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REPORT ON
SAFETY FACTOR ASSESSMENT
POND 003 AND POND 004
NEW MADRID POWER PLANT
NEW MADRID, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Springfield, Missouri

File No. 40616-300
October 2016

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17 October 2016
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Attention: Russ Weatherly
Supervisor, Land and Water Resources

Subject: Report on Safety Factor Assessment
Pond 003 and Pond 004
New Madrid Power Plant
New Madrid, Missouri

Mr. Weatherly:

We are pleased to submit herewith our report to Associated Electric Cooperative, Inc. (AECI) entitled, "Report on Safety Factor Assessment, Pond 003[1] and Pond 004[2], New Madrid Power Plant, New Madrid, Missouri." This report has been prepared in accordance with our agreed to scopes of work and your subsequent authorizations, and includes background information regarding the project, the results of our field investigation program, and the results of our safety factor assessment.

The purpose of this study was to evaluate the subsurface soil and water conditions at the coal combustion residuals (CCR) surface impoundments site and evaluate the stability of the subject impoundments in accordance with the Environmental Protection Agency (EPA) 40 CFR Parts 257 and 261, "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities" (CCR Rule). A subsurface exploration program was conducted in September 2015 at the project site to obtain subsurface information for engineering evaluations. The program consisted of drilling a total of nine (9) test borings and advancing ten (10) cone penetrometer soundings. A review of the subsurface information and laboratory test results revealed that the soils used to construct the impoundment dikes are not susceptible to liquefaction. A series of one-dimensional ground response analyses were performed to estimate the subsurface response to six (6) site-specific earthquake events at the New Madrid site. The results were used to perform Newmark displacement analyses and select the pseudostatic coefficient for use in the seismic stability analyses. The results of the stability analyses indicate that the static safety factors are above the minimum required values for all analyzed sections at each impoundment. Preliminary seismic stability analyses for the analyzed sections indicated acceptable safety factors for all sections except the section on the west side of Pond 003 where CCR had been

1 Pond 003 is also referred to as the 003 Unlined Pond
2 Pond 004 is also referred to as the 004 Slag Dewatering Pond

staged directly adjacent to the dike within the impoundment footprint. AECI has since regraded that material along the west side of Pond 003 to a configuration that that has acceptable safety factors.

This report includes background information regarding the project, the results of our field investigation program, and the detailed results of our safety factor assessment.

Background

The project site is located at the New Madrid Power Plant located at 41 St. Jude Industrial Park Highway, New Madrid, Missouri as shown on **Figure 1**. The approximately 100-acre Pond 003 and 10-acre Pond 004 are located on the east side of the site, adjacent to the Mississippi River.

AECI is be required to meet the requirements of the Environmental Protection Agency (EPA) 40 CFR Parts 257 and 261, "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities" (CCR Rule) effective 19 October 2015. In particular for existing active CCR surface impoundments, AECI must demonstrate that specified slope stability safety factors are met in accordance with §257.73(e). This report satisfies that requirement.

Purpose and Scope

The purpose of this study was to investigate the subsurface soil and water conditions at the site and to perform the initial safety factor assessment in accordance with Section §257.73(e)(1) of the CCR Rule. To achieve the objective discussed above, the scope of work undertaken for this investigation included the tasks listed below.

- Planning and executing a field investigation program to obtain subsurface information for dike liquefaction and slope stability analyses. A total of nine (9) test borings were drilled to depths ranging from between approximately 25 and 100 ft below ground surface. Ten (10) cone penetrometer soundings (CPTs) were performed to depths ranging from approximately 50 to 100 ft below ground surface.

- Conducting a geotechnical laboratory testing program on soil, CCR and boiler slag samples recovered from subsurface explorations to aid in classification and for determination of engineering properties required for engineering analyses.

- Performing a site-specific seismic analysis to estimate the subsurface response to an earthquake event at the New Madrid site.

- Performing a Newmark displacement analysis to determine the amount of slope displacement for a given value of yield acceleration.

- Performing slope stability (static and seismic) and liquefaction analyses.

Field Investigation Program

SUBSURFACE EXPLORATION PROGRAM

A subsurface exploration program was conducted at the project site during the period 14 September 2015 to 22 September 2015 to obtain subsurface information for engineering evaluations. The program consisted of drilling a total of nine (9) test borings and advancing ten (10) CPTs. The borings were drilled by Bulldog Drilling, Inc. of Dupo, IL using an ATV-mounted CME 55 L6 drill rig. The CPT soundings were advanced by ConeTec, Inc. of West Berlin, New Jersey using a track-mounted rig. A Haley & Aldrich representative was present in the field to observe the subsurface explorations.

The locations of the subsurface explorations are shown on **Figure 2**. The as-drilled locations and elevations of the explorations were determined in the field by Smith & Company Engineers by optical survey. The locations and elevations of the explorations should be considered accurate only to the degree implied by the method used. A summary of the subsurface explorations is presented in **Table I**[3].

Test Borings

The test borings were drilled to depths ranging from approximately 25 ft to 100 ft below ground surface. The borings were advanced using 4-1/4-in. inside diameter (i.d.) hollow stem augers. Split-spoon samples were typically obtained continuously for the upper 15 ft at each test boring and at 5 ft intervals thereafter. In some instances, continuous split spoon sampling extended to depths up to 30 ft until natural soil was observed. The standard penetration resistance was determined at each sample level by counting the number of blows required to drive a standard split-spoon sampler (1-3/8-in. inside diameter, 2-in. outside diameter) a distance of either 18 in. or 24 in. into undisturbed soil and ash under the impact of a 140-lb hammer free-falling 30 in. The number of blows required to advance the sampler was recorded for each 6-in. interval. The standard penetration resistance N-value is determined by summing the number of blows required to advance the sampler the middle 12 in. of the 24-in. sampling range or by summing the number of blows required to advance the sampler the last 12 in. of the 18-in. sampling range.

Relatively undisturbed samples of ponded CCR were obtained from test borings HA-B4A and HA-B5A by pushing a 3-in. diameter thin-walled steel tube (Shelby tube) into the CCR at a planned sampling depth. A hydraulically operated stationary piston sampler attached to the drill rods was used to advance the tubes. The tubes were removed from the ground and sealed.

Samples recovered from the borings were taken to Shannon and Wilson, Inc. in Saint Louis, Missouri for laboratory testing. The boring logs are presented in **Appendix A**. The boring logs and related information depict subsurface conditions only at the specific locations and at the particular time designated on the logs. Subsurface conditions at other locations may differ from conditions occurring at the exploration locations. Also the passage of time may result in a change in the subsurface conditions at these exploration locations.

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3 Note: a table that does not appear near its citation can be found in a separate table at the end of the report.

Cone Penetrometer Soundings

The majority of the CPT soundings were performed immediately adjacent to SPT borings to facilitate correlating the readings from the CPT sounding with the samples obtained from the split-spoon and Shelby tube samplers. The CPT soundings were advanced to depths of approximately 50 ft and 100 ft below ground surface. The CPT soundings were performed using a piezocone penetrometer that provides measurements of pore water pressure at one or more locations on the penetrometer surface in general conformance with ASTM D5778. CPT data, including pore pressure measurements, were collected at 2-cm depth intervals.

The rod string and cone were advanced in natural ground at the standard rate of 2 cm/sec. At HA-C8, the rod string was advanced through the existing stratum of fly ash/boiler slag at a rate of approximately 0.6 cm per second and through the underlying natural soil at the standard rate of 2 cm/sec. The slower advancement rate in the fly ash/boiler slag was utilized because research has shown that the slower penetration rate better simulates the drained condition and provides a better interpretation of the CCR friction angle.

Seismic cone penetration testing was used to obtain in-situ measurements of shear wave velocity at HA-C7 and HA-C8. Measurements were taken at 1-meter (3.3-ft) intervals, which correspond to the intervals at which additional rods needed to be added to the rod string. Pore water dissipation testing was also performed at select depths in all CPTs to estimate hydraulic conductivity/pore pressure dissipation properties. The CPT sounding results are presented in **Appendix B**.

LABORATORY TESTING PROGRAM

A laboratory testing program was conducted on selected soil and CCR samples recovered from subsurface explorations to aid in classification and for determination of engineering properties required for design. The primary purpose of the testing program was to evaluate the index and strength properties of the soil, CCR, and boiler slag materials. Testing included natural moisture contents, Atterberg limits, grain size distributions, percent passing the No. 200 sieve, unconsolidated-undrained (UU) triaxial strength, consolidation, and tube density. The tests were performed in general conformance with applicable ASTM test procedures. Results of the laboratory testing program are presented in **Appendix C** and are summarized in **Table II**.

Subsurface Soil and Water Conditions

GEOLOGY

The site is located within the New Madrid Seismic Zone. The new Madrid Seismic Zone lies at the north end of the Mississippi Embayment, which is a deep, low-lying basin filled with Cretaceous to recent sediments. The stratigraphy at our site is presented on **Figure 3** and is based on the general profile develop by Van Arsdale and TenBrink (2000). The project site is immediately underlain by imported embankment fill and levee fill associated with embankment and levee construction as well as various deposits of fly ash and boiler slag associated with coal burning operations.

The existing fill is underlain by Quaternary Mississippi River alluvium, which is characterized by silty clay and sand, Pleistocene Loess, which is characterized by silt and clayey silt, and Pliocene-Pleistocene Upland Complex Gravel consisting of fine to very coarse sand and gravel. These sediments are believed to be surficial deposits of fluvial or estuarine origin.

Underlying the Quaternary Deposits is the Jackson Formation, which is characterized by fluvial/deltaic medium to very fine grained silty sand, interbedded with clayey silt. The Jackson Formation overlies the Eocene Claiborne Group that consists of the Cockfield Formation over the Cook Mountain Formation over The Memphis Sand. The Cockfield formation is characterized by fluvial/deltaic silt and clay interbedded with medium to fine grained sand. The Cook Mountain Formation consists of silt and clay containing variable amounts of lignite and sand. The Memphis Sand is predominately described as consisting of fluvial/deltaic fine to very coarse grained quartzose sand containing rock fragments, pyrite and lignite.

Below the Eocene Claiborne Group is Paleocene consisting of the Wilcox Group and Midway Group. The Wilcox Group is comprised of the Flour Island Formation overlying the Fort Pillow Sand. The Flour Island formation is characterized by silty clay and clayey silt with lenses of fine grained sand. The Fort Pillow Sand is described as consisting of fine to very coarse grained quartzose sand. The Midway Group is comprised of Old Breastworks Formation, Porters Creek Clay and The Clayton Formation. Old Breastworks Formation is described as sandy, micaceous silty clay. The Porters Creek Clay is described as a micaceous clay. The Clayton Formation consists of glauconitic, fossiliferous clay.

Underlying the Wilcox and Midway groups is Upper Cretaceous soil consisting of McNairy Sand, Demopolis Formation and Coffee Formation. McNairy Sand is characterized by fine to coarse grained sand interbedded with silty clay. The Demopolis Formation is composed of calcareous clays, marls and some chalky materials. The Coffee Formation is made up of stratified and cross-bedded clays and fine grained sand.

Below the Upper Cretaceous lies the Paleozoic strata. The Paleozoic strata is described as fine to coarse crystalline dolomite. At the AECI site, the depth to the Paleozoic strata is approximately 1,900 ft below ground surface.

The geologic descriptions discussed herein are credited to various references entitled “General Geology of the Mississippi Embayment” (Cushing, Boswell, Hosman 1964), “Deep Shear Wave Velocity Profiles of Mississippi Embayment Sediments Determined From Surface Wave Measurements” (Rosenblad, 2007) and “Late Cretaceous and Cenozoic Geology of the New Madrid Seismic Zone” (Van Arsdale and TenBrink, 2000).

SUBSURFACE CONDITIONS

Descriptions of the soil conditions encountered during the subsurface exploration program conducted at the site are provided below in order of increasing depth below ground surface. Actual soil conditions between boring locations may differ from these typical descriptions. Refer to the test boring logs for specific descriptions of soil samples obtained from the borings.

The subsurface conditions identified by the CPT soundings do not represent material classifications based on grain-size distributions, index tests, or visual observation. Rather, the CPT soundings provide an indicator of relative behavior type based on the mechanical characteristics measured during the soundings. For this reason, the descriptions of subsurface conditions discussed below are based on our visual-manual classification of samples obtained from test borings and the results of laboratory testing.

- *ROADWAY FILL* - Below the ground surface there is a stratum of fill material primarily described as SAND and GRAVEL. This stratum was encountered only in HA-B1, HA-B2, and HA-B6 and was fully penetrated where encountered. The thickness of this stratum was approximately 1 ft.

- *FLY ASH* - Below the ground surface at HA-B5, there is a stratum of fill material primarily described as brown, dark-brown, and black SILT with sand (ML). This stratum was encountered only in HA-B5 and was fully penetrated. Where encountered and fully penetrated, the thickness of this stratum was approximately 17 ft.

- *FLY ASH INTERMIXED WITH BOILER SLAG* - Below the fly ash at HA-B5, there is a stratum of fill material primarily described as brown and dark-brown SILT with sand and slag particles (ML). This stratum was encountered only in HA-B5 and was fully penetrated. Where encountered, the thickness of this stratum was approximately 15 ft.

- *BOILER SLAG* - Below the ground surface at HA-B4, there is a stratum of fill material primarily described as brown and dark-brown SILT with sand and slag particles (ML). This stratum was encountered only in HA-B4 and was fully penetrated. Where encountered, the thickness of this stratum was approximately 15 ft.

- *FILL* – Below the ground surface in HA-B3 and HA-B7 and below the ROADWAY FILL in HA-B1, HA-B2, and HA-B6 a stratum of FILL material was encountered. The FILL is primarily described as lean CLAY (CL) and fat CLAY (CH). This stratum was encountered and fully penetrated in borings HA-B1, HA-B2, HA-B3, HA-B6, and HA-B7. Where encountered and fully penetrated, the thickness of the stratum ranged from approximately 10.0 ft to 25.0 ft. The density of cohesive, fine-grained soils encountered in this stratum ranged from soft to stiff, but was generally medium stiff to stiff.

- *ALLUVIAL DEPOSITS* – Below the FILL, FLY ASH, FLY ASH INTERMIXED WITH BOILER SLAG, and BOILER SLAG there is a stratum of natural soil primarily described as silty SAND (SM), poorly graded SAND (SP), SILT (ML), lean CLAY (CL), and fat CLAY (CH). This stratum was encountered in all borings. This stratum was fully penetrated in all borings with the exception of HA-B7. Where encountered and fully penetrated, the thickness of this stratum ranged from approximately 7 ft to 26 ft. The density of coarse-grained soils encountered in this stratum ranged from very loose to medium dense. The consistency of fine-grained soils encountered in this stratum ranged from soft to stiff.

- *FLUVIAL DEPOSITS* – Below the ALLUVIAL DEPOSITS, there is a stratum of natural soil primarily described as light brown and gray poorly-graded SAND (SP), and light brown well-graded sand (SW). This stratum was encountered in all borings except HA-B7, but was not fully penetrated by any of the test borings. The density of coarse-grained soils encountered in this stratum ranged from medium dense to dense.

Water levels were typically measured in the boreholes when water was encountered during drilling and after the test borings were completed. Measured water levels are summarized in **Table I**. Where encountered, water levels measured during drilling generally ranged from a depth of 18 to 43 ft below ground surface, which corresponds to a water level ranging between approximately El. 257 and 293 for geotechnical evaluation purposes. It should be noted that the water levels measured in borings HA-B3, HA-B5, and HA-B5A were significantly higher than the water levels measured in the other borings and likely represent localized water conditions within the impoundment footprint.

Water levels were also estimated by the cone penetrometer soundings and are also summarized in **Table I**. Water levels estimated during the soundings generally ranged from 30 to 48 ft below ground surface, which corresponds to a water level ranging between approximately El. 258 and El. 274. It should be noted that measurements estimated during the soundings did not involve physical observation of water levels, but rather an estimated water level based on pore pressure measurements. The estimates of water levels at each sounding should only be considered accurate to the degree implied by the determination method.

Water level readings have been made in the subsurface explorations at times and under conditions discussed herein. However, it must be noted that fluctuations in the level of the water may occur due to variations in power plant sluicing activities, season, rainfall, temperature, dewatering activities, and other factors not evident at the time measurements were made and reported herein.

Safety Factor Assessment

As mentioned previously, the purpose of this study was to perform the initial safety factor assessment in accordance with Section §257.73(e)(1) of the CCR Rule. As required by the CCR Rule, the initial safety factor assessment is performed for each applicable CCR unit to determine calculated factors of safety (using simple static and pseudo-static analysis) relative to the minimum prescribed safety factors for the critical cross section of the embankment. Those are defined as follows:

- For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.
- The calculated static factor of safety under the long-term, maximum storage pool loading conditions must equal or exceed 1.50.
- The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.
- The calculated seismic factor of safety must equal or exceed 1.00.

The results of our evaluation of the safety factors are presented in the following sections of the report.

LIQUEFACTION EVALUATION

During strong earthquake shaking, loose, saturated cohesionless soil deposits may experience a sudden loss of strength and stiffness, sometimes resulting in loss of bearing capacity, large permanent lateral displacements, and/or seismic settlement of the ground. This phenomenon is called soil liquefaction.

In accordance with the requirements of §257.73(e)(1)(iv), liquefaction evaluation required is to assess the potential for liquefaction of the impoundment dikes at the site in question. A variety of screening techniques exist to distinguish sites that are clearly safe with respect to liquefaction from those sites that require more detailed study. One of the most commonly used screening techniques used to make this assessment is the evaluation of fines content and plasticity index. In general, soils having greater than 15 percent (by weight) finer than 0.005 mm, a liquid limit greater than 35 percent, and an in-situ water content less than 90 percent of the liquid limit generally do not liquefy (Seed and Idriss, 1982).

The results of our subsurface investigation indicate that the impoundment dikes at Pond 003 and Pond 004 are primarily constructed of clay soils and have the following characteristics:

- 90 percent (by weight) finer than 0.005
- Liquid limits > 40
- In-situ moisture contents less than 50 percent of the liquid limit

In consideration of the clay soils used to construct the dikes, it is our opinion, in accordance with generally accepted standards, that the impoundment dikes are not constructed of soils that are susceptible to liquefaction.

GLOBAL STABILITY FACTORS OF SAFETY

Stability analyses have been performed in general conformance with the principles and methodologies described in the USACE Slope Stability Manual (U.S. Army Corps of Engineers, 2003). Conventional static and seismic stability analyses of the impoundment dike structures were performed for rotational and block failures using limit equilibrium methods. Limit equilibrium methods compare forces, moments, and stresses which cause instability of the mass of the dike to those which resist that instability. The principle of the limit equilibrium method is to assume that if the slope under consideration were about to fail, or at the structural limit of failure, then one must determine the resulting shear stresses along the expected failure surface. These determined shear stresses are then compared with the shear strength of the soils along the expected failure surface to determine the safety factor. The specific details of the analyses performed for Pond 003 and Pond 004 are presented in the following sections of this report.

DESIGN WATER LEVEL

As stated earlier, subsurface water levels measured during our subsurface exploration program indicated static water levels were generally 30 to 48 ft below the existing ground surface. In Pond 003, zones of perched water within the impoundment were encountered within the fly ash and boiler slag due to sluicing operations. Accordingly, the following static water levels were used in our analyses.

Location	Elevation
Pond 003	East Side – El. 262 West Side – El. 274
Pond 004 (North Portion)	East Side - El. 261
Pond 004 (Southern Portion)	East Side – El. 258 West Side – El. 262

The water retained in each impoundment must be modeled at the maximum storage pool level for the static drained and seismic undrained analyses. The maximum surcharge pool level must be used to model the ponded water for the static undrained analyses. This approach is consistent with the requirements of the CCR Rule. The specific pool levels used in our analyses are summarized below and chosen as the conservative values associated with each impoundment and cross sections.

Location	Maximum Storage Pool Level	Maximum Surcharge Pool Level
Pond 003 (max. storage)	El. 301	El. 309
Pond 004 (max. storage)	El. 294	El. 301

Given the prescribed impoundment pool levels and the design static groundwater levels mentioned above, a seepage analysis was performed to determine the piezometric head between the edge of the impoundment and the toe of the dike, which is where the static groundwater level was encountered. The computer software program, Slide 6.029, developed by RocScience, Inc., was used to perform the seepage analyses and the resulting piezometric head was used in the stability analyses discussed herein.

MATERIAL PROPERTIES

The material properties used in our analyses have been developed using the results of the referenced test borings, CPT soundings, and laboratory testing. When evaluating the CPT results, material strengths were typically determined by averaging the measurements in a particular stratum and choosing conservative strength properties equal to the average value minus one standard deviation. A summary of the material properties is provided below in **Table III**.

TABLE III MATERIAL PROPERTIES				
Material	Material Strength	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)
Embankment Fill	Drained	115	50	30
	Undrained	115	800	0
Levee Fill	Drained	115	50	30
	Undrained	115	800	0
Boiler Slag (Fill)	Drained	110	0	30
	Undrained	110	500	0
Fly Ash (Fill)	Drained	90	0	28
	Undrained	90	500	0
Fly Ash / Boiler Slag (Fill)	Drained	105	0	29
	Undrained	105	800	0
Alluvial Clay	Drained	110	50	28
	Undrained	110	1300	0
Alluvial Sand	Drained	108	0	36
	Undrained	108	0	36
Fluvial Sand	Drained	120	0	38
	Undrained	120	0	38

Seismic cone penetration testing was used to obtain in-situ measurements of shear wave velocity during the subsurface exploration program. The insitu measurements were performed to a depth of 95 ft below ground surface. Below that depth, shear wave velocity measurements of the underlying soils were approximated using published data specific to the Mississippi Embayment and the New Madrid Seismic Zone (Cramer, Hashash, Romero, Rosenblad, Van Arsdale). The site specific shear wave velocity profile is shown on **Figure 4**.

SITE SPECIFIC SEISMIC RESPONSE ANALYSIS

Introduction

As mentioned previously, the New Madrid Power Plant is located within the New Madrid Seismic Zone and the Mississippi embayment. The natural embayment soils underlying the impoundments are estimated to be 1,900-ft thick. It has been demonstrated that strong ground motions are significantly de-amplified at both the short and long periods due to the nonlinear behavior of the soils in the Mississippi embayment. It has also been shown that at short periods increasing soil thickness correlates with a decreasing hazard due the nonlinear soil behavior. Similarly, at long periods, increasing soil thickness correlates with increasing hazard due to soil resonance (Cramer, 2015).

Overview of Site-Specific Seismic Analysis

A one-dimensional ground response analysis was performed to estimate the subsurface response to an earthquake event at New Madrid. Due to the complex nature of the analyses required, Dr. Professor Edward Kavazanjian, Jr. at Arizona State University and Dr. Chris Cramer at the University of Memphis were retained as part of our team to assist with the site-specific seismic analyses.

It is important that the rock motions and soil characteristics are correlated to the site conditions at the New Madrid Power Plant. Properly conditioned bedrock strong ground motions (acceleration time histories) are required to perform a site-specific seismic analysis. Strong motion records for large magnitude events are not available for Central U.S. (Romero and Rix, 2001). Therefore, alternative records were obtained from other sources that approximate the spectral response characteristics at the site.

The bedrock at the site is classified as NEHRP Site Class A, hard rock. The USGS Uniform Hazard spectral response characteristics for a hypothetical Site Class A rock, based on the 2,500 –year return period ground motions, were used to identify the spectral characteristics of the time histories (i.e., the “Target Spectrum”) used for the site-specific evaluation.

USGS Deaggregation and Deterministic Target Spectrum

There is a great deal of uncertainty with regard to predicting the location, size, and shaking intensity of future earthquakes. Probabilistic Seismic Hazard Analysis (PSHA) aims to quantify these uncertainties, and combine them to produce a description of the distribution of future shaking that may occur at a site. The 2008 NSHMP PSHA interactive deaggregation web site was used to obtain the characteristics of the most significant earthquakes (the earthquakes that contribute the most to the seismic hazard) responsible for seismic activity at the New Madrid power plant. This website produces graphical representations of the characteristics of earthquake events most likely to affect the site within a given time span. The deaggregation plot for spectral response period T=0.1s is shown on **Figure D-1 located in Appendix D**. This plot suggests that the representative design earthquake for ground motions with a return period of 2,500 years should be between magnitude 7.5 and 8.0 at a distance of approximately 11 km from the site.

The significant characteristics of the earthquake such as magnitude and distance are used to select representative ground motions. The characteristics are also used to construct the deterministic target spectrum that is used for selecting ground motions.

A special type of target spectrum, called the conditional mean spectrum (CMS), was created for the study because it focuses the spectral response of all the ground motions to a particular period along the target spectrum (Baker, 2011). The particular target period selected is related to characteristics of the structure being analyzed such as shear wave velocity and height of sliding mass in the case of the impoundments. Based on the characteristics of general failure planes determined from slope stability analysis for the impoundment, a target period of 0.1s was chosen for the deterministic CMS target spectrum for the New Madrid Power Plant. The magnitude of the CMS target spectrum was then amplified to a mean plus one standard deviation target which is conservative (i.e., the approximately 84th percentile ground motion, rather than the median, or expected, ground motion) and is generally chosen to evaluate structures that are of critical importance.

The deterministic target spectrum is based on ground motion prediction equations (GMPEs) that use magnitude and distance to predict the spectral response of the ground motion. According to the USGS PSHA, the largest event predicted to affect New Madrid Power Plant is a magnitude 8 earthquake that is 10.5km from the site. The computer software program Shake 2000, developed by GeoMotions, provided the central and eastern U.S. (CEUS) GMPEs and the CMS algorithms used to create the target spectrum. Site-specific spectral responses were generated from five CEUS attenuation relationships using Shake 2000 as shown on **Figure D-2 in Appendix D**. These attenuation relationships were based on a magnitude 8 earthquake as a distance of 10.5 km from the source. The largest spectral response in the group (i.e., Campbell, 2003) was selected to produce the target spectrum for the site.

Conditional Mean Spectrum Groundmotions Scaled To Target Period T=0.1s

The CMS spectrum according to Baker, 2011 is to be constructed with the ground motions scaled so that their spectral response at the target period, T* matches the spectral response at the CMS Target spectrum. The target period, T* is chosen to approximate the fundamental frequency of the sliding mass which can be determined from the location of the failure plane within the slope at a condition of equilibrium (i.e., safety factor equal to 1.0). The shear wave velocity V_S of the sliding mass was estimated to range between 450 ft/sec to as much as 1000 ft/sec for the impoundments at the site based on our in-situ shear wave testing. Our analyses assumed the height of the sliding mass varies from 5ft to 21ft. Based on the anticipated variance of embankment height and shear wave velocity, an average fundamental frequency of T*=0.1s was used to scale the ground motions to the target spectrum

Shake 2000 was used to provide the CMS spectrum for Campbell 2003 CEUS GMPE using a target period T* = 0.1s and amplifying the CMS to correspond to a mean plus one standard deviation spectrum. The mean plus one standard deviation spectrum shown on **Figure D-3 in Appendix D** was used as the deterministic CMS target spectrum for the New Madrid Power Plant.

Rock Motions for The CMS

Six time history records were selected to match the target response spectrum for the site. Five of these rock motions were obtained from naturally occurring events and one rock motion was synthetically generated to match a magnitude 8 earthquake associated with the ground response for the Mississippi Embayment at Memphis, TN (Atkinson 2002). A primary focus was to match the ground motion spectra to the CMS target spectrum, as suggested by NEHRP (2011) when considering magnitude, distance, and focal mechanism. Rock motion records were selected from the Pacific Earthquake Engineering Research (PEER) Center’s Strong Motion Database. The motions are summarized below in **Table IV** and depicted graphically **Figure D-4 in Appendix D**. As shown on **Figure D-5 in Appendix D**, the arithmetic mean spectrum of the generated records closely matches the CMS bedrock spectrum over the period range of interest.

TABLE IV
EARTHQUAKE RECORDS

Event	Return Period	PEER File Name	Earthquake Record Used			
			Earthquake	M	Mechanism	Distance (km)
Conditional Mean Response	2,500-year	RSN497-Nahanni_S3270.AT2	Nahinni	6.76	Reverse	5.32
		RSN550_Chalfant.A_A-CPL070.AT2	Chalfant	6.19	Strike-slip	18.31
		RSN4481_L-Aquila_FA030XTE.AT2	L'Aquila	6.3	Normal	6.81
		RSN825_ CAPEMEND_CPM000.AT2	Cape Mendocino	7.1	Reverse	6.96
		RSN8158_CChurch_LPCCN10W.AT2	Christ Church	6.2	Reverse Oblique	6.12
		N/A	Synthetic (Atkinson and Beresnev)	8.0	N/A	N/A

Due to the unusually large magnitude and close proximity of the earthquake projected for the site, it is difficult to locate ground motions that effectively scale to the shorter period portion of the CMS target spectrum. Many of the selected ground motions have spectral response characteristics that are significantly lower than the target between periods ranging from 0.01s to 0.06s. According to the Federal Highway Administration, due to the low number of ground motions for central and eastern U.S., it is acceptable to spectrally match the ground motions to the lower period portions of the target spectrum (FHWA, 2011). For this reason, the ground motions were spectrally matched to the CMS target spectrum between T=0.02sec to 0.06sec as shown on **Figure D-6 in Appendix D.**

One-Dimensional Ground Response Analysis

As mentioned previously, a one-dimensional ground response analysis was performed to estimate the surface ground motion at the site. The soil column used as input into the model was constructed from the shear wave velocity profile at the site (from in-situ testing) along with other characteristics such as layer thickness, soil density and the dynamic behavior. The dynamic geotechnical properties (damping, modulus-damping curves, density, etc.) used in the ground response analysis were obtained from prior models developed by Dr. Chris Cramer and are representative of the non-linear, pressure dependent soil properties attributed to the Mississippi Embayment as described by Romero and Rix, 2005.

The computer software program Shake2000 was used to numerically simulate the propagation of rock motions applied to the base of the soil column up through the soil layers to the top of the soil column. Shake2000 uses an equivalent linear numerical technique to model the non-linear dynamic soil behavior in the soil column. **Figure D-7 included in Appendix D** shows the results of the Shake ground response analysis for the six representative rock motions. This figure compares the spectral response of the bedrock motions to the surface ground response and shows the transformation in response caused by wave propagation through the 1,900-ft thick soil column. **Table V** summarizes the surface PGA estimates at the New Madrid Power Plant.

TABLE V PREDICTED SURFACE PGA AND NEWMARK MAGNITUDE CORRECTION FACTOR				
Earthquake	Original Magnitude	CMS Scaled-Matched PGA	Shake Surface PGA	Newmark Magnitude Correction Factor[1]
Nahinni	6.76	1.60 g	0.33 g	1.41
Chalfant	6.19	1.77 g	0.33 g	1.65
L'Aquila	6.30	1.60 g	0.66 g	1.60
Cape Mendocino	7.01	1.40 g	0.41 g	1.32
Christ Church	6.25	2.00 g	0.41 g	1.65
Synthetic (Atkinson and Beresnev)	8.00	0.95 g	0.47 g	1.00

[1] Determined using the method developed by Bray and Traversarou

Newmark Displacement Analysis

The Newmark method predicts the amount of block displacement for a given value of yield acceleration. The Newmark displacement analysis is based on the shear stress time history acting along the failure plane within the slope. The yield acceleration is the minimum amount of ground acceleration necessary to initiate motion along the failure surface and is used to determine the appropriate pseudo-static coefficient for seismic stability analyses.

Shake2000 was used to perform the Newmark displacement analysis by incorporating the results of the one-dimensional ground response analysis to estimate slope displacement. Shake2000 incorporates several different variants of the Newmark block displacement method and the numerical approach known as YSLIP developed by Kavazanjian and Matasovic (1996) was chosen for our analysis. All six site-specific bedrock motions were used to evaluate relationships between the Newmark permanent displacements and the associated yield acceleration. Several impoundment cross-sections were evaluated and the most conservative location of the failure plane was determined to be 15 ft below the top of slope.

After performing the Newmark displacement analysis, it was necessary to adjust the displacement predictions to correspond to the difference between the magnitudes of the ground motions used in the analysis and the magnitude of the representative earthquake event established for the New Madrid Power Plant. Correction factors were applied to scale the displacements to the target magnitude 8 event. The correction factors were determined using the approach developed by Bray and Travasarou (2007), which relates permanent displacement from a Newmark analysis with the magnitude of the earthquake event (Bray, 2007). **Figure D-8 in Appendix D** presents the magnitude scaled permanent displacement versus yield acceleration.

DECOUPLED SEISMIC STABILITY ANALYSIS

Methodology for Analyses

The computer software program Slide 6.029 was used to evaluate the static and seismic stability of the impoundment dikes. Analyses were performed to evaluate static drained (long-term) and undrained (short-term) strength conditions for circular and block failures using Spencer's method of slices. Spencer's method of slices was selected because it fully satisfies the requirements of force and moment equilibrium (limit equilibrium method).

Seismic stability was evaluated using pseudo-static analyses and a 20 percent reduction in material strength to represent the approximate threshold between large and small strains induced by cyclic loading (Duncan, 2014). Pseudo-static analysis models the seismic shaking as a "permanent" body force that is added to the force-body diagram of a conventional static limit-equilibrium analysis; typically, only the horizontal component of earthquake shaking is modeled because the effects of vertical forces tend to average out to near zero (Jibson, 2011). This is a traditional approach for evaluating the stability of a slope during earthquake shaking and provides a simplified safety factor analysis for one earthquake pulse. A safety factor greater than or equal to one (FS ≥ 1.0) indicates a slope is stable and a safety factor below one (FS < 1.0) indicates that the slope is unstable.

Pseudo-static Coefficient

The pseudo-static coefficient, k_s, used in our seismic analyses was selected using the results of the Newmark displacement analysis discussed previously. Accordingly, to the MSHA Impoundment Design Manual, the acceptable displacement of coal refuse impoundments is 25% of the upstream freeboard (MSHA, 2009). At each impoundment based observed conditions, that equates to:

- Pond 003 – 8 ft freeboard, acceptable displacement is 24 in.
- Pond 004 – 7-ft Freeboard, acceptable displacement is 21 in.

Assuming the most conservative case of 21-in. acceptable displacement, **Figure D-8 in Appendix D** shows that the yield acceleration corresponding to the most conservative earthquake motion is 0.25g. A pseudostatic coefficient lower than 0.25 will result in more than 21 in. deformation and one higher than 0.25 will result in less than 21 in. deformation. For the seismic stability analyses performed for the impoundments, we selected a pseudostatic coefficient of 0.28. This value was selected because it is slightly above the minimum value, which is conservative, and will result in displacements at each impoundment that are below MSHA acceptable values.

Results of Stability Evaluation

The critical cross section is defined as that which is anticipated to be most susceptible amongst all cross sections. To identify the critical cross sections at our project site, we examined the following conditions at several cross section locations at each impoundment:

a. the geometry of the upstream and downstream slopes;

b. phreatic surface levels within and below the cross sections;
c. subsurface soil conditions;
d. presence or lack of surcharge loads behind the crest of the dikes; and
e. presence or lack of reinforcing measures in front of the dikes.

Examination of the conditions noted above resulted in the identification of five (5) critical cross sections. Two (2) of the cross sections were located at Pond 003 and three (3) of the cross sections were located at the Pond 004. The results of our analyses are presented below in **Table VI** and are shown on the Slide output files included in **Appendix D**. As shown below, the static safety factors are above the minimum required values for all sections. The pseudo-static analyses for the analyzed sections indicate acceptable seismic safety factors for sections A-A', B-B', C-C', and D-D'. Section E-E' was originally modeled with its configuration as of 2015 with CCR staged near the dike on the west side of the Pond 004 impoundment. The preliminary static analyses for that scenario indicated acceptable factors of safety, but the seismic analyses did not. As noted previously, AECI revised the configuration of that staged material in 2016, and the results of the revised E-E' configuration indicate acceptable seismic and static safety factors. The results of the analyses based on the revised configuration are presented in Table VI and Appendix D.

TABLE VI
SUMMARY OF STABILITY EVALUATIONS

Cross Section	Condition[1]	Earthquake Event	Soil Strength	Required Safety Factor	Safety Factor	
					Rotational Failure Surface	Block Failure Surface
A-A’ (Pond 004)	Static	-	Drained	1.5	4.3	4.9
			Undrained	1.4	4.3	4.5
	Seismic	2,500-year	Undrained[2]	1.0	1.2	1.1
B-B’ (Pond 004)	Static	-	Drained	1.5	3.8	4.3
			Undrained	1.4	7.6	6.4
	Seismic	2,500-year	Undrained[2]	1.0	1.2	1.3
C-C’ (Pond 004)	Static	-	Drained	1.5	3.6	4.3
			Undrained	1.4	3.9	4.5
	Seismic	2,500-year	Undrained[2]	1.0	1.1	1.2
D-D’ (Pond 003)	Static	-	Drained	1.5	2.3	3.7
			Undrained	1.4	5.0	6.3
	Seismic	2,500-year	Undrained[2]	1.0	1.2	1.3
E-E’ (Pond 003)	Static	-	Drained	1.5	3.1	4.1
			Undrained	1.4	4.1	4.3
	Seismic	2,500-year	Undrained[2]	1.0	1.1	1.3

1. Refer to Table III for material properties.
2. Shear strengths have been reduced by 20 percent for seismic analyses.

DISCUSSION AND RECOMMENDATIONS

The analyses associated with the safety factor assessment have been performed in accordance with the requirement of Section §257.73 of the CCR Rule. A summary of our conclusions and recommendations as they relate to the rule requirements are provided below.

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

  The results of our subsurface investigation indicate that the impoundment dikes at the Pond 003 and Pond 004 are primarily constructed of clay soils that are not susceptible to liquefaction. Accordingly, this requirement has been met.

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

  As shown in **Table VI**, the static safety factors for the long-term (drained) maximum storage pool condition are above the minimum required values for all critical sections analyzed at Pond 003 and Pond 004. Accordingly, this requirement has been met.

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

  As shown **in Table VI**, the static safety factors for the maximum surcharge pool loading condition (undrained) are above the minimum required values for all critical sections analyzed at Pond 003 and Pond 004. Accordingly, this requirement has been met.

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

  As shown in **Table VI**, the calculated seismic safety factors are above the minimum required value for all critical sections at Pond 003 and Pond 004. Accordingly, this requirement has been met.

CERTIFICATION

Based on our review of the information provided to us by AECI and the results of our field investigations and analyses, it is our opinion that the calculated factors of safety for the critical cross sections of the impoundment embankments for Pond 003 and Pond 004 meet the minimum factors of safety specified in §257.73(e)(1)(i) through (iv) of the EPA's CCR Rule.

Certification Statement – Pond 003

I certify that the Initial Safety Factor Assessment for AECI's Pond 003 at the New Madrid Power Plant meets the requirements of §257.73(e) of the EPA's CCR Rule.

Signed: ______________________________
Certifying Engineer

Print Name: Steven F. Putrich
Missouri License No.: 2014035813
Title: Project Principal
Company: Haley & Aldrich, Inc.

Professional Engineer's Seal:

Certification Statement – Pond 004

I certify that the Initial Safety Factor Assessment for AECI's Pond 004 at the New Madrid Power Plant meets the requirements of §257.73(e) of the EPA's CCR Rule.

Signed: ______________________________
Certifying Engineer

Print Name: Steven F. Putrich
Missouri License No.: 2014035813
Title: Project Principal
Company: Haley & Aldrich, Inc.

Professional Engineer's Seal:

CLOSING

We appreciate the opportunity to provide engineering services on this project to AECI.

Sincerely yours,
HALEY & ALDRICH, INC.

Derrick A. Shelton
Geotechnical Program Manager | Senior Associate

Steven F. Putrich, P.E.
Project Principal

Enclosures:

- References
- Table I – Summary of Subsurface Explorations
- Table II – Summary of Laboratory Test Results
- Figure 1 – Project Locus
- Figure 2 – Subsurface Exploration Location Plan
- Figure 3 – Geologic Column for the New Madrid Seismic Zone
- Figure 4 – Design Shear Wave Velocity Profile
- Appendix A – Test Boring Logs
- Appendix B – CPT Sounding Logs and Related Information
- Appendix C – Laboratory Test Results
- Appendix D - Analyses

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TABLE I

SUMMARY OF SUBSURFACE EXPLORATIONS
ASSOCIATED ELECTRIC COOPEATIVE, INC.
003 UNLINED POND AND 004 SLAG DEWATERING POND
MARSTON, MISSOURI

Exploration Designation[1]	Ground Surface El.[2] (ft)	Northing[2]	Easting[2]	Total Exploration Depth (ft)	Water[3]	
					Depth Below Ground Surface (ft)	Elevation (ft)
HA-B1	309.3	249123.8	1096406.3	50.0	43.0	266.3
HA-B2	300.2	249425.1	1096677.9	95.0	40.5	259.7
HA-B3	308.8	247288.9	1096492.8	75.0	43.0	265.8
HA-B4	304.2	246728.8	1097737.1	95.0	13.0[4]	291.2
HA-B4A	304.2	246728.8	1097737.1	15.0	Not Encountered	--
HA-B5	316.1	246385.4	1096344.8	50.0	43.0	273.1
HA-B5A	316.1	246385.4	1096344.8	29.0	25.0[4]	291.1
HA-B6	307.4	245683.4	1098768.8	75.0	40.0	267.4
HA-B7	302.9	249818.4	1096496.9	27.0	Not Encountered	--
HA-C1	301.1	249768.9	1096418.4	50.0	41.0	260.1
HA-C2	309.2	249121.4	1096407.6	50.0	48.1	261.1
HA-C3	299.9	249422.8	1096674.6	95.1	41.8	258.1
HA-C4	296.5	249095.4	1096352.8	50.0	35.0	261.5
HA-C5	309.5	247296.2	1096499.1	75.1	43.4	266.1
HA-C6	296.7	247092.3	1096316.1	50.0	30.1	266.6
HA-C7	304.2	246735.4	1097740.8	95.1	41.8	262.4
HA-C8	315.8	246390.2	1096337.2	50.0	42.0	273.8
HA-C9	307.3	245688.2	1098766.8	75.1	47.2	260.1
HA-C10	303.0	249815.6	1096496.5	50.5	42.0	261.0

Notes:

1) Technical monitoring of subsurface explorations completed during the period 14 September 2015 through 2 September 2015 was performed by Haley & Aldrich, Inc.

2) Elevations are in feet and reference North American Vertical Datum of 1988 (NAVD88). Ground surface elevations of subsurface explorations were determined by optical survey. Survey performed by Smith & Company, Inc.

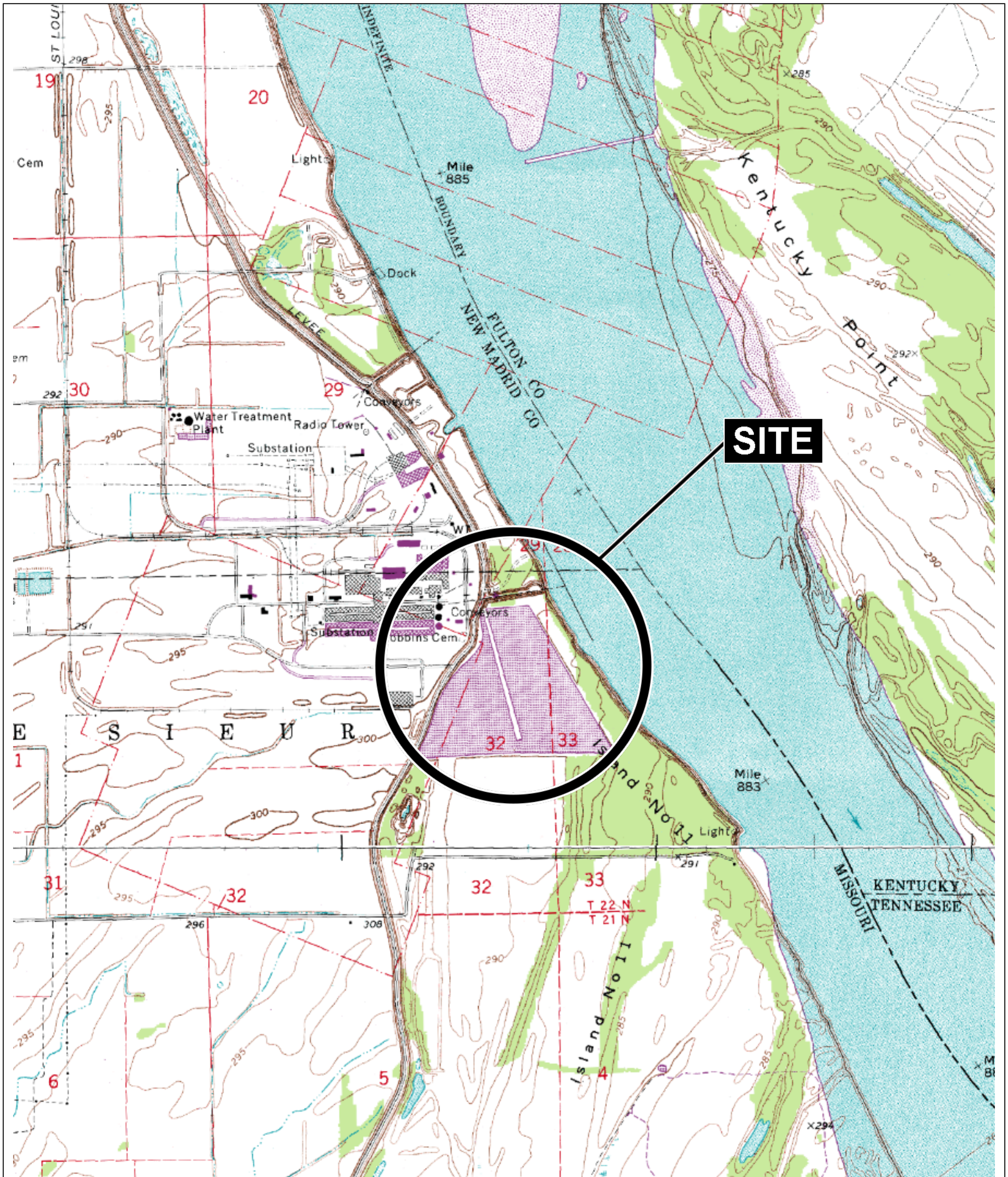
3) Water level readings represent the highest water level observed either during drilling, after completion of the boring, or as indicated by subsurface exploration instruments. Refer to the subsurface exploration logs for additional water level data. Water level readings have been made in the subsurface explorations at times and under conditions discussed herein. However, it must be noted that fluctuations in the level of the water may occur due to variations in season, rainfall, temperature, and other factors not evident at the time measurements were made and reported.

