.1 Scope and Objectives

On behalf of Dynegy Midwest Generation, LLC (DMG); Illinois Power Resources Generating Company (IPRG); and Illinois Power Generating Company (IPGC), I have been retained to provide opinions related to the Illinois Environmental Protection Agency (IEPA) Initial Review Letters (IEPA, 2023a, 2023b, 2023c, 2023d) in response to the Construction Permit Applications for coal combustion residual (CCR) surface impoundments (SIs) at the Coffeen Power Plant, the Edwards Power Plant, the Newton Power Plant, and the Hennepin Power Plant (Golder Associates USA Inc., 2022a, 2022b, 2022c; IngenAE, LLC 2022; HDR Inc., 2022; Geosyntec Consultants, 2022). Specifically, my opinions relate to groundwater models that were developed in support of the Closure Alternatives Analysis (CAA). In their Initial Review Letters (IEPA, 2023a, 2023b, 2023c, 2023d), IEPA raised concerns regarding the adequacy of groundwater modeling that was conducted related to current and former CCR SIs located at each facility. Specifically, IEPA raised concerns regarding the sufficiency of only modeling selected CCR-related constituents at each facility, as opposed to modeling all CCR-related constituents. IEPA's Initial Review Letters indicate that "all constituents listed in Section 845.600 that have been found to be present in the CCR surface impoundment" must "be assessed in the groundwater model" (IEPA, 2023a, 2023b, 2023c, 2023d).

The opinions presented in this report are based on the information that I have reviewed and cited as of the date of this report, as well as my education and experience. I reserve the right to modify my opinions based on additional information that may become available.

1.2 Background

Part 845 of the Illinois Administrative Code (Title 35, Subtitle G, Chapter I, Subchapter j; IEPA, 2021), hereafter referred to as "Part 845", sets standards and requirements pertaining to the design, construction, operation, groundwater monitoring, corrective action, closure, and post-closure care of certain CCR SIs in the State of Illinois. In particular, Part 845 (IEPA, 2021) requires the development of a CAA (Section 845.710) prior to undertaking closure activities. One specific requirement of the CAA [845.710(d)(2)] is that the time to achieve groundwater protection standards (GWPS) must be evaluated for each closure alternative:

> The analysis for each alternative completed pursuant to this Section must… contain the results of groundwater contaminant transport modeling and calculations showing how the closure alternative will achieve compliance with the applicable groundwater protection standards (IEPA, 2021)

In response to this requirement, Ramboll developed groundwater models at selected facilities (Ramboll, 2022a, 2022b, 2022c, 2022d, 2022e) that evaluate the duration required for each closure alternative to achieve the GWPSs. In these models, selected CCR-related constituents were evaluated. Specific CCR SIs for which groundwater models were developed, and that were addressed in IEPA Initial Review Letters (IEPA, 2023a, 2023b, 2023c, 2023d), include the following:

- Ash Pond 1 (AP1; Vistra Identification [ID] Number [No.] 101, Illinois Environmental Protection Agency [IEPA] ID No. W1350150004-01, and National Inventory of Dams [NID] No. IL50722) at the Coffeen Power Plant in Coffeen, IL;
- The Gypsum Management Facility Gypsum Stack Pond (GMF GSP; Vistra ID No. 103, IEPA ID No. W1350150004-03, and NID No. IL50579) and the Gypsum Management Facility Recycle Pond (GMF RP; Vistra ID No. 104, IEPA ID No. W1350150004-04, and NID No. IL50578) at the Coffeen Power Plant in Coffeen, IL;
- The Ash Pond (Vistra ID No. 301, IEPA ID No. W1438050005-01, and NID No. IL50710) at the Edwards Power Plant near Bartonville, IL;
- The Primary Ash Pond (PAP; Vistra ID No. 501, IEPA ID No. W0798070001-01, NID No. IL50719) at the Newton Power Plant, in Newton, IL; and
- The East Ash Pond (EAP); Vistra ID No. 803, IEPA ID No. W1550100002-05, NID No. IL50363) at the Hennepin Power Plant in Hennepin, IL.

A summary of the groundwater modeling results, including an estimate of the time by which each closure alternative is expected to achieve the GWPSs, was provided to IEPA in the CAA (Gradient, 2022a; Gradient 2022b; Gradient 2022c; Gradient 2022d; Gradient 2021a) and the Groundwater Modeling Report (Ramboll, 2022a, 2022b, 2022c, 2022d, 2022e) for each facility, which in turn was included as part of the Construction Permit Application for each facility (Golder Associates USA Inc., 2022a, 2022b, 2022c; IngenAE, LLC, 2022; HDR Inc., 2022; Geosyntec Consultants, 2022).

1.3 Qualifications

I am a Principal at Gradient, an environmental consulting firm located in Boston, Massachusetts, and a licensed professional engineer (PE). With over 25 years of professional experience, I have consulted and testified regarding a variety of projects related to the fate and transport of constituents in the environment, hydrogeology, groundwater and surface water modeling, site characterization, and remediation system design. I have a master's degree in environmental engineering from the Massachusetts Institute of Technology and bachelor's degrees in environmental engineering and physics from the University of Michigan. A copy of my *curriculum vitae* is provided in Appendix A.

I have published and presented on a variety of topics, including groundwater and surface water fate and transport modeling of coal ash constituents, assessments of former coal-fired power plants, mass flux and mass discharge of constituents in groundwater, remedial system optimization, and the impact of environmental regulations in the United States and abroad. As a consultant during the past 25 years, I have applied my knowledge of fate and transport processes to address a range of complex challenges in the electric power, oil and gas, chemical manufacturing, pharmaceutical, mining, agrichemical, and waste disposal sectors. In particular, for the electric power industry, my experience includes projects involving regulatory comment, closure assessments, fate and transport modeling, and risk assessment. Moreover, I have worked on and been involved with projects at approximately 70 different CCR SIs.

I have served as a testifying expert and provided expert testimony, both in deposition and in front of regulatory bodies, on range of coal ash matters, including coal ash surface impoundment closure standards and the fate and transport of CCR-related constituents in the environment. A list of my prior testimony experience is provided in my *curriculum vitae* in Appendix A.

2 Summary of Opinions

A summary of my opinions that are provided in this report is provided below.

2.1 Modeling surrogate constituents is an appropriate approach to achieve model objectives in support of the CAA

Modeling selected constituents is a common approach for evaluation of environmental systems and is sufficient to achieve the model objectives in support of the CAA. All environmental models are, in some regard, simplifications of complex systems; one common model simplification is to use one or more surrogate constituents to conservatively represent the potential behavior of a larger group of constituents. During the selection of surrogate constituents, a model's objectives must be considered.

For the groundwater modeling performed in support of the CAA at the AP1, the GMF GSP, and the GMF RP at the Coffeen Power Plant, the Ash Pond at the Edwards Power Plant, the PAP at the Newton Power Plant, and the EAP at the Hennepin Power Plant, model objectives were to evaluate the effects of various closure alternatives (*i.e.*, source control measures) on groundwater quality and to specifically predict for each closure alternative the time at which GWPSs will be achieved for constituents with GWPS exceedances that are attributable to the unit. A reasonable approach to achieve this model objective is to select, as a surrogate, the constituent at each site that will likely require the longest time to achieve its GWPS. The constituents that have been detected in groundwater at the highest concentrations relative to their GWPSs and with the highest frequency of GWPS exceedances are the constituents that will likely take the longest time to achieve their GWPSs. For these objectives, it is not necessary to model all constituents that have been detected at lower concentrations relative to their GWPSs and with lower frequencies of GWPS exceedances, because these constituents will likely achieve their GWPSs faster than the selected surrogate constituent.

Based on this approach, sulfate was selected as the constituent to evaluate in the groundwater model at the AP1, the GMF GSP, and the GMF RP at the Coffeen Power Plant, and at the PAP at the Newton Power Plant; and boron was selected as the constituent to evaluate in the groundwater model at the Ash Pond at the Edwards Power Plant and at the EAP at the Hennepin Power Plant. These surrogate constituents have similar groundwater transport characteristics as the other constituents that have been detected with potential GWPS exceedances; therefore, subsurface transport during closure conditions would be similar for all of the constituents that have been detected with potential GWPS exceedances. Because each of these constituents is expected to behave in a similar manner during closure, it is appropriate to only model the surrogate constituents and use the surrogate constituents to determine when each closure alternative will likely achieve the GWPSs for all constituents.

2.2 Part 845 does not require that all constituents listed in Section 845.600 be evaluated in a groundwater model

Part 845 does not require that groundwater models developed in support of the CAA, as required by Section 845.710(d)(2) (IEPA, 2021), evaluate "all constituents listed in Section 845.600 that have been found to be present in the CCR surface impoundment" (IEPA, 2023a, 2023b, 2023c, 2023d). Part 845 requires only that groundwater modeling evaluate "how the closure alternative will achieve compliance with the applicable groundwater protection standards" (IEPA, 2021). There is no language in Part 845 suggesting that the groundwater model must evaluate all constituents that have been detected in an SI.

The surrogate constituents that were selected for evaluation in the groundwater models are the constituents that will likely take the longest under each closure scenario to decline to levels below the GWPS and, thus, are appropriate constituents to determine when each closure alternative will achieve the GWPSs, as required in Section 845.710(d)(2) (IEPA, 2021).

2.3 It would be a costly and data-intensive endeavor to model all constituents, and it wouldn't provide any additional useful information

The process of modeling all constituents in an SI would be costly and data-intensive and, ultimately, would not provide any additional information beyond that provided by only modeling the surrogates for evaluating how the closure alternative will achieve compliance with the GWPS. There are a number of CCR-related constituents that have been identified in literature. For example, Appendix III and IV of the 2015 Federal CCR Rule list 22 CCR-related constituents that must be monitored as part of detection and assessment monitoring (US EPA, 2015). Part 845.600 lists 20 CCR-related constituents for which GWPSs have been established (IEPA, 2021).

Building a groundwater model that evaluates all of these potential constituents would be an onerous process. First of all, an extensive amount of groundwater data and evaluation would be required for each constituent, including an evaluation of background groundwater quality and an evaluation of individual partitioning coefficients for each constituent. Subsequently, individual groundwater solute transport models would be need to be developed and calibrated for each constituent. Finally, separate model simulations would need to be evaluated for each closure alternative and for each constituent. Despite the significantly increased effort, the models would not result in any additional useful information for evaluating closure alternatives.

3 Overview of Groundwater Modeling

US EPA's Guidance on the Development, Evaluation, and Application of Environmental Models (US EPA, 2009) defines a model as "a simplification of reality that is constructed to gain insights into select attributes of a particular physical, biological, economic, or social system." In the case of a groundwater model, the physical system being simulated is the subsurface flow of water and the model is "a simplified representation of the complex hydrogeologic conditions in the subsurface" (Anderson *et al*., 2015). There are a variety of different types of models (NRC, 2007):

- Physical models are usually smaller-scale physical versions of the systems being modeled (*e.g*., using laboratory tanks or columns packed with sand or other porous material) (Anderson *et al*., 2015);
- Conceptual models use visual (*e.g*., schematics, flow-charts) or verbal descriptions of important processes and medium properties (US EPA, 1992);
- Empirical models use "statistical equations derived from the available data to calculate an unknown variable" (Anderson *et al*., 2015); and
- Numerical models, which are the types of models that were used to simulate conditions at the Coffeen Power Plant, the Edwards Power Plant, the Newton Power Plant, and the Hennepin Power Plant, involve mathematical representations of processes that govern physical processes.

Different types of numerical groundwater models are used for different applications. Groundwater flow models simulate flow of groundwater through a transmissive media (*e.g*., soil or bedrock). Examples include hydrologic models used to manage water resources and evaluate water supply, rainfall-runoff models that simulate streamflow generation and routing, and models that simulate groundwater-surface water interactions, *etc*. (Anderson *et al*., 2015). Contaminant fate and transport models simulate movement (or "transport") of contaminants through the subsurface due to advection and dispersion[1], and their chemical alteration (or "fate") due to sorption[2] and other chemical reactions or biological processes (OhioEPA, 2007). Contaminant fate and transport models usually rely upon, and work in coordination with, a calibrated groundwater flow model (OhioEPA, 2007). Contaminant fate and transport models are often used to simulate subsurface contaminant migration from a source (*e.g*., a waste disposal facility or a contaminant release) toward potential downgradient receptors (*e.g*., surface water or groundwater supply well) or to support forensic investigations, (*i.e*., to determine sources and age of contaminants present in groundwater).

"The starting point of every groundwater modeling application is to identify the purpose of the model" (Anderson *et al*., 2015). "The purpose of modeling can vary widely, and the approach used may depend on site-specific needs, current understanding of the hydrogeologic system, availability of input data, and expectation and use of the model results" (OhioEPA, 2007). Numerical groundwater models are often used for two primary purposes – to "diagnose" (*i.e*., to re-create the conditions for a past event); or to "forecast"

[1] Advection describes contaminant transport in the primary groundwater flow direction. Mechanical dispersion describes the multidirectional movement of constituents due to differences in flow paths along pore channels or other subsurface heterogeneities (Ramaswami *et al*., 2005).

[2] Sorption (chemical interaction between a contaminant and soil particles) leads to a reduction in the average travel velocity of a contaminant relative to groundwater (Ramaswami *et al*., 2005). The effects of sorption can be quantified using a soil-water partition coefficient, or K_d, which is the constituent concentration that is sorbed to soil particles divided by the concentration that is freely dissolved in groundwater.

(*i.e.*, to predict the effect of a future events) (US EPA, 2009; Anderson *et al*., 2015). Some examples of groundwater modeling objectives (OhioEPA, 2007; US EPA, 1992) are listed below:

- evaluation of groundwater flow direction and velocity;
- evaluation of interaction between hydrogeologic systems;
- evaluation of potential impacts of contamination to wells or surface water;
- estimation of the extent of a contaminant plume;
- estimation of well capture zones and wellhead protection areas;
- development of water supply systems;
- evaluation of physical or hydraulic containment systems; and
- design and assessment of corrective action alternatives.

"The objectives dictate which features of the investigated problem should be represented in the model, and to what degree of accuracy" (US EPA, 1992). Thus, the modeling objective determines the level of complexity required in the model.

US EPA's guidance specifically states that "models are based on simplifying assumptions and cannot completely replicate the complexity inherent in environmental systems" (US EPA, 2009). Different simplifying assumptions can be made in a model based on the model objectives and availability of data. As noted in US EPA's guidance, "[t]he scope (*i.e.*, spatial, temporal and process detail) of models that can be used for a particular application can range from very simple to very complex depending on the problem specification and data availability, among other factors." (US EPA, 2009). Generally, "parsimony (economy or simplicity of assumptions) is desirable in a model" because "model complexity influences uncertainty" (US EPA, 2009). As discussed further in US EPA's guidance, "[m]odels tend to uncertainty as they become increasingly simple or increasingly complex. Thus complexity is an important parameter to consider… [and] the optimal choice generally is a model that is no more complicated than necessary" (US EPA, 2009).

Common simplifications made in a model relate to "the geometry of the investigated domain, the way various heterogeneities [are] smoothed out, the nature of the porous medium (*e.g.*, its homogeneity, isotropy)[3]," as well as the physical and chemical processes being simulated, and the number of constituents considered (US EPA, 1992). Some examples of simplifications that can be made in a model are listed below:

- Numerical models can either be transient (time-varying) or steady state (time-invariant). Steady state models assume that groundwater levels and/or constituent concentrations remain approximately constant over time, whereas transient models account for changing hydraulic or chemical conditions over time (Ramaswami *et al*., 2005). Steady state conditions are often assumed in models if the model is being used to represent average, long-term conditions.
- Models can be one-, two-, or three-dimensional depending "on the purpose of the model, the complexity of the hydrostratigraphy, and the flow system" (Anderson *et al*., 2015).

[3] A porous medium is called homogeneous when its properties are constant throughout the medium. A porous medium is called isotropic if its properties are the same in all directions.

- Homogeneous and isotropic conditions are often used in groundwater models (*i.e.*, aquifer properties are assumed to be constant throughout the aquifer and in all directions, respectively).
- The number of chemical constituents modeled can be limited depending on the model objective. For example, a model application discussed in US EPA's Ground-Water Modeling Compendium (US EPA, 1994) modeled chloride to determine the maximum extent of contamination in the aquifer because chloride "is most mobile and non-retarded" and "its plume would represent the outermost limits of the plumes of the other contaminants of interest."

4 Summary of Site-Specific Groundwater Modeling for Closure Alternatives Analysis

Part 845 (IEPA, 2021) requires the development of a CAA (Section 845.710) prior to undertaking closure activities at certain SIs that contain CCRs. One specific requirement of the CAA [845.710(d)(2)] is that the time to achieve GWPSs must be evaluated for each closure alternative:

> The analysis for each alternative completed pursuant to this Section must… contain the results of groundwater contaminant transport modeling and calculations showing how the closure alternative will achieve compliance with the applicable groundwater protection standards (IEPA, 2021)

In response to this requirement, Ramboll developed groundwater flow and contaminant transport models at selected facilities (Ramboll, 2022a, 2022b, 2022c, 2022d, 2022e) to evaluate the duration required for each closure alternative to achieve the GWPSs.

The three models used by Ramboll for groundwater modeling at these sites (HELP, MODFLOW, and MT3DMS) are widely used, industry-standard models. Brief descriptions of the three models are provided below:

- Hydrologic evaluation of landfill performance (HELP) is a model developed by US EPA that simulates "water movement across, into, through and out of landfills" and "is useful for predicting the amounts of runoff, drainage, and … the buildup of leachate above the [landfill] liner" (Schroeder *et al*., 1994).
- MODFLOW is a finite difference groundwater flow model developed by USGS (Harbaugh, 2005). It is used to simulate two- or three-dimensional, "transient ground-water flow in anisotropic, heterogeneous, layered aquifer systems. It calculates piezometric head distributions, flow rates and water balances" (US EPA, 1994).
- MT3DMS is a contaminant transport model and an update to the modular three-dimensional transport model, MT3D (Zheng and Wang, 1999). MT3DMS simulates changes in contaminant concentrations in groundwater due to "advection, dispersion, diffusion and some basic chemical reactions" (Zheng and Wang, 1999).