4) Possible perched water.

TABLE II
SUMMARY OF LABORATORY TEST RESULTS
ASSOCIATED ELECTRIC COOPEATIVE, INC.
003 UNLINED POND AND 004 SLAG DEWATERING POND
MARSTON, MISSOURI

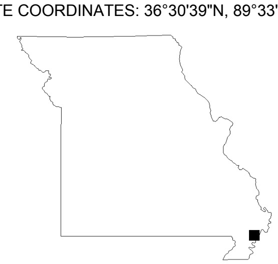
Boring Designation	Sample Number	Sample Depth (ft)	USCS Symbol	Material Type	Moisture Content (%)	LL	PL	PI	% Gravel	% Sand	% Fines	Tube Dry Density (pcf)	UU Triaxial			Consolidation		
													Moisture Content (%)	Dry Density (pcf)	S_u (tsf)	e_o[1]	C_c[1]	P_c[1] (tsf)
HA-B1	S6	11.0-13.0	CL	Fill	22.8	42	20	22			92.7							
HA-B2	S11	28.0-30.0	SM	Natural Soil	20.7				0.0	67.9	32.1							
HA-B3	S3	5.0-7.0	CL	Fill	26.7				0.0	4.8	95.2							
HA-B3	S7	13.0-15.0	CL	Fill	22.8	47	22	25			95.5							
HA-B3	S10	28.0-30.0	CH	Natural Soil	36.1						98.4							
HA-B4	U2	5.0-7.0	ML	Boiler Slag	32.9				0	0.7	99.3	80.0				1.08	0.23	1.1
HA-B4	S15	48.0-50.0	SP	Natural Soil	18.1				0.5	95.1	4.4							
HA-B5	U1	10.0-12.0	ML	Fly Ash	38.3				0.0	1.4	98.6	71.7				1.04	0.18	2.0
HA-B5	U2	20.0-22.0	ML	Fly Ash	34.6							77.8	41.0	73.1	0.3	1.14	0.19	2.8
HA-B6	S4	7.0-9.0	CL	Fill	22.6	45	21	24			94.4							
HA-B6	S7	13.0-15.0	CL	Natural Soil	21.1	39	20	19			96.5							
HA-B7	S6	11.0-13.0	CH	Fill	22.5	59	20	39			87.3							

Notes:
1. e_o = Void Ratio, C_c = Compression Ratio, P_c = Estimated Preconsolidation Pressure



MAP SOURCE: USGS

SITE COORDINATES: 36°30'39"N, 89°33'29"W



HALEY ALDRICH

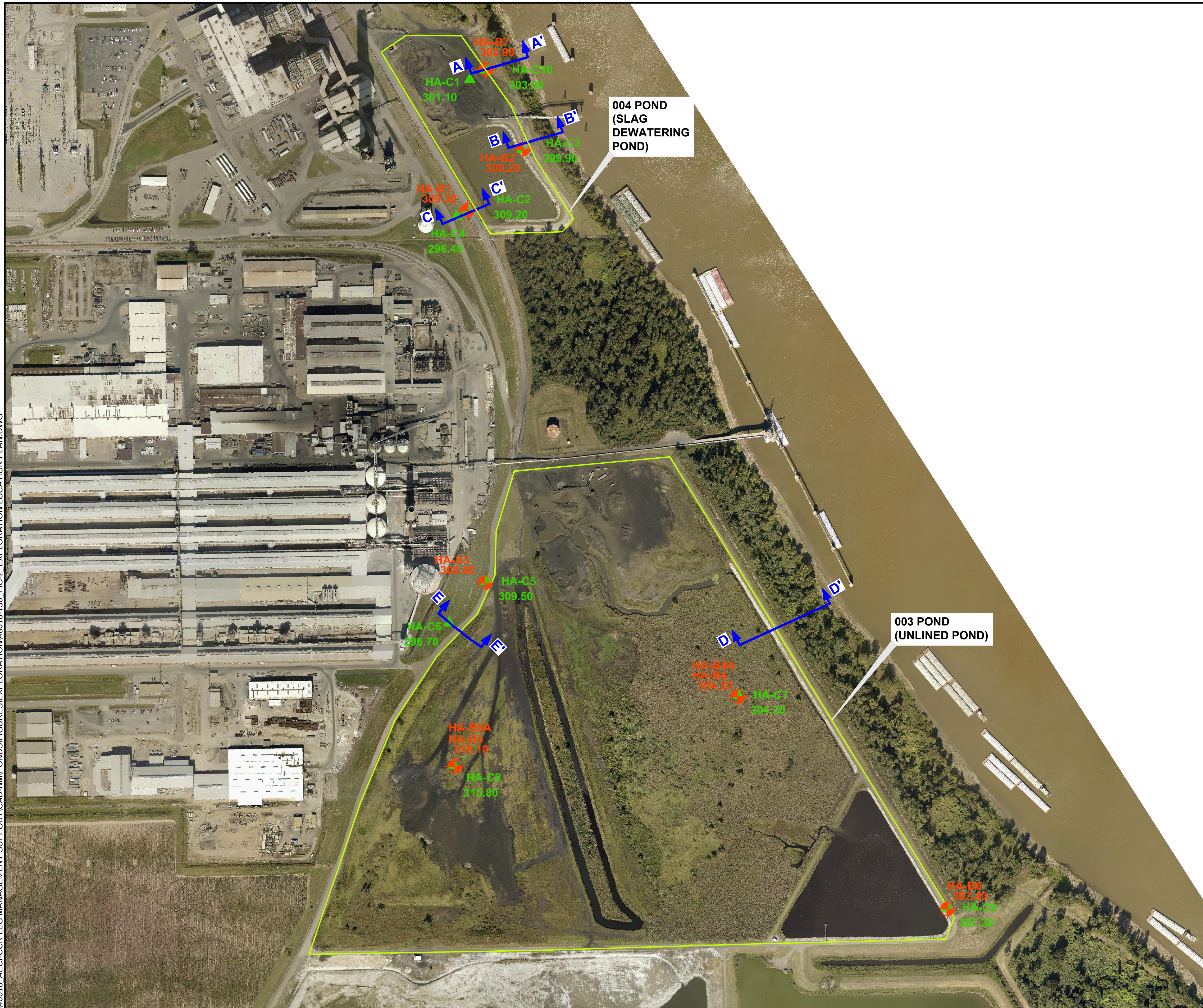
ASSOCIATED ELECTRIC COOPERATIVE, INC.
003 UNLINED POND AND 004 SLAG DEWATERING POND
NEW MADRID POWER PLANT
MARSTON, MISSOURI

PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
FEBRUARY 2016

FIGURE 1

40616_300_LOCUS.PDF



LEGEND

HA-B3 308.8 — DESIGNATION, LOCATION AND GROUND SURFACE ELEVATION OF TEST BORINGS PERFORMED BY BULLDOG DRILLING, INC. OF DUPO, ILLINOIS DURING THE PERIOD 14 SEPTEMBER 2015 TO 22 SEPTEMBER 2015. DESIGNATIONS THAT INCLUDE AN "A" CORRESPOND TO OFFSET BORINGS PERFORMED IMMEDIATELY ADJACENT TO THE ORIGINAL BORING.

HA-C6 296.7 — DESIGNATION, LOCATION AND GROUND SURFACE ELEVATION OF CONE PENETROMETER SOUNDINGS PERFORMED BY CONETEC, INC. OF WEST BERLIN, NEW JERSEY DURING THE PERIOD 15 SEPTEMBER 2015 TO 17 SEPTEMBER 2015.

A A' — GEOLOGIC CROSS-SECTION LOCATION

APPROXIMATE POND EXTENT

NOTES

1. EXPLORATION LOCATION PLAN WAS PREPARED FROM AN AERIAL IMAGE PROVIDED BY AECI THAT WAS CONDUCTED BY PICTOMETRY INTERNATIONAL CORP BETWEEN OCTOBER 4-8, 2014.
2. ELEVATIONS INDICATED ON THIS DRAWING ARE IN FEET AND REFER TO NAVD 1988 DATUM. HORIZONTAL CONTROL IS BASED ON MISSOURI STATE PLANE COORDINATE SYSTEM - EAST ZONE.
3. TECHNICAL MONITORING OF TEST BORINGS AND CONE PENETROMETER SOUNDINGS COMPLETED DURING THE PERIOD 14 SEPTEMBER 2015 TO 22 SEPTEMBER 2015 WAS PERFORMED BY HALEY & ALDRICH, INC.
4. AS DRILLED LOCATIONS AND GROUND SURFACE ELEVATIONS OF TEST BORINGS AND CONE PENETROMETER SOUNDINGS WERE DETERMINED IN THE FIELD BY SMITH & COMPANY ENGINEERS OF POPLAR BLUFF, MISSOURI BY OPTICAL SURVEY.

N

0 500 1000

SCALE IN FEET

HALEY ALDRICH

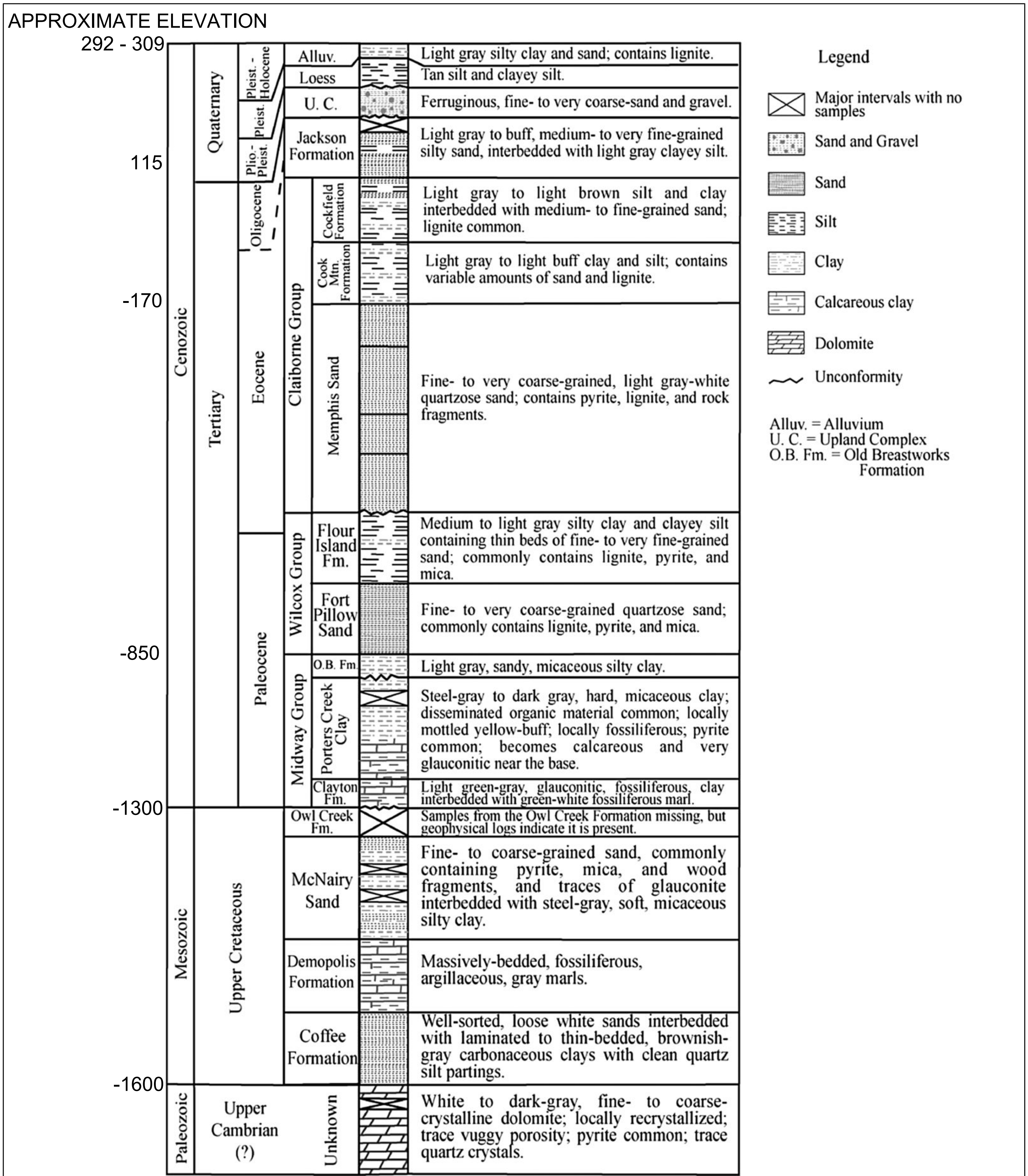
ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT
003 UNLINED POND AND 004 SLAG DEWATERING POND
MARSTON, MO

SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
FEBRUARY 2016

FIGURE 2

VARI, KATALIN Printed: 10/29/2015 1:40 PM Layout: XS LOC
G:\40616_AECI-CCR ELG MANAGEMENT SUPPORT\CAD-NM\PONDS\FIGURES\EXPLORATION\40616-130_FIG-2_EXPLORATION LOCATION PLAN.DWG



NOTES

1. IMAGE REFERENCE: VAN ARSDALE AND TENBRINK (2000).

2. ELEVATIONS SHOWN ARE SPECIFIC TO THE NEW MADRID POWER PLAN SITE AND WERE ESTIMATED USING FIGURES FROM VAN ARSDALE AND TENBRINK (2000) AND ROSENBLAD (2007).

3. ELEVATIONS INDICATED ON THIS DRAWING ARE IN FEET AND REFER TO NAVD 1988 DATUM.

HALEY ALDRICH

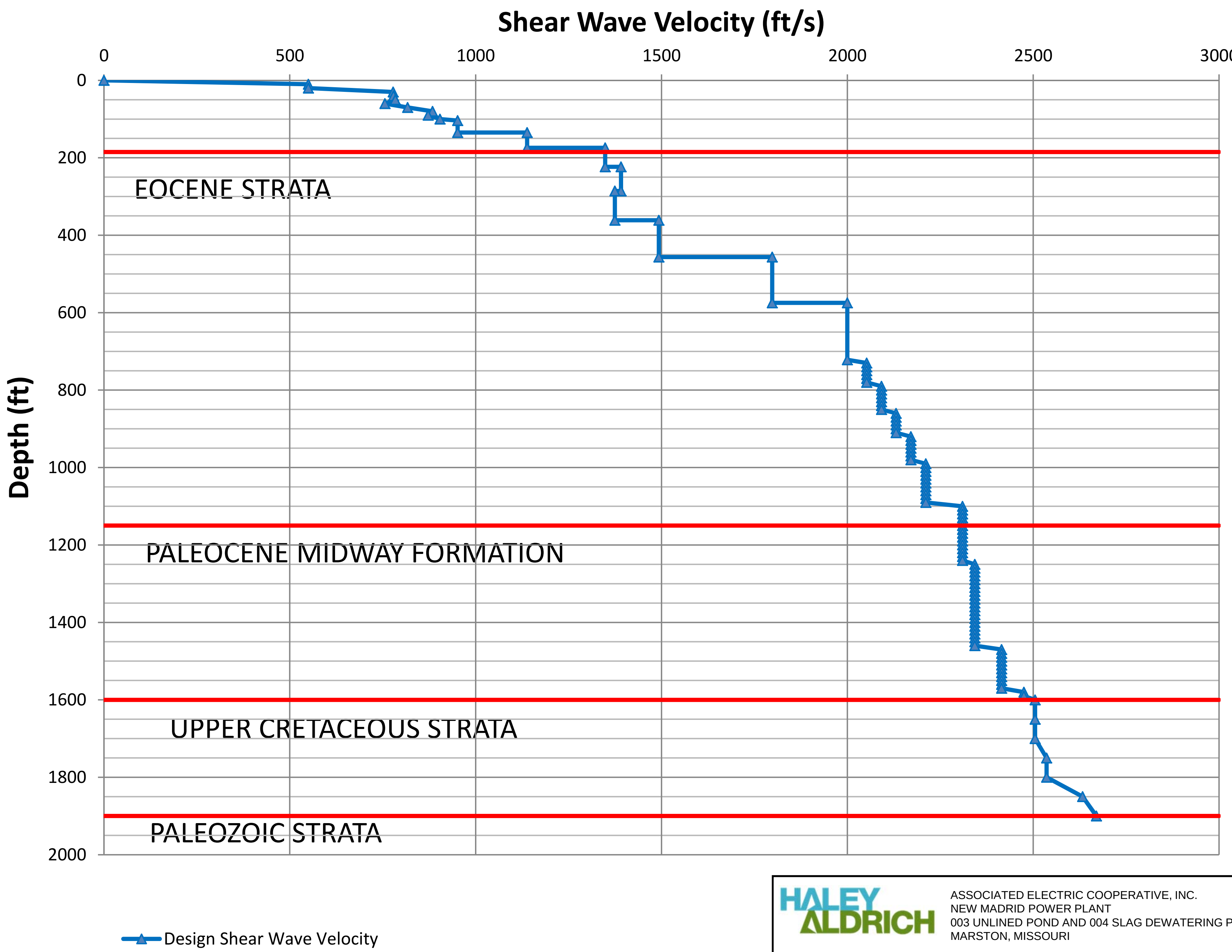
ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT
003 UNLINED POND AND 004 SLAG DEWATERING POND
MARSTON, MO

GEOLOGIC COLUMN FOR THE NEW MADRID SEISMIC ZONE

APPROXIMATE SCALE: AS SHOWN
FEBRUARY 2016

FIGURE 3

40616_3.PDF



HALEY ALDRICH

ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT
003 UNLINED POND AND 004 SLAG DEWATERING POND
MARSTON, MISSOURI

DESIGN SHEAR WAVE VELOCITY PROFILE

SCALE : AS SHOWN
FEBRUARY 2016

FIGURE 4

40616-300_FIG 4.PPT

APPENDIX A

Test Boring Logs

TEST BORING REPORT

Boring No. HA-B1

Project	Slag Dewatering Pond and Unlined Pond, New Madrid Power Plant, Marston, Missouri	File No.	40616-300
Client	Associated Electric Cooperative, Inc.	Sheet No.	1 of 3
Contractor	Bulldog Drilling, Inc.	Start	22 September 2015
		Finish	22 September 2015
		Driller	J. Gates
		H&A Rep.	C. Toscano
		Elevation	309.3
		Datum	NAVD 88
		Location	See Plan N 249,124 E 1,096,406

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	4.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures
Rig Make & Model: CME 55 L6
Bit Type: Cutting Head
Drill Mud: Polymer
Casing: Spun
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model: N/A

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0						-SAND/GRAVEL ROADWAY FILL-										
	3 4 4 4	S1 12	1.0 3.0	308.3 1.0	SM	Loose brown to orange-brown silty SAND with gravel (SM) mps 20 mm, no odor, dry	5	10	5	20	25	35				
						-FILL-										
	3 3 4 5	S2 20	3.0 5.0	306.3 3.0	CL	Medium stiff dark brown lean CLAY (CL) intermixed with pockets of silt and fine sandy silt, mps 1 mm, no odor, moist						100				
5	2 3 5 5	S3 20	5.0 7.0	304.3 5.0	ML	Loose dark brown sandy SILT (ML) intermixed with pockets of lean clay, mps 1 mm, no odor, moist					40	60				
	2 3 4 6	S4 24	7.0 9.0	302.3 7.0	CL	Medium stiff dark brown lean CLAY (CL), mps < 1 mm, no odor, moist						100	S	M	M	H
10	3 3 5 5	S5 15	9.0 11.0		CL	Similar to S4						100	S	M	M	H
	1 2 4 4	S6 24	11.0 13.0		CL	Similar to S4, except intermixed with pockets of silt and seams of fine sand					7	93				
	2 2 3 3	S7 24	13.0 15.0		CL	Similar to S4, except intermixed with pockets of silt and seams of fine sand						100				
15																
	1 3 4 7	S8 24	18.0 20.0		CL	Similar to S4, except gray-brown						100				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
9/22/15					43.0

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 50.0
Rock Cored (ft) --
Samples 14S

Boring No. HA-B1

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA-B1
File No. 40616-300
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																
	2 3 4 5	S9 24	23.0 25.0		CL	Similar to S4, except gray-brown -FILL-						100	S	M	M	H
25																
				283.3 26.0		Note: Drill cuttings indicate alluvial soils at 26.0 ft.										
	1 1 3 4	S10 20	28.0 30.0		CL	Soft light brown lean CLAY (CL) with interbedded seams of fine sandy silt, mps <1 mm, no odor, wet -ALLUVIAL DEPOSITS-						100				
30																
	6 6 12 17	S11 24	33.0 35.0	276.3 33.0	SM	Medium dense light brown silty SAND (SM), mps 1 mm, no odor, dry -FLUVIAL DEPOSITS-					60	40				
35																
	9 11 17 25	S12 20	38.0 40.0		SM	Medium dense light brown silty SAND (SM), mps 2 mm, well stratified, no odor, dry			5	70	25					
40						-FLUVIAL DEPOSITS-										
	11 11 12 14	S13 20	43.0 45.0		SM	Similar to S12			5	80	15					
45						Note: Drill action indicated possible gravel layer at approximately 46.0 ft. Lost approximately 100 gallons of drill fluid from 46.0 to 48.0 ft.										
	9 10 12 17	S14 24	48.0 50.0		SM	Similar to S12			5	75	20					

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. HA-B1

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50				259.3 50.0		BOTTOM OF EXPLORATION 50.0 FT Note: Borehole grouted upon completion.										

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. HA-B2

Project	Slag Dewatering Pond and Unlined Pond, New Madrid Power Plant, Marston, Missouri
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling, Inc.

File No.	40616-300
Sheet No.	1 of 4
Start	21 September 2015
Finish	21 September 2015
Driller	J. Gates
H&A Rep.	C. Toscano
Elevation	300.2
Datum	NAVD 88
Location	See Plan N 249,425 E 1,096,678

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	4.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

- Rig Make & Model: CME 55 L6
- Bit Type: Cutting Head
- Drill Mud: Polymer
- Casing: Spun
- Hoist/Hammer: Winch Automatic Hammer
- PID Make & Model: N/A

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						SAND/GRAVEL ROADWAY FILL-										
	1 2 3 3	S1 20	1.0 3.0	299.2 1.0	CL	Medium stiff gray to gray-brown clean CLAY (CL), mps <1 mm, no odor, moist, trace organic fibers -FILL-						100				
	3 3 4 5	S2 20	3.0 5.0		CL	Similar to S1, except with 15% cinders and slag particles by volume						100				
5	3 3 5 7	S3 24	5.0 7.0		CL	Similar to S1, except trace cinders and slag particles						100	S	M	M	H
	3 4 5 9	S4 24	7.0 9.0		CL	Stiff gray-brown lean CLAY (CL), 5% cinders and slag particles by volume, mps 3 mm, no odor, moist						100				
10	2 3 4 6	S5 24	9.0 11.0		CL	Medium stiff gray to gray-brown lean CLAY (CL), mps < 1mm, no odor, moist, trace organic fibers						100	S	M	M	H
	2 3 5 7	S6 24	11.0 13.0		CL	Similar to S5						100	S	M	M	H
	2 3 4 5	S7 24	13.0 15.0		CL	Similar to S5						100	S	M	M	H
15	2 3 3 4	S8 24	15.0 17.0		CL	Similar to S5						100				
				282.2 18.0		Note: Sands observed on auger flights at approximately 18.0 to 19.0 ft. -ALLUVIAL DEPOSITS-										
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
9/21/15					43.0
9/22/15	06:45				40.5

Sample ID

- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	95.0
Rock Cored (ft)	--
Samples	23S

Boring No. HA-B2

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	2 3 5 7	S9 24	20.0 22.0		SM	Loose light brown silty SAND (SM) with frequent interbedded layers of gray-brown silt, mps 1 mm, stratified, no odor, dry					60	40				
						-ALLUVIAL DEPOSITS-										
	2 4 7 10	S10 18	23.0 25.0	277.2 23.0	CL	Medium dense gray-brown lean CLAY (CL) with frequent interbedded seams and layers of silty fine sand, mps 1 mm, well stratified, no odor, moist					5	95				
25				274.7 25.5												
	4 6 9 11	S11 20	28.0 30.0		SM	Medium dense light brown silty SAND (SM) with interbedded seams of silt and fine sand, mps 1 mm, no odor, moist					68	32				
30																
	11 14 15 17	S12 15	33.0 35.0	267.2 33.0	SP	Medium dense light brown poorly graded SAND (SP), mps 2 mm, no odor, moist				40	60					
						-FLUVIAL DEPOSITS-										
35																
	7 10 11 13	S13 13	38.0 40.0		SP	Similar to S12, except with frequent seams of naturally occurring lignite particles to fragments			5	60	35					
40 ▽																
	9 10 10 13	S14 15	43.0 45.0	257.2 43.0	SM	Medium dense light brown silty SAND (SM) with interbedded seams of silt and fine sand, mps 1 mm, well stratified, no odor, wet					60	40				
45																
	3 4 8 9	S15 12	48.0 50.0		SM	Medium dense dark gray silty SAND (SM), no odor, wet					60	40				
				251.2 49.0	SP	Medium dense gray poorly graded SAND (SP), mps 3 mm, no odor, wet			80	20						

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50						Note: Drill action indicated possible gravel at 52.0 to 53.0 ft.										
	6 7 8 12	S16 12	53.0 55.0	247.2 53.0	SM	Medium dense gray silty SAND (SM), trace coarse to fine gravel, mps 2 mm, no odor, wet			5	80	15					
55						-FLUVIAL DEPOSITS-										
	6 6 8 9	S17 12	58.0 60.0	242.2 58.0	SP	Medium dense gray poorly graded SAND (SP), trace limited fragments and particles, mps 3 mm, no odor, wet			10	90						
60																
	7 9 10 12	S18 14	63.0 65.0		SP	Similar to S17			30	65	5					
65						Note: Drill action indicated possible gravel from 67.0 to 68.0 ft.										
	6 6 8 10	NR	68.0 70.0			No Recovery										
70						Note: Drill action indicated possible gravel from 71.0 to 72.0 ft.										
	7 8 11 10	S19 20	73.0 75.0		SP	Similar to S17, trace coarse to fine gravel, mps 15 mm			10	80	5					
75																
	12 12 14	S20 15	78.0 80.0		SP	Similar to S17, no lignite			10	90						

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	18															
80																
	12 15 18 23	S21 18	83.0 85.0		SP	Dense gray poorly graded SAND (SP), mps 3 mm, no odor, wet			5	90	5					
85																
						-FLUVIAL DEPOSITS-										
						Note: Drill action indicated possible gravel from 87.5 to 88.0 ft.										
	20 14 17 18	S22 15	88.0 90.0		SP	Dense gray well graded SAND with gravel (SP), mps 24 mm, no odor, wet		15	30	45	10					
90																
						Note: Drill action indicated possible gravel from 91.0 to 92.0 ft.										
	19 21 13 23	S23 24	93.0 95.0		SP	Dense gray poorly graded SAND (SP), mps 3 mm, no odor, wet				80	20					
95				205.2 95.0		BOTTOM OF EXPLORATION 95.0 FT										
						Note: Borehole grouted upon completion.										

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA-B3

Project	Slag Dewatering Pond and Unlined Pond, New Madrid Power Plant, Marston, Missouri	File No.	40616-300
Client	Associated Electric Cooperative, Inc.	Sheet No.	1 of 3
Contractor	Bulldog Drilling, Inc.	Start	14 September 2015
		Finish	15 September 2015
		Driller	J. Gates
		H&A Rep.	C. Toscano

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	--	Rig Make & Model: CME 55 L6
Inside Diameter (in.)	4.25	1.375	--	Bit Type: Cutting Head; Drill Mud: Polymer
Hammer Weight (lb)	--	140	-	Casing: Spun; Hoist/Hammer: Winch Automatic Hammer
Hammer Fall (in.)	--	30	-	PID Make & Model: N/A

Elevation 308.8
Datum NAVD 88
Location See Plan
N 247,289
E 1,096,493

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0																
	13 9 5 7	S1 12	1.0 3.0		CL	Stiff brown lean CLAY with sand (CL), trace coarse to fine gravel, mps 25 mm, no odor, dry -FILL-					15	85				
	7 3 3 4	S2 15	3.0 5.0		CL	Similar to S1, except medium stiff, no gravel, fly ash coating on outer surface of soil sample					20	80				
5	2 2 3 5	S3 15	5.0 7.0		CL	Medium stiff brown lean CLAY (CL), trace organic fibers, mps <1 mm, no odor, moist				2	3	95				
	2 1 3 4	S4 12	7.0 9.0		CL	Similar to S3, except soft, mottled, fly ash coating on outer surface of soil sample										
	2 1 3 4	S5 18	9.0 11.0		CL	Soft brown to gray lean CLAY (CL), mps <1 mm, mottled, no odor, moist						100				
10	1 2 2 3	S6 15	11.0 13.0		CL	Soft brown lean CLAY (CL), trace organic fibers, mps <1 mm, no odor, moist					5	95				
	1 1 3 4	S7 18	13.0 15.0		CL	Soft orange-brown to gray-brown lean CLAY (CL), mps <1 mm, no odor, moist					4	96				
15																
	1 3 3 3	S8 16	17.0 19.0	289.8 19.0	CL	Medium stiff brown lean CLAY with sand (CL), mps 1 mm, no odor, wet					25	75				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
9/14/15					43.0

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	75.0
Rock Cored (ft)	--
Samples	19S

Boring No. HA-B3

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																
						Note: Started mud rotary at 23.0 ft.										
	2 3 4 6	S9 18	23.0 25.0		CL	Medium stiff light brown lean CLAY (CL), trace coarse to fine sand, mps 2 mm, no odor, wet						100				
25																
						-ALLUVIAL DEPOSITS-										
	2 2 2 4	S10 20	28.0 30.0	280.8 28.0	CH	Soft brown to gray-brown fat CLAY (CH) with fine sand in occasional partings, mps 1 mm, no odor, dry					4	96	N	M	M	H
30																
	6 11 10 13	S11 24	33.0 35.0	275.8 33.0	SP	Medium dense brown poorly graded SAND (SP), mps 2 mm, no odor, moist, well stratified				10	90					
						-FLUVIAL DEPOSITS-										
35																
	6 7 11 15	S12 20	38.0 40.0		SP	Similar to S11, non stratified				75	25					
40																
				267.8 41.0		Note: Drill action indicated possible gravel at 41.0 ft.										
	13 16 16 18	S13 20	43.0 45.0		SW	Dense brown well graded SAND (SW), mps 3 mm, no odor, wet (coarse to fine gravel found at top 4 in . of spoon sample)			15	60	25					
45																
						-FLUVIAL DEPOSITS-										
	11 11 17 22	S14 18	48.0 50.0		SW	Similar to S13, except medium dense			15	55	30					

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA-B3
File No. 40616-300
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																
	7 8 13 16	S15 18	53.0 55.0	255.8 53.0	SP	Medium dense gray-brown poorly graded SAND (SP), mps 2 mm, no odor, wet				20	80					
55						-FLUVIAL DEPOSITS-										
	10 10 13 13	S16 20	58.0 60.0	250.8 58.0	SW	Medium dense gray-brown well graded SAND (SW), mps 5 mm, no odor, wet			20	65	15					
60																
	11 13 14 18	S17 22	63.0 65.0	245.8 63.0	SP	Medium dense gray-brown poorly graded SAND (SP), mps 2 mm, no odor, wet				35	65					
65																
	15 16 16 12	S18 3	68.0 70.0		SP	Similar to S15, except dense, possibly pushing gravel (poor recovery)				20	80					
70																
	9 13 14 15	S19 18	73.0 75.0	235.8 73.0	SW	Medium dense gray-brown well graded SAND (SW), mps 3 mm, no odor, wet			15	60	25					
75				233.8 75.0		BOTTOM OF EXPLORATION 75.0 FT Note: Borehole grouted upon completion to ground surface.										

TEST BORING REPORT

Boring No. HA-B4

Project	Slag Dewatering Pond and Unlined Pond, New Madrid Power Plant, Marston, Missouri	File No.	40616-300
Client	Associated Electric Cooperative, Inc.	Sheet No.	1 of 4
Contractor	Bulldog Drilling, Inc.	Start	17 September 2015
		Finish	18 September 2015
		Driller	J. Gates
		H&A Rep.	C. Toscano

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	--	Rig Make & Model: CME 55 L6
Inside Diameter (in.)	4.25	1.375	--	Bit Type: Cutting Head; Drill Mud: Polymer
Hammer Weight (lb)	--	140	-	Casing: Spun; Hoist/Hammer: Winch Automatic Hammer
Hammer Fall (in.)	--	30	-	PID Make & Model: N/A

Elevation 304.2
Datum NAVD 88
Location See Plan
N 246,729
E 1,097,737

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0																
	1 2 1 1	S1 5	1.0 3.0		ML	Very loose brown to dark brown SILT with sand (ML) with frequent interbedded seams and layers of medium to fine grained cinders and slag, mps 3 mm, no odor, wet					15	85				
						-BOILER SLAG-										
	2 2 1 2	S2 15	3.0 5.0		ML	Similar to S1				5	15	80				
5	2 1 1 2	S3 12	5.0 7.0		ML	Similar to S1					10	90				
	1 1 1 1	S4 15	7.0 9.0		ML	Similar to S1, except no sand, wet (perched groundwater)					5	95				
10	WOH/24"	S5 24	9.0 11.0		ML	Very loose dark brown SILT (ML), mps <1 mm, no odor, wet (outside of spoon dry)						100				
	1 1 1 1	S6 20	11.0 13.0	293.2 11.0	SM	Very loose black silty SAND (SM), mps 3 mm, no odor, wet, contains cinders and slag particles Note: Spoon completely wet, possible perched groundwater.			40	50	10					
	1 1 1 1	S7 15	13.0 15.0		SM	Similar to S6 (natural silt found in tip of spoon)			20	70	10					
15	WOH/24"	S8 24	15.0 17.0	289.2 15.0	CL	Very soft brown lean CLAY (CL), trace wood particles, mps 2 mm, no odor, wet						100				
						-ALLUVIAL DEPOSITS-										
	1 1 2 2	S9 24	18.0 20.0		CL	Soft brown to orange-brown lean CLAY (CL), mps < 1 mm, no odor, moist					5	95				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
9/17/15					13.0

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 95.0
Rock Cored (ft) --
Samples 23S

Boring No. HA-B4

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																
	1 1 6 11	S10 24	23.0 25.0		CL	Similar to S9						100				
				280.2 24.0	SP	Medium dense light brown poorly graded SAND (SP), mps 2 mm, well stratified, no odor, moist				40	60					
25						-ALLUVIAL DEPOSITS-										
	5 6 7 10	S11 24	28.0 30.0		SP	Medium dense light brown poorly graded SAND (SP) with frequent interbedded seams and layers of dark brown silty SAND, mps 1 mm, well stratified, no odor, moist				15	85					
30																
	3 4 7 8	S12 24	33.0 35.0		SP	Similar to S11				10	90					
35																
	7 8 13 19	S13 20	38.0 40.0	266.2 38.0	SP	Medium dense light brown poorly graded SAND (SP), mps 2 mm, no odor, moist				40	60					
40						-FLUVIAL DEPOSITS-										
				263.2 41.0												
	8 10 11 12	S14 18	43.0 45.0		SW	Medium dense light brown well graded SAND (SW), mps 3 mm, no odor, wet			20	65	15					
45																
	10 10 15 15	S15 13	48.0 50.0	256.2 48.0	SP	Medium dense light brown poorly graded SAND (SP), mps 2 mm, no odor, wet			2	63	31	4				

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																
	7 7 10 12	S16 20	53.0 55.0	251.2 53.0	SW	Medium dense light brown well graded SAND (SW), mps 5 mm, no odor, wet, trace fine gravel			20	65	15					
55																
						-FLUVIAL DEPOSITS-										
	7 10 10 12	S17 18	58.0 60.0	246.2 58.0	SP	Medium dense light brown poorly graded SAND (SP), mps 10 mm, no odor, wet, trace coarse to fine gravel			5	90	5					
60																
	10 10 16 18	S18 24	63.0 65.0		SP	Similar to S17				60	40					
65																
	10 10 12 13	S19 6	68.0 70.0	236.2 68.0	SW	Medium dense light brown well graded SAND (SW), mps 5 mm, no odor, wet, trace fine gravel			20	60	20					
70																
	16 17 18 22	S20 18	73.0 75.0	231.2 73.0	SP	Dense gray-brown poorly graded SAND (SP), mps 2 mm, stratified, no odor, wet				60	40					
75																
						Note: Drill action indicated possible occasional gravel layers up to 12 in. thick from 77.0 to 81.0 ft.										

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
80																
	11 10 9 10	S21 20	83.0 85.0		SP	Medium dense gray poorly graded SAND (SP), trace coarse to fine gravel, mps 20 mm, no odor, wet			10	75	15					
85						-FLUVIAL DEPOSITS-										
	9 10 11 17	S22 18	88.0 90.0	216.2 88.0	SW	Medium dense gray well graded SAND (SW), trace coarse gravel, mps 20 mm, no odor, wet		5	45	40	10					
90																
	10 14 12 15	S23 20	93.0 95.0		SW	Similar to S22			55	35	10					
95				209.2 95.0		BOTTOM OF EXPLORATION 95.0 FT Note: Borehole grouted upon completion. Pushed four undisturbed shelby tube samples in offset hole. See Test Boring Report HA-B4A for details.										

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. HA-B4A

Project	Slag Dewatering Pond and Unlined Pond, New Madrid Power Plant, Marston, Missouri
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling, Inc.

File No. 40616-300
Sheet No. 1 of 1
Start 17 September 2015
Finish 18 September 2015
Driller J. Gates
H&A Rep. C. Toscano

Elevation 304.2
Datum NAVD 88
Location See Plan
N 246,729
E 1,097,737

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	4.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures
Rig Make & Model: CME 55 L6
Bit Type: Cutting Head
Drill Mud: Polymer
Casing: Spun
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model: N/A

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0						Note: Augered to shelby tube sampling depths without collecting split-spoon samples.										
	PUSH	U1 12	3.0 5.0		ML	Brown SILT (ML)										
5	PUSH	U2 24	5.0 7.0		ML	Dark brown SILT (ML)										
	PUSH	U3 0	7.0 9.0			No Recovery										
10	PUSH	U4 0	9.0 11.0			No Recovery										
15				289.2 15.0		BOTTOM OF EXPLORATION 15.0 FT Note: Borehole grouted upon completion. See Test Boring Report HA-B4 for additional details.										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
9/18/15					Dry

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 15.0
Rock Cored (ft) --
Samples 4U

Boring No. HA-B4A

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA-B5

Project	Slag Dewatering Pond and Unlined Pond, New Madrid Power Plant, Marston, Missouri
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling, Inc.

File No.	40616-300
Sheet No.	1 of 2
Start	15 September 2015
Finish	15 September 2015
Driller	J. Gates
H&A Rep.	C. Toscano
Elevation	316.1
Datum	NAVD 88
Location	See Plan N 246,385 E 1,096,345

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	4.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

Rig Make & Model: CME 55 L6
Bit Type: Cutting Head
Drill Mud: Polymer
Casing: Spun
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model: N/A

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0																
	5 7 7 9	S1 20	1.0 3.0		ML	Medium dense black SILT with sand (ML), mps 2 mm, no odor, dry -FLY ASH-					25	75				
	4 4 5 4	S2 24	3.0 5.0		ML	Similar to S1, except loose					25	75				
5	2 2 2 2	S3 20	5.0 7.0		ML	Similar to S1, except very loose				10	30	60				
	2 1 2 2	S4 18	7.0 9.0		ML	Very loose brown to dark brown SILT (ML) interbedded with seams of fine sand, mps 1 mm, no odor, moist, trace organic fibers (wet at tip of spoon)					10	90				
	1 1 2 2	S5 18	9.0 11.0		ML	Similar to S4, except wet to moist					10	90				
10	1 1 1 1	S6 18	11.0 13.0		ML	Similar to S4, except with frequent interbedded seams of medium to fine sand, mps 2 mm, wet					20	80				
	1 1 1 1	S7 20	13.0 15.0		ML	Similar to S4					10	90				
15	WOH 1 1 1	S8 24	15.0 17.0		ML	Similar to S4 Note: Sample moist to wet throughout entire sample. May be perched groundwater.					10	90				
	WOH 1 2 1	S9 16	17.0 19.0	299.1 17.0	ML	Similar to S4, except with interbedded layers of coarse to fine sand (boiler slag particles), mps 2 mm -FLY ASH/BOILER SLAG-				15	25	60				
	4 1	S10 18	19.0 21.0		ML	Similar to S4, except moist to wet					10	90				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
9/15/15					43.0

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	50.0
Rock Cored (ft)	--
Samples	19S

Boring No. HA-B5

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	2 1															
	2 3 1 1	S11 18	21.0 23.0		ML	Very loose brown to dark brown SILT (ML) with frequent interbedded layers of black coarse to fine grained cinders and slag particles, mps 3 mm, no odor, wet					5	95				
						-FLY ASH/BOILER SLAG-										
	1 1 2 3	S12 18	23.0 25.0		ML	Similar to S11					5	95				
25	1 2 1 1	S13 18	25.0 27.0		ML	Similar to S11					5	95				
	1 1 1 1	S14 24	27.0 29.0		ML	Similar to S11					5	95				
30	WOH WOH 1 1	S15 24	29.0 31.0		ML	Similar to S11					5	95				
				284.1 32.0												
	2 4 4 7	S16 24	33.0 35.0		CH	Medium stiff gray fat CLAY with fine sand in frequent partings (CH), mps 1 mm, no odor, moist					5	95	S	M	M	H
35																
						-ALLUVIAL DEPOSITS-										
	3 4 4 7	S17 24	38.0 40.0		CH	Similar to S16 Note: Medium to fine sand found in tip of spoon.					5	95	S	M	M	H
40				276.1 40.0												
	14 20 18 16	S18 20	43.0 45.0		SP	Dense light brown poorly graded SAND (SP), mps 3 mm, no odor, wet				80	20					
45																
						-FLUVIAL DEPOSITS-										
	15 12 14 26	S19 15	48.0 50.0		SP	Similar to S18				80	20					

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50				266.1 50.0		BOTTOM OF EXPLORATION 50.0 FT Note: Borehole grouted to 65 ft upon completion. Pushed three shelby tube samples in offset hole at depths of 10.0 to 12.0 ft, 20.0 to 22.0 ft, and 27.0 to 29.0 ft. See Test Boring Report HA-B5A for details.										

TEST BORING REPORT

Boring No. HA-B5A

Project: Slag Dewatering Pond and Unlined Pond, New Madrid Power Plant, Marston, Missouri
Client: Associated Electric Cooperative, Inc.
Contractor: Bulldog Drilling, Inc.

File No. 40616-300
Sheet No. 1 of 2
Start: 16 September 2015
Finish: 16 September 2015
Driller: J. Gates
H&A Rep.: C. Toscano

Elevation: 316.1
Datum: NAVD 88
Location: See Plan
N 246,385
E 1,096,345

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	4.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

Rig Make & Model: CME 55 L6
Bit Type: Cutting Head
Drill Mud: Polymer
Casing: Spun
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model: N/A

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						Note: Augered to shelby tube sampling depths without collecting split-spoon samples.										
5																
10	P U S H	U1 24	10.0 12.0		ML	Brown to dark brown SILT (ML)										
15																
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
9/16/15					25.0

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 29.0
Rock Cored (ft) --
Samples 3U

Boring No. HA-B5A

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	PUSH	U2 24	20.0 22.0		ML	Brown to dark brown SILT (ML)										
25																
	PUSH	U3 8	27.0 29.0	287.1 29.0	ML	Brown to dark brown SILT (ML) Poor recovery due to the presence of cinders and boiler slag.										
						BOTTOM OF EXPLORATION 29.0 FT Note: Borehole grouted upon completion. See Test Boring Report HA-B5 for additional details.										

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. HA-B6

Project	Slag Dewatering Pond and Unlined Pond, New Madrid Power Plant, Marston, Missouri
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling, Inc.