A summary of each of these site-specific groundwater models is provided below.

4.1 Ash Pond 1 at the Coffeen Power Plant

The Coffeen Power Plant is a retired electric power generating facility operated by IPGC with coal-fired units located approximately two miles south of the City of Coffeen, Illinois. The plant operated as a coal-fired power plant from 1964 until November 2019 and has five CCR management units. AP1 is a 23-acre, unlined SI with a total storage capacity of 300 acre-feet that was used to manage CCR and non-CCR waste streams (Ramboll, 2022a; Gradient, 2022e).

Based on groundwater monitoring data collected between 2015 and 2021, potential GWPS exceedances of boron, sulfate, and total dissolved solids (TDS) were identified at groundwater monitoring wells near and downgradient of AP1 (Ramboll, 2022a)[4,5]. For boron, sulfate, and TDS, the maximum detected concentrations (based on data collected between 2015 and 2021 from 17 wells near and downgradient of AP1) were 7.5 mg/L, 2,400 mg/L, and 4,000 mg/L, respectively (Gradient, 2022e). Sulfate was the constituent detected at the highest concentration relative to its GWPS.

Ramboll prepared a groundwater modeling report (Ramboll, 2022a) for AP1 that was submitted to IEPA as part of the Construction Permit Application (Golder Associates USA Inc., 2022a). The objective of the groundwater modeling was "to evaluate the effects of closure (source control measures) for AP1 on groundwater quality," and, specifically, to predict the time to meet GWPS in the compliance wells under two proposed closure scenarios – closure in place (CIP) and closure by removal (CBR) (Ramboll, 2022a). The CIP scenario considered would involve "removal of CCR from the eastern portion of AP1, consolidation into the western portion of AP1, and construction of a cover system over the remaining CCR," whereas CBR would involve "removal of all CCR and regrading of the removal area" (Ramboll, 2022a).

Ramboll's modeling approach involved using the HELP model to estimate recharge under the different closure scenarios, using MODFLOW 2005 to simulate groundwater flow in three dimensions, and using MT3DMS model to simulate the three-dimensional transport of sulfate (Ramboll, 2022a). "Sulfate was selected for transport modeling … because: (i) it is commonly present in coal ash leachate; and (ii) it is mobile and typically not very reactive but conservative (*i.e.*, low rates of sorption or degradation) in groundwater" (Ramboll, 2022a). Sulfate was modeled as a conservative substance that does "not significantly sorb or chemically react with aquifer solids (distribution coefficient [Kd] was set to 0 milliliters per gram [mL/g])" (Ramboll, 2022a).

4.2 GMF Gypsum Stack Pond and Recycle Pond at the Coffeen Power Plant

The GMF GSP and the GMF RP at the Coffeen Power Plant were put in operation in 2010 and were used to manage CCR and non-CCR waste streams. The GMF GSP is a 77-acre lined SI and the GMF RP is a 17-acre lined SI (Ramboll 2022b; Gradient, 2022f).

Based on groundwater monitoring data collected between 2015 and 2021, potential GWPS exceedances of boron, sulfate, and TDS were identified at groundwater monitoring wells near and downgradient of the GMF GSP and the GMF RP (Ramboll, 2022b)[6]. The maximum detected concentrations (based on data collected between 2015 and 2021 from 43 wells near and downgradient of the GMF GSP and the GMF RP) for boron, sulfate, and TDS were 4.6 mg/L, 1,800 mg/L, and 3,400 mg/L, respectively (Gradient, 2022f). Sulfate was the constituent detected at the highest concentration relative to its GWPS.

Ramboll prepared a groundwater modeling report (Ramboll, 2022b) for the GMF GSP and the GMF RP that was submitted to IEPA as part of the Construction Permit Application (Golder Associates USA Inc., 2022b, 2022c). The objective of the groundwater modeling was "to evaluate the effects of closure (source

[4] Cobalt and pH were also detected in groundwater downgradient of AP1 at concentrations in excess of their respective GWPSs, but investigations provided at the time of modeling concluded that these constituents are not related to AP1 (Ramboll, 2022a).
[5] Due to the conservative nature of the site-specific risk assessment that was conducted at AP1 and the attempt to "screen-in" rather than "screen-out" constituents (Gradient, 2022e), risks were calculated for constituents at concentrations that may not be associated with AP1 and may not have been identified as potential groundwater exceedances, which are based on statistical evaluations of the full dataset rather than single measurements.
[6] Due to the conservative nature of the site-specific risk assessment that was conducted at GMF GSP and GMF RP and the attempt to "screen-in" rather than "screen-out" constituents (Gradient, 2022f), risks were calculated for constituents at concentrations that may not be associated with GMF GSP and GMF RP, and may not have been identified as potential groundwater exceedances, which are based on statistical evaluations of the full dataset rather than single measurements.

control measures) for the GMF GSP and GMF RP on groundwater quality," and, specifically, to predict the time to meet GWPS in the compliance wells under two proposed closure scenarios – CIP and CBR (Ramboll, 2022b). The CIP scenario considered would involve "removal of CCR from the GMF RP and the southern portion of the GSP, consolidation into the northern portion of the GSP, and construction of a cover system over the remaining CCR," whereas CBR would involve "removal of all CCR and SI liner and regrading of the removal area for both GMF GSP and GMF RP" (Ramboll, 2022b).

Ramboll's modeling approach involved using HELP to estimate recharge under the different closure scenarios, using MODFLOW 2005 to simulate groundwater flow in three dimensions, and using MT3DMS to simulate the three-dimensional transport of sulfate (Ramboll, 2022b). "Sulfate was selected for transport modeling … because: (i) it is commonly present in coal ash leachate; and (ii) it is mobile and typically not very reactive but conservative (*i.e.*, low rates of sorption or degradation) in groundwater" (Ramboll, 2022b). Sulfate was modeled as a conservative substance that does "not significantly sorb or chemically react with aquifer solids (distribution coefficient [Kd] was set to 0 milliliters per gram [mL/g])" (Ramboll, 2022b).

4.3 Ash Pond at the Edwards Power Plant

The Edwards Power Plant is a retired electric power generating facility operated by IPRG with coal-fired units located near Bartonville, Illinois. The plant began operations in 1960 and ceased operations in December 2022. The facility has one SI for CCR storage known as the Ash Pond which covers approximately 91 acres (Ramboll, 2022c; Gradient, 2022g).

Based on groundwater monitoring data collected between 2015 and 2021, potential GWPS exceedances of boron, sulfate and TDS were identified at groundwater monitoring wells near and downgradient of the Ash Pond (Ramboll, 2022c)[7,8]. For boron, sulfate, and TDS, the maximum detected concentrations (based on data collected between 2015 and 2021 from 28 wells near and downgradient of the Ash Pond) were 12 mg/L, 570 mg/L and 2,600 mg/L, respectively (Gradient, 2022g). Boron was the constituent detected at the highest concentration relative to its GWPS.

Ramboll prepared a groundwater modeling report (Ramboll, 2022c) for the Ash Pond that was submitted to IEPA as part of the Construction Permit Application (IngenAE, LLC 2022). The objective of the groundwater modeling conducted by Ramboll was to "evaluate the effects of closure (source control) measures (CCR consolidation and CIP and CBR scenarios) for the Ash Pond on groundwater quality following initial corrective action measures, which includes removal of free liquids from the Ash Pond" (Ramboll, 2022c). More specifically, the objective of groundwater modeling was to predict the time to meet GWPS under two proposed closure scenarios – CIP and CBR. The CIP scenario considered would involve "CCR removal from the northwest areas of the Ash Pond, consolidation to the northeast, central and southern areas of the Ash Pond, and construction of a cover system over the remaining CCR" (Ramboll, 2022c).

Ramboll's modeling approach involved using HELP to estimate recharge under the two closure scenarios, using MODFLOW 2005 to simulate groundwater flow in three dimensions and using MT3DMS to simulate the three-dimensional transport of boron (Ramboll, 2022c). "Boron was selected for transport modeling …

[7] Barium, lithium, and chloride were also detected in groundwater downgradient of the Ash Pond at concentrations in excess of their respective GWPSs, but investigations provided at the time of modeling concluded that these constituents are not related to the Ash Pond (Ramboll, 2022c).
[8] Due to the conservative nature of the site-specific risk assessment that was conducted at the Ash Pond and the attempt to "screen-in" rather than "screen-out" constituents (Gradient, 2022g), risks were calculated for constituents at concentrations that may not be associated with the Ash Pond and may not have been identified as potential groundwater exceedances, which are based on statistical evaluations of the full dataset rather than single measurements.

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 source of boron is the Ash Pond" (Ramboll, 2022c). Boron was modeled as a conservative substance that does "not significantly sorb or chemically react with aquifer solids (distribution coefficient [Kd] was set to 0 mL/g)" (Ramboll, 2022c).

4.4 Primary Ash Pond at the Newton Power Plant

The Newton Power Plant is an electric power generating facility operated by IPGC with coal-fired units located near Newton, Illinois. The plant began operating in approximately 1977 and has one SI for CCR storage known as the PAP which covers approximately 404 acres (Ramboll, 2022d; Gradient, 2022h).