File No. 40616-300
Sheet No. 1 of 3
Start 16 September 2015
Finish 17 September 2015
Driller J. Gates
H&A Rep. C. Toscano

Elevation 307.4
Datum NAVD 88
Location See Plan
N 245,683
E 1,098,769

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	4.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

Rig Make & Model: CME 55 L6
Bit Type: Cutting Head
Drill Mud: Polymer
Casing: Spun
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model: N/A

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0						SAND/GRAVEL ROADWAY-										
	6 6 9 13	S1 24	1.0 3.0	306.4 1.0	CL	Stiff light brown lean CLAY (CL), mps 1 mm, no odor, dry -FILL-					10	90				
	5 4 6 7	S2 24	3.0 5.0		CL	Stiff gray lean CLAY (CL) interbedded with layers of brown SILT with sand (ML), mps 1 mm, no odor, dry					10	90				
5	3 3 5 8	S3 24	5.0 7.0		CL	Medium stiff gray lean CLAY with sand (CL), mps < 1 mm, no structure, no odor, dry					15	85				
	3 3 6 8	S4 24	7.0 9.0		CL	Medium stiff gray lean CLAY with sand (CL), mps <1 mm, no structure, no odor, dry					6	94				
10	3 6 6 8	S5 24	9.0 11.0		CL	Stiff light brown lean CLAY with sand (CL), mps 1 mm, no odor, dry					15	85				
	3 4 6 9	S6 24	11.0 13.0	296.4 11.0	CL	Stiff gray lean CLAY (CL), mps <1 mm, stratified, no odor, dry -ALLUVIAL DEPOSITS-						100				
	6 7 6 9	S7 24	13.0 15.0		CL	Stiff gray lean CLAY (CL) with sand and fine sand in frequent partings					3	97				
15	4 5 9 9	S8 24	15.0 17.0		CL	Similar to S7, trace organic fibers					5	95				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
9/16/15					40.0

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 75.0
Rock Cored (ft) --
Samples 20S

Boring No. HA-B6

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. HA-B6
File No. 40616-300
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	10 10 12 15	S9 24	20.0 22.0		CL	Medium stiff gray lean CLAY (CL) with frequent interbedded layers of fine sand (SM), mps 1 mm, no odor, moist					60	40				
						-ALLUVIAL DEPOSITS-										
25	3 3 4 4	S10 24	25.0 27.0		CL	Medium stiff brown lean CLAY (CL) with interbedded layers and seams of silty sand, mps 1 mm, no odor, moist					5	95				
						Note: Switched to mud rotary at 20.0 ft.										
	2 1 1 2	S11 24	28.0 30.0		CL	Very soft yellow-brown to brown lean CLAY (CL), mps < 1 mm, no odor, moist						100				
30				276.4 31.0												
	4 4 5 10	S12 18	33.0 35.0		SP	Loose light brown poorly graded SAND (SP) with occasional layers of silt, mps 2 mm, well stratified, no odor, dry				20	80					
35				270.4 37.0												
	7 9 11 13	S13 20	38.0 40.0		SP	Medium dense light brown poorly graded SAND (SP), mps 2 mm, stratified, no odor Note: Wet at tip of spoon.				60	40					
40						-FLUVIAL DEPOSITS-										
	9 11 15 19	S14 16	43.0 45.0		SP	Similar to S13				90	10					
45																
	8 11 12 14	S15 18	48.0 50.0		SP	Similar to S13				90	10					

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. HA-B6

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																
	13 13 13 16	S16 18	53.0 55.0		SP	Similar to S13				80	20					
55						-FLUVIAL DEPOSITS-										
	9 9 15 17	S17 18	58.0 60.0	249.4 58.0	SW	Medium dense light brown well graded SAND (SW), trace fine gravel, mps 5 mm, no odor, wet			20	60	20					
60																
	10 11 13 15	S18 18	63.0 65.0		SW	Similar to S17, except trace shell fragments, stratified			25	60	15					
65																
	10 11 8 11	S19 12	68.0 70.0		SW	Similar to S17, well stratified			25	55	20					
70																
	10 10 15 13	S20 15	73.0 75.0		SW	Similar to S17, except trace coarse to fine gravel, mps 20 mm			35	55	10					
75				232.4 75.0		BOTTOM OF EXPLORATION 75.0 FT Note: Borehole grouted upon completion.										

H&A-TEST BORING-07-1 HA-LIB09.GLB HA-TB+CORE+WELL-07-1.GDT M:\GINT\40616-300_TEST BORINGS-2015 (2).GPJ Nov 2, 15

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA-B7

Project	Slag Dewatering Pond and Unlined Pond, New Madrid Power Plant, Marston, Missouri	File No.	40616-300
Client	Associated Electric Cooperative, Inc.	Sheet No.	1 of 2
Contractor	Bulldog Drilling, Inc.	Start	22 September 2015
		Finish	22 September 2015
		Driller	J. Gates
		H&A Rep.	C. Toscano

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	4.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

Rig Make & Model: CME 55 L6
Bit Type: Cutting Head
Drill Mud: Polymer
Casing: Spun
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model: N/A

Elevation 302.9
Datum NAVD 88
Location See Plan
N 249,818
E 1,096,497

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0																
	12 12 7 4	S1 15	1.0 3.0		SM	Medium dense black silty SAND (SM), mps 2.0 mm, no odor, dry, contains cinders and slag particles				30	50	20				
				300.4 2.5		-FILL-										
					CL	Stiff gray lean CLAY (CL), trace cinders and slag, mps 4 mm, no odor, dry						100				
	3 5 5 5	S2 20	3.0 5.0		CL	Stiff gray lean CLAY (CL) intermixed with cinder and slag fragments to particles, mps 15 mm, no odor, dry		5	5	10	20	60				
5	3 4 7 8	S3 20	5.0 7.0		CL	Similar to S2, mps 5 mm			5	5	5	85				
	3 4 6 7	S4 24	7.0 9.0		CL	Similar to S2			10	5	5	80				
10	2 4 4 6	S5 20	9.0 11.0		CL	Similar to S2, except medium stiff, trace cinders and slag particles, mps 3 mm						100				H
	3 4 7 8	S6 24	11.0 13.0	291.9 11.0	CH	Medium stiff gray-brown fat CLAY with sand (CH), no odor, dry					13	87				H
	2 4 6 6	S7 24	13.0 15.0		CH	Similar to S6, except gray to gray-brown, no cinders and slag						100				H
15	2 3 3 3	S8 24	15.0 17.0		CH	Similar to S6, except medium stiff						100				H
	1 1 2 3	S9 24	17.0 19.0		CH	Similar to S6, except moist, soft						100				
	1 1	S10 24	19.0 21.0	283.9 19.0	CL	Very soft lean CLAY (CL), mps < 1 mm, no odor, wet					10	90				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
9/22/15					Dry

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	27.0
Rock Cored (ft)	--
Samples	12S

Boring No. HA-B7

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	1 1															
	WOH 2 3 3	S11 24	21.0 23.0	281.9 21.0	SM	Loose brown silty SAND (SM), mps 1 mm, well stratified, no odor, dry					60	40				
						-ALLUVIAL DEPOSITS-										
25	2 3 6 7	S12 24	25.0 27.0		SM	Similar to S11, except with frequent seams of silt and fine sand, well stratified, moist					60	40				
				275.9 27.0		BOTTOM OF EXPLORATION 27.0 FT Note: Borehole grouted upon completion.										

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

APPENDIX B

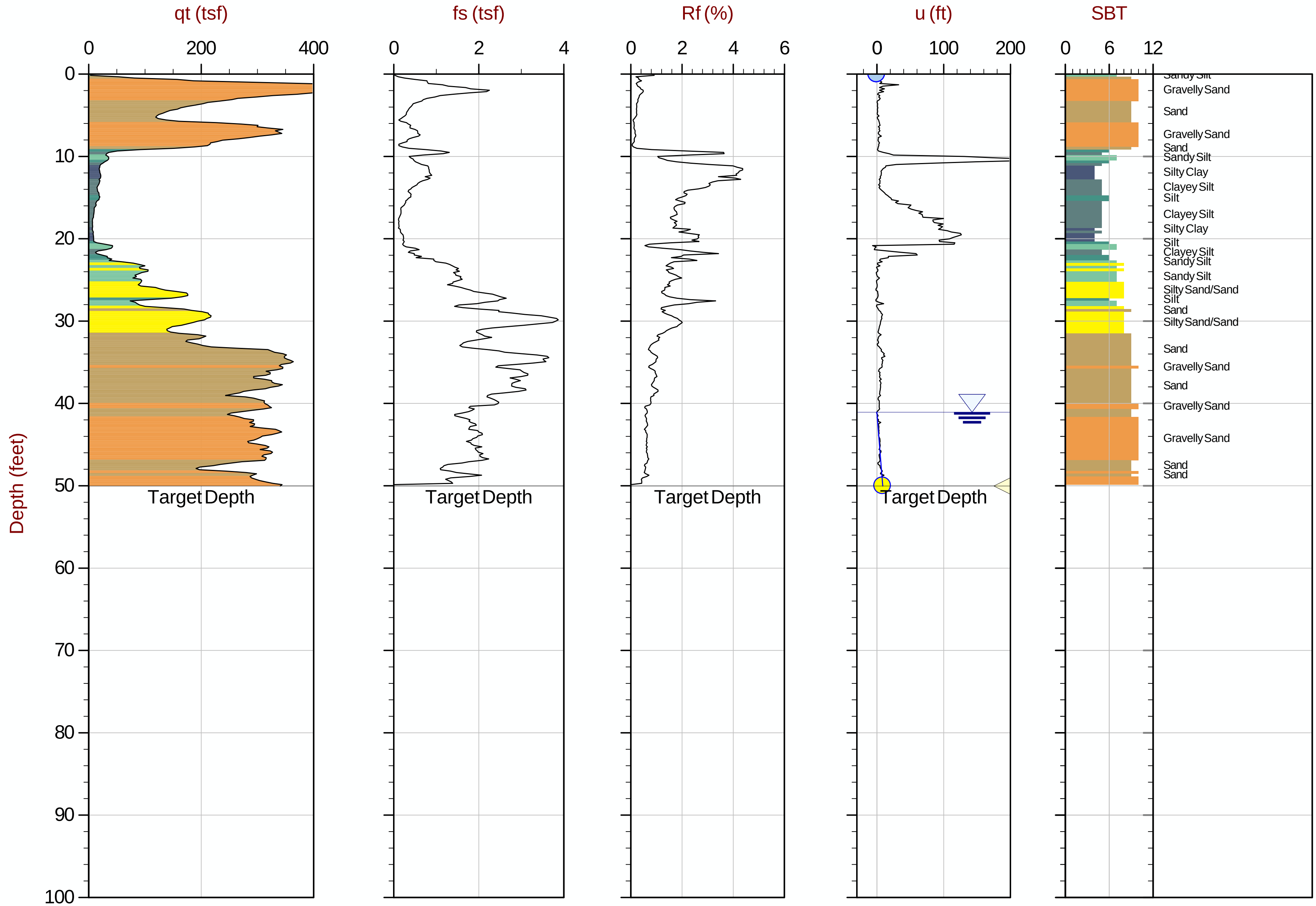
CPT Sounding Logs and Related Information

ConeTec

Haley & Aldrich

Job No: 15-53087
Date: 09:17:15 17:40
Site: AECI-New Madrid

Sounding: CPT15-HAC1
Cone: 419:T1500F15U500



Max Depth: 15.250 m / 50.03 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_CP01.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4044206m E: 270757m

Hydrostatic Line · Ueq · Assumed Ueq · PPD, Ueq achieved · PPD, Ueq not achieved

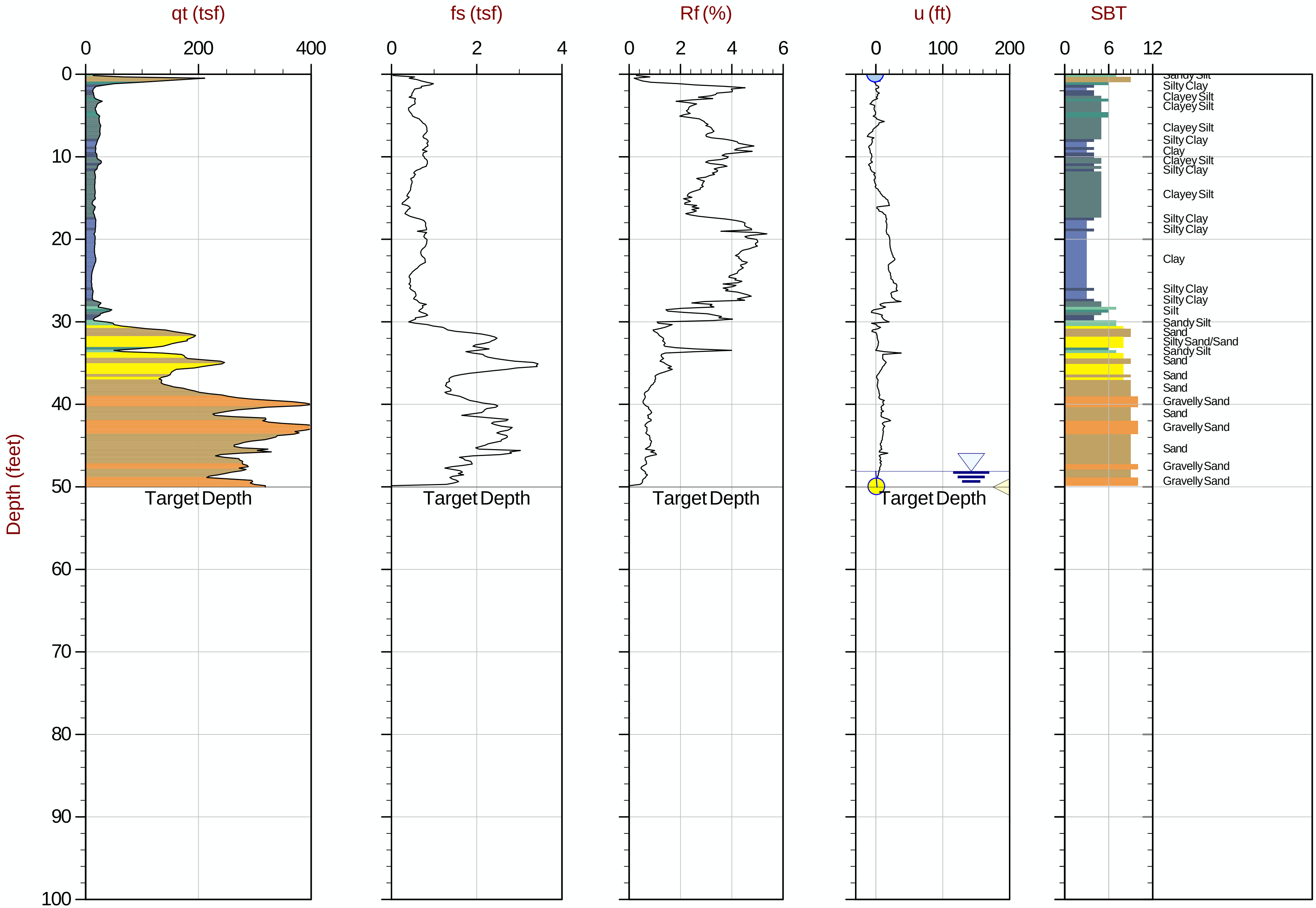
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 09:17:15 14:41
Site: AECI-New Madrid

Sounding: CPT15-HAC2
Cone: 419:T1500F15U500



Max Depth: 15.250 m / 50.03 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_CP02.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4044000m E: 270758m

Hydrostatic Line · Ueq · Assumed Ueq · PPD, Ueq achieved · PPD, Ueq not achieved

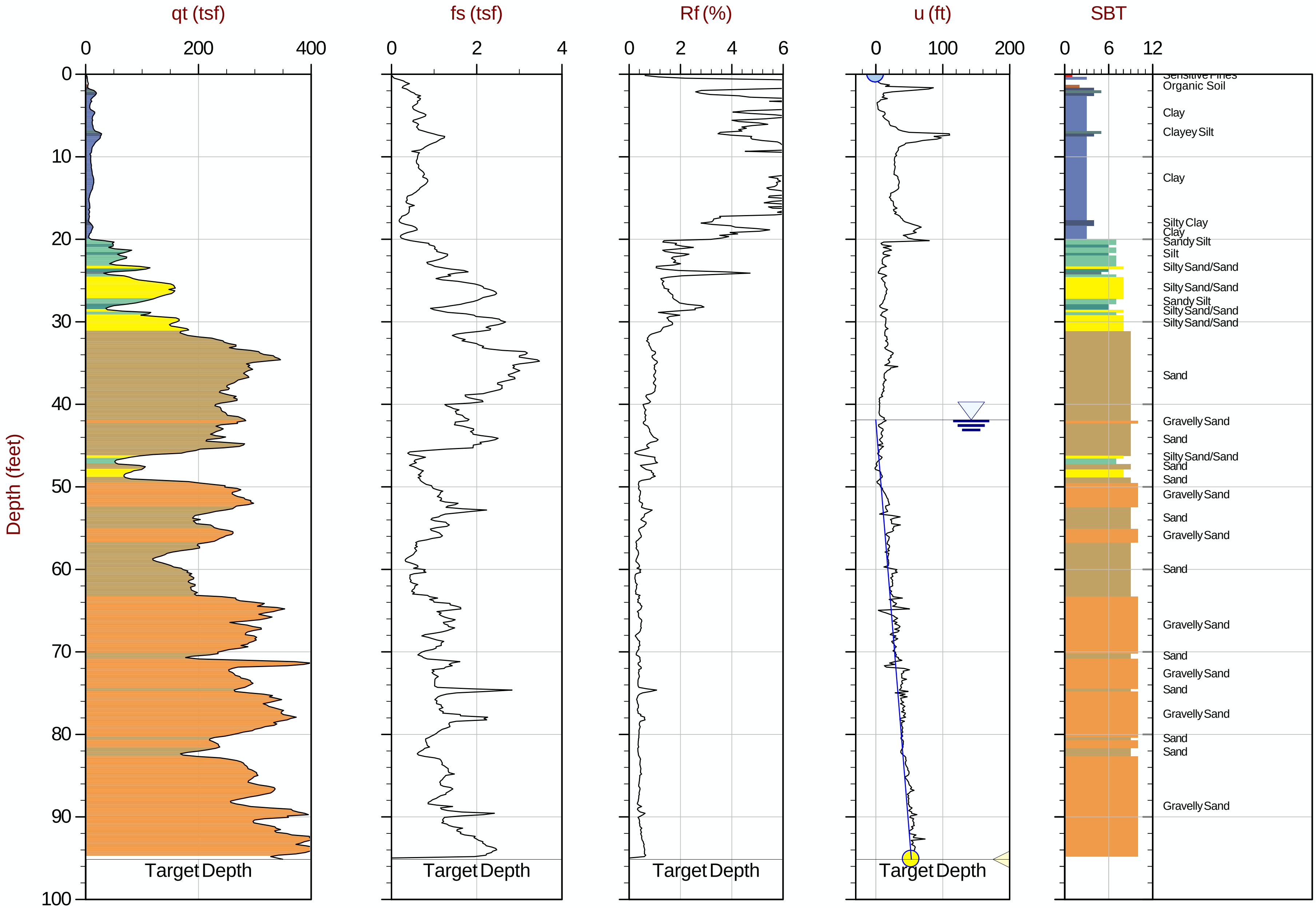
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 09:17:15 15:59
Site: AECI-New Madrid

Sounding: CPT15-HAC3
Cone: 419:T1500F15U500



Max Depth: 29.000 m / 95.14 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_CP03.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4044097m E: 270832m

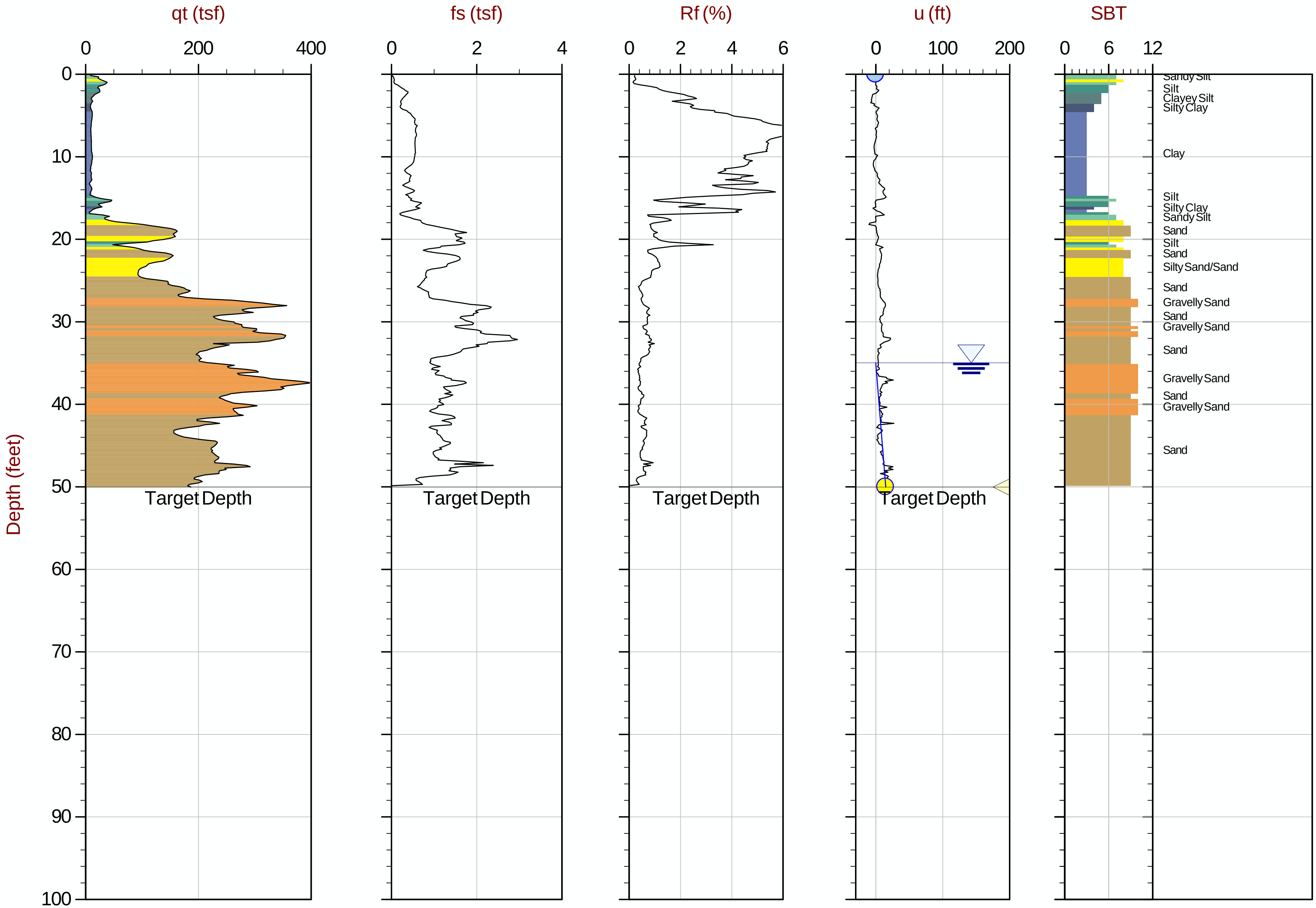
Hydrostatic Line · Ueq · Assumed Ueq · PPD, Ueq achieved · PPD, Ueq not achieved

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

Haley & Aldrich

Job No: 15-53087
Date: 09:17:15 13:17
Site: AECI-New Madrid

Sounding: CPT15-HAC4
Cone: 419:T1500F15U500



Max Depth: 15.250 m / 50.03 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_CP04.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4044000m E: 270732m

Hydrostatic Line · Ueq · Assumed Ueq · PPD, Ueq achieved · PPD, Ueq not achieved

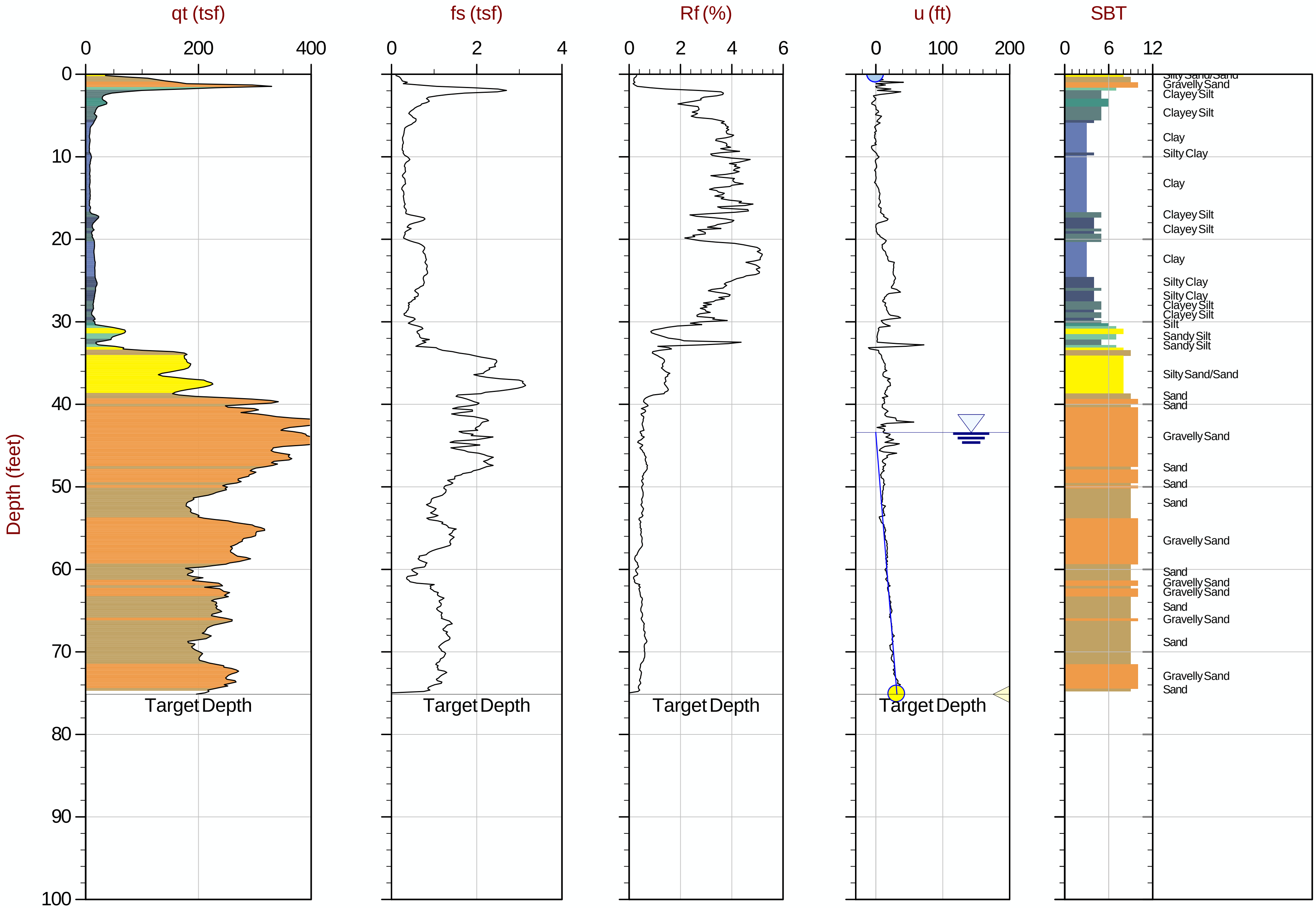
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 09:15:15 17:52
Site: AECI-New Madrid

Sounding: CPT15-HAC5
Cone: 419:T1500F15U500



Max Depth: 22.900 m / 75.13 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_CP05.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4043453m E: 270755m

Hydrostatic Line   Ueq   Assumed Ueq   PPD, Ueq achieved   PPD, Ueq not achieved

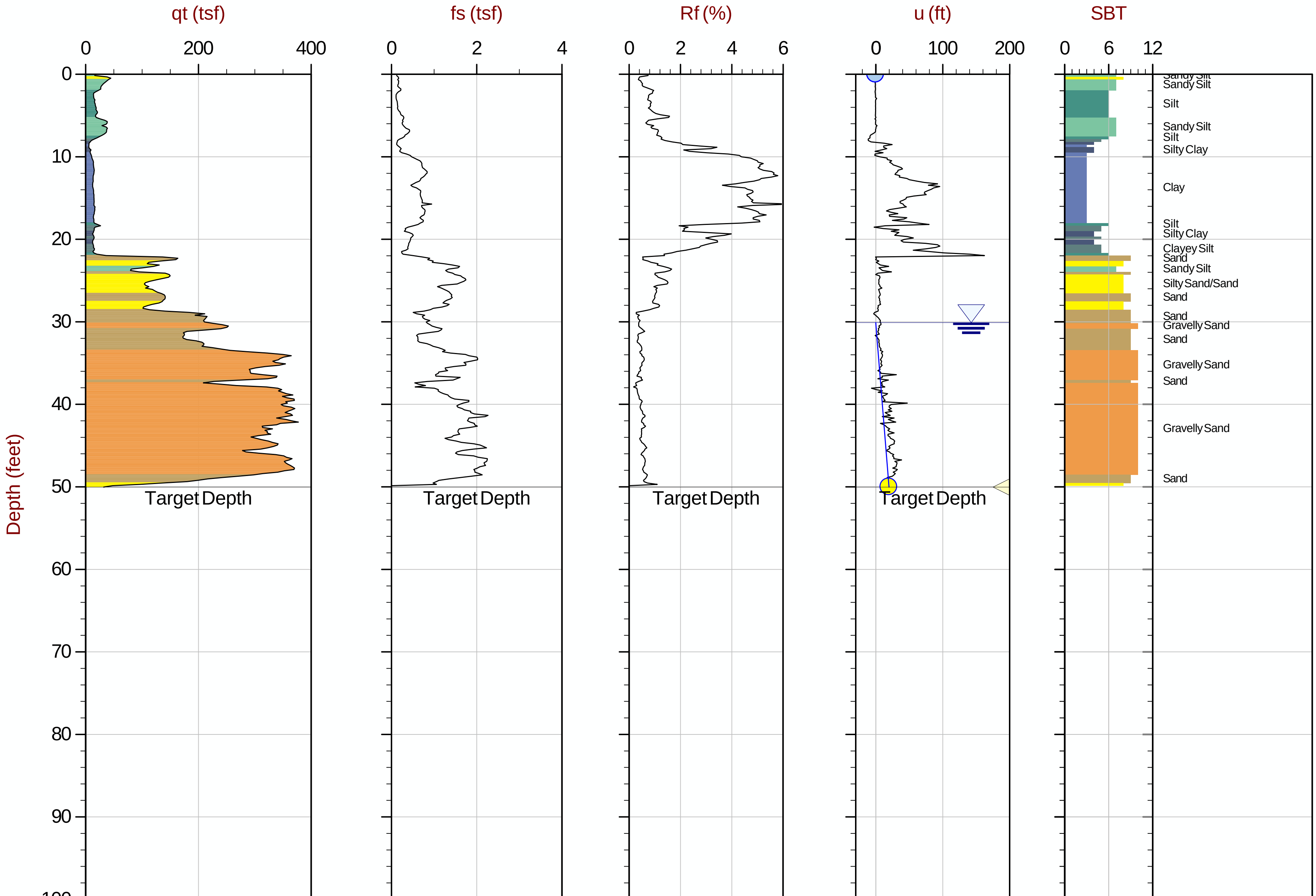
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 09:16:15 10:26
Site: AECI-New Madrid

Sounding: CPT15-HAC6
Cone: 419:T1500F15U500



Max Depth: 15.250 m / 50.03 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_CP06.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4043392m E: 270698m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

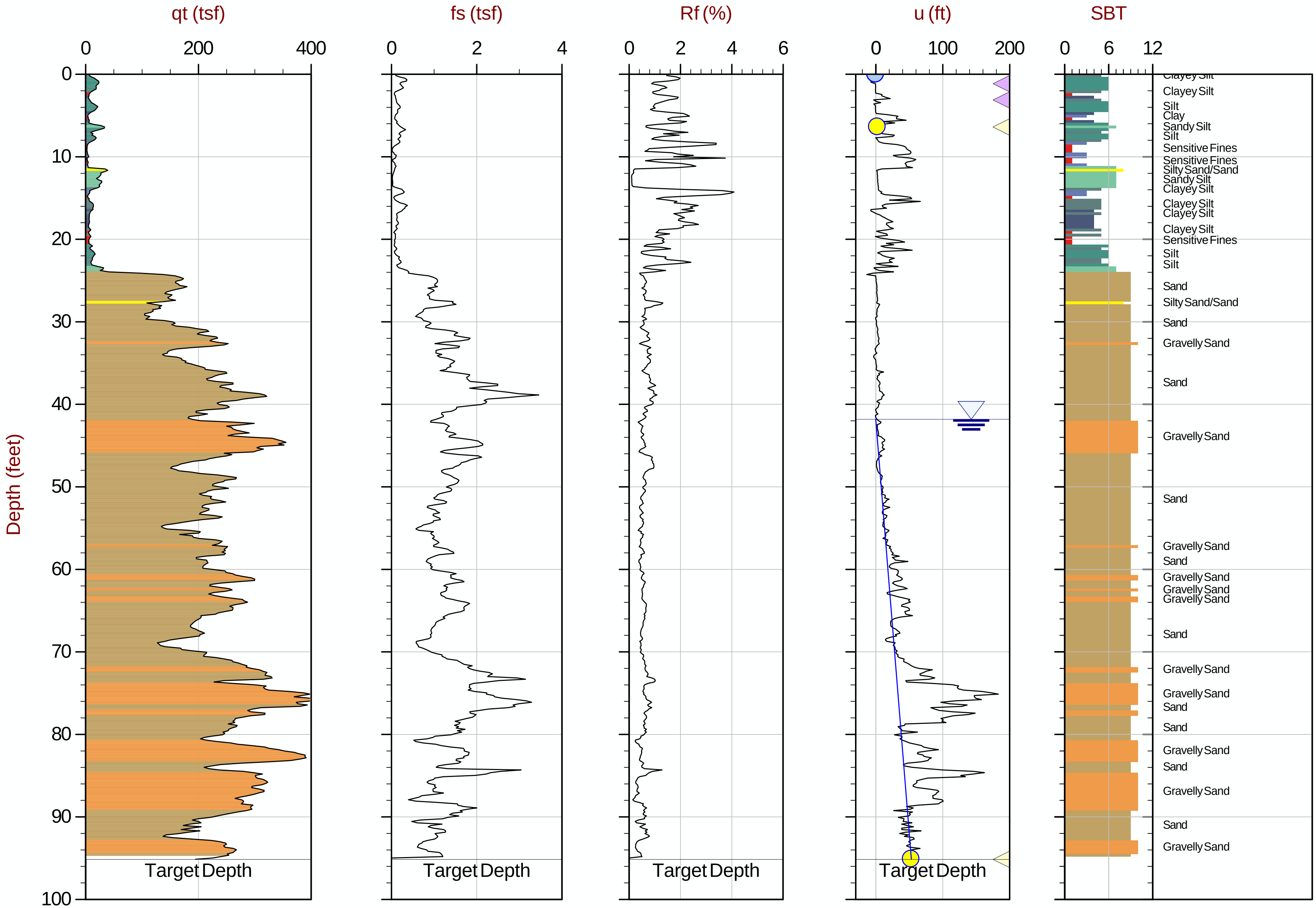
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 09:15:15 14:36
Site: AECI-New Madrid

Sounding: SCPT15-HAC7
Cone: 419:T1500F15U500



Max Depth: 29.000 m / 95.14 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_SP07.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4043266m E: 271126m

Hydrostatic Line   Ueq   Assumed Ueq   PPD, Ueq achieved   PPD, Ueq not achieved

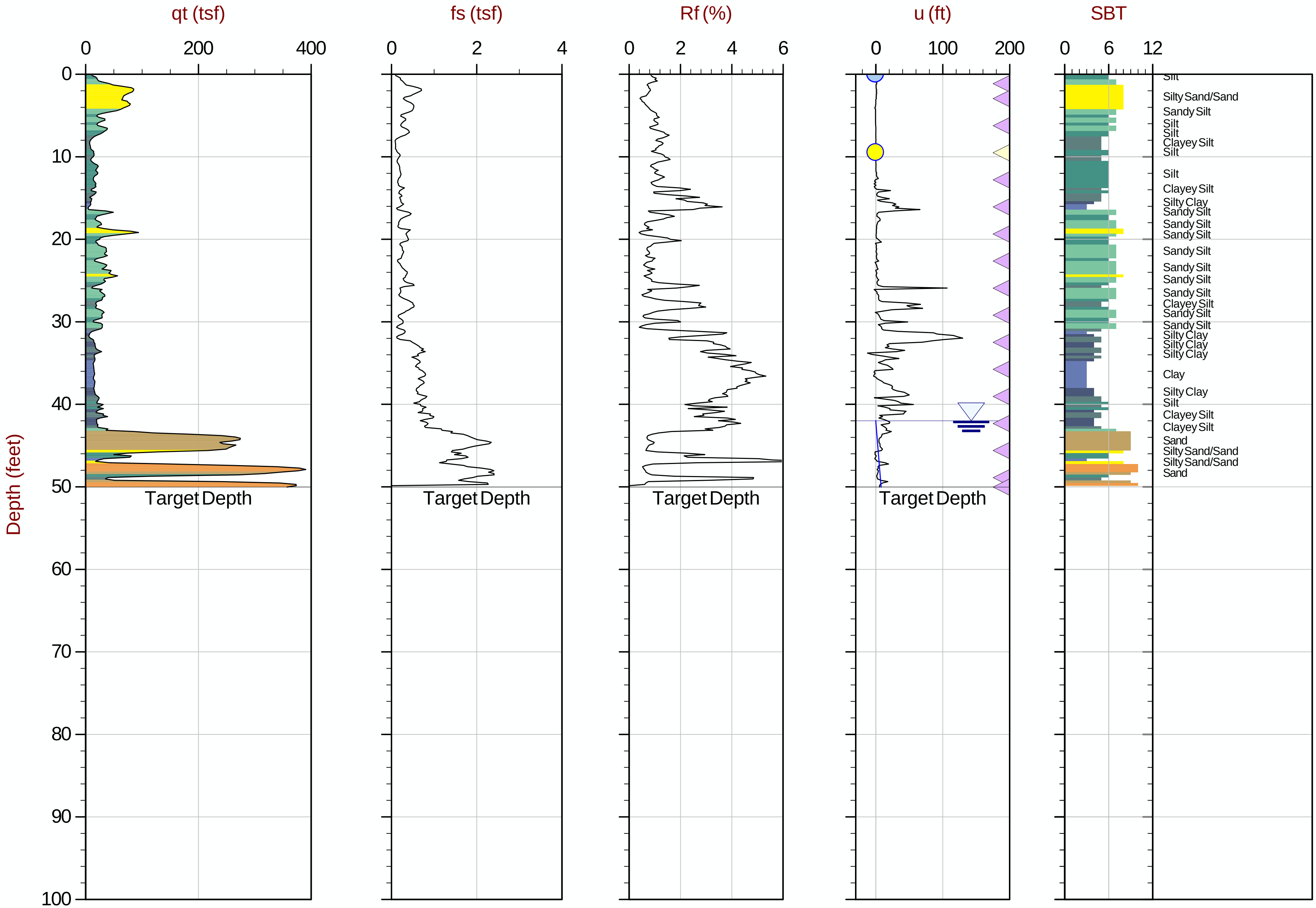
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 09:16:15 12:39
Site: AECI-New Madrid

Sounding: SCPT15-HAC8
Cone: 419:T1500F15U500



Max Depth: 15.250 m / 50.03 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_SP08.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4043175m E: 270700m

Hydrostatic Line   Ueq   Assumed Ueq   PPD, Ueq achieved   PPD, Ueq not achieved

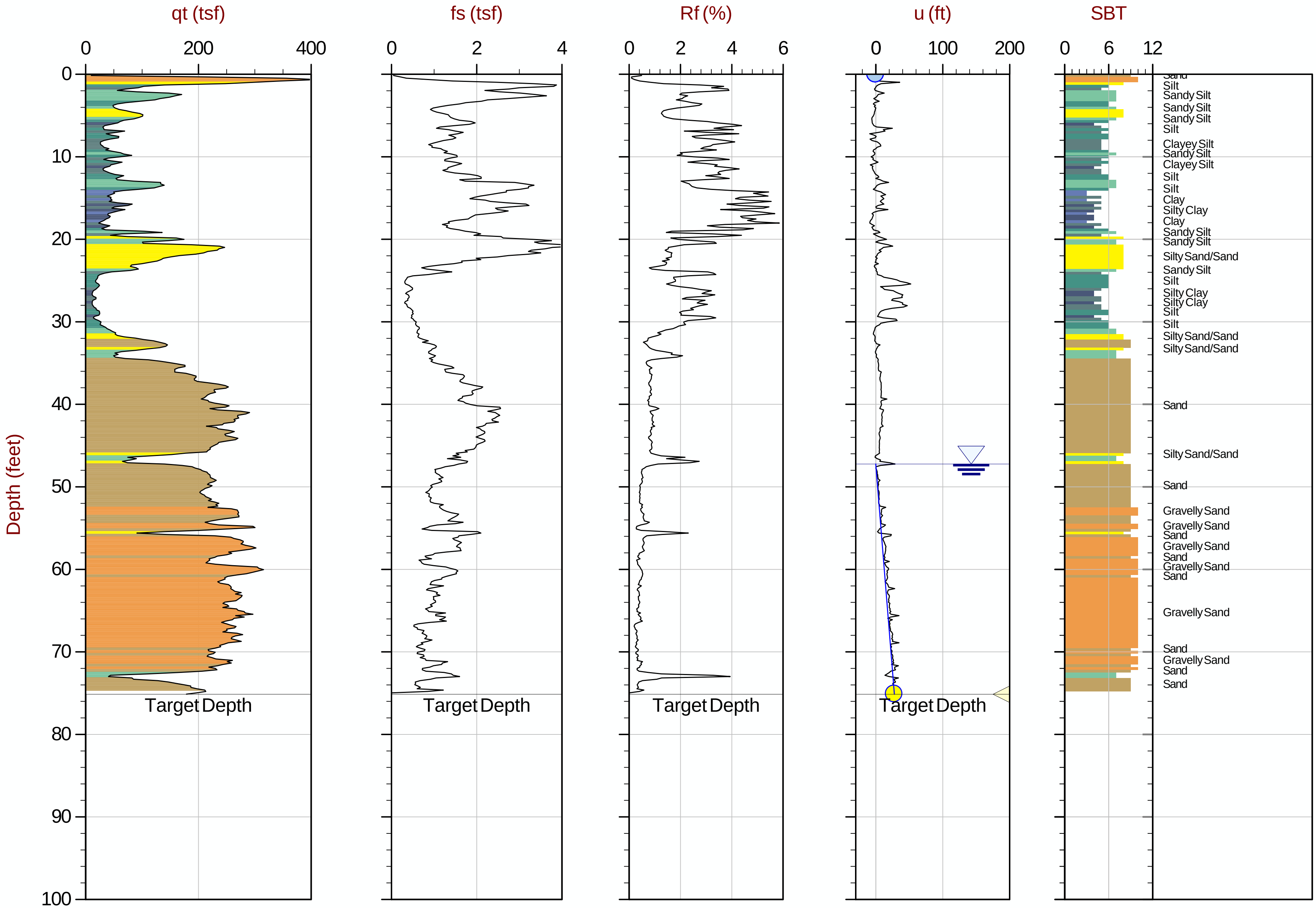
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

ConeTec

Haley & Aldrich

Job No: 15-53087
Date: 09:17:15 11:57
Site: AECI-New Madrid

Sounding: CPT15-HAC9
Cone: 419:T1500F15U500



Max Depth: 22.900 m / 75.13 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_CP09.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4042932m E: 271425m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

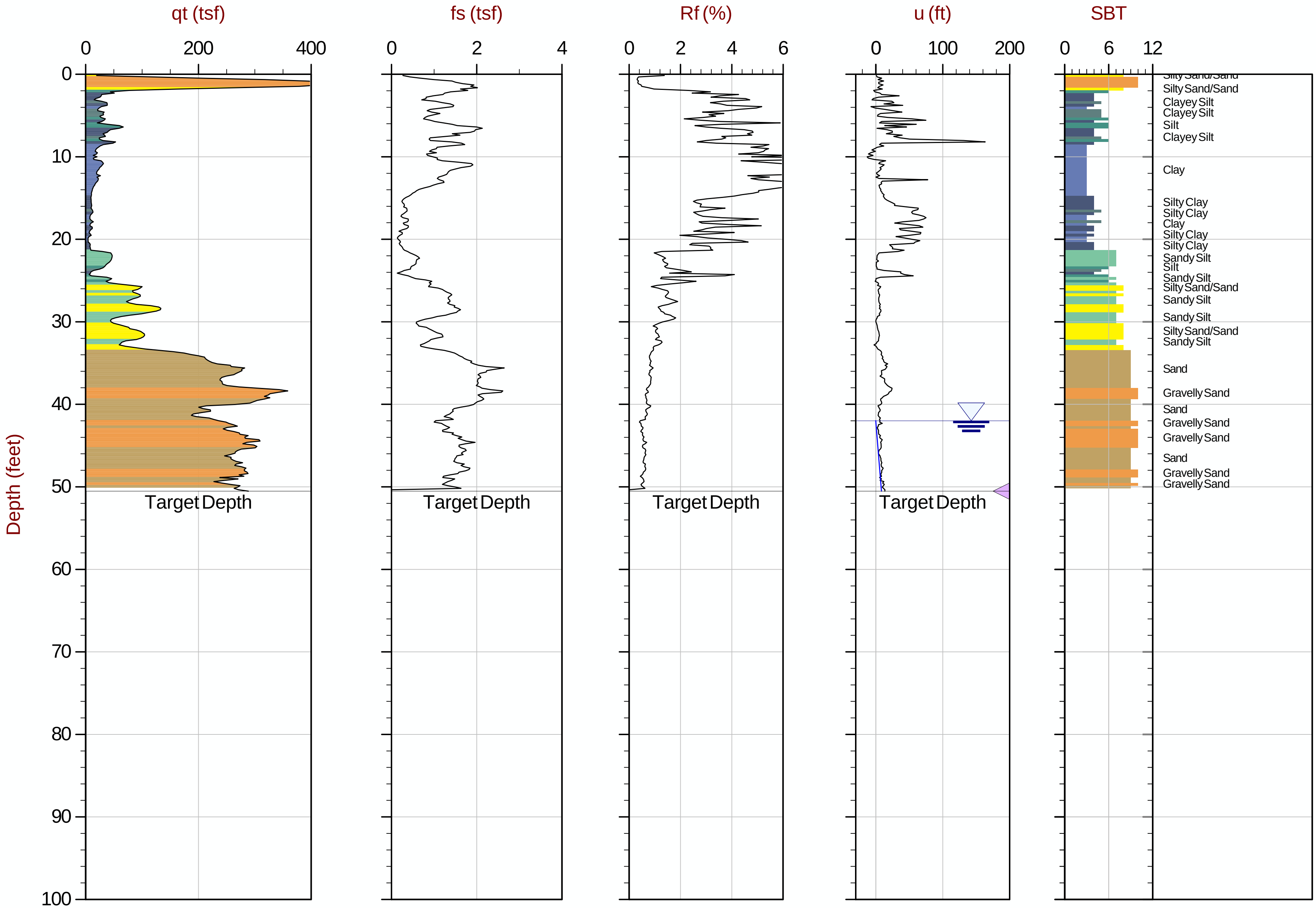
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 09:17:15 17:40
Site: AECI-New Madrid