Based on groundwater monitoring data collected between 2015 and 2021, potential GWPS exceedances of lithium, sulfate, and TDS were identified at groundwater monitoring wells near and downgradient of the PAP (Ramboll, 2022d)[9,10]. For lithium, sulfate, and TDS, the maximum detected concentrations (based on data collected between 2015 and 2021 from 29 wells near and downgradient of the PAP) were 0.3 mg/L, 3,200 mg/L, and 5,500 mg/L, respectively (Gradient, 2022h). Sulfate was the constituent detected at the highest concentration relative to its GWPS.

Ramboll prepared a groundwater modeling report (Ramboll, 2022d) for the PAP that was submitted to IEPA as part of the Construction Permit Application (HDR Inc., 2022). The objective of the groundwater modeling conducted by Ramboll was "to evaluate the effects of Closure (source control measures) for the PAP on groundwater quality," and specifically, to predict the time to meet GWPS in the compliance wells under two proposed closure scenarios – CIP and CBR (Ramboll, 2022d). The CIP scenario considered would involve "removal of CCR from the southern portion of the PAP, consolidation into the northern portion of the PAP, and construction of a cover system over the remaining CCR," whereas CBR would involve "removal of all CCR and regrading of the removal area" (Ramboll, 2022d).

Ramboll's modeling approach involved using HELP to estimate recharge under the different closure scenarios, using MODFLOW 2005 to simulate groundwater flow in three dimensions, and using MT3DMS to simulate the three-dimensional transport of sulfate (Ramboll, 2022d). "Sulfate was selected for transport modeling … because: (i) it is commonly present in coal ash leachate; and (ii) it is mobile and typically not very reactive but conservative (*i.e.*, low rates of sorption or degradation) in groundwater" (Ramboll, 2022d). Sulfate was modeled as a conservative substance that does "not significantly sorb or chemically react with aquifer solids (distribution coefficient [Kd] was set to 0 milliliters per gram [mL/g])" (Ramboll, 2022d).

4.5 East Ash Pond at the Hennepin Power Plant

The Hennepin Power Plant is a retired electric power generating facility operated by DMG with coal-fired units located in Hennepin, Illinois. The plant began operations in the early 1950s and was retired in 2019.

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[9] pH was also detected in groundwater downgradient of the PAP outside of its acceptable range, but investigations provided at the time of modeling concluded that pH impacts to groundwater are not related to the PAP (Ramboll 2022d).

[10] Due to the conservative nature of the site-specific risk assessment that was conducted at the PAP and the attempt to "screen-in" rather than "screen-out" constituents (Gradient, 2022h), risks were calculated for constituents at concentrations that may not be associated with the PAP and may not have been identified as potential groundwater exceedances, which are based on statistical evaluations of the full dataset rather than single measurements.

CCRs associated with plant operation were stored in several ponds including the EAP, which covers approximately 21 acres (Ramboll, 2022e; Gradient, 2021b).

Based on groundwater monitoring data collected between 2015 and 2021 at 13 wells near and downgradient of the EAP, no potential GWPS exceedances attributable to the EAP were identified (Ramboll, 2022e; Gradient, 2021b)[11]. Ramboll prepared a groundwater modeling report (Ramboll, 2022e) for the EAP that was submitted to IEPA as part of the Construction Permit Application (Geosyntec Consultants, 2022). The objective of the groundwater modeling conducted by Ramboll was "to simulate future conditions and groundwater concentrations of boron for proposed closure alternatives for the EAP. Boron was selected for modeling because it is one of the most common and mobile CCR-related constituents. A total of three scenarios were simulated: no action, EAP CIP, and EAP CBR" (Ramboll, 2022e). The no action scenario assumed "no closure at the EAP (current conditions retained)" (Ramboll, 2022e). Under the CIP scenario, the EAP was assumed to "be graded and covered with a geomembrane and soil layers," whereas the CBR scenario assumed that "CCR materials from the EAP will be removed" and "[t]he existing liner system and 1 foot of material beneath the side slope and bottom liner will be excavated" (Ramboll, 2022e). The three scenarios also assumed closure of the Coal Combustion Waste Landfill, which is located adjacent to and north of the EAP (Ramboll, 2022e).

Ramboll's modeling approach involved using HELP to estimate recharge under the different closure scenarios, using MODFLOW to simulate groundwater flow in three dimensions and using MT3DMS to simulate the three-dimensional transport of boron (Ramboll, 2022e). "Boron was selected for groundwater transport modeling … 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" (Ramboll, 2022e). Boron was modeled as a conservative substance that "minimally adsorbs and does not decay, and mixing and dispersion are the primary attenuation mechanisms in groundwater" (Ramboll, 2022e).

[11] Due to the conservative nature of the site-specific risk assessment that was conducted at the EAP and the attempt to "screen-in" rather than "screen-out" constituents (Gradient, 2021b), risks were calculated for constituents at concentrations that may not be associated with the EAP and may not have been identified as potential groundwater exceedances, which are based on statistical evaluations of the full dataset rather than single measurements.

5 Modeling surrogate constituents is an appropriate approach to achieve model objectives in support of the CAA.

All environmental models are, in some regard, simplifications of complex systems, and it is common to make simplifications to models based on the model objectives. Using one or more surrogate constituents to represent the potential behavior of a larger group of constituents, with the surrogate constituents selected in accordance with the model objectives, is a simplification that is commonly made in environmental models.

For the groundwater modeling performed in support of the CAAs at AP1, the GMF GSP, and the GMF RP at the Coffeen Power Plant, the Ash Pond at the Edwards Power Plant, the PAP at the Newton Power Plant, and the EAP at the Hennepin Power Plant, the model objectives were to evaluate the effects of various closure alternatives on groundwater quality and to specifically predict the time at which GWPSs will be achieved for each closure alternative. For each of these SIs, the constituent with the highest concentration relative to its GWPS (*i.e.*, "Exceedance Ratio"; Table 5.1) was selected for transport modeling because it will likely be the constituent that takes the longest time to achieve its GWPS. It is not necessary to model other constituents that have been detected at lower concentrations relative to their GWPSs because these constituents will likely achieve their GWPSs faster than the surrogate constituent. Thus, the approach of modeling the constituent with the highest concentration relative to its GWPS is reasonable and sufficient to achieve the model objectives.

Table 5.1 Summary of Potential GWPS Exceedances at Downgradient Monitoring Wells Between 2015 and 2021

Constituents with a Detected Potential GWPS Exceedance	Maximum Detected Concentration (mg/L)	GWPS (mg/L)	Exceedance Ratio	Surrogate Constituent (Modeled in Support of CAA)
Coffeen Ash Pond 1				
Boron	7.5	2	3.8	Sulfate
Sulfate	2,400	400	**6.0**	
TDS	4,000	1,200	3.3	
Coffeen GMF Gypsum Stack Pond and Recycle Pond				
Boron	4.6	2	2.3	Sulfate
Sulfate	1,800	400	**4.5**	
TDS	3,400	1,200	2.8	
Edwards Ash Pond				
Boron	12	2	**6.0**	Boron
Sulfate	570	400	1.4	
TDS	2,600	1,200	2.2	
Newton Primary Ash Pond				
Lithium	0.3	0.04	7.5	Sulfate
Sulfate	3,200	400	**8.0**	
TDS	5,500	1,200	4.6	

Constituents with a Detected Potential GWPS Exceedance	Maximum Detected Concentration (mg/L)	GWPS (mg/L)	Exceedance Ratio	Surrogate Constituent (Modeled in Support of CAA)
Hennepin East Ash Pond				
Boron[a]	1.41	2	0.7	Boron

Notes:

Sources: Ramboll (2022a, 2022b, 2022c, 2022d, 2022e); Gradient (2022e, 2022f, 2022g, 2022h, 2021b).

CAA = Closure Alternatives Analysis; CCR = Coal Combustion Residual; GMF = Gypsum Management Facility; GWPS = Groundwater Protection Standards; TDS = Total Dissolved Solids.

(a) No GWPS exceedances were identified for the Hennepin East Ash Pond but Boron was selected as the constituent for transport modeling because boron is one of the most common and mobile CCR-related constituents (Ramboll, 2022e).

Model surrogate constituent selection also considered the number of locations where a GWPS was exceeded and the size of each constituent's footprint in groundwater. In general, constituents with the highest frequency of GWPS exceedances correlated with constituents that were detected at the highest concentrations relative to their GWPSs. Thus, the approach of modeling the constituent with the highest concentration relative to its GWPS is reasonable and sufficient to achieve the model objectives.

Based on this approach, the following constituents were selected as the surrogate constituents to be evaluated in the groundwater model:

- sulfate at the AP1 at the Coffeen Power Plant;
- sulfate at the GMF GSP, and the GMF RP at the Coffeen Power Plant;
- boron at the Ash Pond at the Edwards Power Plant;
- sulfate at the PAP at the Newton Power Plant; and
- boron at the EAP at the Hennepin Power Plant.