Sounding: CPT15-HAC10
Cone: 419:T1500F15U500



Max Depth: 15.400 m / 50.52 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_CP10.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4044217m E: 270784m

Hydrostatic Line   Ueq   Assumed Ueq   PPD, Ueq achieved   PPD, Ueq not achieved

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

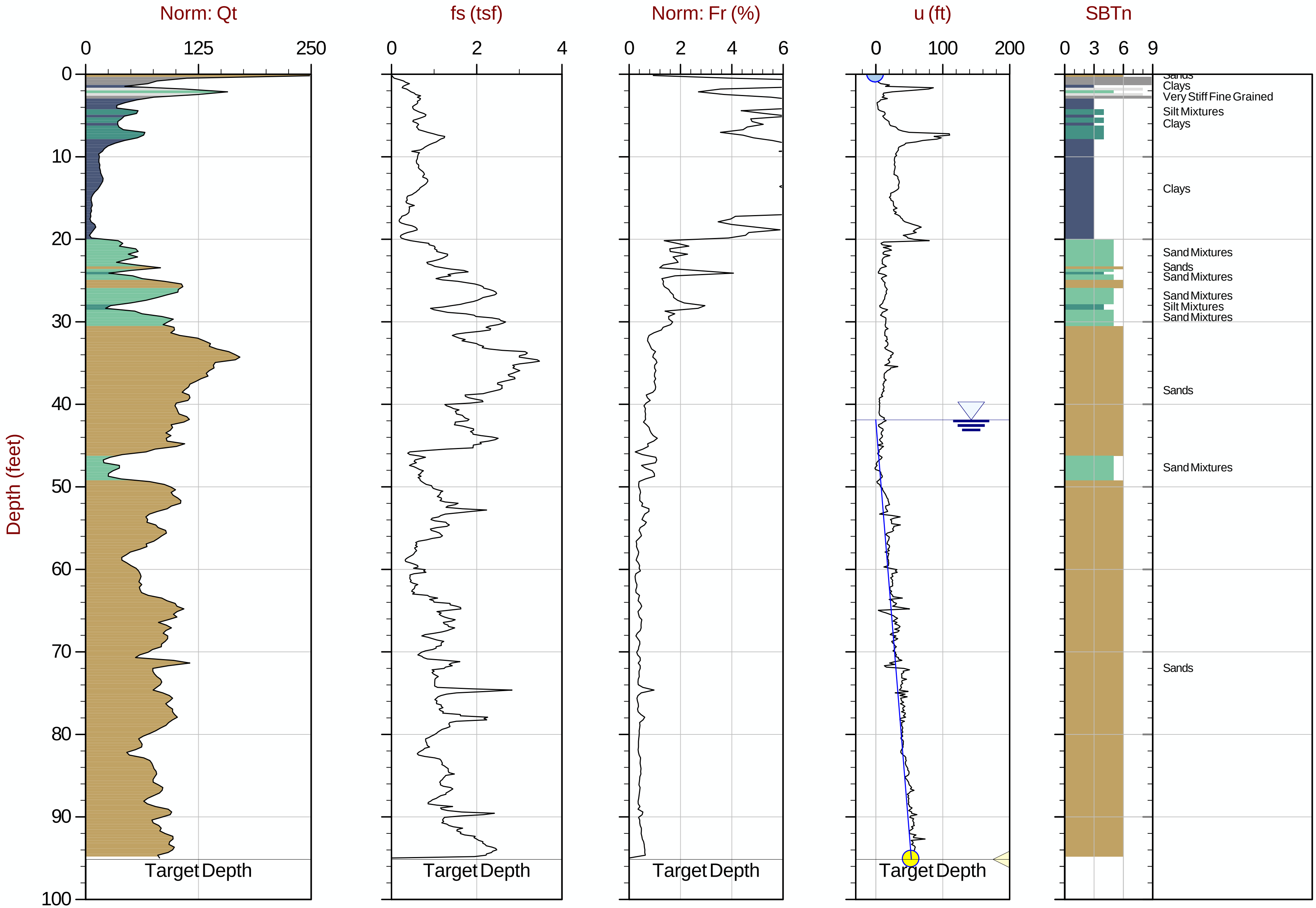
Normalized Cone Penetration Test Plots

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 09:17:15 15:59
Site: AECI-New Madrid

Sounding: CPT15-HAC3
Cone: 419:T1500F15U500



Max Depth: 29.000 m / 95.14 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_CP03.COR

SBT: Robertson, 1990
Coords: UTM Zone 16 N: 4044097m E: 270832m

Hydrostatic Line   Ueq   Assumed Ueq   PPD, Ueq achieved   PPD, Ueq not achieved

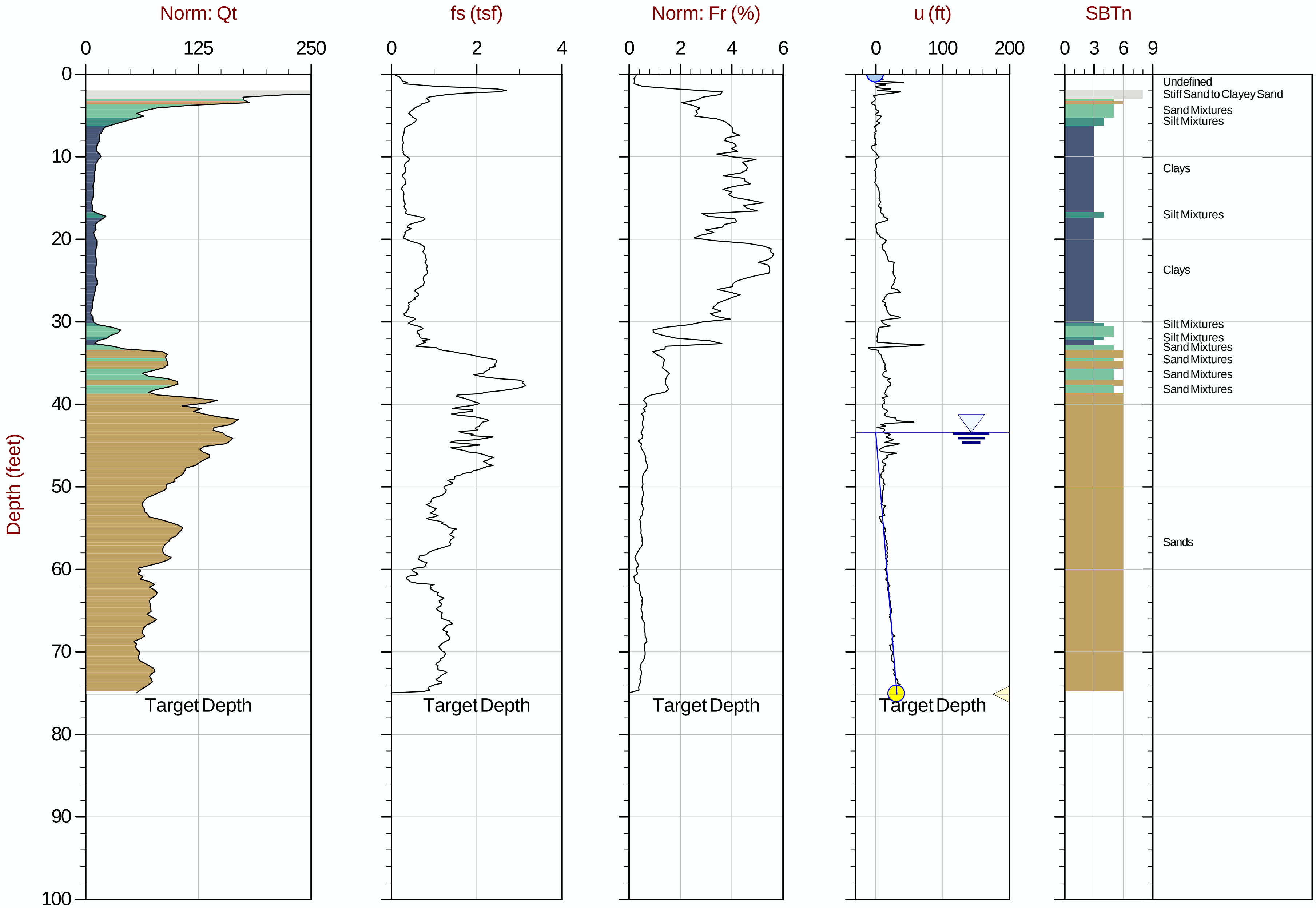
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 09:15:15 17:52
Site: AECI-New Madrid

Sounding: CPT15-HAC5
Cone: 419:T1500F15U500



Max Depth: 22.900 m / 75.13 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_CP05.COR

SBT: Robertson, 1990
Coords: UTM Zone 16 N: 4043453m E: 270755m

Hydrostatic Line · Ueq · Assumed Ueq · PPD, Ueq achieved · PPD, Ueq not achieved

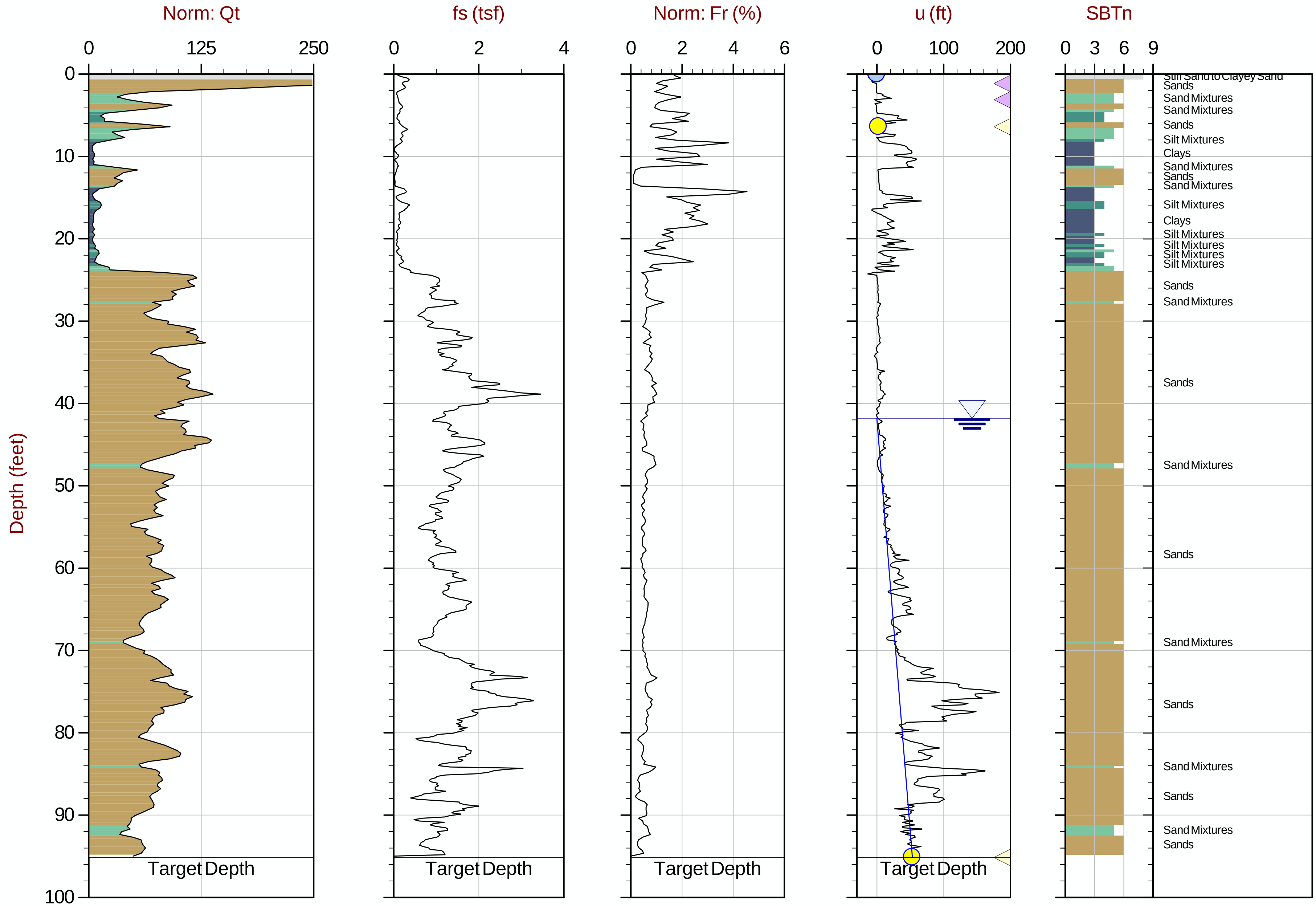
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 09:15:15 14:36
Site: AECI-New Madrid

Sounding: SCPT15-HAC7
Cone: 419:T1500F15U500



Max Depth: 29.000 m / 95.14 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_SP07.COR

SBT: Robertson, 1990
Coords: UTM Zone 16 N: 4043266m E: 271126m

Hydrostatic Line | Ueq | Assumed Ueq | PPD, Ueq achieved | PPD, Ueq not achieved

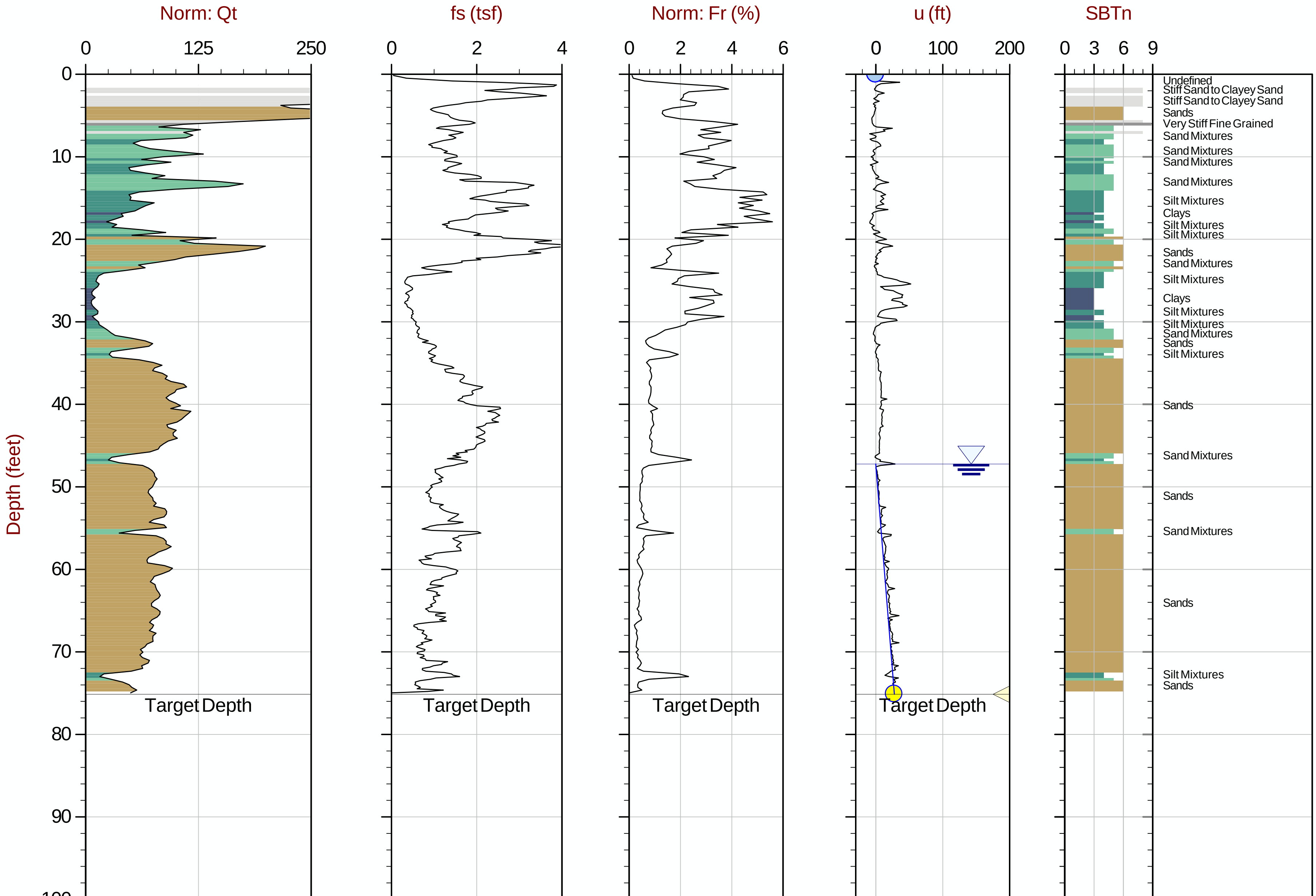
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 09:17:15 11:57
Site: AECI-New Madrid

Sounding: CPT15-HAC9
Cone: 419:T1500F15U500



Max Depth: 22.900 m / 75.13 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_CP09.COR

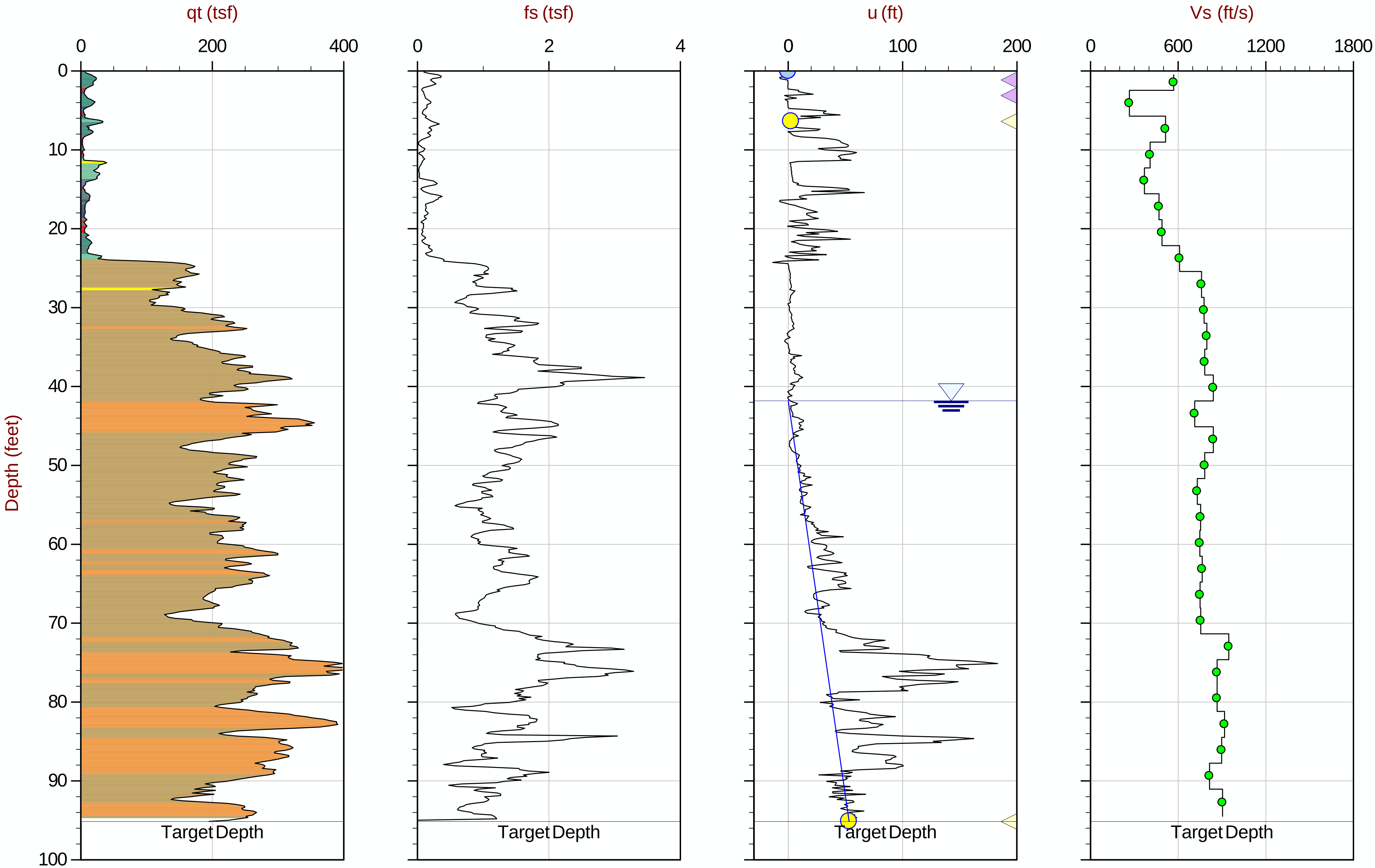
SBT: Robertson, 1990
Coords: UTM Zone 16 N: 4042932m E: 271425m

Hydrostatic Line   Ueq   Assumed Ueq   PPD, Ueq achieved   PPD, Ueq not achieved

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

Seismic Cone Penetration Test Plots

Haley & Aldrich	Job No: 15-53087	Sounding: SCPT15-HAC7
	Date: 09:15:15 14:36	Cone: 419:T1500F15U500
	Site: AECI-New Madrid	



Max Depth: 29.000 m / 95.14 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_SP07.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4043266m E: 271126m

Hydrostatic Line   Ueq   Assumed Ueq   PPD, Ueq achieved   PPD, Ueq not achieved

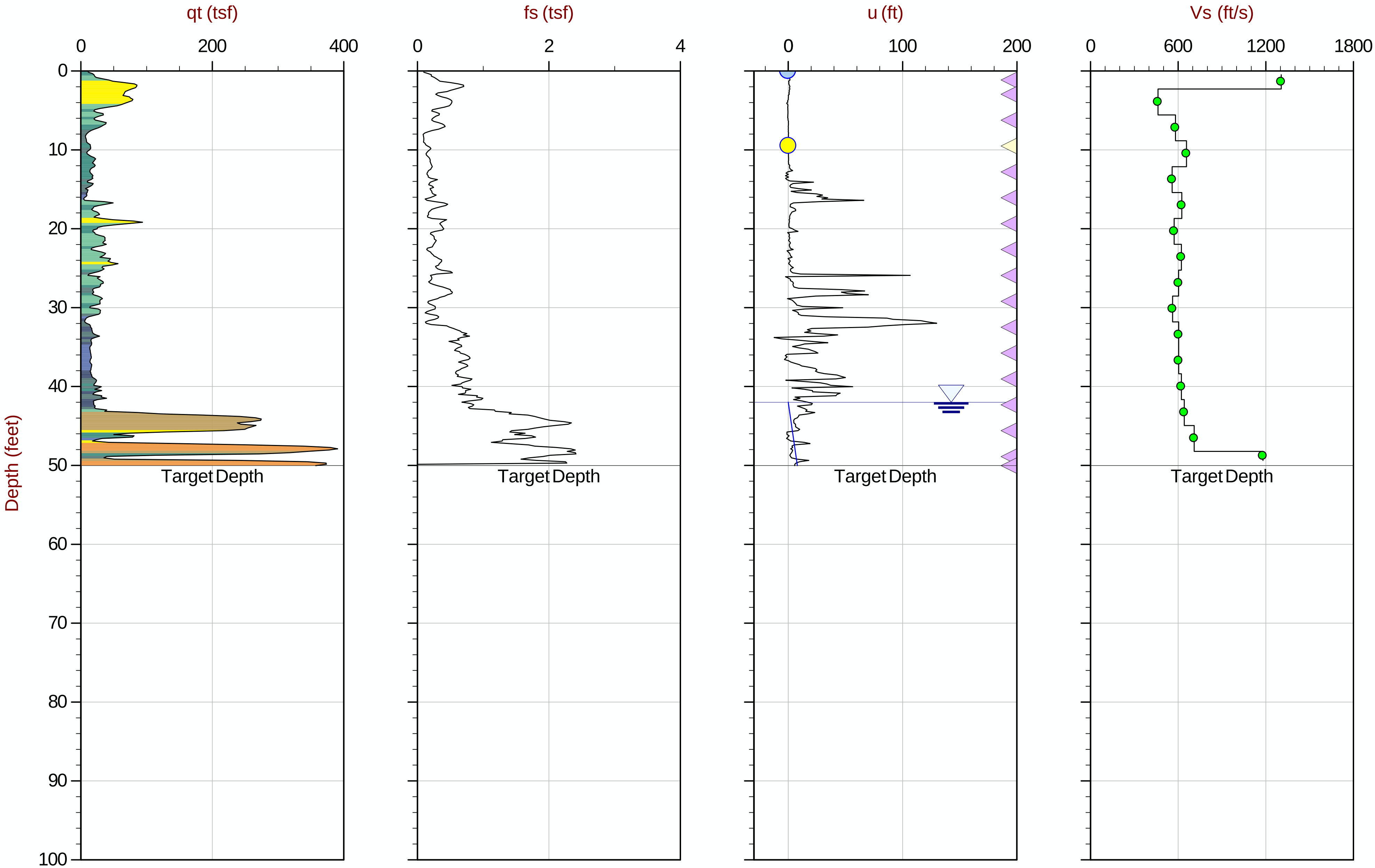
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 09:16:15 12:39
Site: AECI-New Madrid

Sounding: SCPT15-HAC8
Cone: 419:T1500F15U500



Max Depth: 15.250 m / 50.03 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 15-53087_SP08.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4043175m E: 270700m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

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

Seismic Cone Penetration Test Tabular Results (Vs)

Job No: 15-53087
Client: Haley & Aldrich
Project: AECI - New Madrid
Sounding ID: SCPT15-HAC7
Date: 15-Sep-2015

Seismic Source: Beam
Source Offset (ft): 1.50
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)
1.15	0.49	1.58			
3.12	2.46	2.88	1.30	2.29	570
6.40	5.74	5.93	3.05	11.46	266
9.68	9.02	9.15	3.21	6.25	514
12.96	12.30	12.39	3.25	7.95	408
16.24	15.58	15.66	3.26	8.84	369
19.52	18.86	18.92	3.27	6.97	469
22.80	22.15	22.20	3.27	6.67	490
26.08	25.43	25.47	3.27	5.37	610
29.36	28.71	28.75	3.28	4.31	760
32.64	31.99	32.02	3.28	4.21	778
35.92	35.27	35.30	3.28	4.11	797
39.21	38.55	38.58	3.28	4.19	782
42.49	41.83	41.86	3.28	3.90	841
45.77	45.11	45.14	3.28	4.59	714
49.05	48.39	48.42	3.28	3.90	841
52.33	51.67	51.69	3.28	4.19	782
55.61	54.95	54.97	3.28	4.48	731
58.89	58.23	58.25	3.28	4.35	754
62.17	61.52	61.53	3.28	4.38	749
65.45	64.80	64.81	3.28	4.29	765
68.73	68.08	68.09	3.28	4.37	750
72.01	71.36	71.37	3.28	4.34	755
75.30	74.64	74.65	3.28	3.46	947
78.58	77.92	77.93	3.28	3.78	867
81.86	81.20	81.21	3.28	3.78	867
85.14	84.48	84.49	3.28	3.57	918
88.42	87.76	87.78	3.28	3.65	898
91.70	91.04	91.06	3.28	4.02	815
95.14	94.49	94.50	3.44	3.81	904

CONETEC

Job No: 15-53087
Client: Haley & Aldrich
Project: AECI - New Madrid
Sounding ID: SCPT15-HAC8
Date: 16-Sep-2015

Seismic Source: Beam
Source Offset (ft): 1.50
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)
1.15	0.49	1.58			
2.95	2.30	2.74	1.16	0.89	1306
6.23	5.58	5.78	3.03	6.56	462
9.51	8.86	8.98	3.21	5.51	582
12.80	12.14	12.23	3.25	4.94	657
16.08	15.42	15.49	3.26	5.83	559
19.36	18.70	18.76	3.27	5.23	625
22.64	21.98	22.03	3.27	5.71	573
25.92	25.26	25.31	3.27	5.27	622
29.20	28.54	28.58	3.28	5.43	603
32.48	31.82	31.86	3.28	5.83	562
35.76	35.10	35.14	3.28	5.43	604
39.04	38.39	38.41	3.28	5.43	604
42.32	41.67	41.69	3.28	5.27	622
45.60	44.95	44.97	3.28	5.11	642
48.88	48.23	48.25	3.28	4.62	710
50.03	49.38	49.40	1.15	0.97	1181

Pore Pressure Dissipation Summary and

Pore Pressure Dissipation Plots

Job No: 15-53087
Client: Haley & Aldrich
Project: AECI - New Madrid, Marston, MO
Start Date: 15-Sep-2015
End Date: 17-Sep-2015

CPTu PORE PRESSURE DISSIPATION SUMMARY

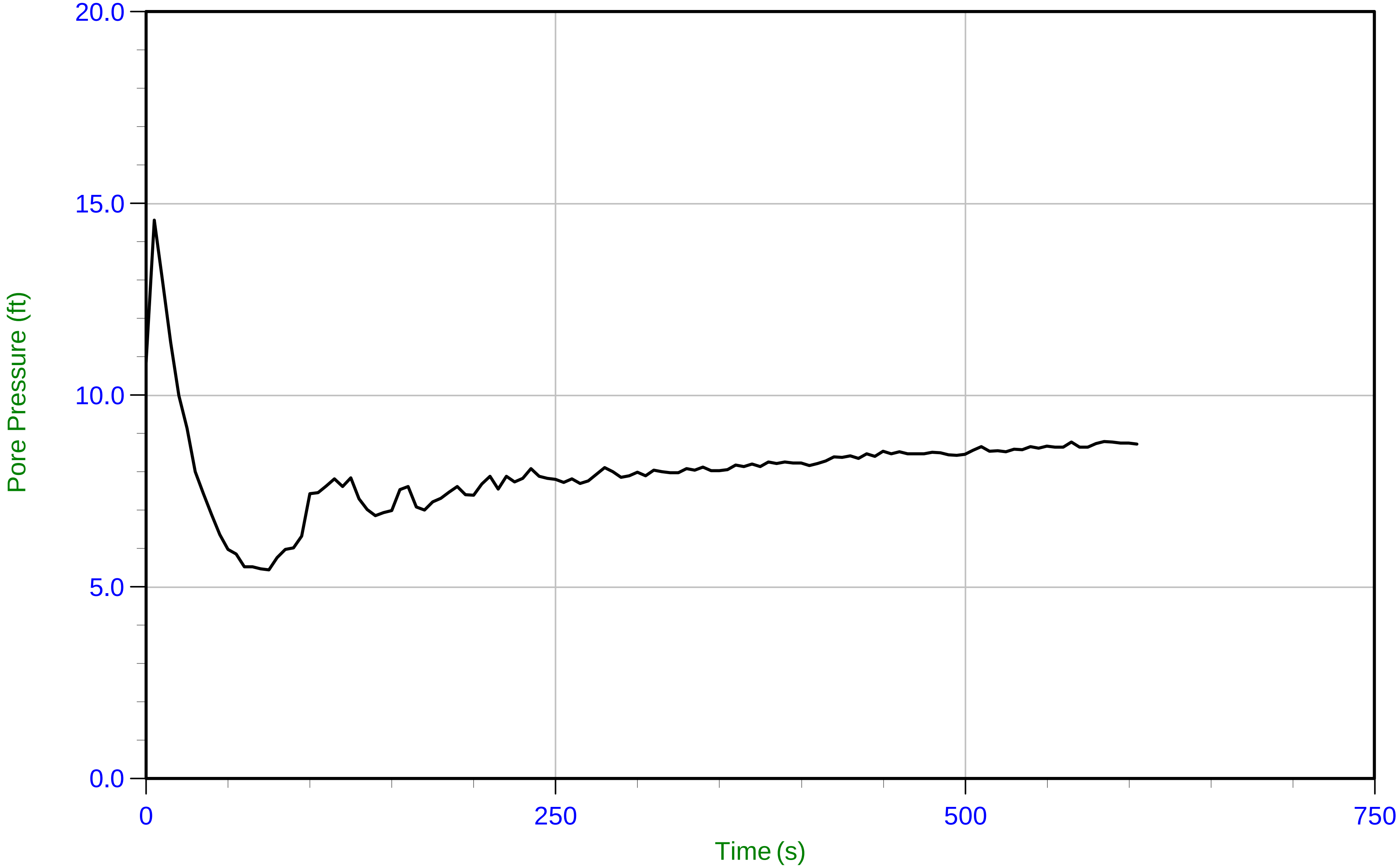
Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (ft)	Estimated Equilibrium Pore Pressure U_{eq} (ft)	Calculated Phreatic Surface (ft)	Estimated Phreatic Surface (ft)
CPT15-HAC1	15-53087_CP01	15	605	50.03	8.97	41.07	
CPT15-HAC2	15-53087_CP02	15	700	50.03	1.92	48.12	
CPT15-HAC3	15-53087_CP03	15	600	95.14	53.33	41.81	
CPT15-HAC4	15-53087_CP04	15	600	50.03	15.06	34.97	
CPT15-HAC5	15-53087_CP05	15	1000	75.13	31.73	43.40	
CPT15-HAC6	15-53087_CP06	15	300	50.03	19.92	30.11	
SCPT15-HAC7	15-53087_SP07	15	300	1.15			
SCPT15-HAC7	15-53087_SP07	15	300	3.12			
SCPT15-HAC7	15-53087_SP07	15	190	6.40	2.59	3.81	
SCPT15-HAC7	15-53087_SP07	15	600	95.14	53.33	41.81	
SCPT15-HAC8	15-53087_SP08	15	200	1.15			
SCPT15-HAC8	15-53087_SP08	15	150	2.95			
SCPT15-HAC8	15-53087_SP08	15	150	6.23			
SCPT15-HAC8	15-53087_SP08	15	150	9.51	0.34	9.17	
SCPT15-HAC8	15-53087_SP08	15	400	12.80			
SCPT15-HAC8	15-53087_SP08	15	600	16.08			
SCPT15-HAC8	15-53087_SP08	15	1700	19.36			
SCPT15-HAC8	15-53087_SP08	15	600	22.64			
SCPT15-HAC8	15-53087_SP08	15	400	25.92			
SCPT15-HAC8	15-53087_SP08	15	600	29.20			
SCPT15-HAC8	15-53087_SP08	15	7020	32.48			
SCPT15-HAC8	15-53087_SP08	15	5800	35.76			
SCPT15-HAC8	15-53087_SP08	15	900	39.04			
SCPT15-HAC8	15-53087_SP08	15	2400	42.32			
SCPT15-HAC8	15-53087_SP08	15	600	45.60			
SCPT15-HAC8	15-53087_SP08	15	200	48.88			
SCPT15-HAC8	15-53087_SP08	15	900	50.03			
CPT15-HAC9	15-53087_CP09	15	500	75.13	27.89	47.24	
CPT15-HAC10	15-53087_CP10	15	600	50.52			
Totals	29 dissipations		484.4 min				

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 17-Sep-2015 17:40:26
Site: AECI-New Madrid

Sounding: CPT15-HAC1
Cone: AD419
Cone Area: 15 sq cm



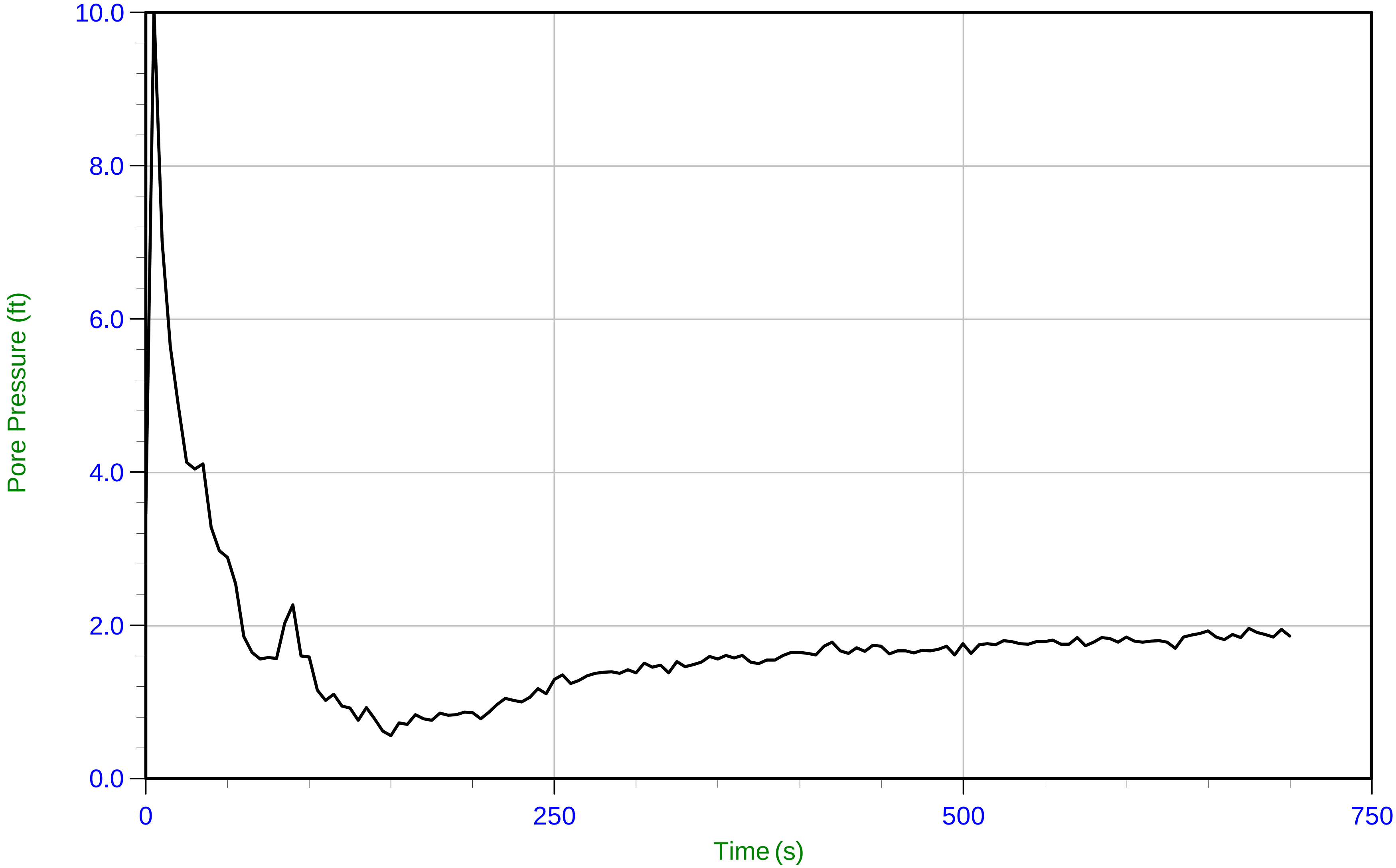
Trace Summary:

Filename: 15-53087_CP01.PPD
Depth: 15.250 m / 50.032 ft
Duration: 605.0 s

U Min: 5.4 ft
U Max: 14.6 ft

WT: 12.517 m / 41.066 ft
Ueq: 9.0 ft

Haley & Aldrich	Job No: 15-53087	Sounding: CPT15-HAC2
	Date: 17-Sep-2015 14:41:36	Cone: AD419
	Site: AECI-New Madrid	Cone Area: 15 sq cm



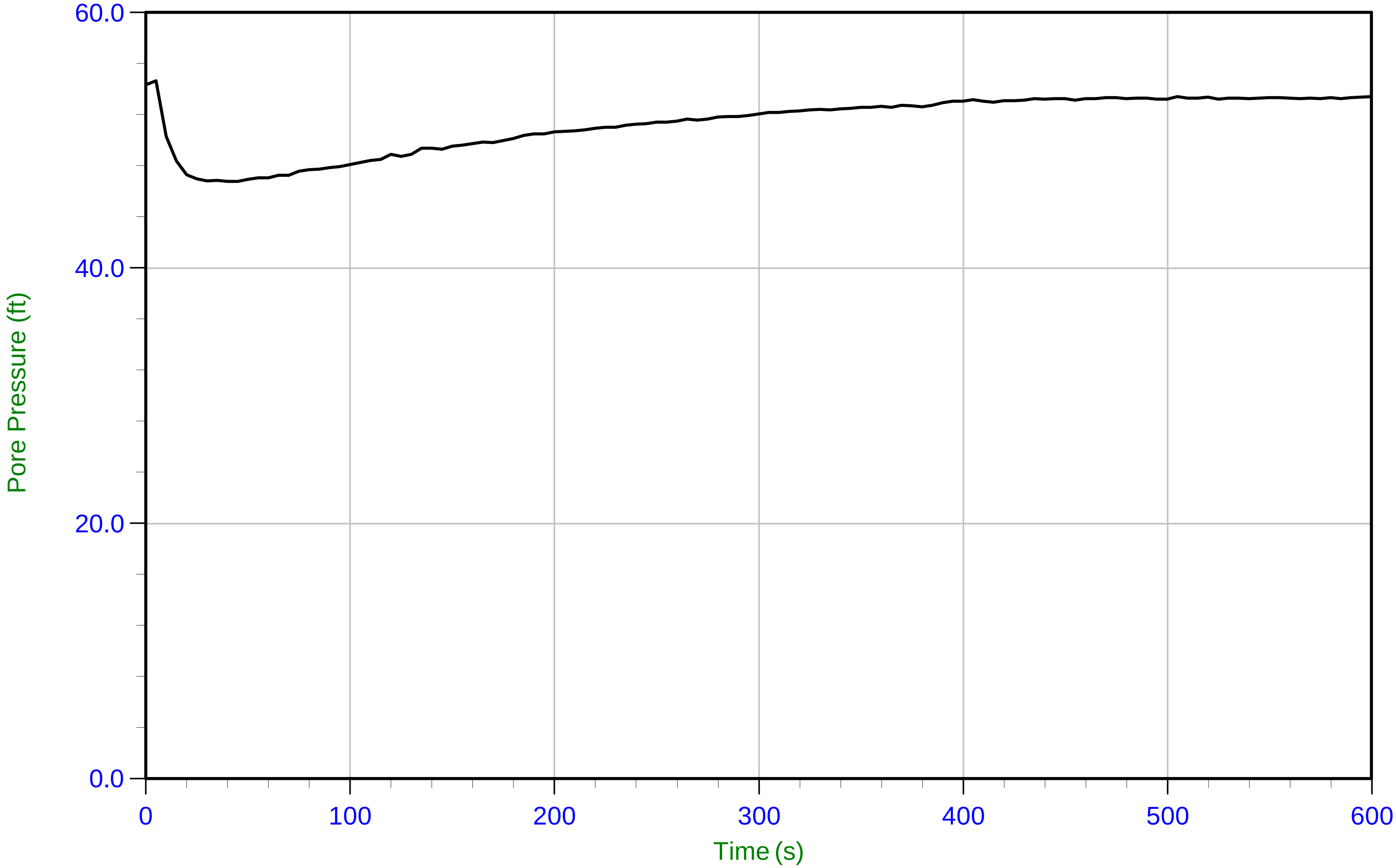
Trace Summary:			
	Filename: 15-53087_CP02.PPD	U Min: 0.6 ft	WT: 14.666 m / 48.116 ft
	Depth: 15.250 m / 50.032 ft	U Max: 10.1 ft	Ueq: 1.9 ft
	Duration: 700.0 s		

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 17-Sep-2015 15:59:49
Site: AECI-New Madrid

Sounding: CPT15-HAC3
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_CP03.PPD
Depth: 29.000 m / 95.143 ft
Duration: 600.0 s

U Min: 46.8 ft
U Max: 54.7 ft

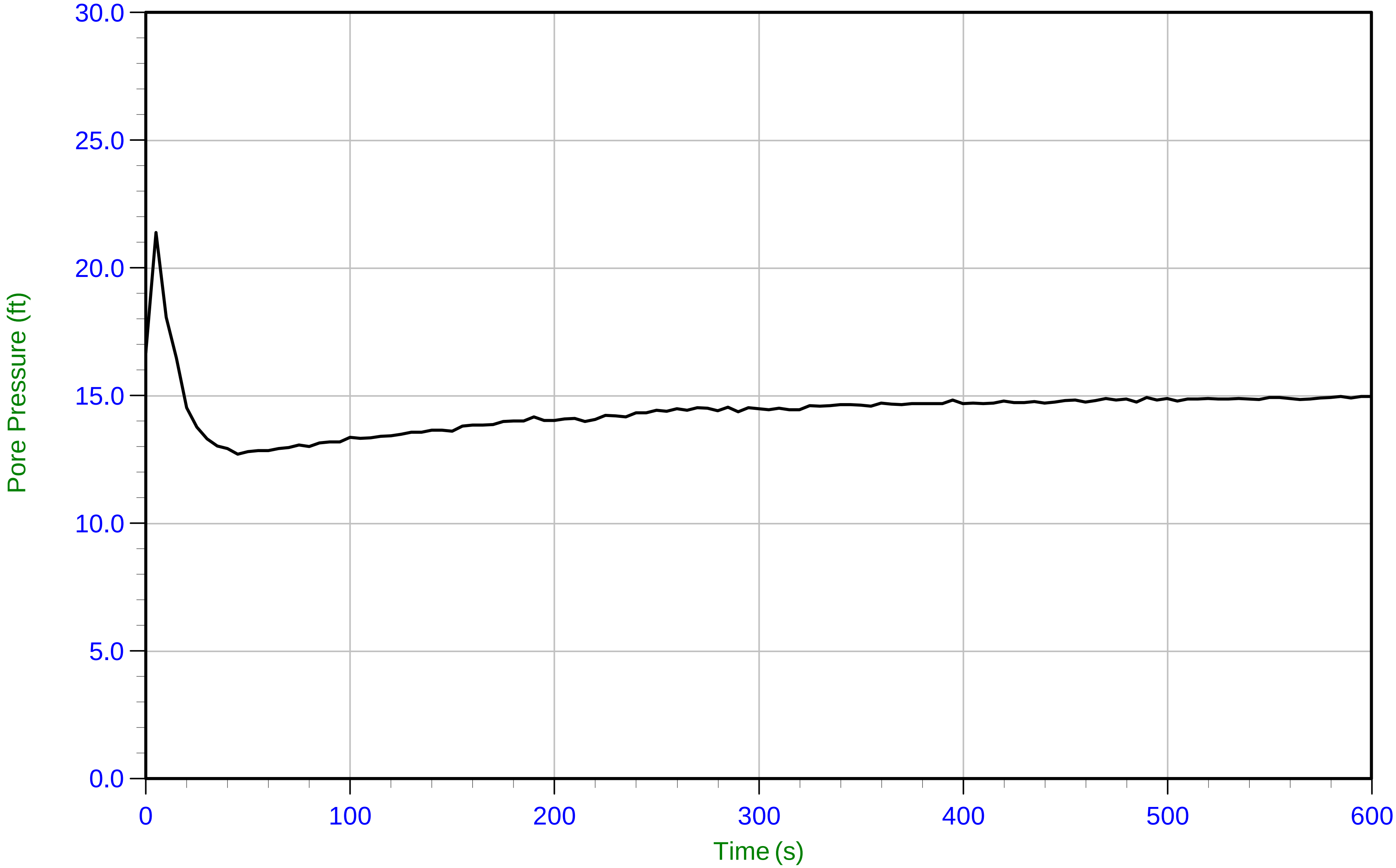
WT: 12.744 m / 41.811 ft
Ueq: 53.3 ft

ConeTec

Haley & Aldrich

Job No: 15-53087
Date: 17-Sep-2015 13:17:21
Site: AECI-New Madrid

Sounding: CPT15-HAC4
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_CP04.PPD
Depth: 15.250 m / 50.032 ft
Duration: 600.0 s