Moreover, the other constituents with potential GWPS exceedances that have been identified – boron and TDS at AP1, the GMF GSP, and the GMF RP at the Coffeen Power Plant; sulfate and TDS at the Ash Pond at the Edwards Power Plant; and lithium and TDS at the PAP at the Newton Power Plant (Table 5.1) – have similar groundwater transport characteristics to the selected surrogate constituents. Specifically, the surrogate constituents have a similar propensity to sorb to soils as the other constituents with potentially identified GWPS exceedances (*i.e.*, all constituents have relatively small values of K_d; Table 5.2); therefore, subsurface transport during closure conditions would be similar for all of the constituents that have been detected with potential GWPS exceedances. Because each of these constituents is expected to behave in a similar manner during closure, it is appropriate to only model the surrogate constituents and use the surrogate constituents to determine when each closure alternative will achieve the GWPSs for all constituents.

Table 5.2 Soil-Water Partition Coefficient (K_d) for Constituents with GWPS Exceedances

Chemical Constituent	Soil-Water Partition Coefficient, K_d (L/kg)
Boron[a]	$1.1x10^{-5}$
Lithium[b]	0
Sulfate[c]	0
TDS[c]	0

Notes:

GWPS = Groundwater Protection Standards; TDS = Total Dissolved Solids; US EPA = United States Environmental Protection Agency.

(a) US EPA (2014) reported select percentiles of chemical-specific K_d values for SIs containing combined ash. The 50th percentile value of K_d in saturated zone is used here.

(b) US EPA (2014) noted that "lithium does adsorb weakly to clay soils" but "sufficient information was not available to develop chemical-specific K_d values for lithium," and a K_d of 0 was used "to estimate lithium fate and transport".

(c) Ions such as "[c]alcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, nitrate, and silica typically make up most of the dissolved solids in water" (USGS, 2014). These ions do not significantly sorb to soil and their K_d is generally assumed to be zero. For example, US EPA (2014) used a K_d of 0 for chloride.

6 Part 845 does not require that all constituents listed in Section 845.600 be evaluated in CAA models.

In its Initial Review Letters, IEPA raised concerns regarding the sufficiency of only modeling selected constituents at each facility by noting that "[t]he Agency requires all constituents listed in Section 845.600 that have been found to be present in the CCR surface impoundment to be assessed in the groundwater model" (IEPA, 2023a, 2023b, 2023c, 2023d; emphasis added). However, there is no language in Part 845 suggesting that the groundwater model must evaluate all constituents that have been detected in an SI. Part 845 requires only that groundwater modeling evaluate "how the closure alternative will achieve compliance with the applicable groundwater protection standards" for each closure alternative (Section 845.710(d)(2) in IEPA, 2021).

The surrogate constituents that were selected for evaluation in the groundwater model for each SI are the constituents that will likely take the longest time to achieve their GWPS and, thus, are appropriate choices to achieve the CAA modeling objectives and to fulfill the requirements of Section 845.710(d)(2) (IEPA, 2021). All of the other constituents that have been detected in the SI are either already at levels below their respective GWPSs or will likely achieve their GWPSs faster than the surrogate constituent. Therefore, for each SI, the groundwater modeling performed by Ramboll predicted the time at which all of the constituents will likely have achieved compliance with the GWPSs for each closure alternative (*i.e.*, the time at which each closure alternative will achieve compliance with GWPSs), thereby satisfying Part 845 requirements.

7 It would be a costly and data-intensive endeavor to model all constituents, and it would not provide any additional useful information.

A number of CCR-related constituents have been identified in literature. For example, Part 845.600 lists 20 CCR-related constituents for which GWPSs have been established (IEPA, 2021) and Appendix III and IV of the 2015 Federal CCR Rule list 22 CCR-related constituents that must be monitored as part of detection and assessment monitoring (US EPA, 2015). The process of modeling all of these constituents would be significantly more data-intensive and costly than the process of modeling a single constituent.

Building a groundwater model that evaluates the time to achieve GWPSs for all constituents detected in an SI would involve collection of a large amount of data for each constituent (*e.g.*, to evaluate background groundwater quality, to determine whether observed concentrations are related to the SI or to an alternative source, to evaluate individual partitioning coefficients, *etc*.). Subsequently, individual groundwater solute transport models would need to be developed and calibrated for each constituent, and separate model simulations would need to be performed for each closure alternative with each constituent. The overall effort will likely scale with the number of constituents being considered (*i.e.*, the effort will be 20 times higher if 20 constituents are being evaluated instead of one), and the process would be onerous.

Despite the significantly increased effort, the models would not result in any additional useful information for meeting the CAA objectives that could not be obtained by modeling just the surrogate constituent. The predicted time to achieve GWPSs will likely be the longest for the constituent detected at the highest concentration relative to its GWPS (*i.e.*, the surrogate constituent) as the other constituents will either already be present at levels below their GWPSs or will likely achieve their GWPSs faster than the surrogate constituent. Thus, the additional information obtained from modeling all constituents (*i.e.*, the predicted time to achieve GWPSs for each constituent) will likely not affect the time at which all the constituents achieve compliance with the GWPSs for each closure alternative, which is the primary objective of the groundwater modeling performed in support of the CAA.

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Appendix A

***Curriculum Vitae* and Testimony History of**
Andrew Bittner, M.Eng., P.E.

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Principal
(he/him)
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Areas of Expertise

Contaminant fate and transport in porous and fractured media, migration of coal ash combustion products in groundwater and surface water, non-aqueous phase liquid (NAPL) transport, surface water and groundwater hydrology, groundwater and surface water modeling, remedial investigation design, remedy evaluation and optimization, cost allocation, international regulatory compliance and remediation.

Education & Certifications

M.Eng., Environmental Engineering and Water Resources, Massachusetts Institute of Technology, 2000

B.S.E., Environmental Engineering, University of Michigan, 1997

B.S., Physics, University of Michigan, 1997

Licensed Professional Engineer: Idaho, New Hampshire

Professional Experience

2000 – Present GRADIENT, Boston, MA
Environmental Engineer. Specializes in the fate and transport of contaminants in groundwater and surface water, coal combustion products, groundwater hydrology, groundwater flow and contaminant transport modeling, NAPL transport, and remedial investigation and design. Has served as principal-in-charge, testifying expert, and consulting expert on large, multi-disciplinary projects at coal combustion product surface impoundments and landfills, pharmaceutical facilities, automotive facilities, manufacturing plants, dry cleaning facilities, and Superfund sites. Extensive experience in South America and at other international sites.

1997 – 1999 PARSONS ENGINEERING SCIENCE, Canton, MA
Environmental Engineer. Specialized in industrial wastewater treatability. On-site supervisor for bioremediation bench scale treatment and laboratory study for a major pharmaceutical company. Built hydraulic models for pharmaceutical wastewater treatment facilities. Designed hazardous waste treatment systems for a major pharmaceutical company. Performed site investigations to delineate NAPL plumes and design remedial recovery plans.

12/7/2022

Professional Affiliations

National Ground Water Association; Chi Epsilon – Environmental Engineering Honor Society

Technical Session Chair:

- World of Coal Ash Conference. Lexington, KY. May 8-11, 2017. Session title: "Groundwater."
- Battelle Conference on Remediation of Chlorinated and Recalcitrant Compounds. Palm Springs, CA. May 23-26, 2016. Session title: "Coal Ash Facility Restoration".
- Battelle Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterey, CA. May 21-24, 2012. Session title: "Environmental Remediation in Emerging Markets."
- Defense Research Institute. Panelist for session titled "Groundwater-Surface Water Connectivity and the Clean Water Act." New Orleans, LA. May 13-14, 2019.
- World of Coal Ash Conference. St. Louis, MO. May 13-16, 2019. Session title: "Project-Specific Case Studies."
- World of Coal Ash Conference. Covington, KY. May 16-19, 2022. Session title: "Regulatory."

Projects – *Coal Combustion Products*

Electric Power Research Institute: Modeled groundwater impacts from coal combustion product (CCP) surface impoundments with intersecting groundwater conditions and evaluated hydrogeological factors and other characteristics that influence risks to human health and the environment (HHE).

Utility Client: Served as litigation consulting expert regarding the fate and transport of metal constituents in groundwater from 18 different coal combustion residual (CCR) disposal facilities at 7 sites in the Midwest.

Utility Client: Prepared expert report and provided testimony related to the fate and transport of metal constituents in groundwater from 11 different coal combustion residual (CCR) disposal facilities at 6 sites in West Virginia, Virginia, and Ohio.

Utility Client: Prepared expert report in support of "Petition for a Finding of Inapplicability or, in the Alternative, an Adjusted Standard from 35 ILL. Admin. Code Part 845". Report assessed current risks to human and environmental receptors and evaluated net environmental benefits (*i.e.*, NEBA) of potential closure options at a former CCR disposal facility.

Utility Client: Prepared Closure Alternatives Assessment (CAA), Corrective Measures Assessment (CMA), and Corrective Action Alternatives Analysis (CAAA) for multiple CCR surface impoundments located at a series of Midwestern power plants. Reports were prepared consistent with requirements of 35 ILL. Admin. Code Part 845.

Utility Client: Evaluated risks to human health and the environment associated with CCR surface impoundments at six coal fired power plants in the Southern US. Evaluations included assessing CCR constituent migration in groundwater and the flux of constituents into nearby surface waters.