U Min: 12.7 ft
U Max: 21.4 ft

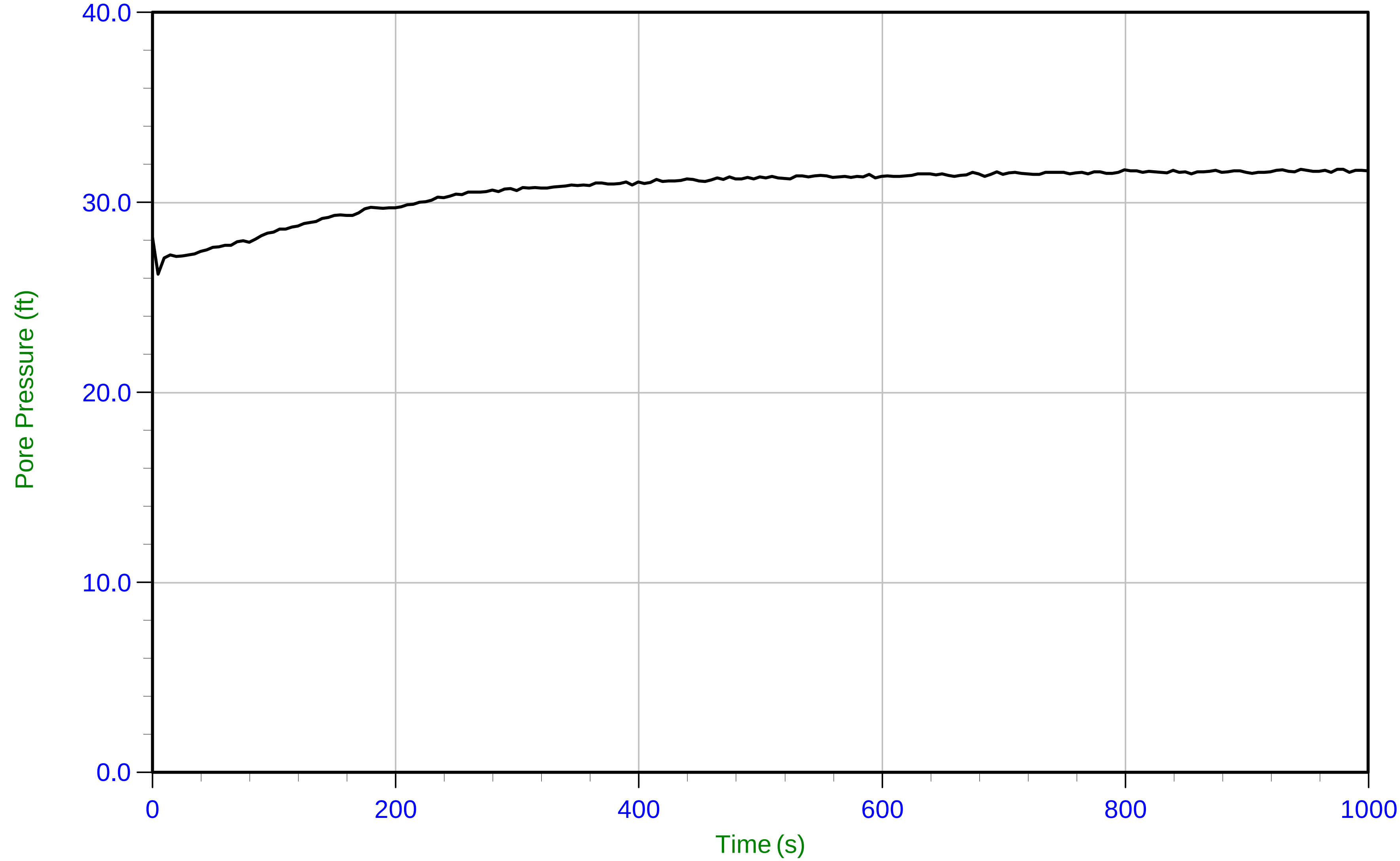
WT: 10.660 m / 34.973 ft
Ueq: 15.1 ft

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 15-Sep-2015 17:52:55
Site: AECI-New Madrid

Sounding: CPT15-HAC5
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_CP05.PPD
Depth: 22.900 m / 75.130 ft
Duration: 1000.0 s

U Min: 26.2 ft
U Max: 31.8 ft

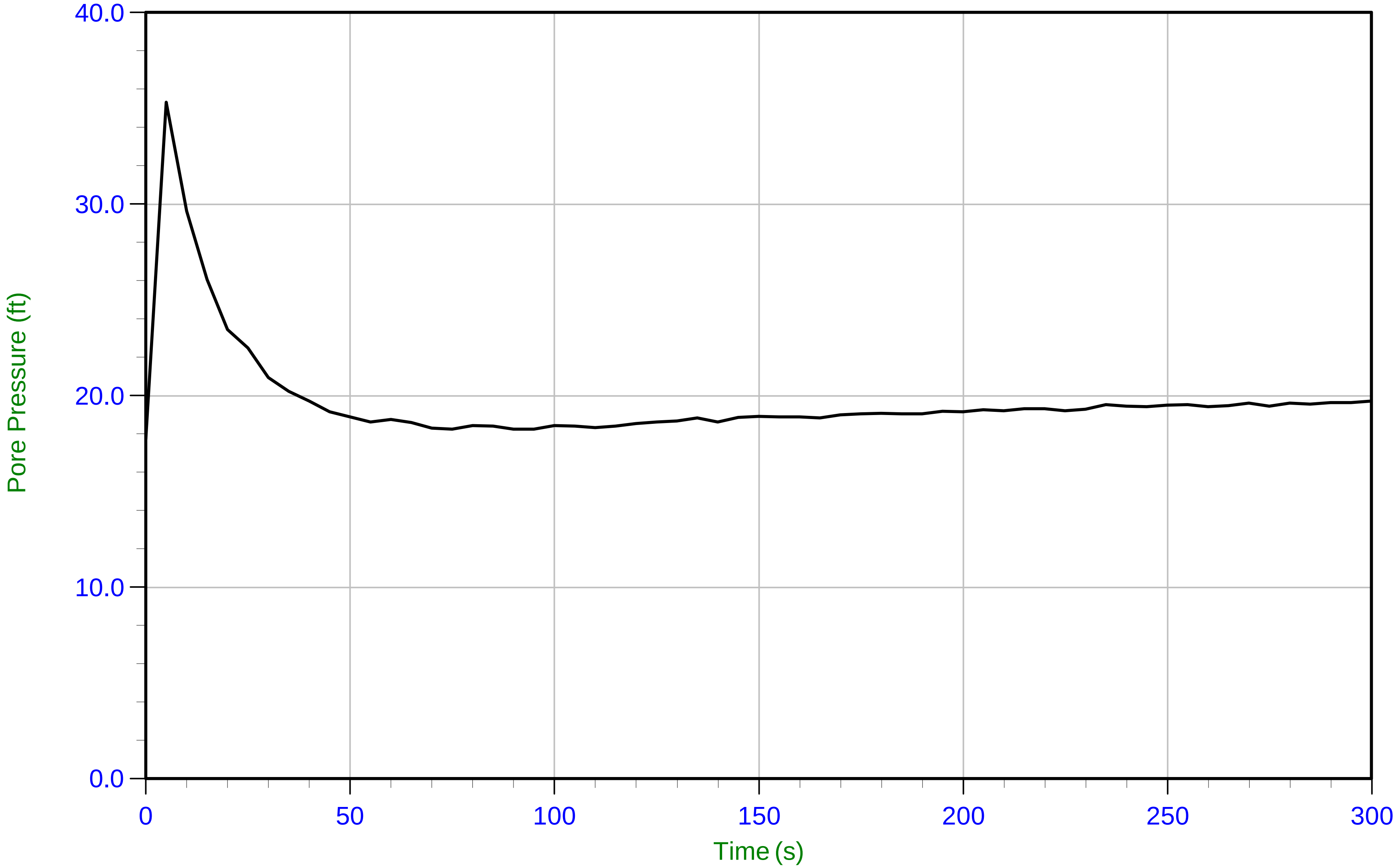
WT: 13.230 m / 43.405 ft
Ueq: 31.7 ft

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 16-Sep-2015 10:26:29
Site: AECI-New Madrid

Sounding: CPT15-HAC6
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

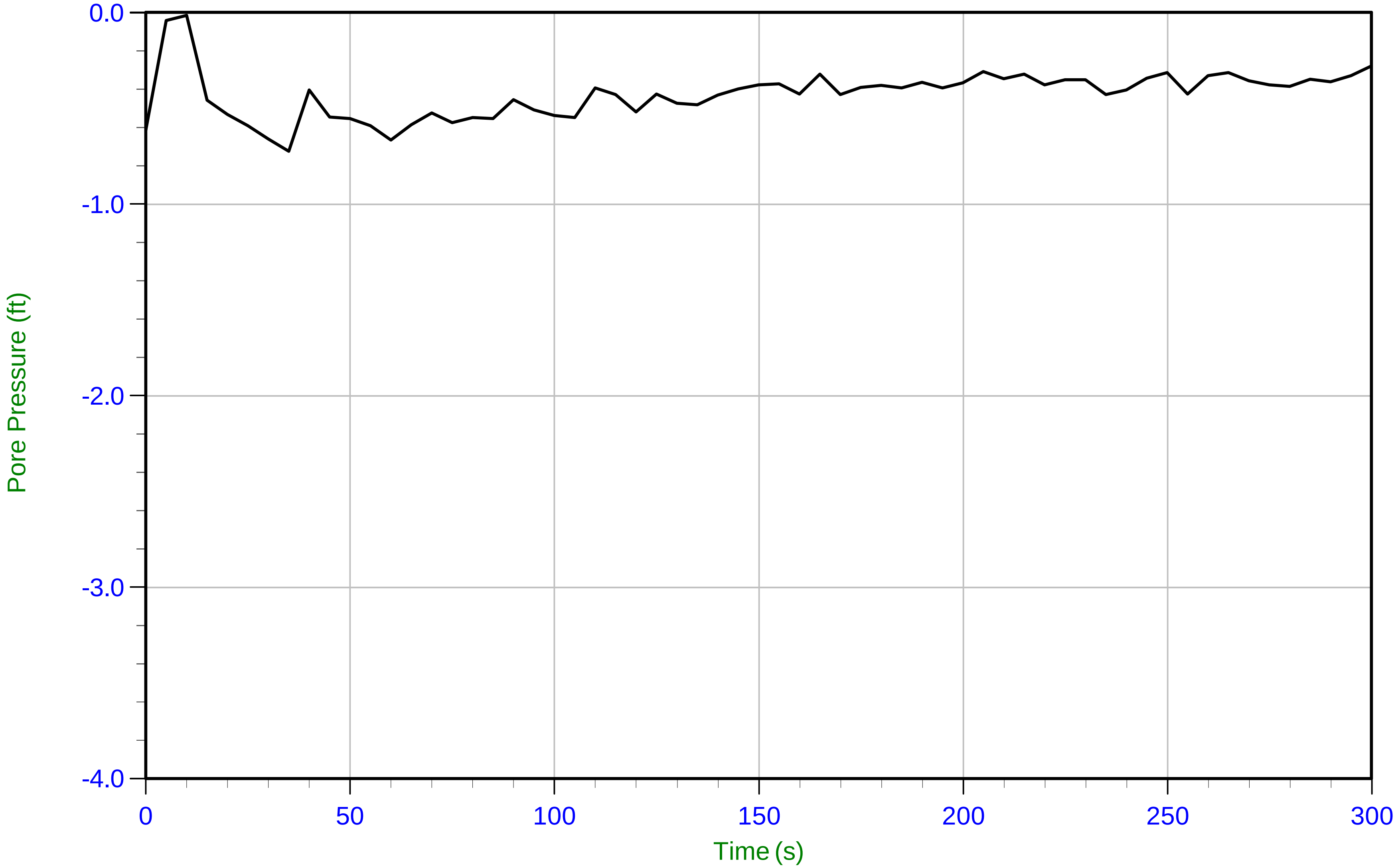
Filename: 15-53087_CP06.PPD
Depth: 15.250 m / 50.032 ft
Duration: 300.0 s

U Min: 17.7 ft
U Max: 35.3 ft

WT: 9.177 m / 30.108 ft
Ueq: 19.9 ft

CONETEC

Haley & Aldrich	Job No: 15-53087 Date: 15-Sep-2015 14:36:00 Site: AECI-New Madrid	Sounding: SCPT15-HAC7 Cone: AD419 Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_SP07.PPD
Depth: 0.350 m / 1.148 ft
Duration: 300.0 s

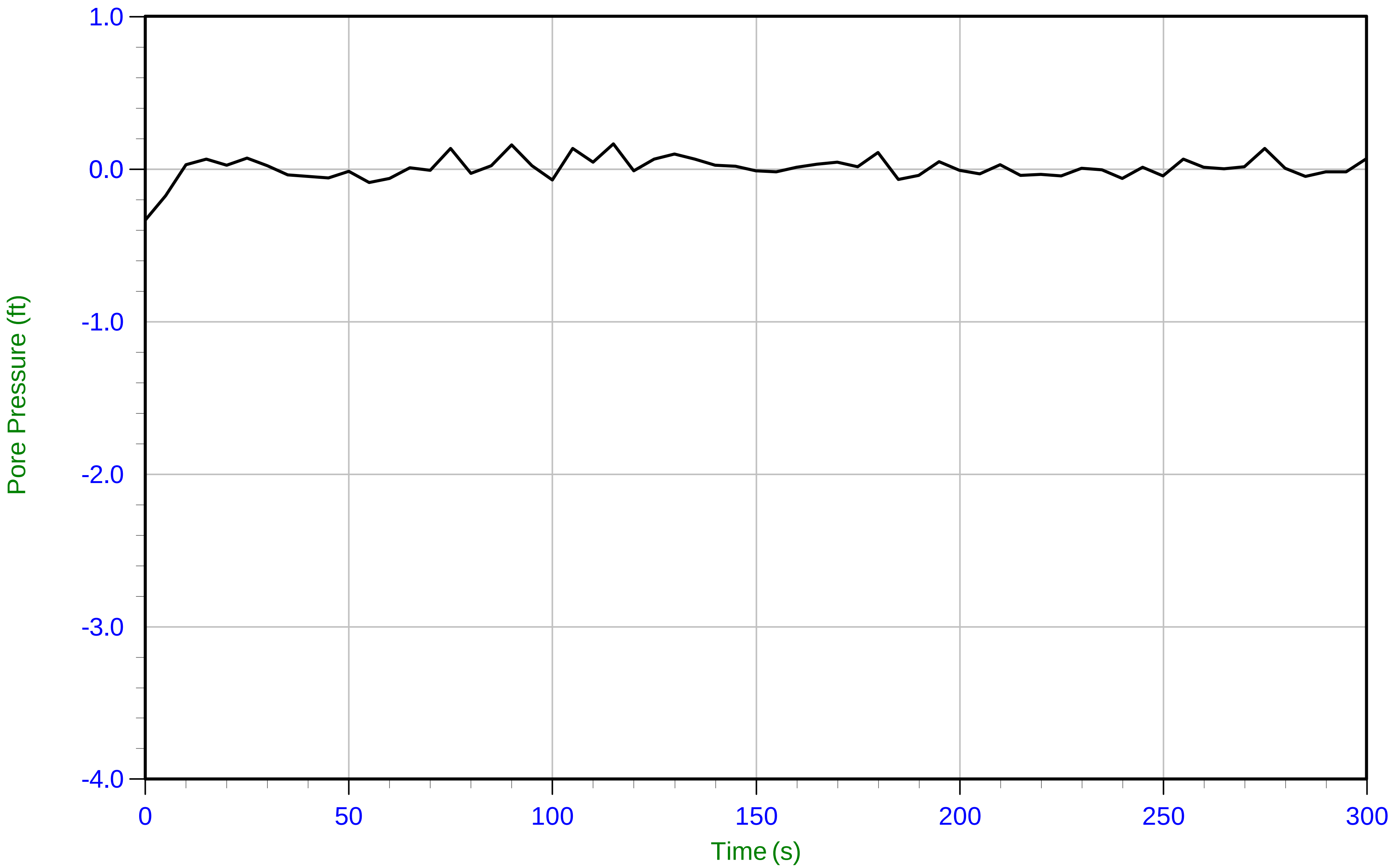
U Min: -0.7 ft
U Max: -0.0 ft

ConeTec

Haley & Aldrich

Job No: 15-53087
Date: 15-Sep-2015 14:36:00
Site: AECI-New Madrid

Sounding: SCPT15-HAC7
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_SP07.PPD
Depth: 0.950 m / 3.117 ft
Duration: 300.0 s

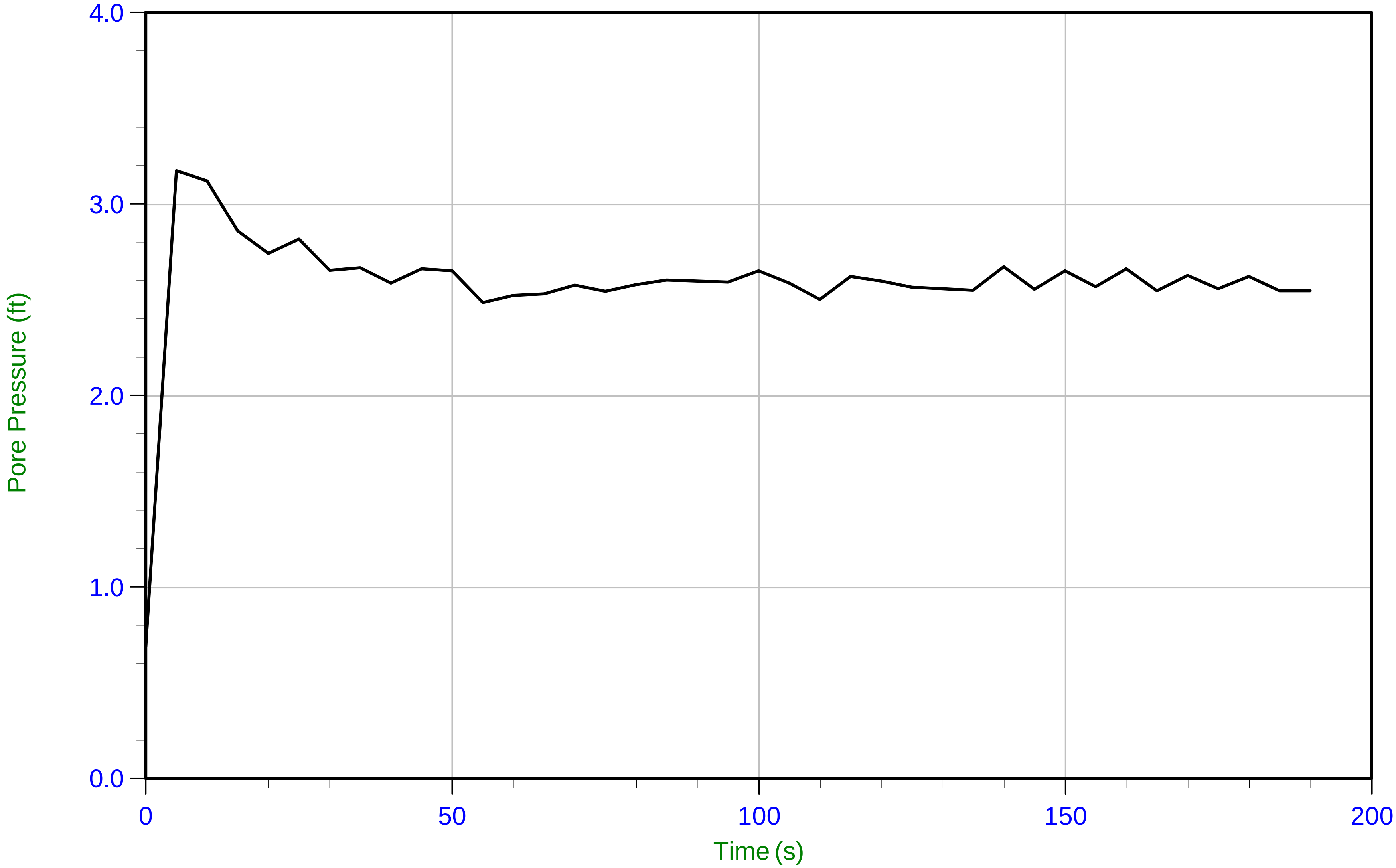
U Min: -0.3 ft
U Max: 0.2 ft

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 15-Sep-2015 14:36:00
Site: AECI-New Madrid

Sounding: SCPT15-HAC7
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_SP07.PPD
Depth: 1.950 m / 6.398 ft
Duration: 190.0 s

U Min: 0.7 ft
U Max: 3.2 ft

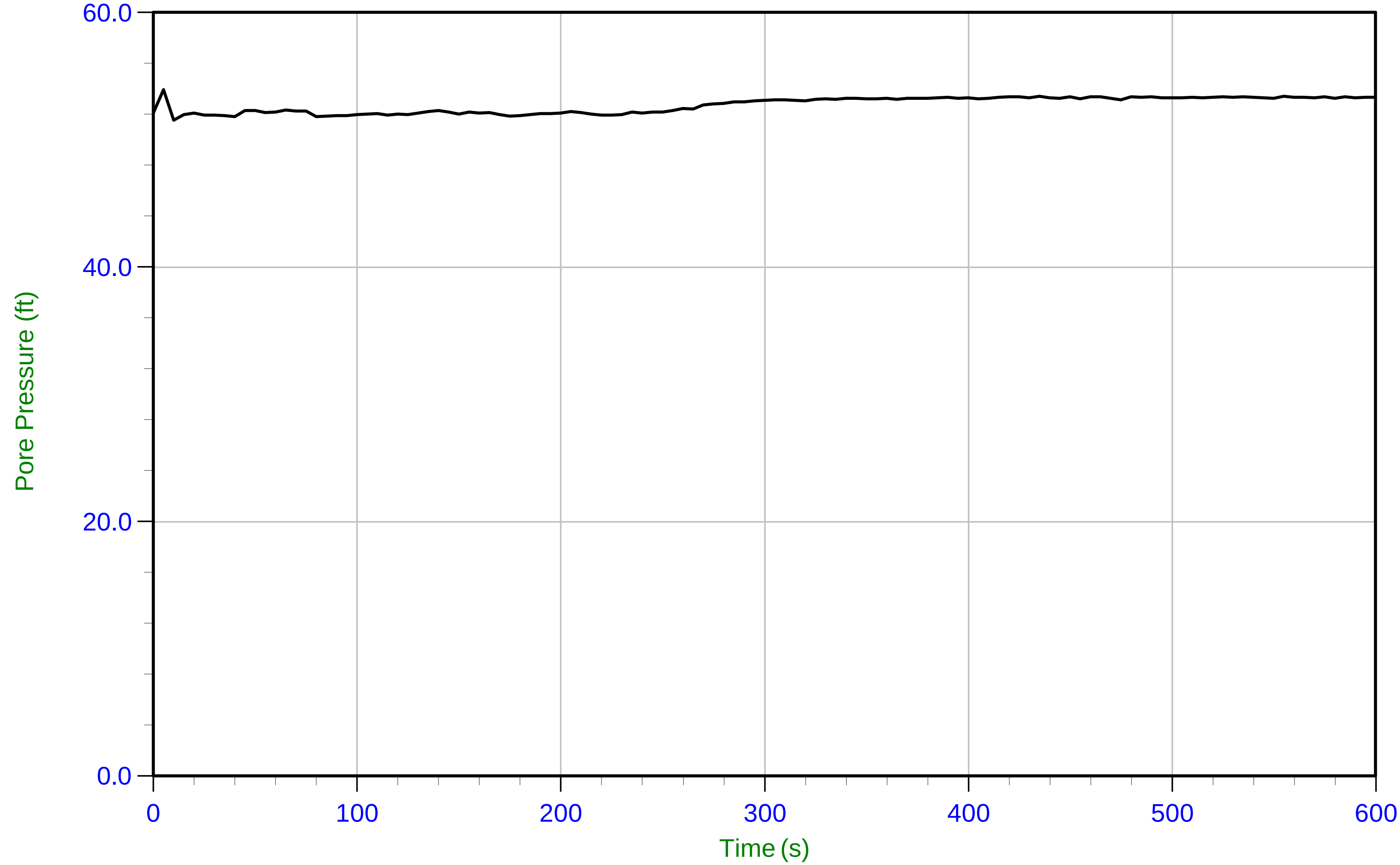
WT: 1.161 m / 3.809 ft
Ueq: 2.6 ft

ConeTec

Haley & Aldrich

Job No: 15-53087
Date: 15-Sep-2015 14:36:00
Site: AECI-New Madrid

Sounding: SCPT15-HAC7
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_SP07.PPD
Depth: 29.000 m / 95.143 ft
Duration: 600.0 s

U Min: 51.5 ft
U Max: 53.9 ft

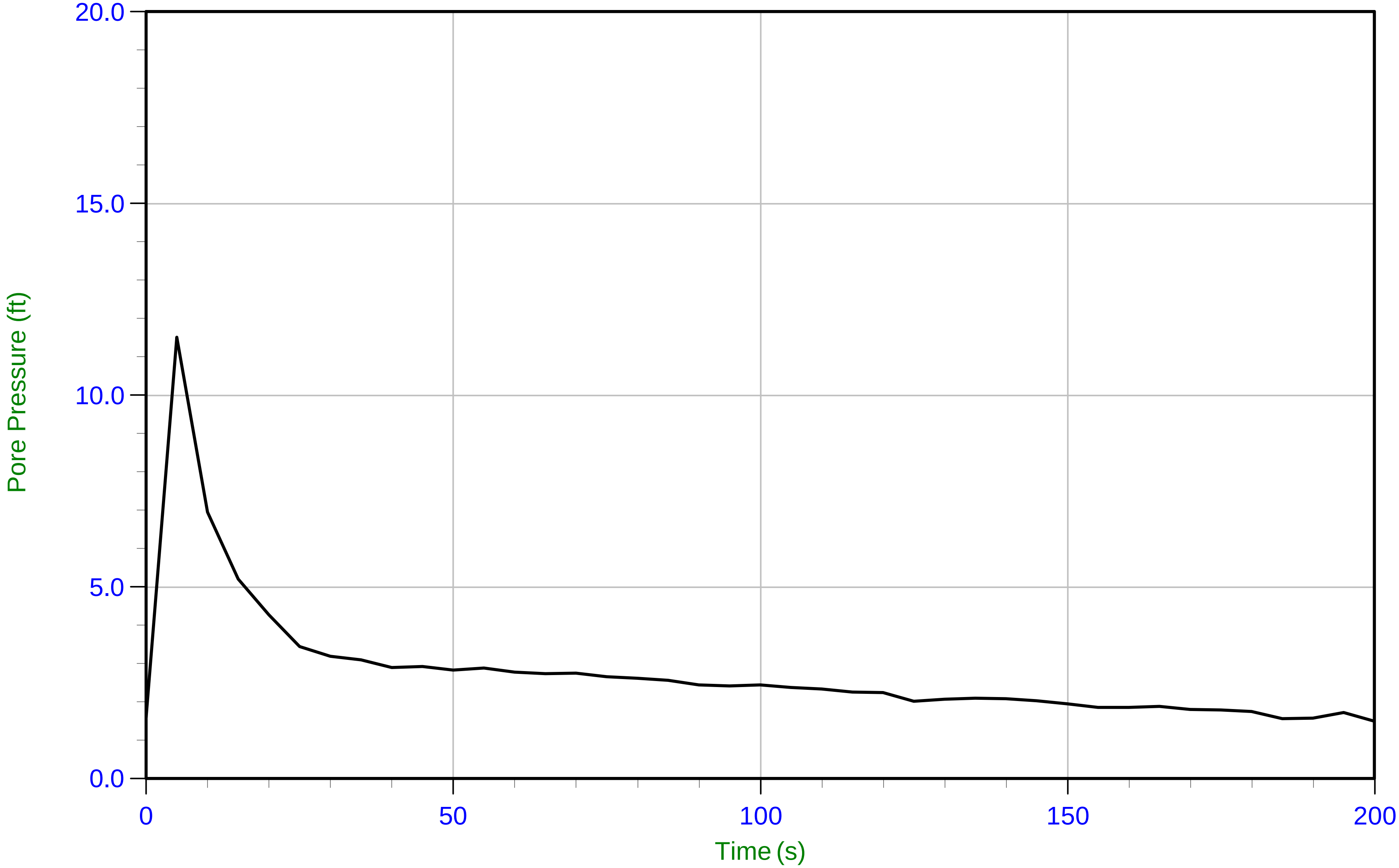
WT: 12.744 m / 41.811 ft
Ueq: 53.3 ft

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 16-Sep-2015 12:39:09
Site: AECI-New Madrid

Sounding: SCPT15-HAC8
Cone: AD419
Cone Area: 15 sq cm



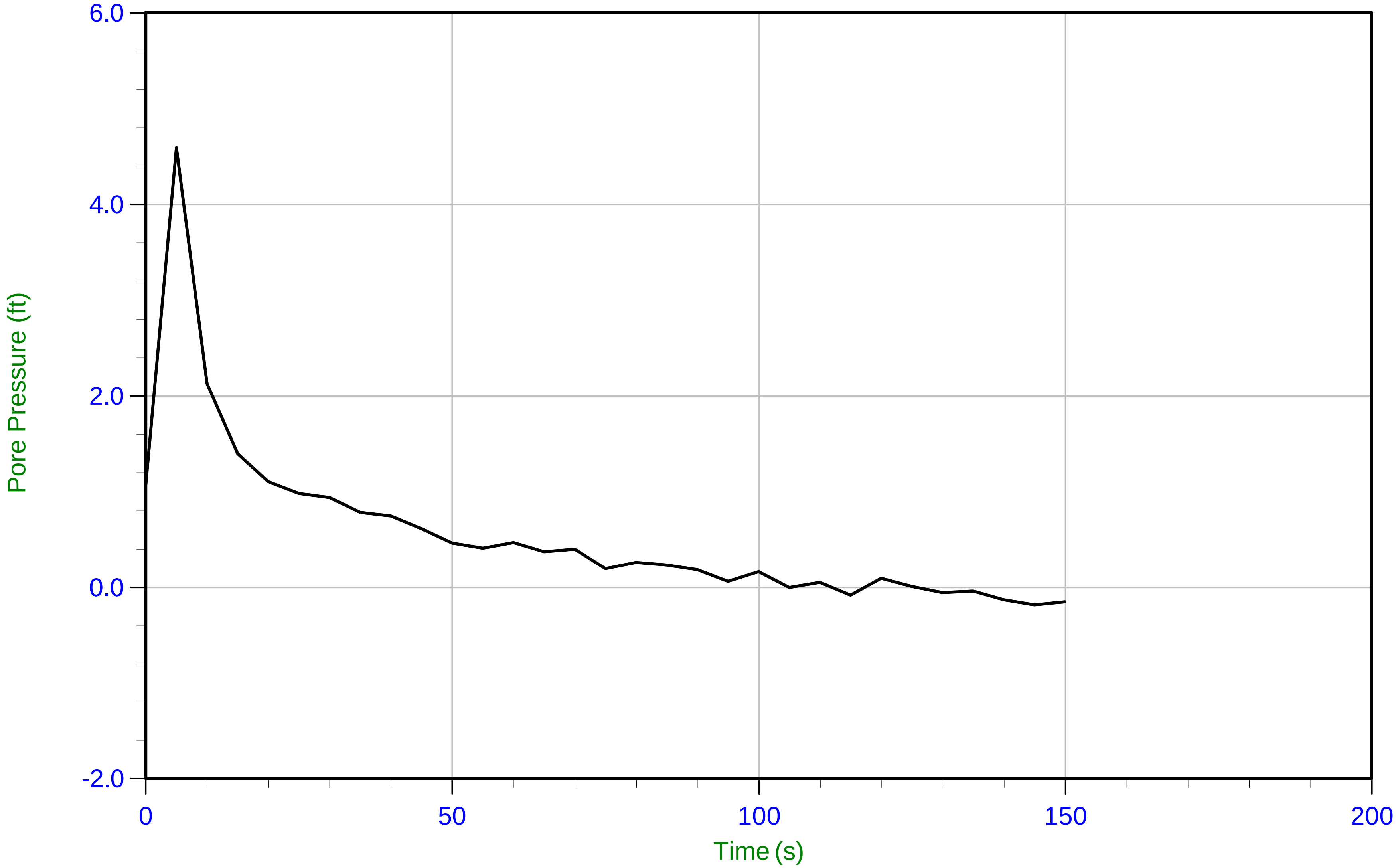
Trace Summary:

Filename: 15-53087_SP08.PPD
Depth: 0.350 m / 1.148 ft
Duration: 200.0 s

U Min: 1.5 ft
U Max: 11.5 ft

CONETEC

Haley & Aldrich	Job No: 15-53087	Sounding: SCPT15-HAC8
	Date: 16-Sep-2015 12:39:09	Cone: AD419
	Site: AECI-New Madrid	Cone Area: 15 sq cm

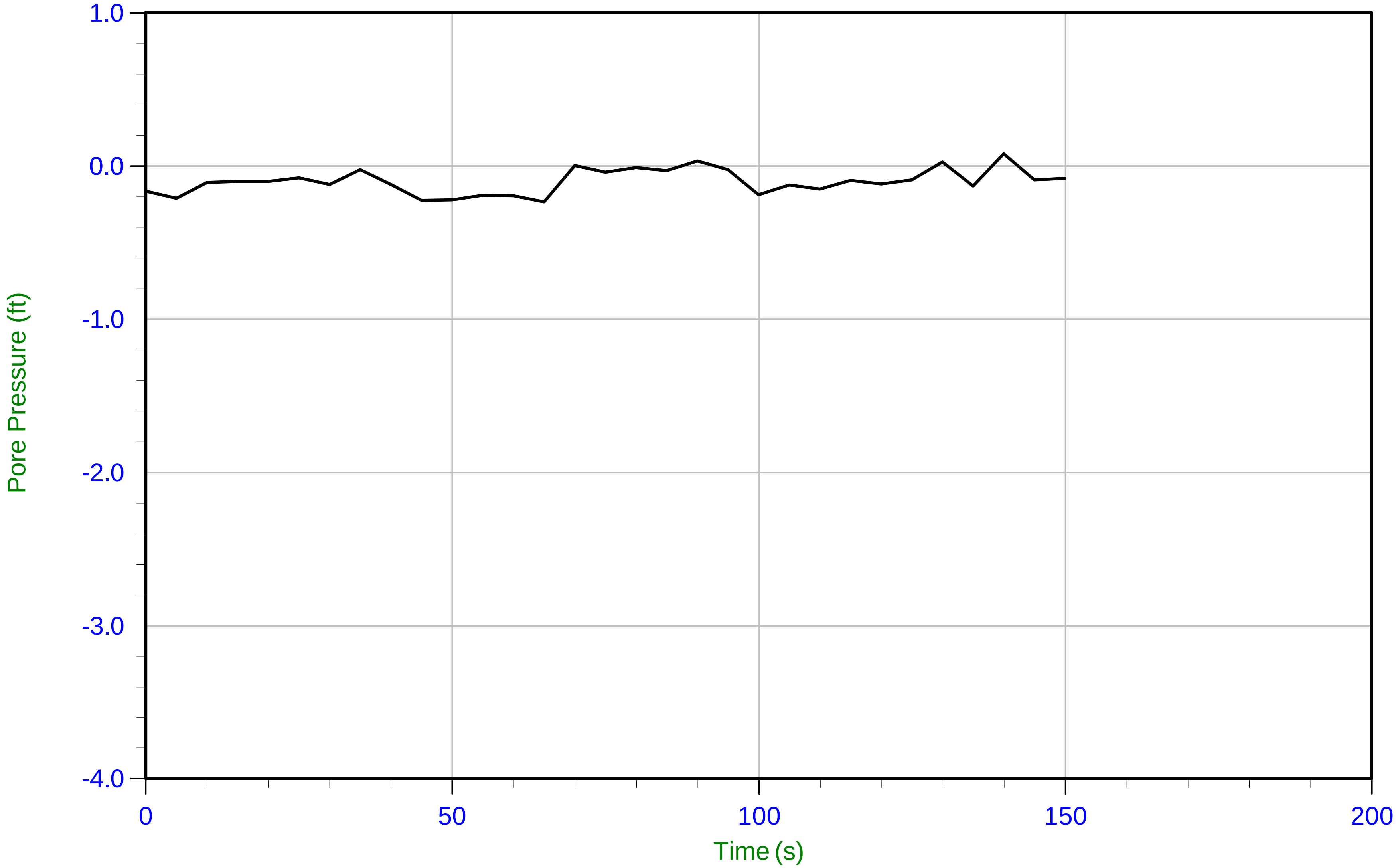


Trace Summary:

Filename: 15-53087_SP08.PPD
Depth: 0.900 m / 2.953 ft
Duration: 150.0 s

U Min: -0.2 ft
U Max: 4.6 ft

Haley & Aldrich	Job No: 15-53087	Sounding: SCPT15-HAC8
	Date: 16-Sep-2015 12:39:09	Cone: AD419
	Site: AECI-New Madrid	Cone Area: 15 sq cm



Trace Summary:

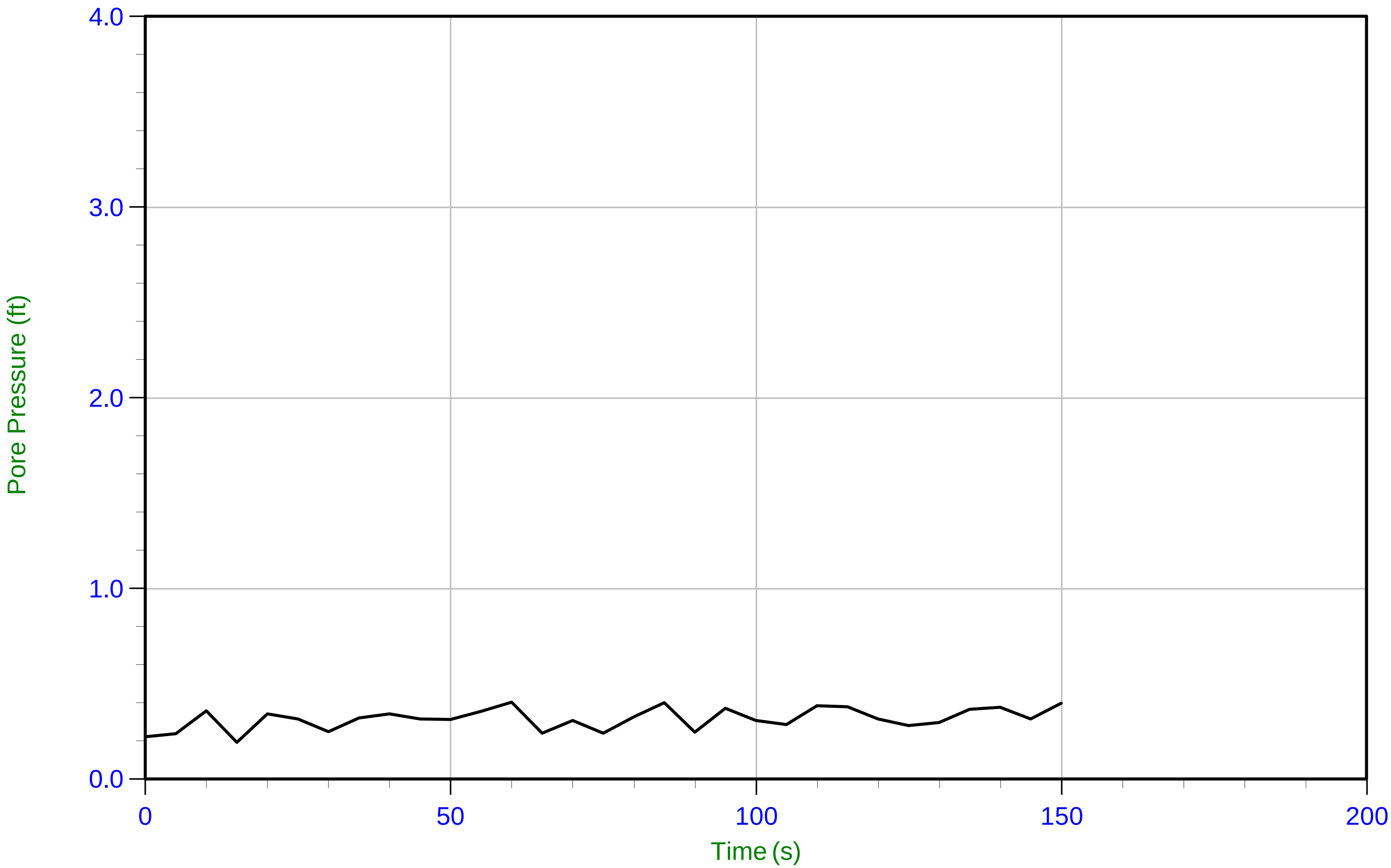
Filename: 15-53087_SP08.PPD
Depth: 1.900 m / 6.234 ft
Duration: 150.0 s

U Min: -0.2 ft
U Max: 0.1 ft

Haley & Aldrich

Job No: 15-53087
Date: 16-Sep-2015 12:39:09
Site: AECI-New Madrid

Sounding: SCPT15-HAC8
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_SP08.PPD
Depth: 2.900 m / 9.514 ft
Duration: 150.0 s