Utility Client: Calculated alternative groundwater protection standards (GWPSs) at a coal fired power plant facility in the Midwestern US. Alternative standards were calculated based on site-specific human and ecological receptors and attenuation factors.

Utility Client: Prepared expert report and testified before state pollution control board regarding proposed coal ash disposal regulations.

Electric Power Research Institute: Evaluated the performance of alternative liners, including engineered clay liners, natural clay liners, and geomembrane composite-lined systems at CCP impoundments. Used a probabilistic approach to model the flux of CCP constituents through each liner and the subsequent transport of constituents through the underlying vadose and saturated zone.

Industry Research Group: Developed methodology to evaluate performance equivalency of various surface impoundment liner systems. The methodology, which was submitted to US EPA in order to inform future rulemakings, presented a process to evaluate and compare hydraulic flux and travel times through different liner systems including geocomposite, compacted clay, and natural clay liners.

Confidential Client: Developed a screening level risk assessment for a manufacturing facility beneficially using coal fly ash as a soil stabilizer. The risk assessment compared estimated coal ash constituent exposure concentrations in soil, groundwater, and surface water to relevant benchmarks protective of human health and the environment.

Manufacturing Client: Performed beneficial use risk assessments consistent with US EPA Federal Coal Combustion Residual (CCR) Rule and Secondary Use Guidance for multiple commercial and construction products containing coal ash – including carpet backing, interior and exterior trim, and backer board. Analysis evaluated risks to groundwater, surface water, indoor air, and soil. Evaluation also considered exposure pathways for residents, construction workers, and landfill workers associated with installation of products, active life of the installed products, and post-life disposal in a landfill.

Electric Power Research Institute: Developed framework for creating alternative groundwater standards at CCP storage sites. The framework considers the development of alternative standards for the protection of human health and the environment, current and future uses of groundwater near CCP management units, and potential attenuation that may occur between the current point of compliance and a relevant point of exposure.

Utility Client: Prepared expert report and provided testimony related to the fate and transport of metal constituents in groundwater, including sulfate, boron, and arsenic, from over 30 different coal combustion residual surface impoundments at 15 sites in North Carolina and South Carolina.

Industry Research Group: Prepared technical comments regarding proposal to add boron to list of Appendix IV constituents to the Federal CCR Rule. Evaluated technical practicability and cost implications associated with the potential boron addition.

Industry Research Group: Prepared technical comments regarding portion of Federal CCR Rule that requires the groundwater protection standard (GWPS) of Appendix IV constituents with no MCL to be the background concentration. Evaluated technical practicability, cost implications, and potential benefits associated with the requirement for the four current Appendix IV constituents with no established MCL - cobalt, lithium, molybdenum, and lead.

Confidential Client: Developed a screening level risk assessment for a steel production and recycling facility that is beneficially using coal fly ash as a soil stabilizer. The risk assessment addressed a requirement in the Federal Coal Combustion Residuals (CCR) Disposal Rule for a characterization of risk from unencapsulated beneficial use of CCR. Used the Industrial Waste Evaluation Model (IWEM) to evaluate potential transport of coal ash constituents, including arsenic, in groundwater as a result of the beneficial reuse.

Utility Client: Prepared expert report interpreting data produced during a field investigation performed at a large Midwestern coal ash landfill.

Utility Client: For litigation support, modeled the fate and transport of arsenic and other coal ash related constituents in groundwater and surface water downgradient of a large Midwestern coal ash surface impoundment located in a karst environment. Model simulations compared potential impacts to groundwater and surface water resulting from potential surface impoundment closure scenarios.

Manufacturing Client: Performed beneficial use risk assessments consistent with US EPA Federal Coal Combustion Residual (CCR) Rule and Secondary Use Guidance for multiple commercial and construction products containing coal ash. Analysis evaluated risks to groundwater, surface water, indoor air, worker safety, and residential safety. Evaluation also considered exposure pathways associated with installation of products, active life of the installed products, and post-life disposal in a landfill. Used the Industrial Waste Evaluation Model (IWEM) to evaluate potential transport of coal ash constituents, including arsenic, in groundwater as a result of the beneficial reuse.

Industry Research Group: Developed a groundwater fate and transport model to evaluate the level of groundwater protection provided by various coal ash surface impoundment closure options, including closure in place and closure by removal. Model simulated transport of arsenic (III) and arsenic (V) in groundwater downgradient of coal ash disposal facilities. Model results are being used by utilities in support of closure planning which is required by Federal Coal Combustion Residual Rule.

Confidential Client: Prepared expert report on human health and ecological risks due to a potential spill of barged coal combustion byproducts (CCBs) on a large Midwestern river. Modeled the fate and transport of key CCB constituents, including arsenic, in surface water for a range of spill scenarios and river flow conditions and estimated potential downstream concentrations at drinking water intake locations.

Industry Research Group: Evaluated technical approach used by United States Environmental Protection Agency (US EPA) to simulate the migration of arsenic, selenium, and other metals in groundwater from overlying coal combustion storage units. Model analyses were included in regulatory comments submitted in response to US EPA's 2010 Coal Combustion Product Risk Assessment.

Industry Research Group: Developed relative risk framework to assess impacts to groundwater associated coal combustion product (CCP) surface impoundment closure scenarios. Framework identified potential deterministic and probabilistic modeling approaches to simulate potential migration of CCP constituents, including arsenic, boron, selenium, and molybdenum through the vadose and saturated zones for each closure alternative.

Industry Research Group: Modeled the downward migration of leachate from unlined coal combustion product surface impoundments using a probabilistic framework for a wide range of climatic and site conditions. Model results provided estimated durations for interactions between the impoundment leachate and nearby surface and groundwater.

Industry Research Group: As part of a relative risk framework, performed detailed sensitivity analysis of all factors associated with a coal ash surface impoundment closure that may impact the fate and transport of constituents in groundwater. Factors analyzed included surface impoundment characteristics (*e.g.*, volume, depth, and leachate quality), hydrogeological conditions (*e.g.*, hydraulic conductivity, hydraulic gradient, soil type, depth to groundwater, and surface water proximity), climatic characteristics (*e.g.*, precipitation), and closure details (*e.g.*, closure type and duration).

Projects – *Fate & Transport and Modeling*

Manufacturing Client: Consulting expert for a class certification case. Evaluated PFAS transport from known and potential sources.

Natural Gas Processing Facility: Prepared an expert report evaluating the hydrogeological conditions at and downgradient of a natural gas processing plant and provided assessment of the fate and transport over time of light non-aqueous phase liquids (LNAPLs) released from the plant and associated pipelines.

Confidential Client, Rhode Island: Designed and calibrated a groundwater flow and solute transport model for multiple chlorinated organic constituents at a Northeastern Superfund Site. Used one year long tracer test to calibrate model. Model was used to predict the future effectiveness of various remedial alternatives.

Confidential Client: Designed and calibrated a groundwater flow and solute transport model for a Superfund site that has groundwater impacted with volatile organic compounds including benzene, tetrachloroethylene, trichloroethylene, and vinyl chloride. The model was used successfully to present the case to US EPA for shutting down the source remedy.

Confidential Client, Brazil: Developed 3-D numerical groundwater and solute transport model using MODFLOW and MT3D for volatile organic compounds and pesticides. Used model to evaluate and design remediation alternatives. Managed multiple site investigation and characterization studies. Projects involved calculation of risks to human health from exposure to soils, groundwater, indoor air, and outdoor air.

Savage Well Superfund Site: For a potentially responsible party (PRP) group, managed the development of a 3-D numerical groundwater and solute transport model for tetrachloroethylene (PCE) at a Superfund site in New Hampshire. Calibrated the model using approximately 10 years of data with review and oversight by US EPA and United States Geological Survey (USGS). Designed an optimization algorithm to develop the optimal groundwater pump and treat system.

Confidential Client, Massachusetts: Developed a 2-D contaminant transport model for PCE to demonstrate that contaminant contribution from a dry cleaning operation to the town water supply wells was insignificant compared to contribution from other potential sources. Managed the installation and operation of a pump and treat system at the Site.

Confidential Client, Argentina: Developed a 2-D numerical groundwater and solute transport model using MODFLOW and MT3D. Used the calibrated model to design a hydraulic barrier system to control off-site migration.

Confidential Client: Performed site-specific vapor intrusion modeling using the Johnson-Ettinger model at a pharmaceutical facility. Performed a detailed sensitivity analysis for each model input parameter.

Confidential Client: Performed NAPL transport and travel time calculations through porous media vadose and saturated zones and clay confining layers.

Confidential Client: Wrote critique of US EPA geochemistry model.

Projects – *Remediation*

Confidential Client: Evaluated potential liabilities related to range of issues including waste surface impoundment closure, groundwater remediation, and regulatory compliance at sites around the world that were involved in a corporate transaction.

Manufacturing Client, New Hampshire: Served as consulting expert for a case related to a failed groundwater remedy. Evaluated remedy design and installation and performed probabilistic modeling to determine appropriate design factors.