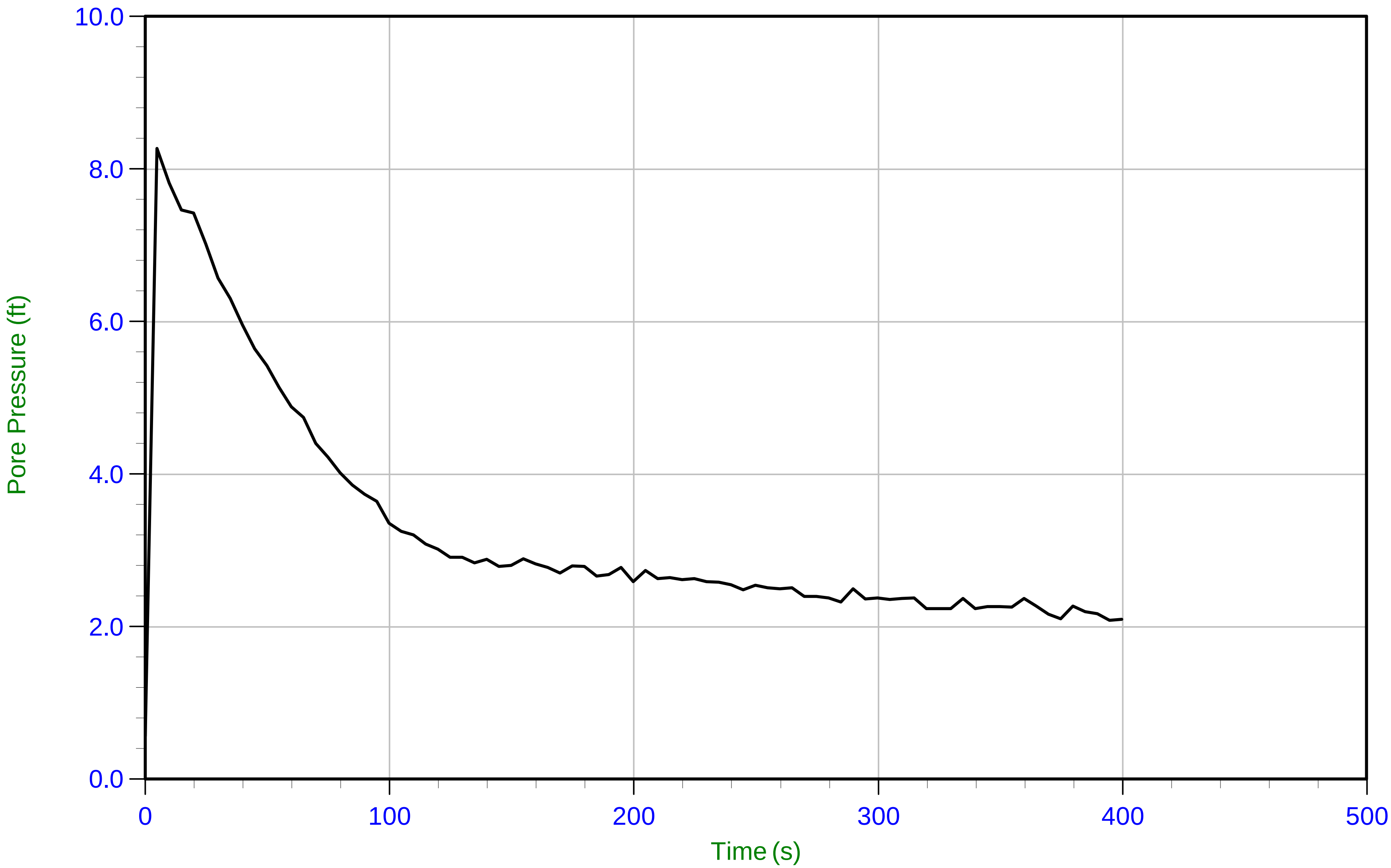
U Min: 0.2 ft
U Max: 0.4 ft

WT: 2.796 m / 9.172 ft
Ueq: 0.3 ft

Haley & Aldrich

Job No: 15-53087
Date: 16-Sep-2015 12:39:09
Site: AECI-New Madrid

Sounding: SCPT15-HAC8
Cone: AD419
Cone Area: 15 sq cm

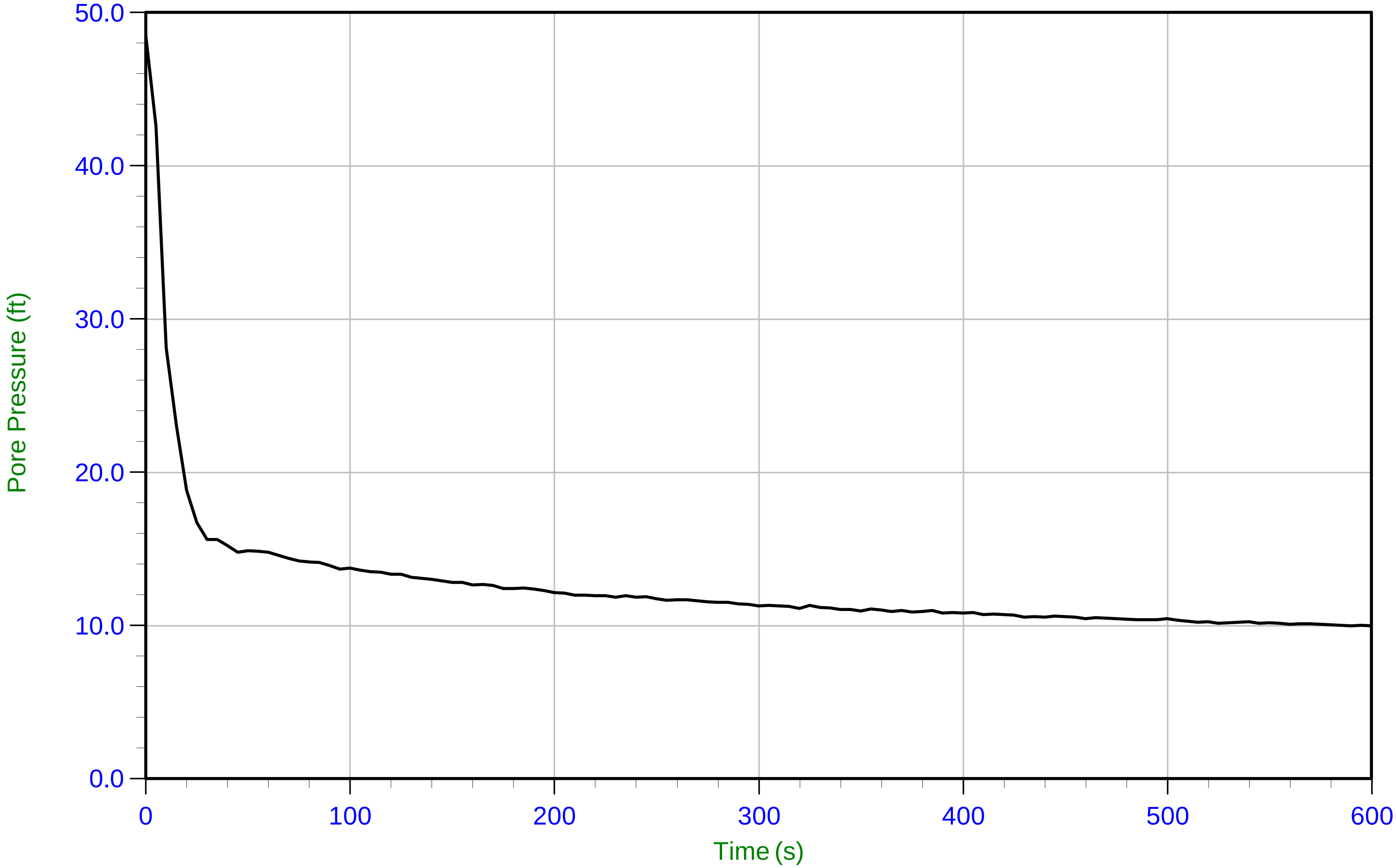


Trace Summary:

Filename: 15-53087_SP08.PPD
Depth: 3.900 m / 12.795 ft
Duration: 400.0 s

U Min: 0.6 ft
U Max: 8.3 ft

Haley & Aldrich	Job No: 15-53087	Sounding: SCPT15-HAC8
	Date: 16-Sep-2015 12:39:09	Cone: AD419
	Site: AECI-New Madrid	Cone Area: 15 sq cm



Trace Summary:

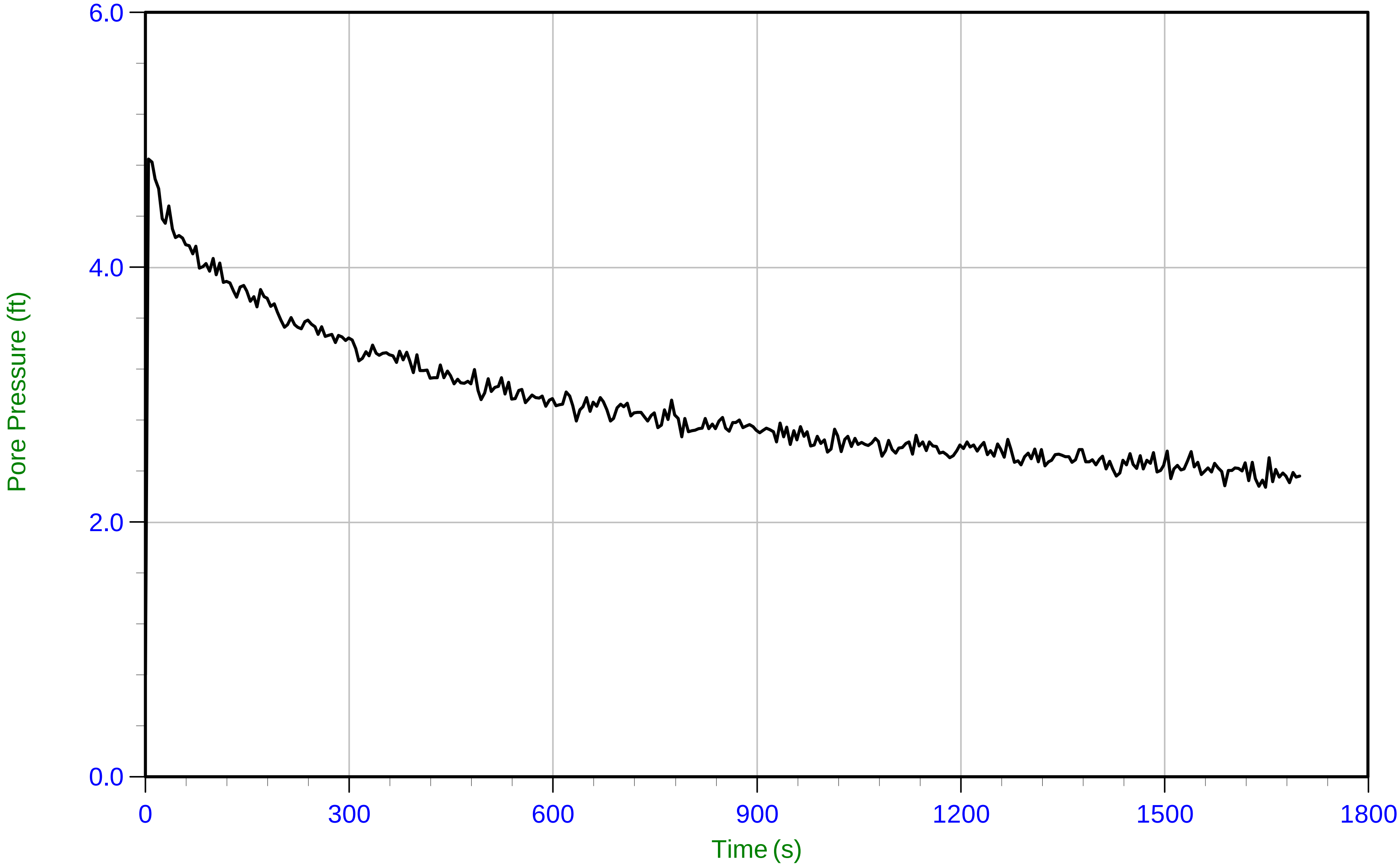
Filename: 15-53087_SP08.PPD
Depth: 4.900 m / 16.076 ft
Duration: 600.0 s

U Min: 10.0 ft
U Max: 48.5 ft

Haley & Aldrich

Job No: 15-53087
Date: 16-Sep-2015 12:39:09
Site: AECI-New Madrid

Sounding: SCPT15-HAC8
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_SP08.PPD
Depth: 5.900 m / 19.357 ft
Duration: 1700.0 s

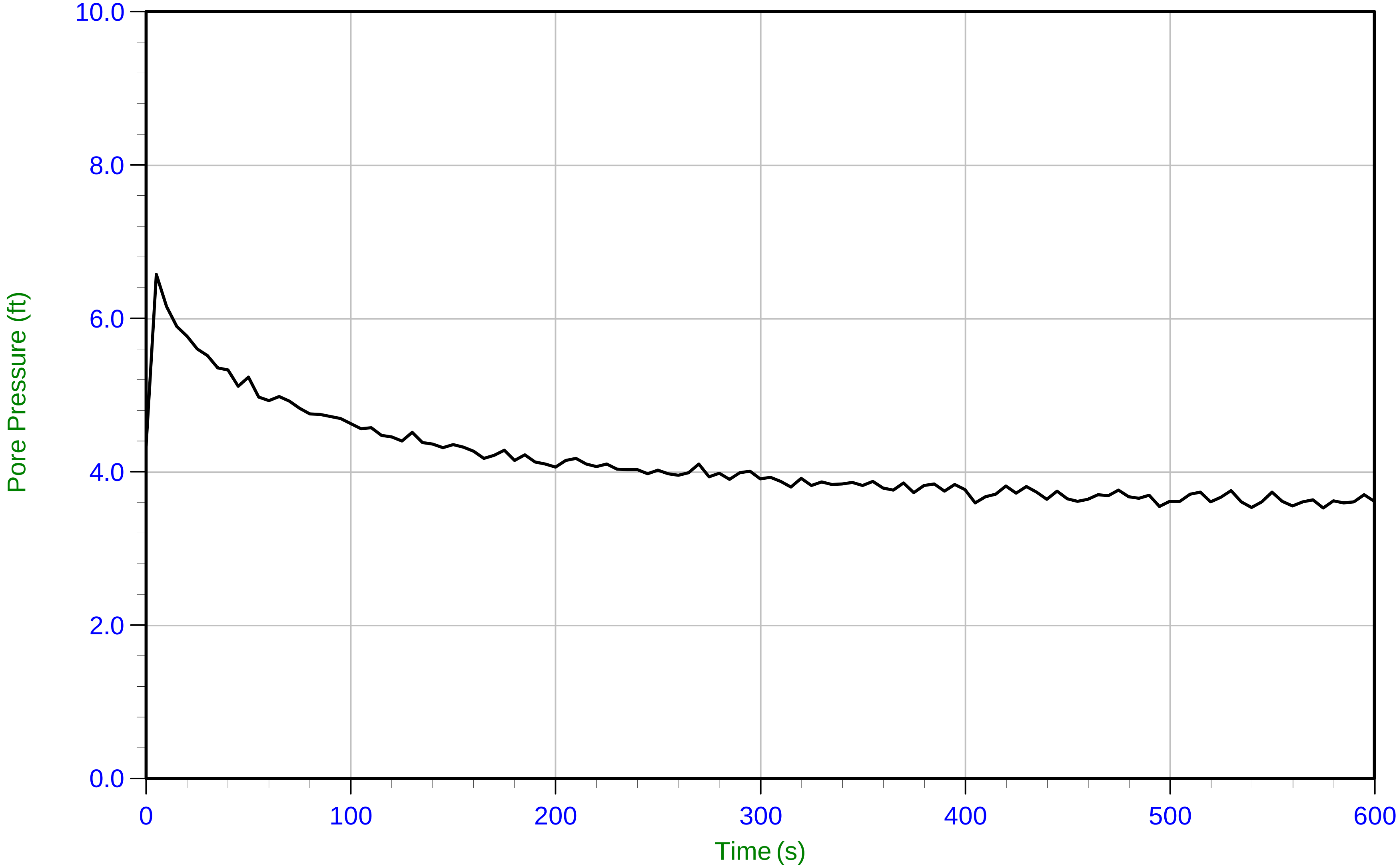
U Min: 0.8 ft
U Max: 4.9 ft

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 16-Sep-2015 12:39:09
Site: AECI-New Madrid

Sounding: SCPT15-HAC8
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_SP08.PPD
Depth: 6.900 m / 22.638 ft
Duration: 600.0 s

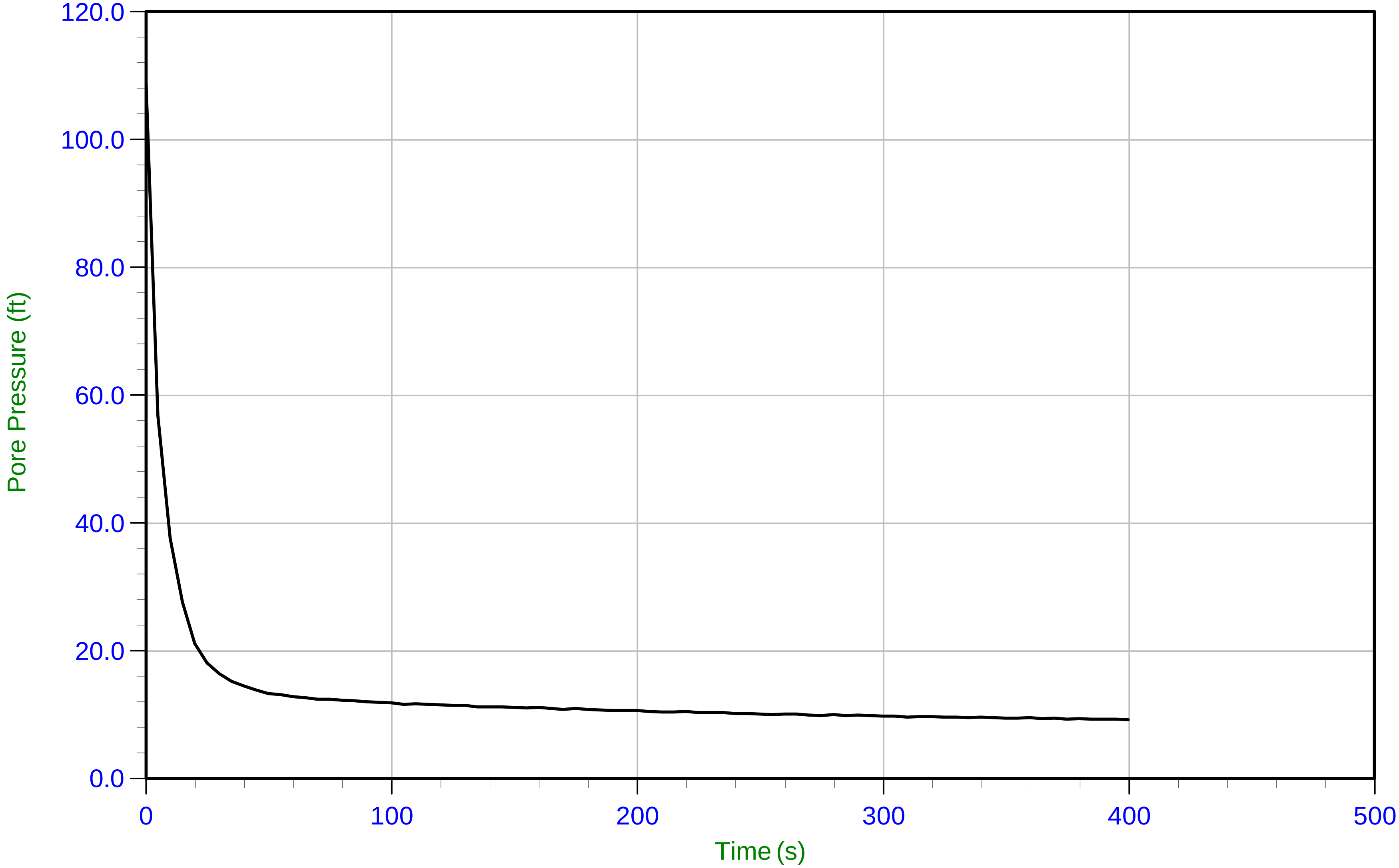
U Min: 3.5 ft
U Max: 6.6 ft

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 16-Sep-2015 12:39:09
Site: AECI-New Madrid

Sounding: SCPT15-HAC8
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_SP08.PPD
Depth: 7.900 m / 25.918 ft
Duration: 400.0 s

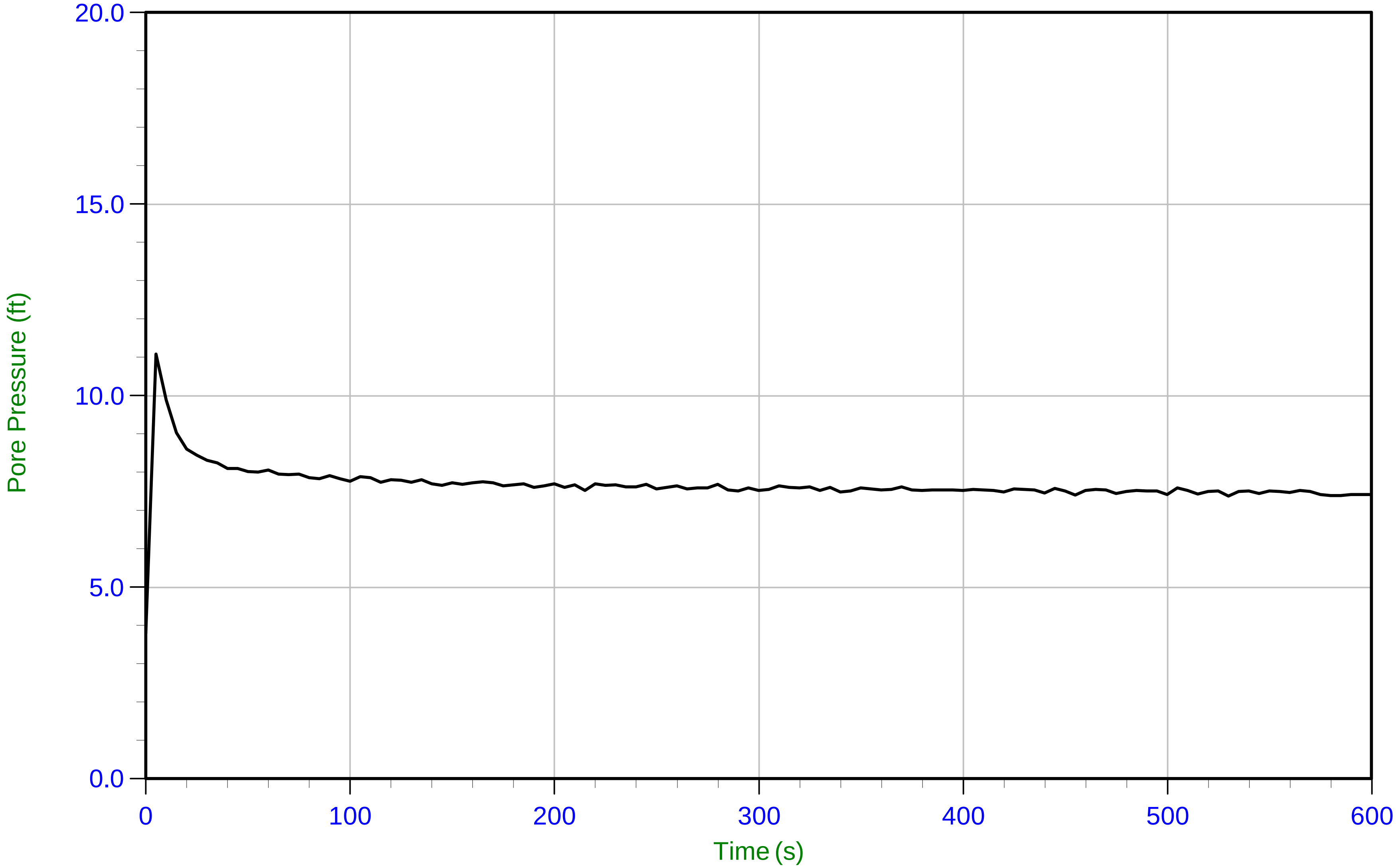
U Min: 9.2 ft
U Max: 108.8 ft

ConeTec

Haley & Aldrich

Job No: 15-53087
Date: 16-Sep-2015 12:39:09
Site: AECI-New Madrid

Sounding: SCPT15-HAC8
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_SP08.PPD
Depth: 8.900 m / 29.199 ft
Duration: 600.0 s

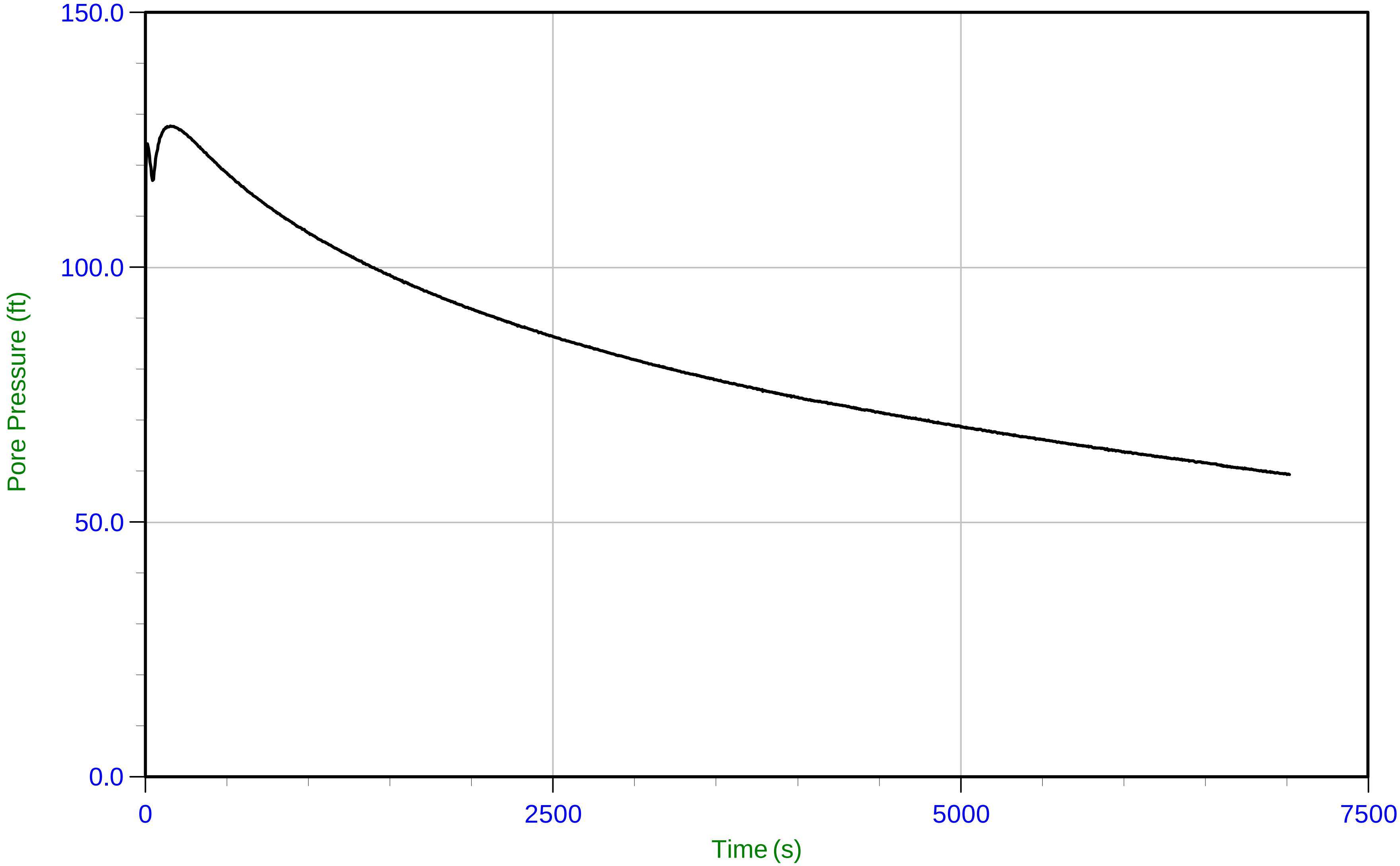
U Min: 3.8 ft
U Max: 11.1 ft

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 16-Sep-2015 12:39:09
Site: AECI-New Madrid

Sounding: SCPT15-HAC8
Cone: AD419
Cone Area: 15 sq cm



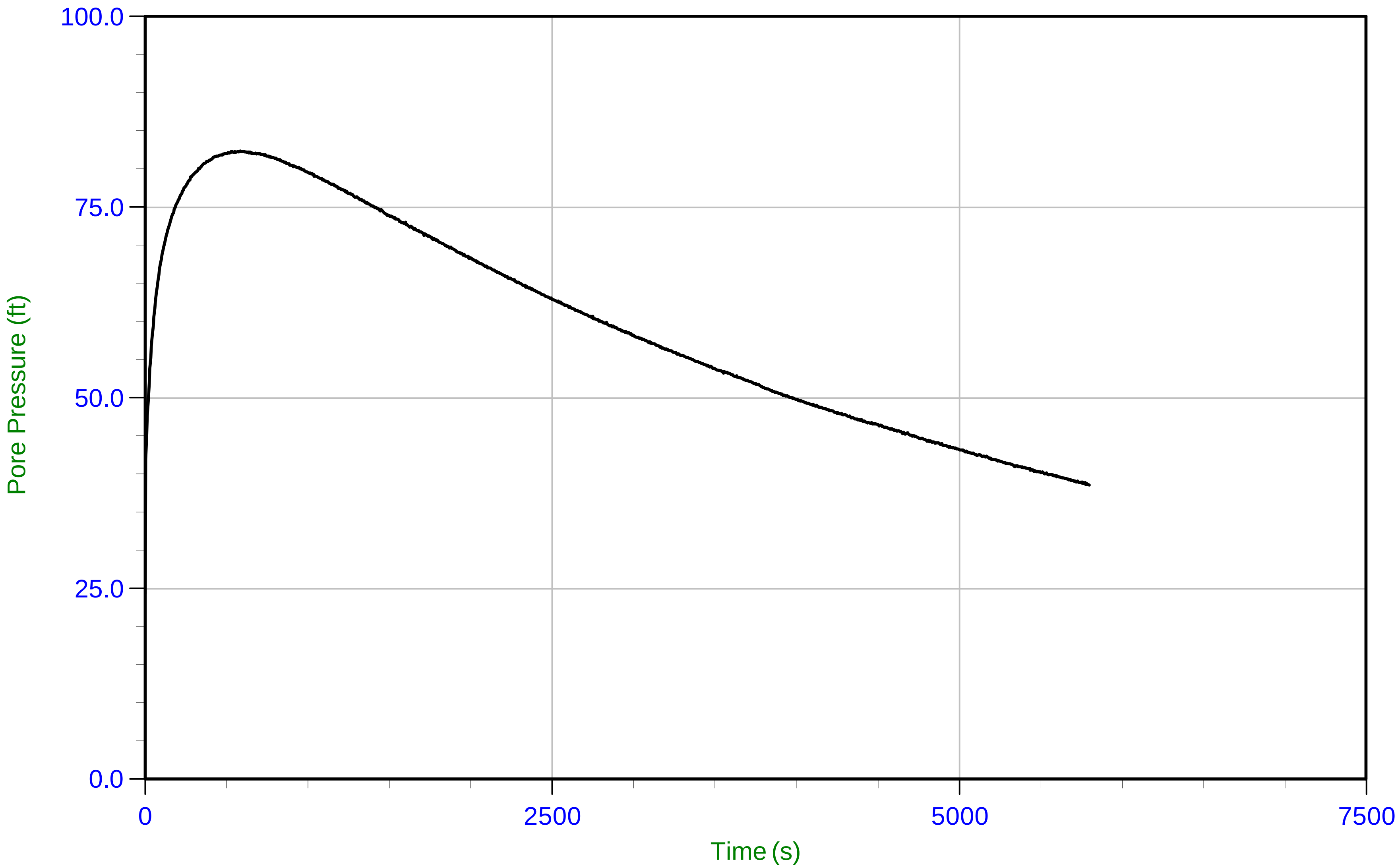
Trace Summary:

Filename: 15-53087_SP08.PPD
Depth: 9.900 m / 32.480 ft
Duration: 7020.0 s

U Min: 59.3 ft
U Max: 127.7 ft

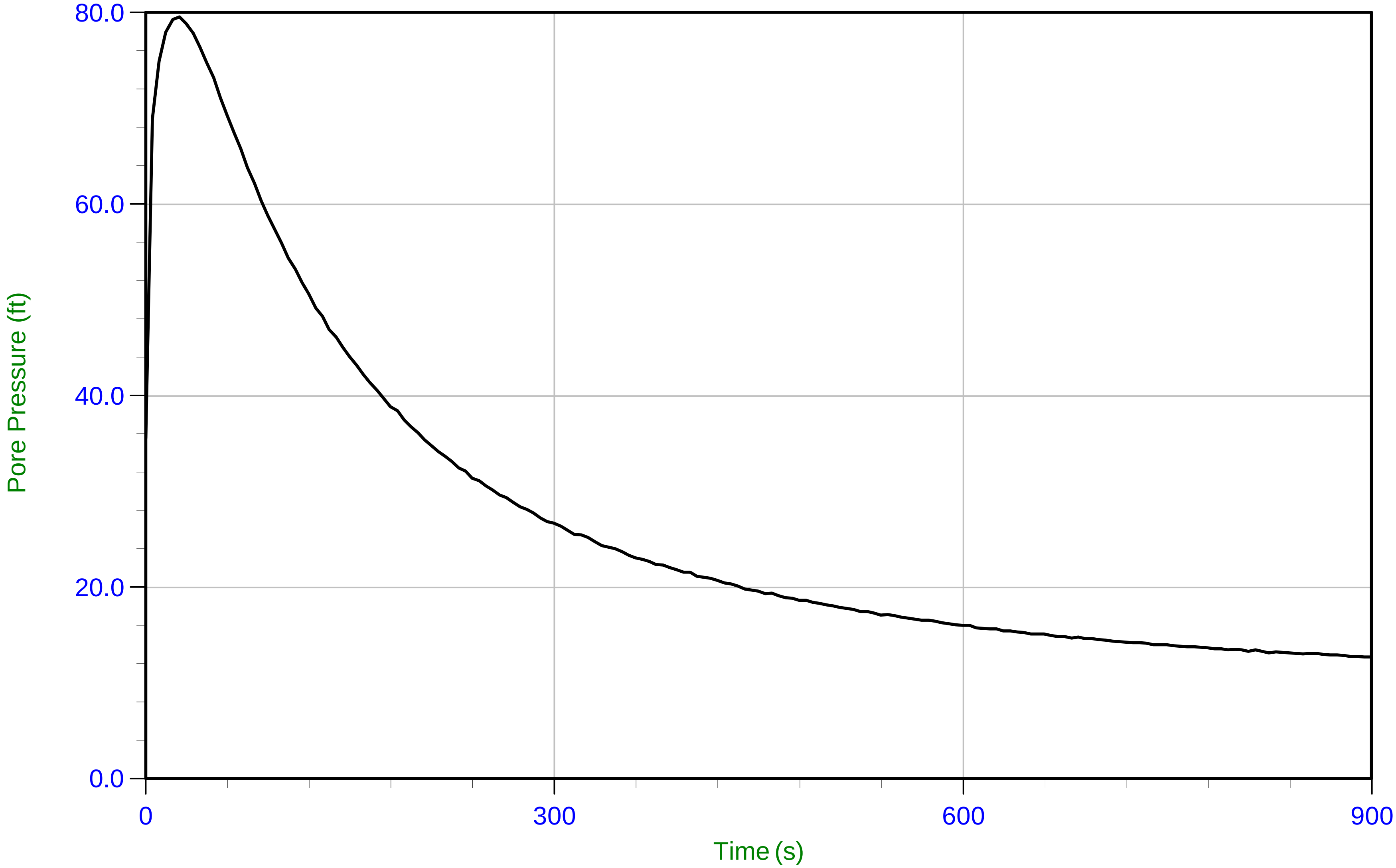
CONETEC

Haley & Aldrich	Job No: 15-53087	Sounding: SCPT15-HAC8
	Date: 16-Sep-2015 12:39:09	Cone: AD419
	Site: AECI-New Madrid	Cone Area: 15 sq cm



Trace Summary:	Filename: 15-53087_SP08.PPD	U Min: 24.3 ft
	Depth: 10.900 m / 35.761 ft	U Max: 82.4 ft
	Duration: 5800.0 s	

Haley & Aldrich	Job No: 15-53087	Sounding: SCPT15-HAC8
	Date: 16-Sep-2015 12:39:09	Cone: AD419
	Site: AECI-New Madrid	Cone Area: 15 sq cm



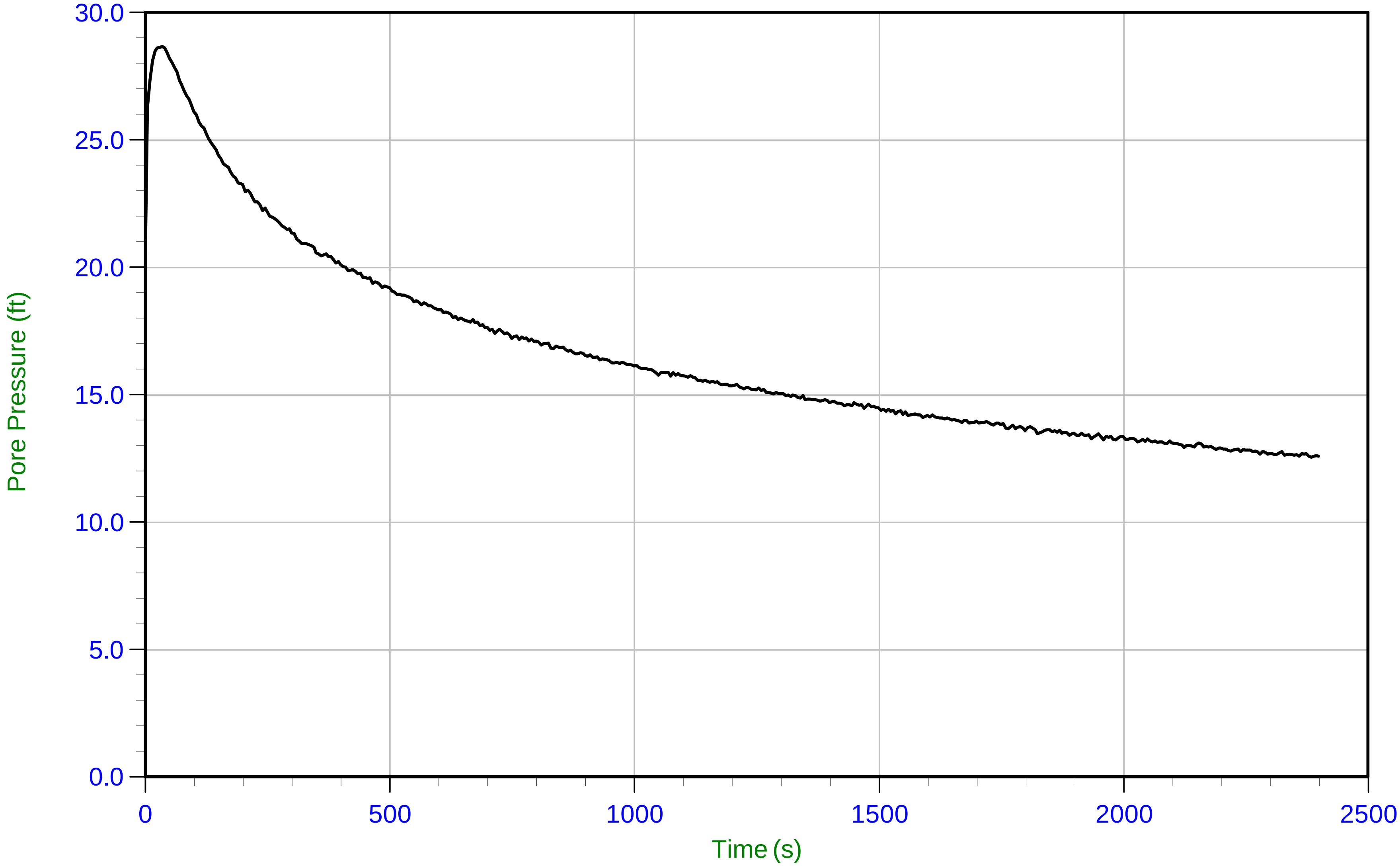
Trace Summary:

Filename: 15-53087_SP08.PPD	U Min: 12.7 ft
Depth: 11.900 m / 39.042 ft	U Max: 79.6 ft
Duration: 900.0 s	

Haley & Aldrich

Job No: 15-53087
Date: 16-Sep-2015 12:39:09
Site: AECI-New Madrid

Sounding: SCPT15-HAC8
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

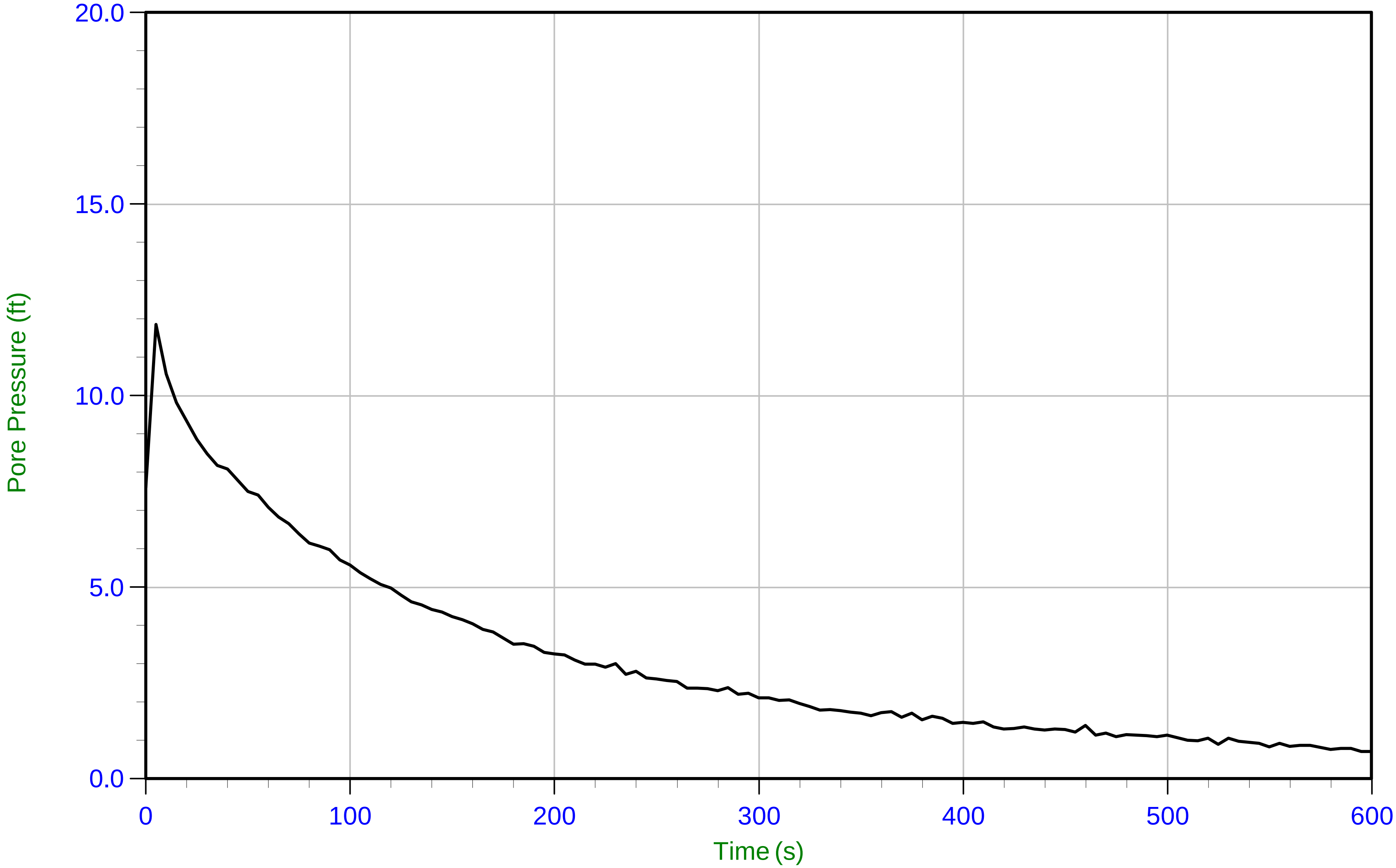
Filename: 15-53087_SP08.PPD
Depth: 12.900 m / 42.322 ft
Duration: 2400.0 s

U Min: 12.6 ft
U Max: 28.7 ft

Haley & Aldrich

Job No: 15-53087
Date: 16-Sep-2015 12:39:09
Site: AECI-New Madrid

Sounding: SCPT15-HAC8
Cone: AD419
Cone Area: 15 sq cm

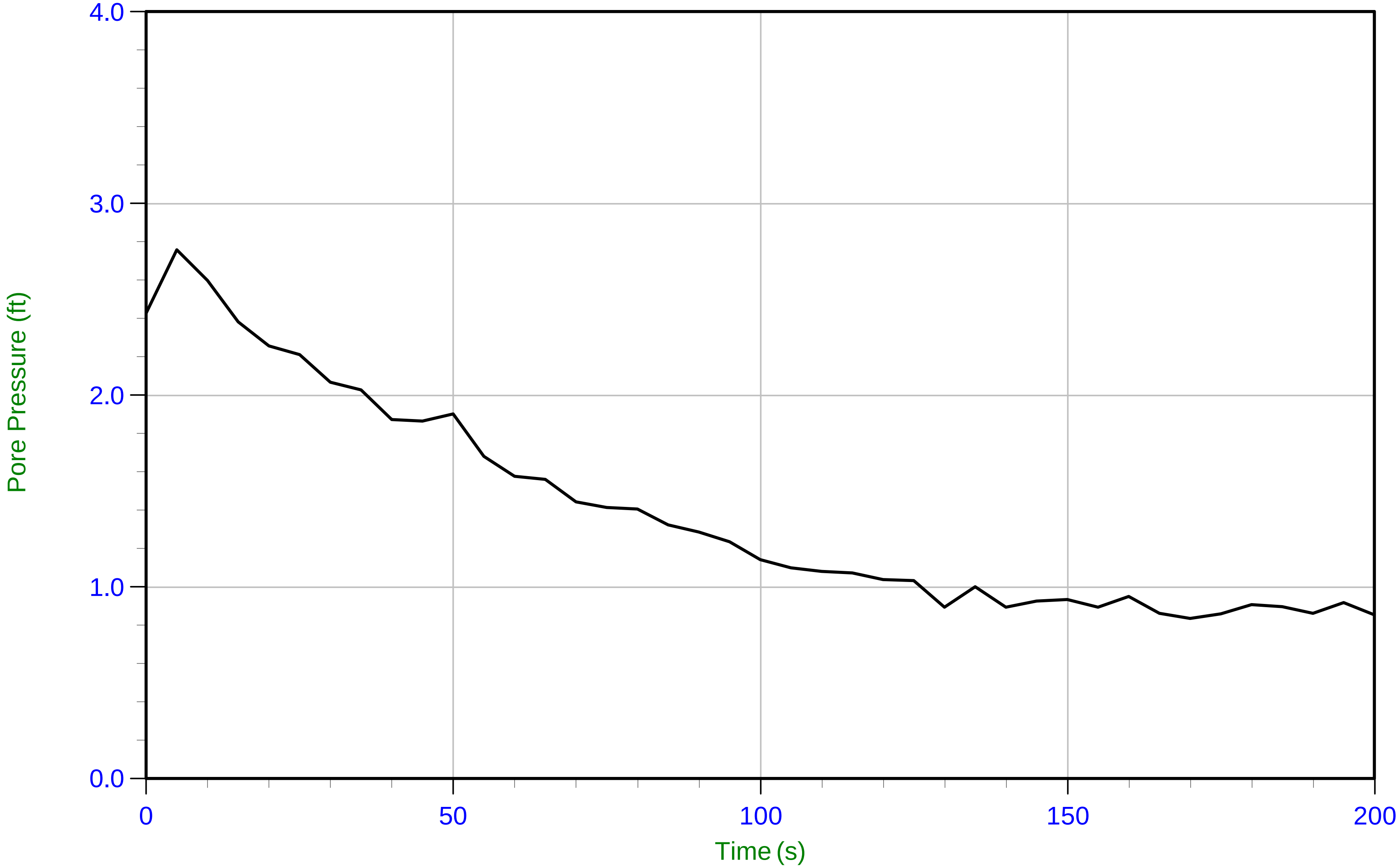


Trace Summary:

Filename: 15-53087_SP08.PPD
Depth: 13.900 m / 45.603 ft
Duration: 600.0 s

U Min: 0.7 ft
U Max: 11.9 ft

Haley & Aldrich	Job No: 15-53087	Sounding: SCPT15-HAC8
	Date: 16-Sep-2015 12:39:09	Cone: AD419
	Site: AECI-New Madrid	Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_SP08.PPD
Depth: 14.900 m / 48.884 ft
Duration: 200.0 s

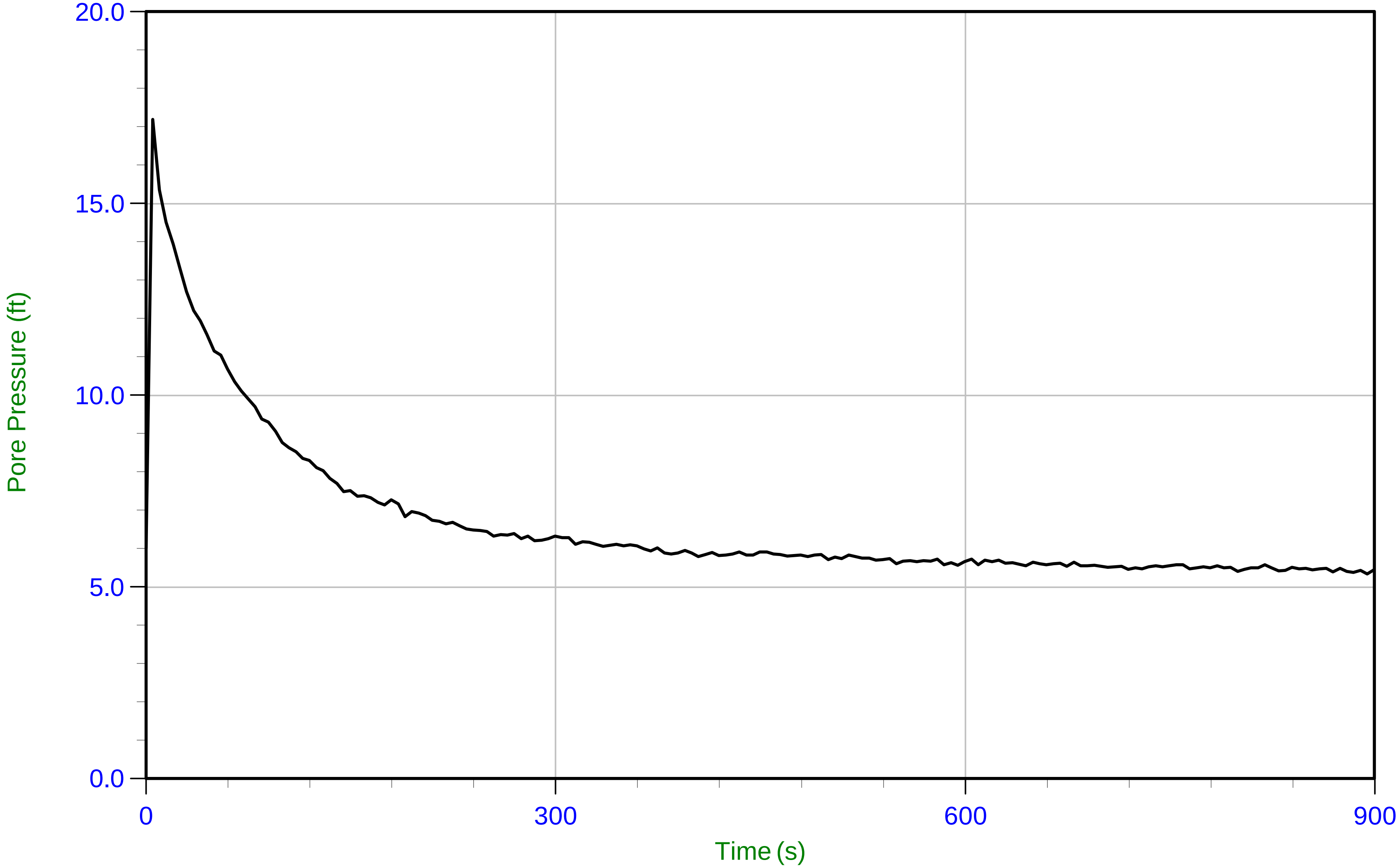
U Min: 0.8 ft
U Max: 2.8 ft

ConeTec

Haley & Aldrich

Job No: 15-53087
Date: 16-Sep-2015 12:39:09
Site: AECI-New Madrid

Sounding: SCPT15-HAC8
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_SP08.PPD
Depth: 15.250 m / 50.032 ft
Duration: 900.0 s

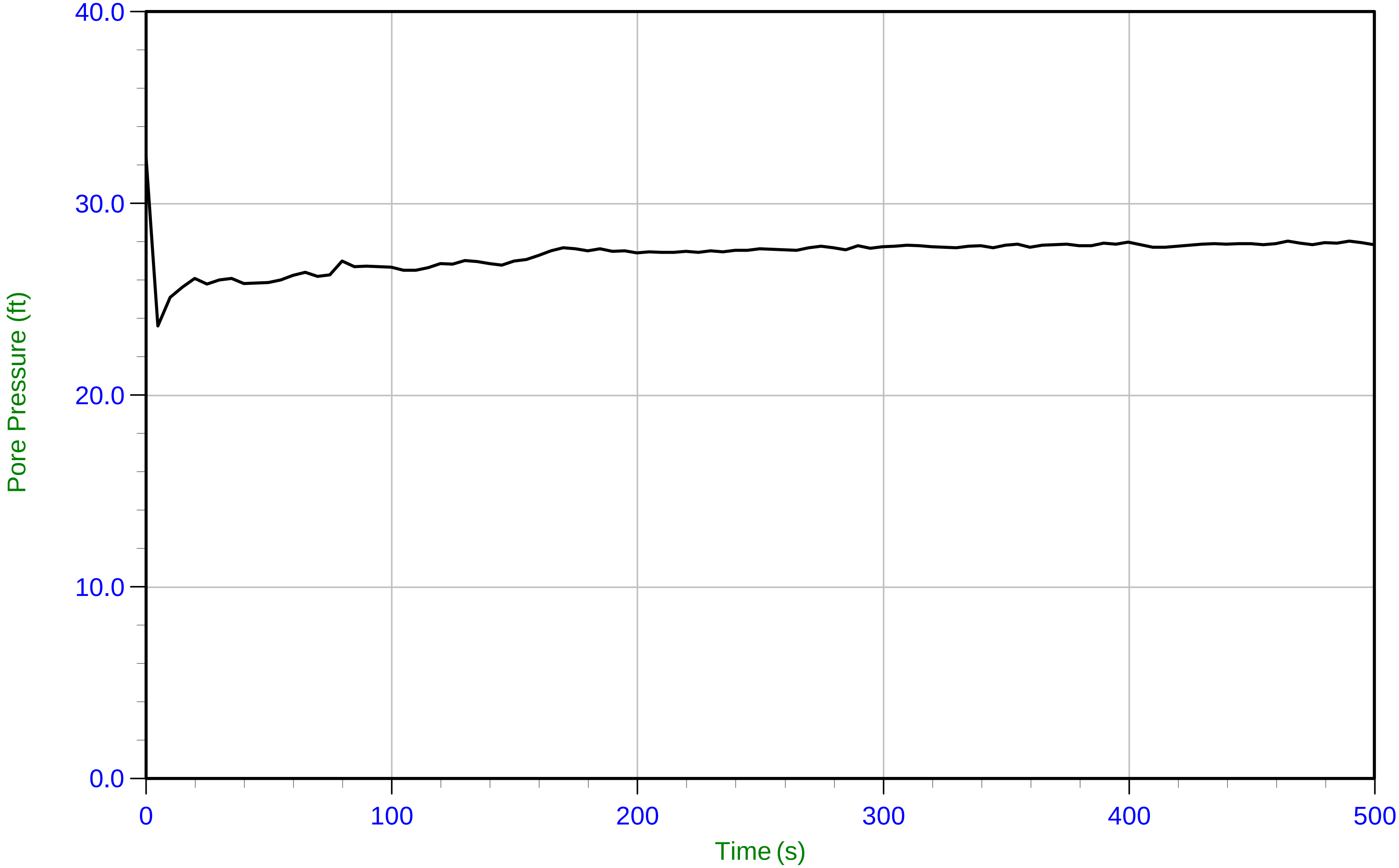
U Min: 5.3 ft
U Max: 17.2 ft

ConeTec

Haley & Aldrich

Job No: 15-53087
Date: 17-Sep-2015 11:57:35
Site: AECI-New Madrid

Sounding: CPT15-HAC9
Cone: AD419
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53087_CP09.PPD
Depth: 22.900 m / 75.130 ft
Duration: 500.0 s

U Min: 23.6 ft
U Max: 32.4 ft

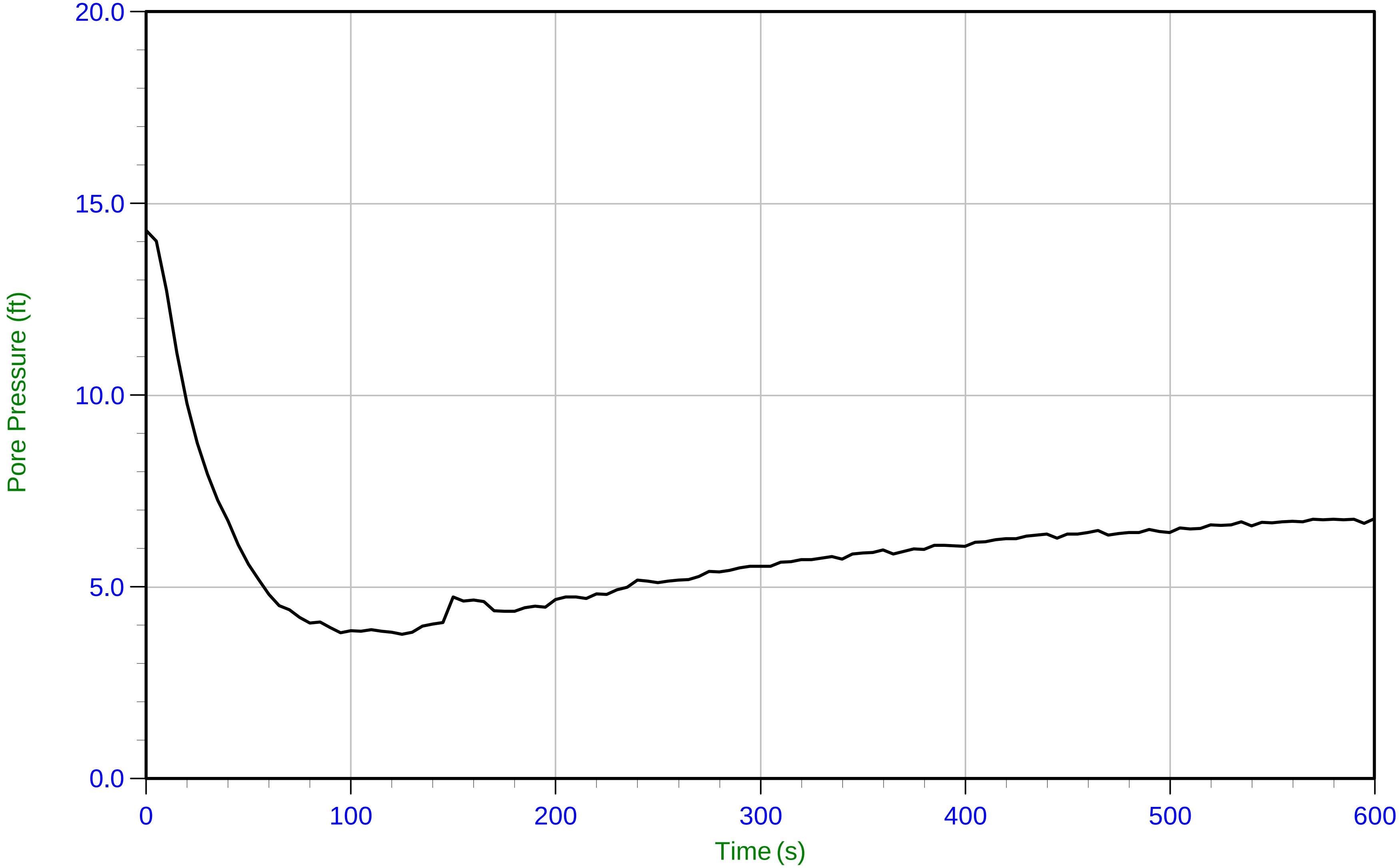
WT: 14.398 m / 47.237 ft
Ueq: 27.9 ft

CONETEC

Haley & Aldrich

Job No: 15-53087
Date: 17-Sep-2015 17:40:44
Site: AECI-New Madrid

Sounding: CPT15-HAC10
Cone: AD419
Cone Area: 15 sq cm



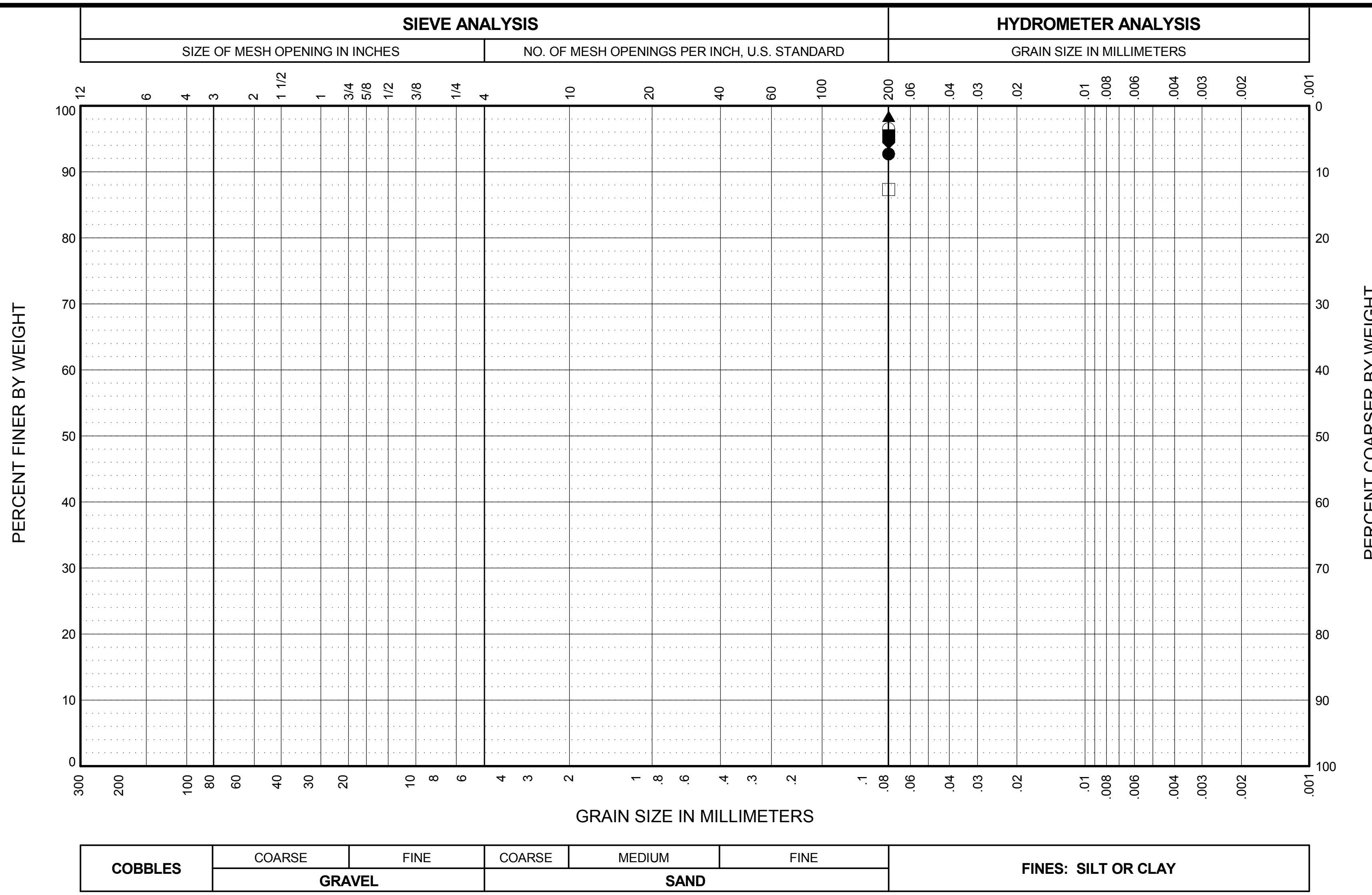
Trace Summary:

Filename: 15-53087_CP10.PPD
Depth: 15.400 m / 50.524 ft
Duration: 600.0 s

U Min: 3.8 ft
U Max: 14.3 ft

APPENDIX C

Laboratory Test Results



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HA-B1, S6	11.0-13.0	CL	Gray-brown, Lean Clay.	92.7	22.8	42	20	22
■ HA-B3, S7	13.0-15.0	CL	Brown, Lean Clay.	95.5	22.8	47	22	25
▲ HA-B3, S10	28.0-30.0	CL	Light gray-brown, Lean Clay.	98.4	36.1			
◆ HA-B6, S4	7.0-9.0	CL	Gray-brown, Lean Clay.	94.4	22.6	45	21	24
○ HA-B6, S7	13.0-15.0	CL	Gray-brown, Lean Clay.	96.5	21.1	39	20	19
□ HA-B7, S6	11.0-13.0	CH	Light gray-brown, Fat Clay.	87.3	22.5	59	20	39

AECI Structural Integrity Assessments
Slag Dewatering Pond and Unlined Pond
Marston, Missouri

GRAIN SIZE DISTRIBUTION

October 2015 41-1-37431-003

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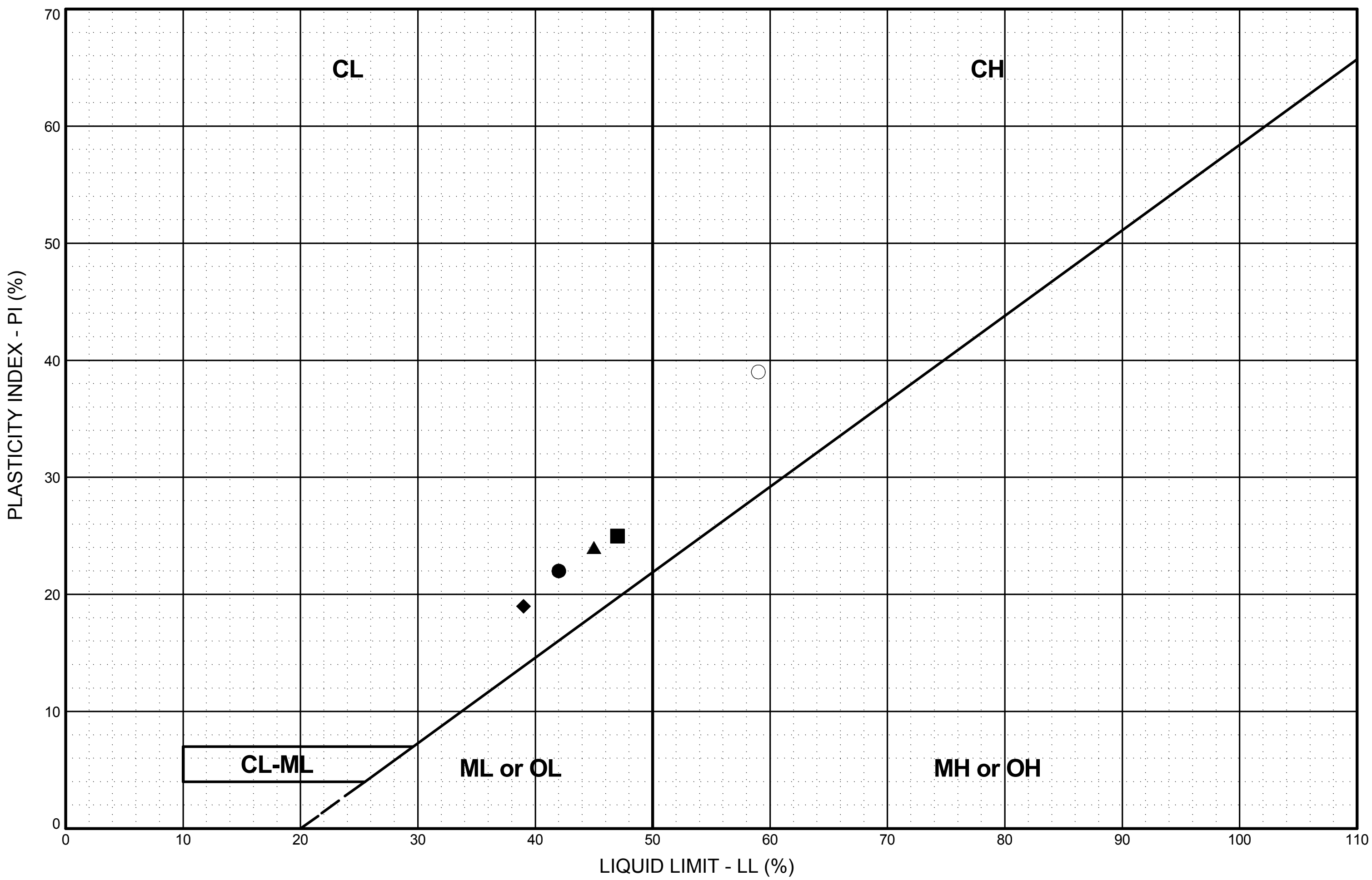
FIG.

FIG.

GSAMAIN2 41-1-37431-002 LAB DATA.GPJ SHAN_WIL.GDT 10/8/15



LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

CH: High plasticity inorganic clays

ML or OL: Inorganic and organic silts and clayey silts of low plasticity

MH or OH: Inorganic and organic silts and clayey silts of high plasticity

CL-ML: Silty clays and clayey silts

ATTMAIN2 41-1-37431-002 LAB DATA.GPJ SHAN_WIL.GDT 10/8/15

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION	LL %	PL %	PI %	NAT. W.C. %	PASS. #200, %
● HA-B1, S6	11.0-13.0	CL	Gray-brown, Lean Clay.	42	20	22	22.8	92.7
■ HA-B3, S7	13.0-15.0	CL	Brown, Lean Clay.	47	22	25	22.8	95.5
▲ HA-B6, S4	7.0-9.0	CL	Gray-brown, Lean Clay.	45	21	24	22.6	94.4
◆ HA-B6, S7	13.0-15.0	CL	Gray-brown, Lean Clay.	39	20	19	21.1	96.5
○ HA-B7, S6	11.0-13.0	CH	Light gray-brown, Fat Clay.	59	20	39	22.5	87.3

AECI Structural Integrity Assessments
Slag Dewatering Pond and Unlined Pond
Marston, Missouri

PLASTICITY CHART

October 2015 41-1-37431-003

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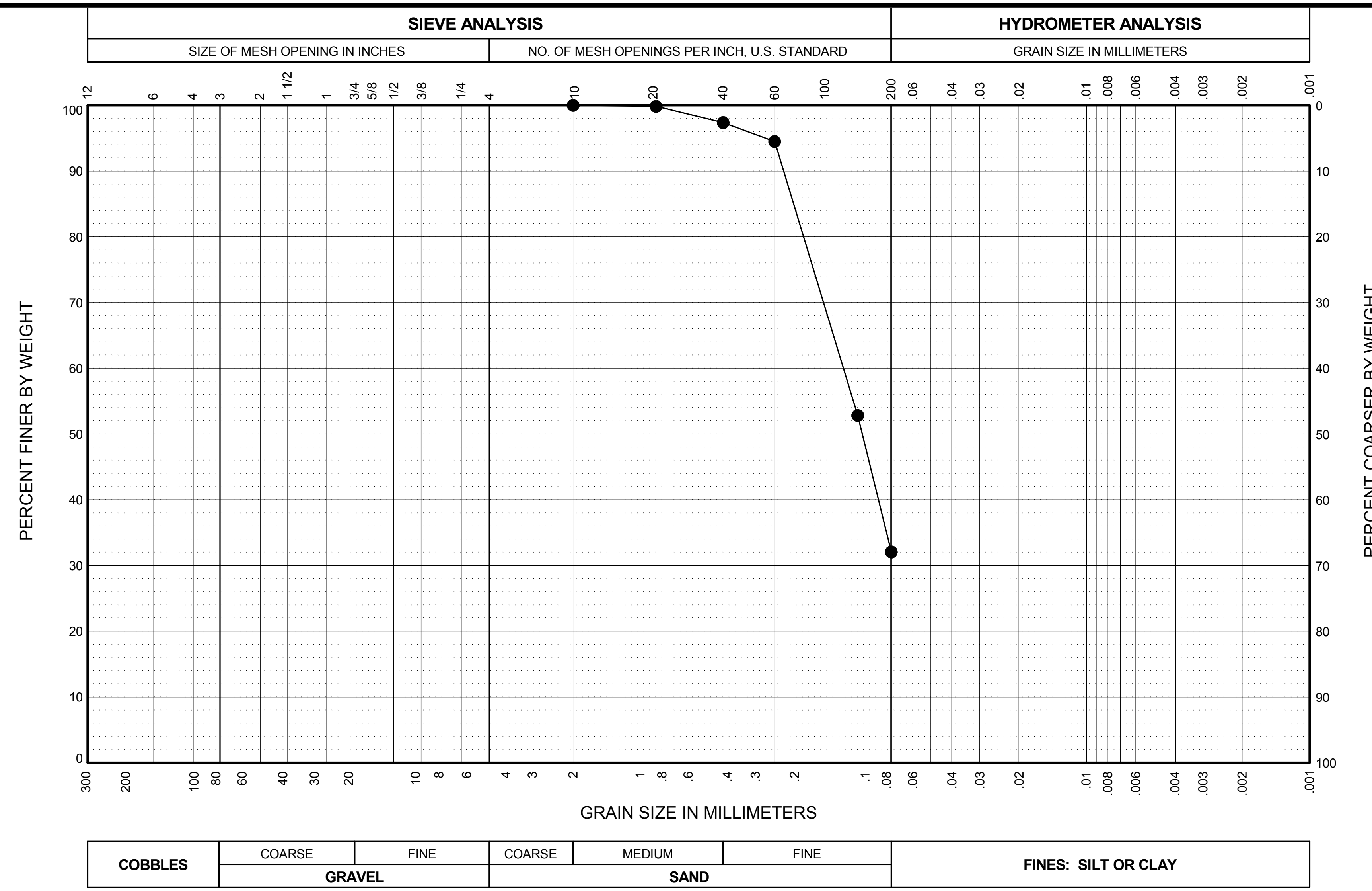
FIG.

FIG.



GSAMAIN2 41-1-37431-002 LAB DATA.GPJ SHAN_WIL.GDT 10/8/15

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HA-B2, S11	28.0-30.0	SM	Gray-brown, Silty Sand.	32.1	20.7			

AECI Structural Integrity Assessments
Slag Dewatering Pond and Unlined Pond
Marston, Missouri

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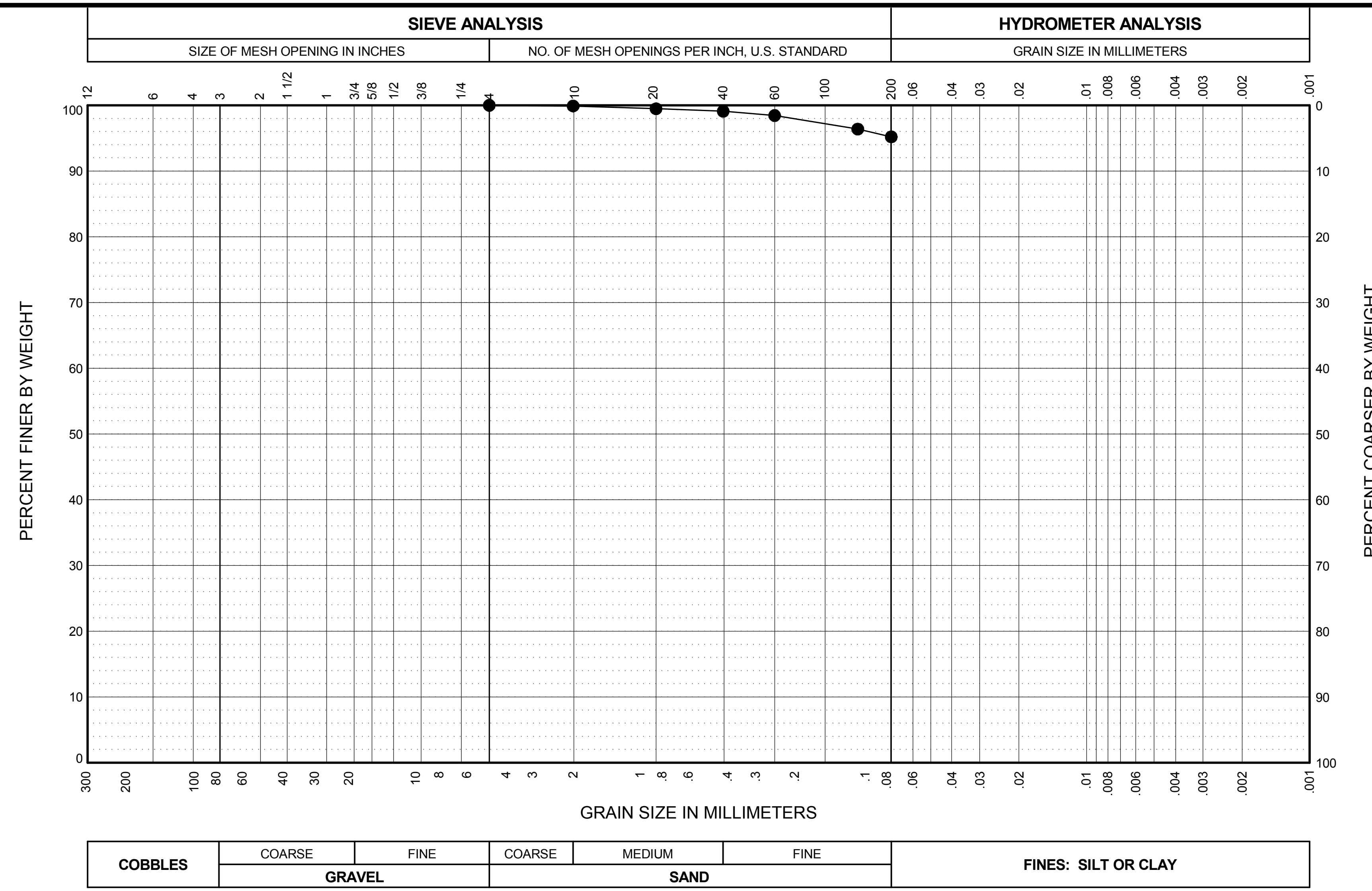
FIG.

FIG.



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HA-B3, S3	5.0-7.0	CL	Dark gray, Lean Clay.	95.2	26.7			

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Marston, Missouri

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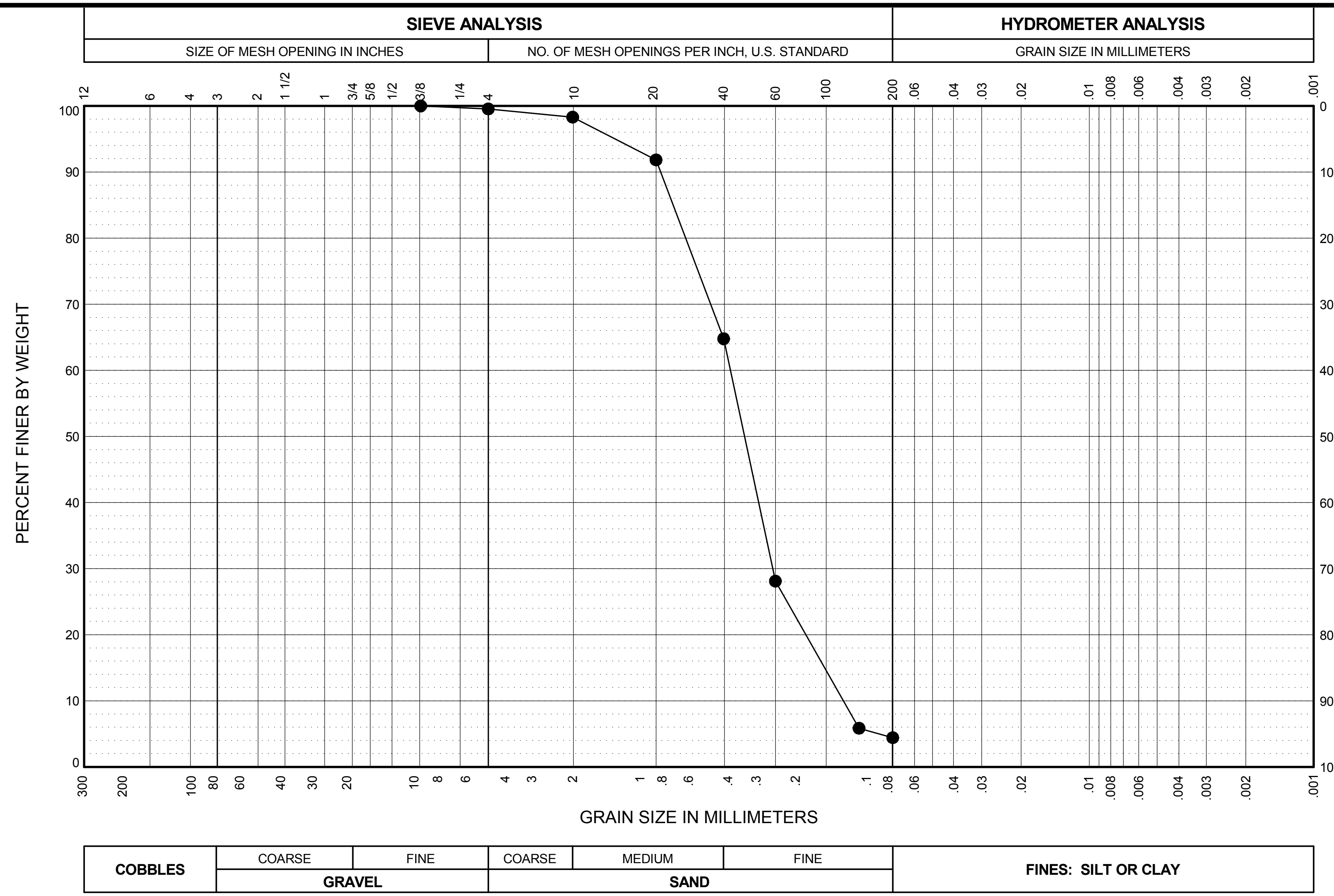
FIG.

FIG.

GSAMAIN2 41-1-37431-002 LAB DATA.GPJ SHAN_WIL.GDT 10/8/15



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HA-B4, S15	48.0-50.0	SP	Brown, Poorly Graded Sand.	4.4	18.1			

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Slag Dewatering Pond and Unlined Pond
Marston, Missouri

GRAIN SIZE DISTRIBUTION

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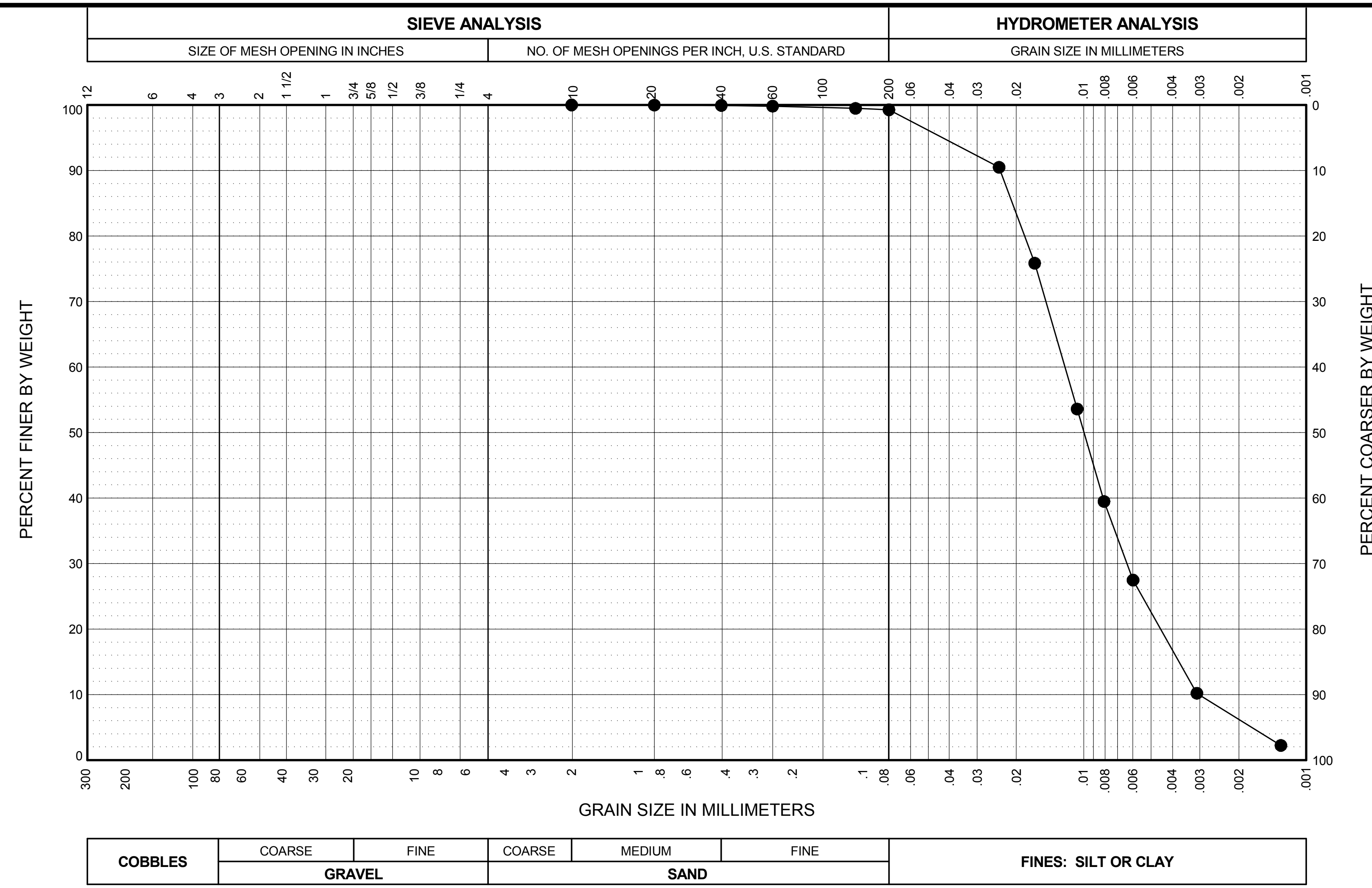
FIG.

FIG.

GSAMAIN2 41-1-37431-002 LAB DATA.GPJ SHAN_WIL.GDT 10/8/15



GSAMAIN2 41-1-37431-003 LAB DATA.GPJ SHAN_WIL.GDT 10/27/15

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HA-B4, U2	5.7	ML	Dark gray, Silt (Ash).	99.3	32.9			

AECI Structural Integrity Assessments
Slag Dewatering Pond and Unlined Pond
Marston, Missouri

GRAIN SIZE DISTRIBUTION

October 2015 41-1-37431-003

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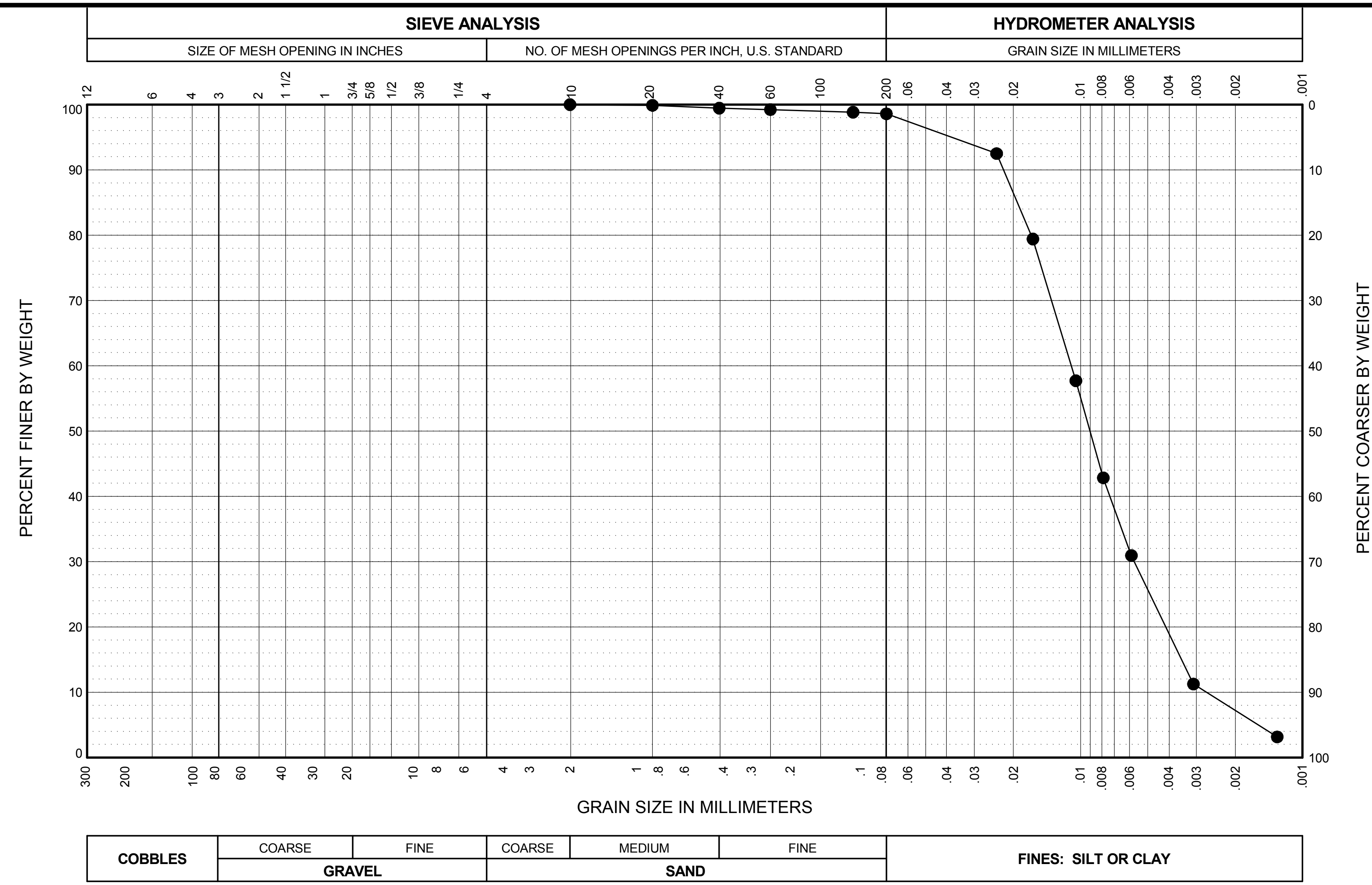
FIG.

FIG.



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HA-B5, U1	10.6	ML	Dark gray, Silt (Ash).	98.6	25.3			

AECI Structural Integrity Assessments
Slag Dewatering Pond and Unlined Pond
Marston, Missouri

GRAIN SIZE DISTRIBUTION

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FIG.

GSAMAIN2 41-1-37431-003 LAB DATA.GPJ SHAN_WIL.GDT 10/27/15

FIG.

PROJECT	AECI Structural Integrity Assessment	DATE	10/12/15	BORING NO.	HA-B4
JOB NO.	41-1-37431-003	SHEET NO.	1	TESTED BY	CMB
CLIENT NAME	Haley & Aldrich			CHECKED BY	

CLASSIFICATION OF UNDISTURBED SAMPLE

SAMPLE NO. U2 DEPTH (ft) 5.0-7.0

Sampling Method Push

Type of Sample Shelby Tube Inch 3"

Brass or Steel

DEPTH FT.	NAT. W.C. Strength info.	W.C.	TYPE OF TEST	CLASSIFICATION
				24 INCH RECOVERY Sample: Good Fair Poor Disturbed
5.0	PP=N/A	HAT-3	MC	Dark gray, Silt (ML) (ASH); moist; <10% fine sand, 90% low dry strength, rapid dilatancy, low plasticity.
			SAVED	
5.5			Consol/Hydro	
6.0			SAVED	
6.5				6.6 Dark gray, Silty Sand (SM) (Slag); moist; 20% low to no plasiticity fines; 80% fine to coarse grained, subangular, sand.
7.0	PP=N/A	HAT-4	MC	

Can/Tare No.	HAT-3	HAT-4
WET + TARE	74.43	73.65
DRY + TARE	58.35	56.61
TARE	2.54	2.57
% WATER	28.8	31.5

Procedure: ASTM D 2488

NOTE: Soil description is based on visual-manual procedure. This description is not meant for engineering purposes requiring precise classification of soils.

All sample percentages for cobbles and boulders are by volume.

REMARKS:

Shannon & Wilson, Inc.
2043 Westport Center Drive
St. Louis, MO 63146

PROJECT	AECI Structural Integrity Assessment	DATE	10/14/15	BORING NO.	HA-B5
JOB NO.	41-1-37431-003	SHEET NO.	1	TESTED BY	CMB
CLIENT NAME	Haley & Aldrich			CHECKED BY	

CLASSIFICATION OF UNDISTURBED SAMPLE

SAMPLE NO. U1 DEPTH (ft) 10.0-12.0

Sampling Method Push

Type of Sample Shelby Tube Inch 3"

Brass or Steel

DEPTH FT.	NAT. W.C. Strength info.	W.C.	TYPE OF TEST	CLASSIFICATION
				24 INCH RECOVERY Sample: Good Fair Poor Disturbed
10.0	PP=N/A	HAT-5	MC SAVED	Dark gray, Silt (ML) (ASH); moist; <10% fine sand, 90% low dry strength, rapid dilatancy, low plasticity.
10.5			Consol/Hydro SAVED	-Sample below 10.8 feet very soft, seeped past extruder head during pushing.
11.0				
11.5				Moisture sample obtained from sample lining tube.
12.0	PP=N/A	HAT-6	MC	

Can/Tare No.	HAT-5	HAT-6
WET + TARE	45.03	35.53
DRY + TARE	35.54	24.87
TARE	2.56	2.54
% WATER	28.8	47.7

Procedure: ASTM D 2488

NOTE: Soil description is based on visual-manual procedure. This description is not meant for engineering purposes requiring precise classification of soils.

All sample percentages for cobbles and boulders are by volume.