PRP Group, Nevada: Provided hydrogeological support at an industrial site with groundwater impacts due to benzene, chlorobenzene, chloroform, perchlorate, and chromium. Evaluated and critiqued a Remedial Investigation (RI) Report related to a neighboring property and developed a conceptual site model (CSM) describing the fate and transport mechanisms of constituents in groundwater. Prepared submittals and presented conclusions at meetings with the State Environmental Agency.

Confidential Client, Brazil: Designed and implemented nano-scale zero valent iron remedy to prevent off-site arsenic migration. Upon completion of remedy, negotiated site closure with state of Rio de Janeiro environmental agency.

Confidential Client, Brazil: Designed and implemented a pilot scale enhanced *in-situ* bioremediation remedy for groundwater impacted with chlorinated organic compounds at a former agricultural product manufacturing facility.

Confidential Client, New Hampshire: As an independent third party, performed a review of a proposed Electrical Resistive Heating remedy for a chlorinated solvent dense non-aqueous phase liquid (DNAPL) source zone.

Confidential Client, New York: Provided regulatory comments regarding a US EPA Proposed Remedial Action Plan at a Region II Superfund Site on Long Island. Provided support during mediation and during negotiations with US EPA.

Confidential Client, New Jersey: Provided regulatory comments regarding a US EPA Proposed National Priorities List (NPL) listing at a Region II Superfund Site.

Confidential Client, Brazil: Managed multiple conceptual and detailed engineering remedial design projects for a soil vapor extraction system, dual-phase extraction system, and a pump and treat system. Remediation efforts focused on soil and groundwater contamination by pesticides and chlorinated solvents.

Confidential Client, Brazil: Managed site remediation projects to operate and maintain a soil vapor extraction system, dual-phase extraction system, and a hydraulic barrier system.

Confidential Client, Argentina: Managed conceptual and detailed engineering remedial design project for dual-phase extraction system focused on the remediation of volatile organic compounds in soil and groundwater.

Confidential Client: On-site supervisor for bioreactor bench scale study at a pharmaceutical wastewater treatment plant. Performed an in-depth investigation on the bio-inhibitory effects due to the chronic exposure of biomass to manganese. Performed laboratory work required to support the bioreactors including tests for mixed liquor volatile suspended solids (MLVSS), total suspended solids (TSS), chemical oxygen demand (COD), dissolved oxygen (DO), ammonia (NH_3), and respirometry.

Confidential Client: Lead environmental engineer for a belt filter press replacement project for a pharmaceutical company wastewater treatment plant. Designed and sized polymer addition system.

Projects – *Site Characterization*

Confidential Client, Brazil: Provided strategic oversight for a series of environmental investigations, remedial actions, and agency negotiations for an automotive facility located in São Paolo.

Confidential Client: Managed large-scale cost allocation at a Midwestern Superfund site. Forensically evaluated the sources of tar to river sediments considering site industrial operational history, contaminant fate and transport, chemistry, site modification and filling history, and observed contaminant patterns. Calculated the mass of tar present in the environment using both visual observations and analytical data.

Confidential Client, Brazil: Managed large-scale site investigations and human health risk assessment projects at a former pharmaceutical facility located in São Paulo. Key compounds were petroleum hydrocarbons and volatile organic compounds.

Confidential Client, New York: Served as consulting expert for large cost allocation involving over 16 responsible parties and chlorinated organic groundwater plumes extending for nearly 2 miles. Evaluated lateral and vertical groundwater flow direction, chemical usage history, and groundwater chemistry to support a *de minimis* contribution argument for our client.

Confidential Client, Ohio: Served as consulting expert for cost allocation project at a Midwestern landfill. Evaluated differences in toxicity and risk associated with municipal solid waste and industrial hazardous waste. Used data to devise risk-weighted allocation approach for remedy costs.

Confidential Client, Brazil: Managed site investigation to evaluate groundwater responses due to seasonal precipitation events and their effect on potential contaminant fate & transport.

Confidential Client: Managed site investigation project identifying sources of PCE present at a former electrical resistor manufacturing facility. Soil, groundwater, and soil gas data were evaluated and used to identify individual sources of PCE to the subsurface. The impact of each source on remediation costs related to the site was evaluated and successfully used as a tool to mediate between responsible parties. Served as consulting expert during mediation between responsible parties.

Confidential Client, New Jersey: Delineated NAPL plumes and investigated spill history, sewer maps, and gas chromatography fingerprint results at East Coast Superfund Site. Designed French Drain to recover NAPL from subsurface.

City of Pittsfield, Massachusetts: Technical consultant to the city for mediation between General Electric (GE) and governmental agencies. Evaluated reports and clean-up standards, and attended mediation sessions on behalf of the city.

Projects – *Clean Water Act*

Municipal Client, Ohio: Consulting expert for significant nexus evaluation to determine whether wetlands and surface water tributaries are jurisdictional waters of the United States.

Publications/Presentations

Radloff, KA; Lewis, AS; Bittner, AB; Zhang Q; Minkara, R. 2022. "A Risk Evaluation of Controlled Low-Strength Materials (CLSM) Containing Coal Combustion Products (CCPs) in Construction Projects." Presented at the World of Coal Ash (WOCA) Conference, Covington, KY. May 17.

Kondziolka, J; Radloff, KA; Bittner, AB. 2022. "Emerging Clean Water Act Issues for CCR Surface Impoundments." Presented at the World of Coal Ash (WOCA) Conference, Covington, KY. May 17.

Bittner, AB; Kondziolka, J. 2022. "Alternative Liner Performance Demonstrations – A Science-Based Approach to Inform Policy Development ." Presented at the World of Coal Ash (WOCA) Conference, Covington, KY. May 18.

Bittner, AB. 2022. "Decision Analysis Applied to CCR Surface Impoundment Closure and Corrective Action." Presented at the World of Coal Ash (WOCA) Conference, Covington, KY. May 18.

Lewis, AS; Bittner, AB; Radloff, KA. 2022. "Using Human Health and Ecological Risk Assessment at Coal Combustion Product (CCP) Sites to Meet Closure Objectives ." Presented at the World of Coal Ash (WOCA) Conference, Covington, KY. May 18.

Radloff, KA; Lewis, AS; Bittner, AB. 2021. "Challenges Using Data Generated by LEAF Methods in Risk Evaluations." Presented at the USWAG CCR Webinar. August 5.

Register, JR; Bittner A. 2020. "USEPA Reconsideration of CCR Regulations Impacting the Geosynthetic Industry." Presented to the Fabricated Geomembrane Institute. October 8.

Dale, A, Kondziolka, J, de Lassus, C, Bittner, A, Hensel, B. 2020. "Probabilistic Modeling of Leaching from Coal Ash Impoundment Liners: A Case Study in Science Informing Policy Development." Presented at the International Society of Exposure Science Virtual Meeting, California, September 21.

Briggs, N; Lewis, AS; Bittner, AB. 2020. "Evaluating Climate Change Impacts on CCP Surface Impoundments and Landfills." Presented at the World of Coal Ash (WOCA) Conference, St. Louis, Missouri, May 16.

Bittner, AB; Lewis, AS. 2020. "Beneficial use assessment of building materials containing CCPs." *Gradient Trends: Risk Science and Application* 77 (Winter):3,5.

Register, JR; Bittner A. 2019. "Insane in the Geomembrane." Presented to the Fabricated Geomembrane Institute. August 6..

Bittner, AB; Spak, MS; Cox, WS. 2019. "Carving out the Contours: The Clean Water Act and the Migration of Affected Groundwater to Waters of the United States." *For the Defense* 61(6):55-59.

Bittner, A. Lewis, A. 2019. "CCP Beneficial Use Risk Assessment: Case Studies for Three Different Applications." Presented at the World of Coal Ash (WOCA) Conference, St. Louis, Missouri, May 14.

Lewis, A. Bittner, A. 2019. "Risk Based Considerations for Establishing Alternative Groundwater Standards at Coal Combustion Product Sites." Presented at the World of Coal Ash (WOCA) Conference, St. Louis, Missouri, May 15.

Lewis, AS; Bittner, A. 2018. "Risk-Based Approaches for Establishing Alternative Standards at Coal Combustion Sites." Presented at the World of Coal Ash (WOCA) Ponded Ash Workshop, Louisville, Kentucky, October 30-31.

Lewis, AS; Bittner, A. 2017. "The Relative Impact Framework for Evaluating Coal Combustion Residual Surface Impoundment Closure Options: Application and Lessons Learned." *Coal Combustion and Gasification Products (CCGP)* 9:1-3.

Lewis, AS; Dube, EM; Bittner, A. 2017. "Key role of leachate data in evaluating CCP beneficial use." *ASH at Work* 1:32-34.

Lewis, AS; Bittner, AB; Lemay, JC. 2017. "Achieving Groundwater Protection Standards for Appendix IV Constituents: The Problem with Using Background Concentrations in the Absence of Maximum Contaminant Levels (MCLs)." Presented at the 2017 World of Coal Ash Conference (WOCA), Lexington, KY, May 8-11.

Bittner, A. 2017. "Evaluation of Groundwater Protectiveness of Potential Surface Impoundment Closure Options." Presented at the American Coal Ash Association's 7th Annual World of Coal Ash Conference, Lexington, KY, May 11.

Lewis, A; Bittner A; Radloff, K; Hensel, B. 2017. "Storage of coal combustion products in the United States: Perspectives on potential human health and environmental risks." In *Coal Combustion Products (CCPs): Characteristics, Utilization and Beneficiation, 1st Edition*. Woodhead Publishing, May 2.

Bittner, AB; Kondziolka, JM; Lewis, A; Hensel, B; Ladwig, K. 2016. "Groundwater Assessment Framework for Evaluating the Relative Impacts of Coal Ash Surface Impoundment Closure Options." Presented at Battelle's Tenth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Palm Springs, CA, May 22-26.

Bittner, AB; Kondziolka, JM; Sharma, M; Nangeroni, P; McGrath, R. 2016. "Using Tracer Test Data to Calibrate a Groundwater Flow and Solute Transport Model." Presented at Battelle's Tenth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Palm Springs, CA, May 22-26.

Bittner, A. 2016. "A Retrospective Look at Remediation in the State of Rio de Janeiro, Brazil: And What Lessons We Can Apply to Remediation Projects in Other Emerging International Markets." Presented at Battelle's Tenth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Palm Springs, CA, May 22-26. 17p.

Bittner, A. 2016. "The Federal CCR Rule and How it is Impacting Coal Ash Disposal." Presented at Battelle's Tenth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Palm Springs, CA, May 22-26. 17p.

Bittner, A. 2016. "Coal Ash Beneficial Reuse Assessment Consistent with Requirements of the 2015 Federal CCR Rule." Presented at EUCI's Sixth Annual Coal Combustion Residuals and Effluent Limitation Guidelines Conference, Charlotte, NC, March 30-31. 30p.

Herman, K; Flewelling, S; Bittner, AB; Tymchak, M; Swamy, M. 2015. "Alternate Endpoints for Remediating NAPL-Impacted Sites." Presented at the EPRI/AWMA Env-Vision Conference, Crystal City, VA, May 14.

Lewis, A; Bittner, AB; Herman, K; Dubé, E; Long, C; Hensel, B; Ladwig, K. 2015. "Framework for Evaluating Relative Impacts for Surface Impoundment Closure Options." Presented at the 2015 World of Coal Ash Conference, Nashville, TN, May 8.

Bittner, AB. Lewis, A; Herman, K; Dubé, E; Long, CM; Kondziolka, K, Hensel, B; Ladwig, K. 2015 "Groundwater Assessment Framework to Evaluate Relative Impacts of Surface Impoundment Closure Options." Presented at the 2015 World of Coal Ash Conference, Nashville, TN, May 7.

Bittner, AB. 2014. "Evolving environmental regulations in Brazil." *Gradient Trends: Risk Science and Application* 59 (Winter):4.

Bittner, AB. 2013. "Modeling Mass Discharge from the Source Zone." Presented at Second International Symposium on Bioremediation and Sustainable Environmental Technologies, Jacksonville, FL, June 11.

Bittner, AB. 2013. "Successful Implementation of a Risk-based Remedial Solution in Brazil." Presented at the 2013 NGWA Groundwater Summit, San Antonio, TX, April 28.

Bittner, AB. 2013. "Evolving methods for evaluating vapor intrusion." *Gradient Trends: Risk Science and Application* 57(Spring): 4.

Esakkiperumal, C; Bittner, A. 2013. "Use of Mass-Flux Based Approach to Optimize the Design of a Hydraulic Containment System." Presented at the 2013 NGWA Groundwater Summit, San Antonio, TX, April 28.

Bittner, A. 2010. "A Weight-of-Evidence Approach to Assess NAPL Mobility." Presented at the 7th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, May 27.

Herman, K; Bittner, A. 2010. "How Much Tar is In the Mud? – Reducing Uncertainty in Characterizing the Distribution and Mass of DNAPL in Sediments." Presented at the EPRI MGP 2010 Symposium, January 28.

Bittner, AB. 2009. "Is your NAPL mobile?" *Gradient Trends: Risk Science & Application* 45(Spring):3.

Herman, K; Bittner, A. 2008. "Reducing Uncertainty in DNAPL Characterization." Presented at the 24th Annual International Conference on Soils, Sediments, and Water, October 23.

Bittner, AB; Baffrey, RN; Esakkiperumal, C. 2006. "Using Sediment Transport Modeling to Support Environmental Forensic PCB Analyses." Presented at Society of Environmental Toxicology and Chemistry Conference, Montreal, Canada, November 8.

Bittner, AB. 2006. "Groundwater and Air Modeling Used to Support Forensic Analyses." Presented at the Gradient Breakfast Seminar Titled: Forensic Chemistry – The Intersection of Science and Law, May 16.

Bittner, AB. 2006. "M&A emerging issues and requirements." *Gradient Trends: Risk Science & Application* 36(Spring):4.

Sharma, M; Saba, T; Bittner, A. 2003. "Optimization of Groundwater Pump and Treat Systems." Presented at the 19th Annual International Conference on Contaminated Soil, Sediments and Water, Amherst, MA, October 23.

Sharma, M; Saba, T; Bittner, A. 2003. "Optimization of Groundwater Pump and Treat Systems Using Numerical Modeling and the Monte Carlo Approach." Presented at the National Ground Water Association Mid-South Focus Conference, Nashville, TN, September 19.

Bittner, AB; Halsey, P; Khayyat, A; Luu, K; Maag, B; Sagara, J; Wolfe, A. 2002. "Drinking water quality assessment and point-of-use treatment in Nepal." *Civil Eng. Practice* 17:5-24.

Bittner, AB. 2000. "Drinking Water Quality Assessment in Nepal: Nitrates and Ammonia [Thesis]." Submitted to Massachusetts Institute of Technology.

ANDREW BITTNER, P.E.
Testimony Experience

Mr. Bittner has provided testimony in the following matters.

1. MACTEC Engineering & Consulting, Inc. v. Hitchiner Manufacturing Co., Inc., and Thomas & Betts Corporation vs. Dragin Drilling, Inc. and Windham Environmental Corporation, d/b/a Remede Products and d/b/a Redux Technology. American Arbitration Association No. 111920064106. Provided testimony (2007) in deposition related to contaminant fate and transport and groundwater flow modeling.

2. Ernest Hardy, et al. v. Cheshire Oil Company, Inc. and Gabrielle Realty, LLC. Prepared expert report (2008) regarding the fate and transport of methyl tertiary butyl ether in groundwater. Case settled prior to deposition.

3. Sierra Club v. Pennsylvania Department of Environmental Protection and FirstEnergy Generation, LLC, Permittee. Commonwealth of Pennsylvania, Environmental Hearing Board Docket No. 2015-093-R. Prepared expert report (2017) in support of permittee regarding the fate and transport coal combustion constituents in surface water. Case settled prior to deposition.

4. Davis Gas Processing, Inc. *et al*. v. Western Gas Resource, Inc. *et al*. Railroad Commission of Texas Hearings Division. Oil and Gas Docket No. 09-0304555. Prepared expert report (2018) titled "Evaluation of Groundwater Hydrogeology and LNAPL Fate and Transport at the Davis Gas Processing Plant and Surrounding Area in Bowie, Texas." Case Settled prior to deposition.

5. The Estate of Bobby Clary *et al*., v. American Electric Power Co. Inc. *et al*. Gavin Landfill Litigation. Circuit Court of Raleigh County, West Virginia. Civil Action No. 16-C-8000. Prepared expert report (2018) titled "Assessment of January 2017 Field Investigation and Results at the Gavin Landfill in Cheshire, Ohio." Case Settled prior to deposition.

6. Duke Energy Carolinas, LLC and Duke Energy Progress, LLC *v*. AG Insurance SA/NV (f/k/aL'Etoile S.A. Belge d'Assurances) *et al*. Prepared export report (April 2020), rebuttal report (May 2020), and surrebuttal report (June 2020). Provided testimony (September 2020) in deposition related to fate and transport of coal combustion product constituents at multiple coal ash disposal facilities and coal-fired power plants.

7. Provided pre-filed testimony (August 2020) related to the Illinois Environmental Protection Agency (IEPA) Proposed Part 845 Rulemaking of the Illinois Administrative Code (Title 35, Subtitle G, Chapter I, Subchapter j). Provided oral testimony (September 2020) related to the proposed rule before the Illinois Pollution Control Board.

8. Draft Allocation for the Lower Passaic River. Prepared expert rebuttal report "Comments on the Draft Allocation Recommendation for TFCFA" (November 2020).

9. Expert Report submitted in support of "Petition for a Finding of Inapplicability or, in the Alternative, an Adjusted Standard from 35 ILL. Admin. Code Part 845." "Human Health and Ecological Risk Evaluation and Relative Impact Assessment. Joppa Generating Station – Joppa West, Joppa, Illinois" (May 11, 2021).

10. AEP Generation Resources Inc. *et al*. *v*. AG Insurance SA/NV (f/k/a AG de 1830 Compagnie Belge and as Successor to L'Etoile S.A. Belge d'Assurances and Transferor to Bothnia International

Insurance Company Ltd.) *et al*. Prepared export report (June 2022) and rebuttal report (September 2022) related to fate and transport of coal combustion product constituents at multiple coal ash disposal facilities and coal-fired power plants. Provided testimony (October and November 2022) in deposition.