REMARKS:

Shannon & Wilson, Inc.
2043 Westport Center Drive
St. Louis, MO 63146

PROJECT	AECI Structural Integrity Assessment	DATE	10/9/15	BORING NO.	HA-B5
JOB NO.	41-1-37431-003	SHEET NO.	1	TESTED BY	CMB
CLIENT NAME	Haley & Aldrich			CHECKED BY	

CLASSIFICATION OF UNDISTURBED SAMPLE

SAMPLE NO. U2 DEPTH (ft) 20.0-22.0

Sampling Method Push

Type of Sample Shelby Tube Inch 3"

Brass or Steel

DEPTH FT.	NAT. W.C. Strength info.	W.C.	TYPE OF TEST	CLASSIFICATION
				24 INCH RECOVERY Sample: Good Fair Poor Disturbed
20.0	PP=N/A	HAT-1	MC	Dark gray, Silt (ML) (ASH) with fine to coarse Sand layers (slag), moist; 20% fine to coarse, subangualr sand; 80% low dry strength, rapid dilatancy, low plasticity.
			SAVED	
20.5			UU	
21.0			SAVED	
			Consol	
21.5			SAVED	
22.0	PP=N/A	HAT-2	MC	

Can/Tare No.	HAT-1	HAT-2
WET + TARE	61.95	76.46
DRY + TARE	48.31	58.13
TARE	2.52	2.54
% WATER	29.8	33.0

Procedure: ASTM D 2488

NOTE: Soil description is based on visual-manual procedure. This description is not meant for engineering purposes requiring precise classification of soils.

All sample percentages for cobbles and boulders are by volume.

REMARKS:

TUBE DENSITY
ASTM D2937

Project	AECI Structural Integrity Assessment	Client	Haley & Aldrich		
Location	Marston, Missouri	Tested By / Date		CMB	10/9-14/15
Job No.	41-1-37431-003	Calculated By / Date		CMB	10/16/15
File	41-1-37431-003 D2937	Checked By / Date		CMB	10/16/15

Sample Boring	HA-B4	HA-B5	HA-B5	
Sample Number	U2	U1	U2	
Sample Depth	5.0 - 7.0	10.0 - 12.0	20.0 - 22.0	
Height (in)	22.620	23.790	23.845	
Diameter (in)	2.881	2.862	2.884	
Weight (gms)	4030.5	3983	4280.00	
Tare ID				
Tare weight (gms)				
Wet Weight (gms)				
Dry Weight (gms)				
Moisture %	30.2	38.3	34.6	
Area (in^2)	6.52	6.43	6.53	0.00
Volume (in)	147.46	153.05	155.77	0.00
Volume (ft)	0.09	0.09	0.09	0.00
Volume (cm)	2416.41	2507.99	2552.58	0.00
Wet Density (pcf)	104.1	99.1	104.7	#DIV/0!
Dry Density (pcf)	80.0	71.7	77.8	#DIV/0!

CONSOLIDATION TEST

Sheet 1

Project	AECI Structural Integrity Assessment	Client		Haley & Aldrich, Inc.	
Location	Marston, Missouri	Tested By / Date		CMB	10/21/15
Job Number	41-1-37431-003	Calculated By / Date		CMB	10/30/15
Boring	HA-B4	Checked By / Date		JTB	11/2/15
Sample	U2	File		41-1-37431-003 HA-B4 U2 D2435	
Depth (ft)	5.7	Procedure		ASTM D2435	

	Initial Data		*Final Data*				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	1.004	2.503	0.850	inches	Tare No.	C-1	
Measured Reading 2	1.003	2.502	0.850	inches	Tare Weight	2.51	
Measured Reading 3	1.005	2.505	0.849	inches	Wet Weight	50.82	
Measured Reading 4	1.004	2.503	0.849	inches	Dry Weight	38.60	
Average Reading	1.004	2.503	0.850	inches	M.C. %	33.9%	
Wet Weight + Ring	288.07	Wet+Ring+Tare	358.83	grams	*Trimmings #2*		
Weight of Ring	144.11	Dry+Ring+Tare	330.88	grams	Tare No.	C-2	
Specific Gravity	2.66	Tare Weight	82.92	grams	Tare Weight	2.56	
Sample Volume	80.97		66.97	cm^3	Wet Weight	43.76	
Height of Solids	0.484		0.484	inches	Dry Weight	33.77	
Void Ratio	1.08		0.72		M.C. %	32.0%	
Saturation	95.6		100.0	percent	Ring Number	410	
Weight of Water	40.11		27.95	grams	Inundated @	0.27	tsf
Moisture Content	38.6		26.9	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	111.0		122.9	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	80.1		96.8	pcf	Method Used	A or B	
Notes: The specific gravity is computed assuming saturation at the end of the test.					Computed Ht.	0.830	inches

Load 1		Load 2		Load 3		Load 4	
Air Press.	1.6	Air Press.	2.4	Air Press.	3.9	Air Press.	7.1
Load, tsf	0.25	Load, tsf	0.5	Load, tsf	1.0	Load, tsf	2.0
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	77	0.1	120	0.1	183	0.1	390
0.25	79	0.25	123	0.25	191	0.25	421
0.5	80	0.5	124	0.5	198	0.5	443
1	81	1	126	1	201	1	459
2	82	2	128	2	204	2	471
4	83	4	130	4	209	4	480
8	85	8	131	8	212	8	488
17	87	15	133	15	216	15	495
30	88	30	135	30	220	30	501
60		60		60		60	506
120		120		120		120	512
240		240		240		240	517
480		480		480		370	520
1440		1440		1440		1305	528

Load 5		Load 6		Load 7		Load 8	
Air Press.	3.9	Air Press.	2.4	Air Press.	3.9	Air Press.	7.1
Load, tsf	1.0	Load, tsf	0.5	Load, tsf	1.0	Load, tsf	2.0
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	518	0.1	507	0.1	510	0.1	525
0.25	517	0.25	507	0.25	510	0.25	526
0.5	517	0.5	507	0.5	510	0.5	526
1	517	1	506	1	510	1	526
2	517	2	506	2	510	2	527
4	516	4	505	4	510	4	527
8	516	8	505	8	511	8	528
15	516	15	504	15	511	15	528
30		30		30		30	529
60		60		60		60	
120		120		120		120	
240		240		240		240	
480		480		480		480	
1440		1440		1440		1440	

CONSOLIDATION TEST

Sheet 2

Project	AECI Structural Integrity Assessment			Client		Haley & Aldrich, Inc.	
Location	Marston, Missouri			Tested By / Date		CMB	10/21/15
Job Number	41-1-37431-003			Calculated By / Date		CMB	10/30/15
Boring	HA-B4			Checked By / Date		JTB	11/2/15
Sample	U2			File		41-1-37431-003 HA-B4 U2 D2435	
Depth (ft)	5.7			Procedure		ASTM D2435	
	Initial Data		*Final Data*				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	1.004	2.503	0.850	inches	Tare No.	C-1	
Measured Reading 2	1.003	2.502	0.850	inches	Tare Weight	2.51	
Measured Reading 3	1.005	2.505	0.849	inches	Wet Weight	50.82	
Measured Reading 4	1.004	2.503	0.849	inches	Dry Weight	38.60	
Average Reading	1.004	2.503	0.850	inches	M.C. %	33.9%	
Wet Weight + Ring	288.07	Wet+Ring+Tare	358.83	grams	*Trimmings #2*		
Weight of Ring	144.11	Dry+Ring+Tare	330.88	grams	Tare No.	C-2	
Specific Gravity	2.66	Tare Weight	82.92	grams	Tare Weight	2.56	
Sample Volume	80.97		66.97	cm^3	Wet Weight	43.76	
Height of Solids	0.484		0.484	inches	Dry Weight	33.77	
Void Ratio	1.08		0.72		M.C. %	32.0%	
Saturation	95.6		100.0	percent	Ring Number	410	
Weight of Water	40.11		27.95	grams	Inundated @	0.27	tsf
Moisture Content	38.6		26.9	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	111.0		122.9	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	80.1		96.8	pcf	Method Used	A or B	
Notes: The specific gravity is computed assuming saturation at the end of the test.					Computed Ht.	0.830	inches

Load 9		Load 10		Load 11		Load 12	
Air Press.	13.3	Air Press.	25.9	Air Press.	50.8	Air Press.	101.3
Load, tsf	4.0	Load, tsf	8.0	Load, tsf	16.0	Load, tsf	32.0
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	707	0.1	1104	0.1	1473	0.1	1812
0.25	762	0.25	1147	0.25	1503	0.25	1830
0.5	788	0.5	1167	0.5	1518	0.5	1841
1	804	1	1180	1	1530	1	1851
2	817	2	1193	2	1540	2	1859
4	827	4	1203	4	1548	4	1867
8	838	8	1211	8	1556	8	1874
15	845	15	1219	15	1563	15	1880
30	851	30	1226	30	1570	30	1886
60	858	60	1232	60	1575	60	1891
120	863	120	1238	120	1580	120	1897
240	868	240	1243	240	1586	240	1902
410	871	480	1248	480	1591	480	1906
4245	884	1440	1255	1440	1598	1440	1913

CONSOLIDATION TEST

Sheet 3

Project	AECI Structural Integrity Assessment			Client		Haley & Aldrich, Inc.	
Location	Marston, Missouri			Tested By / Date		CMB	10/21/15
Job Number	41-1-37431-003			Calculated By / Date		CMB	10/30/15
Boring	HA-B4			Checked By / Date		JTB	11/2/15
Sample	U2			File		41-1-37431-003 HA-B4 U2 D2435	
Depth (ft)	5.7			Procedure		ASTM D2435	
	Initial Data		*Final Data*				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	1.004	2.503	0.850	inches	Tare No.	C-1	
Measured Reading 2	1.003	2.502	0.850	inches	Tare Weight	2.51	
Measured Reading 3	1.005	2.505	0.849	inches	Wet Weight	50.82	
Measured Reading 4	1.004	2.503	0.849	inches	Dry Weight	38.60	
Average Reading	1.004	2.503	0.850	inches	M.C. %	33.9%	
Wet Weight + Ring	288.07	Wet+Ring+Tare	358.83	grams	*Trimmings #2*		
Weight of Ring	144.11	Dry+Ring+Tare	330.88	grams	Tare No.	C-2	
Specific Gravity	2.66	Tare Weight	82.92	grams	Tare Weight	2.56	
Sample Volume	80.97		66.97	cm^3	Wet Weight	43.76	
Height of Solids	0.484		0.484	inches	Dry Weight	33.77	
Void Ratio	1.08		0.72		M.C. %	32.0%	
Saturation	95.6		100.0	percent	Ring Number	410	
Weight of Water	40.11		27.95	grams	Inundated @	0.27	tsf
Moisture Content	38.6		26.9	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	111.0		122.9	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	80.1		96.8	pcf	Method Used	A or B	
Notes: The specific gravity is computed assuming saturation at the end of the test.					Computed Ht.	0.830	inches

CALIBRATION OF CONSOLIDATION DEFORMATION

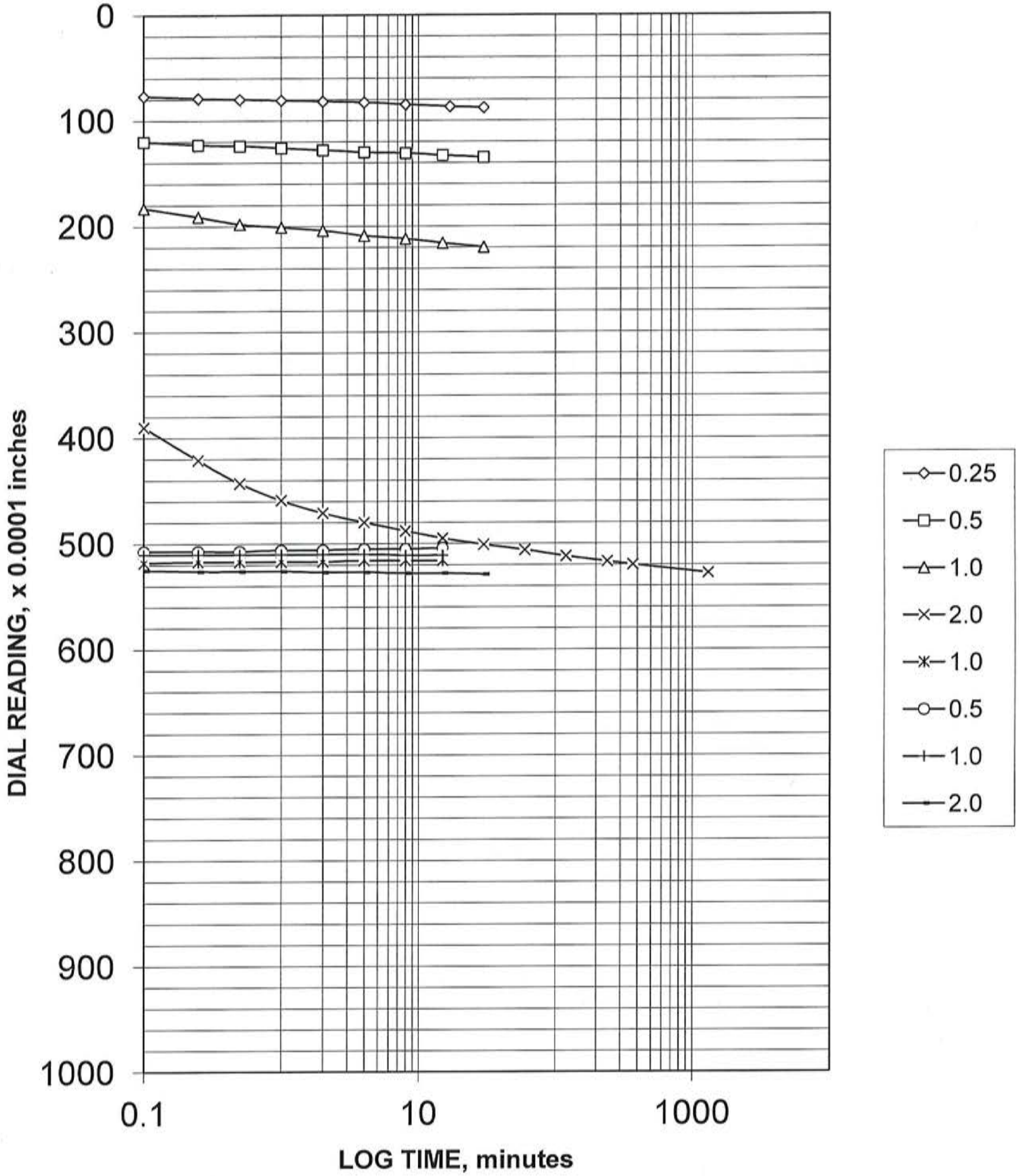
Procedure SWCP-15 (Reference ASTM D2435 AASHTO T216)

Equipment Calibrated:	Consolidation Deformation	Date Calibrated:	10/29/15
Reason for Calibration:	Test Completion	Next Calibration Due:	Next Test
Equipment Used:	Consolidation Appartus	Calibrated By:	CMB
	Steel Calibration Disk	Checked By:	CMB

Machine Number: 410

Load tsf	Machine Def x 10^{-4}	Correction Factor x 10^{-4}	U-100 x 10^{-4}	Corr. U-100 x 10^{-4}	Compression, Percent	C_v	Void Ratio
0.01	0	0	0	0	0.00%	0	1.08
0.25	41	0	79.0	38	0.38%	3.3E+00	1.07
0.5	56	0	123.0	67	0.67%	3.3E+00	1.06
1.0	72	0	198.0	126	1.26%	2.4E+00	1.05
2.0	92	0	485.0	393	3.93%	1.3E+00	0.99
1.0	84	43	517.0	390	3.90%	NA	0.99
0.5	77	43	506.0	386	3.86%	NA	1.00
1.0	81	43	511.0	387	3.87%	NA	1.00
2.0	83	43	526.0	400	4.00%	NA	0.99
4.0	113	0	838.0	725	7.25%	1.2E+00	0.93
8.0	136	0	1209.0	1073	10.73%	1.0E+00	0.85
16.0	158	0	1541.0	1383	13.83%	1.2E+00	0.79
32.0	177	0	1863.0	1686	16.86%	9.8E-01	0.73

CONSOLIDATION TEST



AECI Structural Integrity Assessment
Marston, Missouri

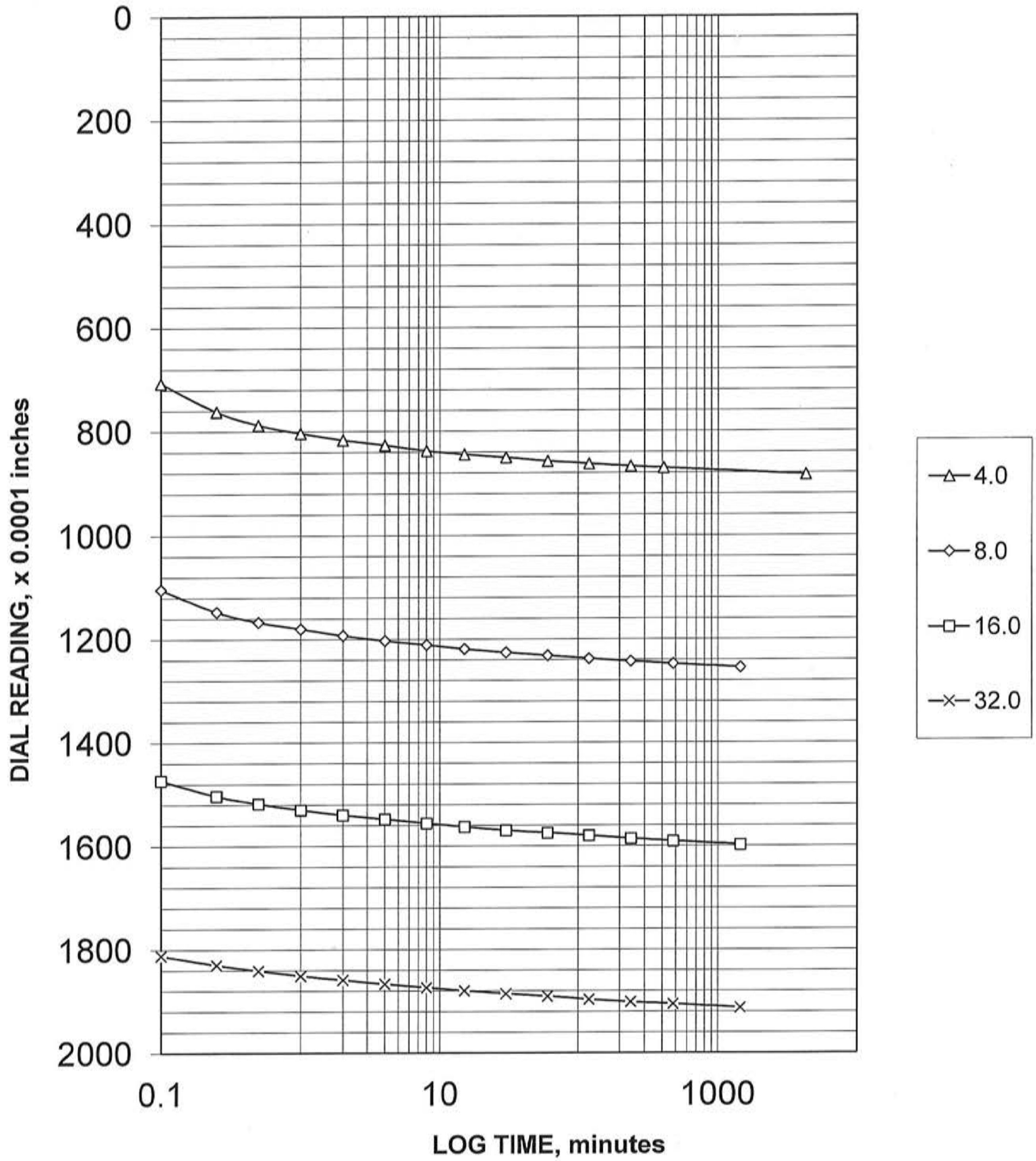
TIME PLOTS
HA-B4
U2

October 2015 41-1-37431-003

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

CONSOLIDATION TEST



AECI Structural Integrity Assessment
Marston, Missouri

TIME PLOTS
HA-B4
U2

October 2015 | 41-1-37431-003

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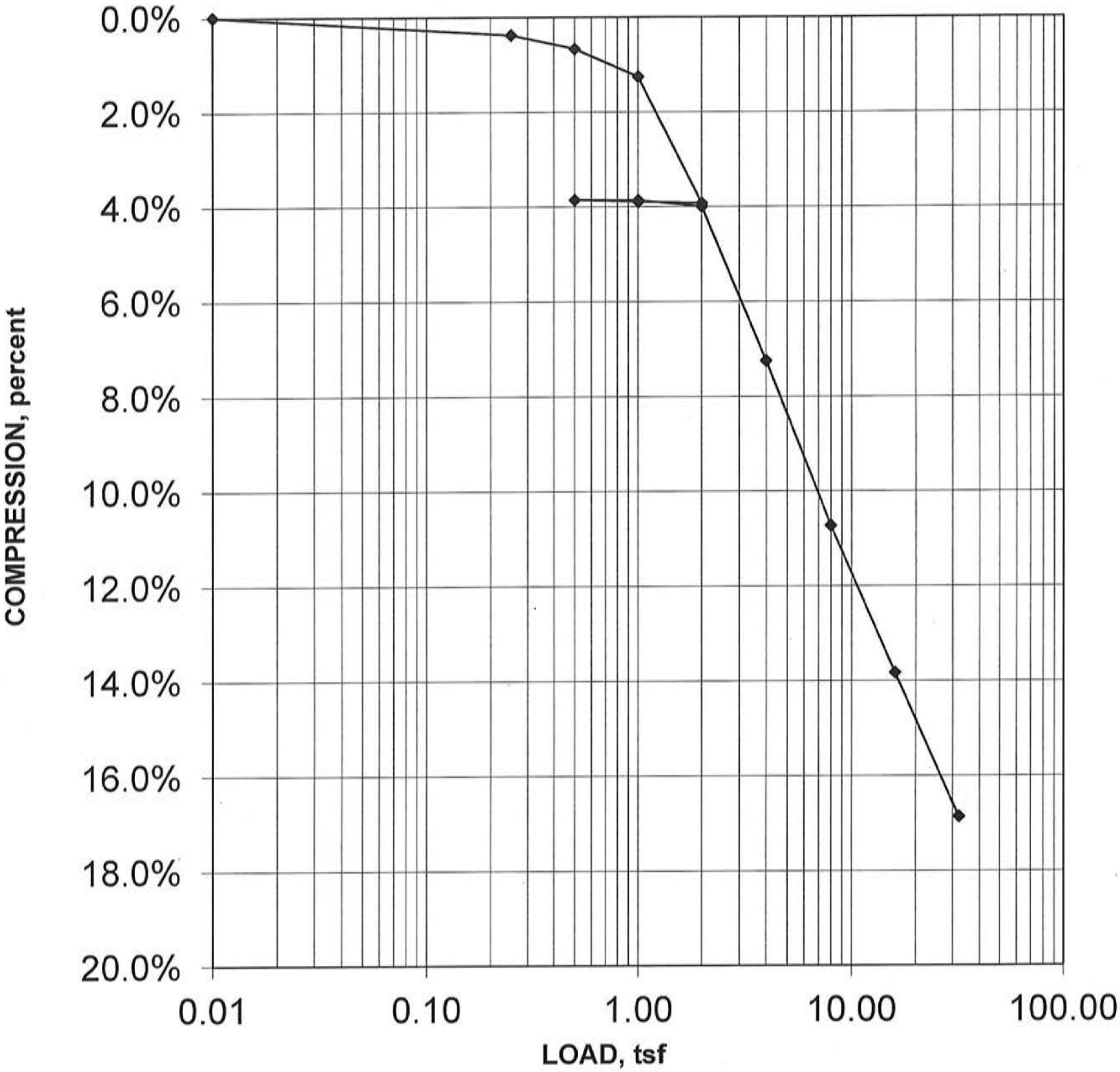
FIG.

CONSOLIDATION TEST



Load, tsf	Coefficient of Consolidation, mm^2/second	Load, tsf	Coefficient of Consolidation, mm^2/second
0.25	3.3E+00	2.0	NA
0.5	3.3E+00	4.0	1.2E+00
1.0	2.4E+00	8.0	1.0E+00
2.0	1.3E+00	16.0	1.2E+00
1.0	NA	32.0	9.8E-01
0.5	NA		
1.0	NA		

AECI Structural Integrity Assessment
Marston, Missouri

SETTLEMENT PLOTS

HA-B4

U2

October 2015 41-1-37431-003

SHANNON & WILSON, INC.
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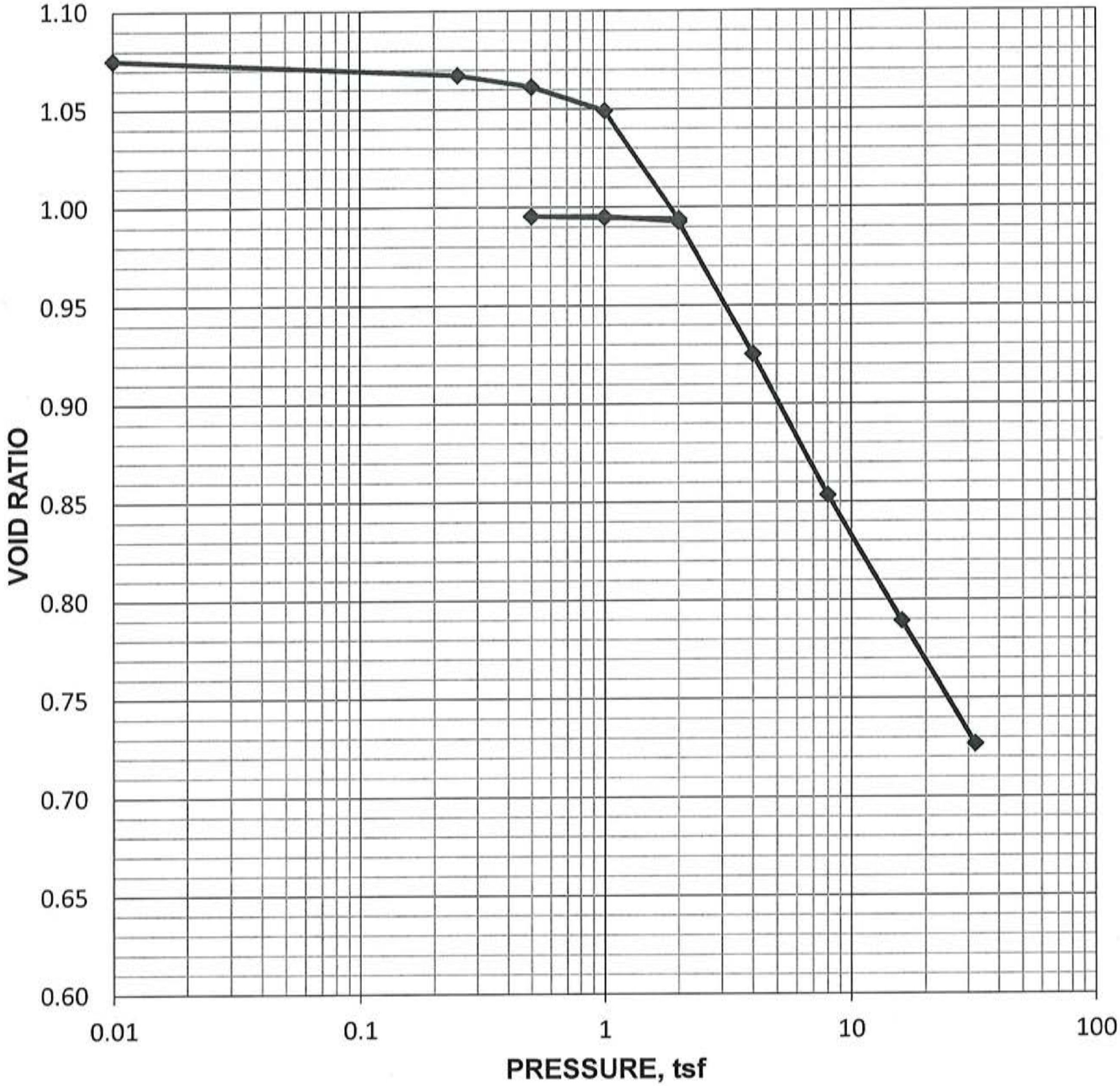
FIG.

CONSOLIDATION TEST



Load, tsf	Coefficient of Consolidation, mm²/second	Load, tsf	Coefficient of Consolidation, mm²/second
0.25	3.3E+00	2.0	NA
0.5	3.3E+00	4.0	1.2E+00
1.0	2.4E+00	8.0	1.0E+00
2.0	1.3E+00	16.0	1.2E+00
1.0	NA	32.0	9.8E-01
0.5	NA		
1.0	NA		

AECI Structural Integrity Assessment
Marston, Missouri

VOID RATIO PLOT

HA-B4

U2

October 2015 41-1-37431-003

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

CONSOLIDATION TEST

Sheet 1

Project	AECI Structural Integrity Assessment	Client	Haley & Aldrich, Inc.	
Location	Marston, Missouri	Tested By / Date	CMB	10/21/15
Job Number	41-1-37431-003	Calculated By / Date	CMB	10/30/15
Boring	HA-B5	Checked By / Date	JTB	11/2/15
Sample	U1	File	41-1-37431-003 HA-B5 U1 D2435	
Depth (ft)	10.6	Procedure	ASTM D2435	

	Initial Data		*Final Data*				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	1.003	2.502	0.876	inches	Tare No.	C-3	
Measured Reading 2	1.002	2.504	0.878	inches	Tare Weight	2.50	
Measured Reading 3	1.004	2.503	0.887	inches	Wet Weight	60.74	
Measured Reading 4	1.003	2.502	0.880	inches	Dry Weight	48.80	
Average Reading	1.003	2.503	0.880	inches	M.C. %	25.8%	
Wet Weight + Ring	279.51	Wet+Ring+Tare	362.76	grams	*Trimmings #2*		
Weight of Ring	146.33	Dry+Ring+Tare	332.70	grams	Tare No.	C-4	
Specific Gravity	2.61	Tare Weight	83.07	grams	Tare Weight	2.49	
Sample Volume	80.86		69.71	cm^3	Wet Weight	51.79	
Height of Solids	0.492		0.492	inches	Dry Weight	41.96	
Void Ratio	1.04		0.76		M.C. %	24.9%	
Saturation	72.5		100.0	percent	Ring Number	411	
Weight of Water	29.88		30.06	grams	Inundated @	0.26	tsf
Moisture Content	28.9		29.1	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	102.8		119.4	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	79.8		92.5	pcf	Method Used	A or B	
Notes: The specific gravity is computed assuming saturation at the end of the test.					Computed Ht.	0.865	inches

Load 1		Load 2		Load 3		Load 4	
Air Press.	1.6	Air Press.	2.4	Air Press.	4.0	Air Press.	7.1
Load, tsf	0.26	Load, tsf	0.5	Load, tsf	1.0	Load, tsf	2.0
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	150	0.1	267	0.1	430	0.1	590
0.25	154	0.25	276	0.25	438	0.25	598
0.5	159	0.5	281	0.5	443	0.5	604
1	162	1	286	1	447	1	609
2	169	2	289	2	451	2	614
4	173	4	292	4	454	4	618
8	176	8	296	8	458	8	623
17	179	15	300	15	462	15	627
30	182	30	303	30	465	30	631
60		60		60		60	635
120		120		120		120	639
240		240		240		240	643
480		480		480		370	645
1440		1440		1440		1305	654

Load 5		Load 6		Load 7		Load 8	
Air Press.	4.0	Air Press.	2.4	Air Press.	4.0	Air Press.	7.1
Load, tsf	1.0	Load, tsf	0.5	Load, tsf	1.0	Load, tsf	2.0
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	644	0.1	630	0.1	634	0.1	651
0.25	644	0.25	630	0.25	635	0.25	652
0.5	643	0.5	629	0.5	635	0.5	652
1	643	1	629	1	635	1	653
2	643	2	628	2	635	2	653
4	643	4	627	4	635	4	653
8	642	8	626	8	635	8	654
15	642	15	626	15	636	15	654
30		30		30		30	655
60		60		60		60	
120		120		120		120	
240		240		240		240	
480		480		480		480	
1440		1440		1440		1440	

CONSOLIDATION TEST

Sheet 2

Project	AECI Structural Integrity Assessment			Client		Haley & Aldrich, Inc.	
Location	Marston, Missouri			Tested By / Date		CMB	10/21/15
Job Number	41-1-37431-003			Calculated By / Date		CMB	10/30/15
Boring	HA-B5			Checked By / Date		JTB	11/2/15
Sample	U1			File		41-1-37431-003 HA-B5 U1 D2435	
Depth (ft)	10.6			Procedure		ASTM D2435	
	Initial Data		*Final Data*				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	1.003	2.502	0.876	inches	Tare No.	C-3	
Measured Reading 2	1.002	2.504	0.878	inches	Tare Weight	2.50	
Measured Reading 3	1.004	2.503	0.887	inches	Wet Weight	60.74	
Measured Reading 4	1.003	2.502	0.880	inches	Dry Weight	48.80	
Average Reading	1.003	2.503	0.880	inches	M.C. %	25.8%	
Wet Weight + Ring	279.51	Wet+Ring+Tare	362.76	grams	*Trimmings #2*		
Weight of Ring	146.33	Dry+Ring+Tare	332.70	grams	Tare No.	C-4	
Specific Gravity	2.61	Tare Weight	83.07	grams	Tare Weight	2.49	
Sample Volume	80.86		69.71	cm^3	Wet Weight	51.79	
Height of Solids	0.492		0.492	inches	Dry Weight	41.96	
Void Ratio	1.04		0.76		M.C. %	24.9%	
Saturation	72.5		100.0	percent	Ring Number	411	
Weight of Water	29.88		30.06	grams	Inundated @	0.26	tsf
Moisture Content	28.9		29.1	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	102.8		119.4	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	79.8		92.5	pcf	Method Used	A or B	
Notes: The specific gravity is computed assuming saturation at the end of the test.					Computed Ht.	0.865	inches

Load 9		Load 10		Load 11		Load 12	
Air Press.	13.3	Air Press.	25.9	Air Press.	51.1	Air Press.	101.7
Load, tsf	4.0	Load, tsf	8.0	Load, tsf	16.0	Load, tsf	32.0
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	774	0.1	994	0.1	1245	0.1	1521
0.25	783	0.25	1006	0.25	1259	0.25	1534
0.5	790	0.5	1013	0.5	1267	0.5	1543
1	796	1	1021	1	1277	1	1552
2	802	2	1028	2	1285	2	1561
4	807	4	1034	4	1291	4	1569
8	814	8	1041	8	1298	8	1576
15	820	15	1046	15	1304	15	1582
30	825	30	1052	30	1310	30	1588
60	830	60	1058	60	1316	60	1594
120	834	120	1062	120	1321	120	1600
240	839	240	1068	240	1326	240	1605
410	842	480	1072	480	1332	480	1611
4245	855	1440	1080	1440	1340	1440	1619

CONSOLIDATION TEST

Sheet 3

Project	AECI Structural Integrity Assessment			Client		Haley & Aldrich, Inc.	
Location	Marston, Missouri			Tested By / Date		CMB	10/21/15
Job Number	41-1-37431-003			Calculated By / Date		CMB	10/30/15
Boring	HA-B5			Checked By / Date		JTB	11/2/15
Sample	U1			File		41-1-37431-003 HA-B5 U1 D2435	
Depth (ft)	10.6			Procedure		ASTM D2435	
	Initial Data		*Final Data*				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	1.003	2.502	0.876	inches	Tare No.	C-3	
Measured Reading 2	1.002	2.504	0.878	inches	Tare Weight	2.50	
Measured Reading 3	1.004	2.503	0.887	inches	Wet Weight	60.74	
Measured Reading 4	1.003	2.502	0.880	inches	Dry Weight	48.80	
Average Reading	1.003	2.503	0.880	inches	M.C. %	25.8%	
Wet Weight + Ring	279.51	Wet+Ring+Tare	362.76	grams	*Trimmings #2*		
Weight of Ring	146.33	Dry+Ring+Tare	332.70	grams	Tare No.	C-4	
Specific Gravity	2.61	Tare Weight	83.07	grams	Tare Weight	2.49	
Sample Volume	80.86		69.71	cm^3	Wet Weight	51.79	
Height of Solids	0.492		0.492	inches	Dry Weight	41.96	
Void Ratio	1.04		0.76		M.C. %	24.9%	
Saturation	72.5		100.0	percent	Ring Number	411	
Weight of Water	29.88		30.06	grams	Inundated @	0.26	tsf
Moisture Content	28.9		29.1	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	102.8		119.4	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	79.8		92.5	pcf	Method Used	A or B	
Notes: The specific gravity is computed assuming saturation at the end of the test.					Computed Ht.	0.865	inches

CALIBRATION OF CONSOLIDATION DEFORMATION

Procedure SWCP-15 (Reference ASTM D2435 AASHTO T216)

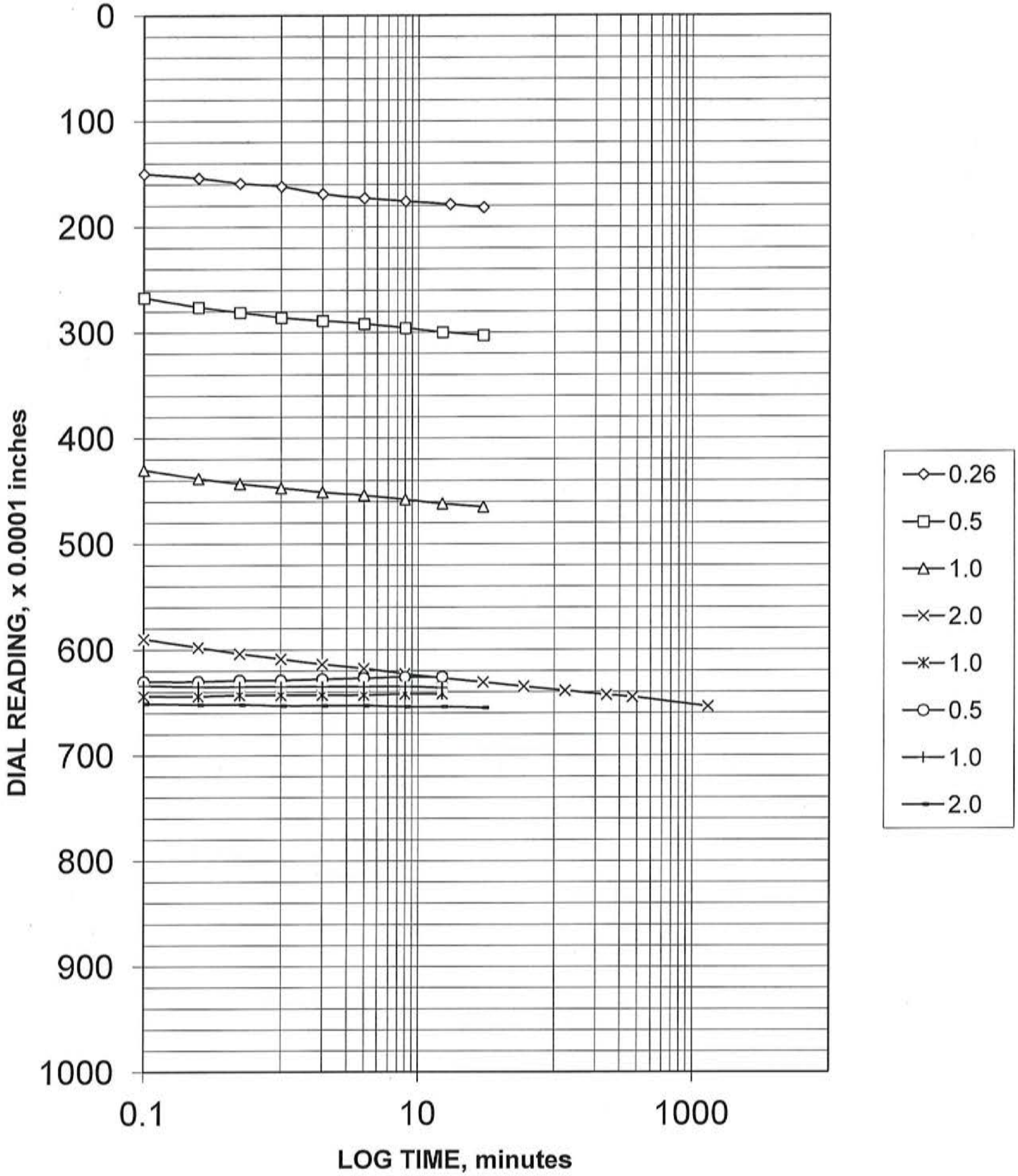
Equipment Calibrated:	Consolidation Deformation	Date Calibrated:	10/29/15
Reason for Calibration:	Test Completion	Next Calibration Due:	Next Test
Equipment Used:	Consolidation Appartus	Calibrated By:	CMB
	Steel Calibration Disk	Checked By:	CMB

Machine Number: 411

Load tsf	Machine Def x 10^{-4}	Correction Factor x 10^{-4}	U-100 x 10^{-4}	Corr. U-100 x 10^{-4}	Compression, Percent	C_v	Void Ratio
0.01	0	0	0	0	0.00%	0	1.039
0.26	62	0	159.0	97	0.97%	2.9E+00	1.020
0.5	85	0	283.5	199	1.99%	2.3E+00	0.999
1.0	108	0	445.5	338	3.38%	2.1E+00	0.971
2.0	132	0	607.0	475	4.75%	2.1E+00	0.943
1.0	122	47	643.0	474	4.74%	NA	0.943
0.5	109	47	629.0	473	4.73%	NA	0.943
1.0	119	47	635.0	469	4.69%	NA	0.944
2.0	133	47	652.0	472	4.72%	NA	0.943
4.0	158	0	797.0	639	6.39%	1.7E+00	0.909
8.0	188	0	1020.0	832	8.32%	1.8E+00	0.870
16.0	215	0	1279.0	1064	10.64%	1.5E+00	0.823
32.0	236	0	1575.0	1339	13.39%	6.3E-01	0.767

P:\37xxx\37400\37431\Phase 003\41-1-37431-003 HA-B5 U1 D2435 10/30/2015

CONSOLIDATION TEST



AECI Structural Integrity Assessment
Marston, Missouri

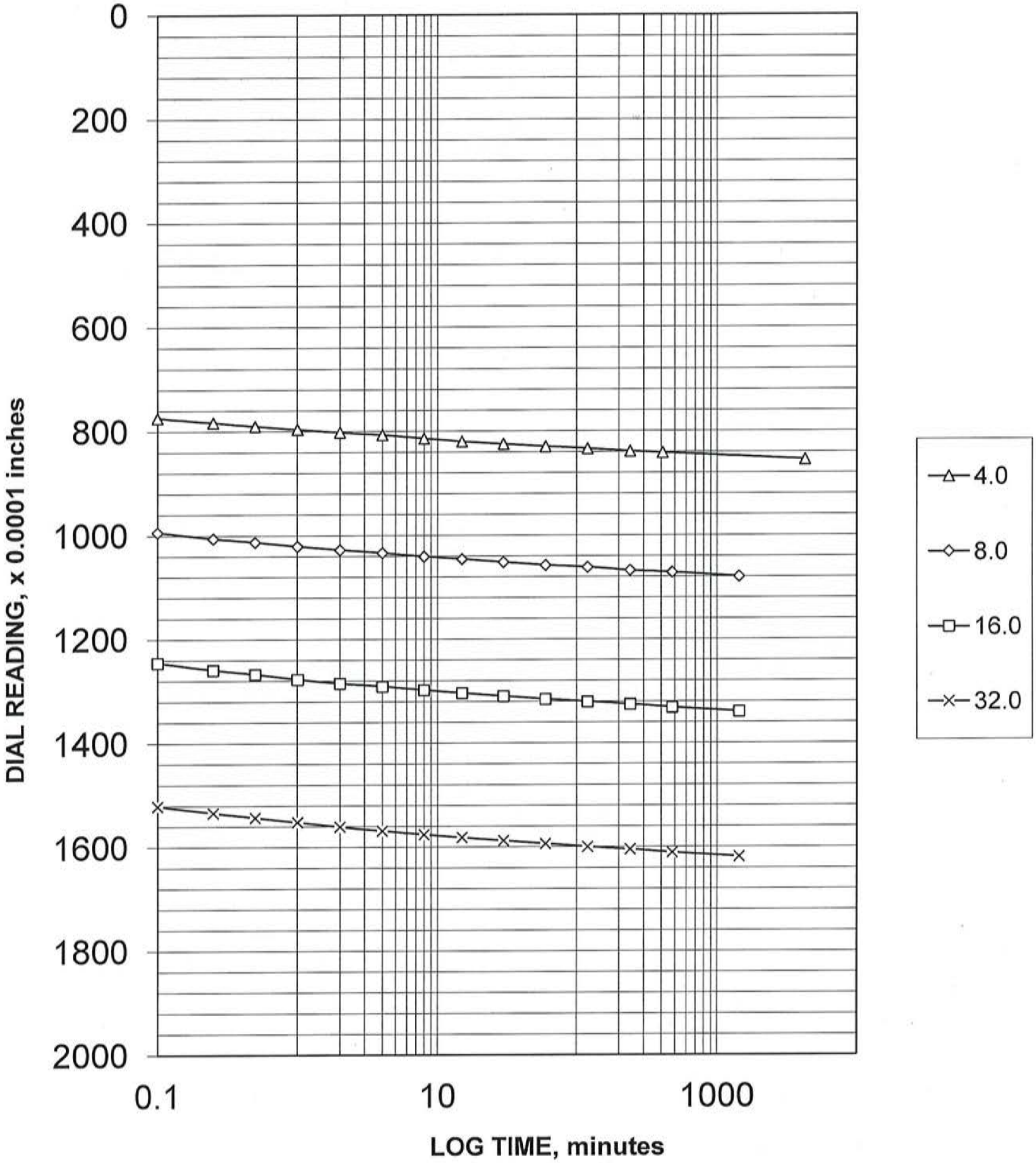
TIME PLOTS
HA-B5
U1

October 2015 41-1-37431-003

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

CONSOLIDATION TEST



AECI Structural Integrity Assessment
Marston, Missouri

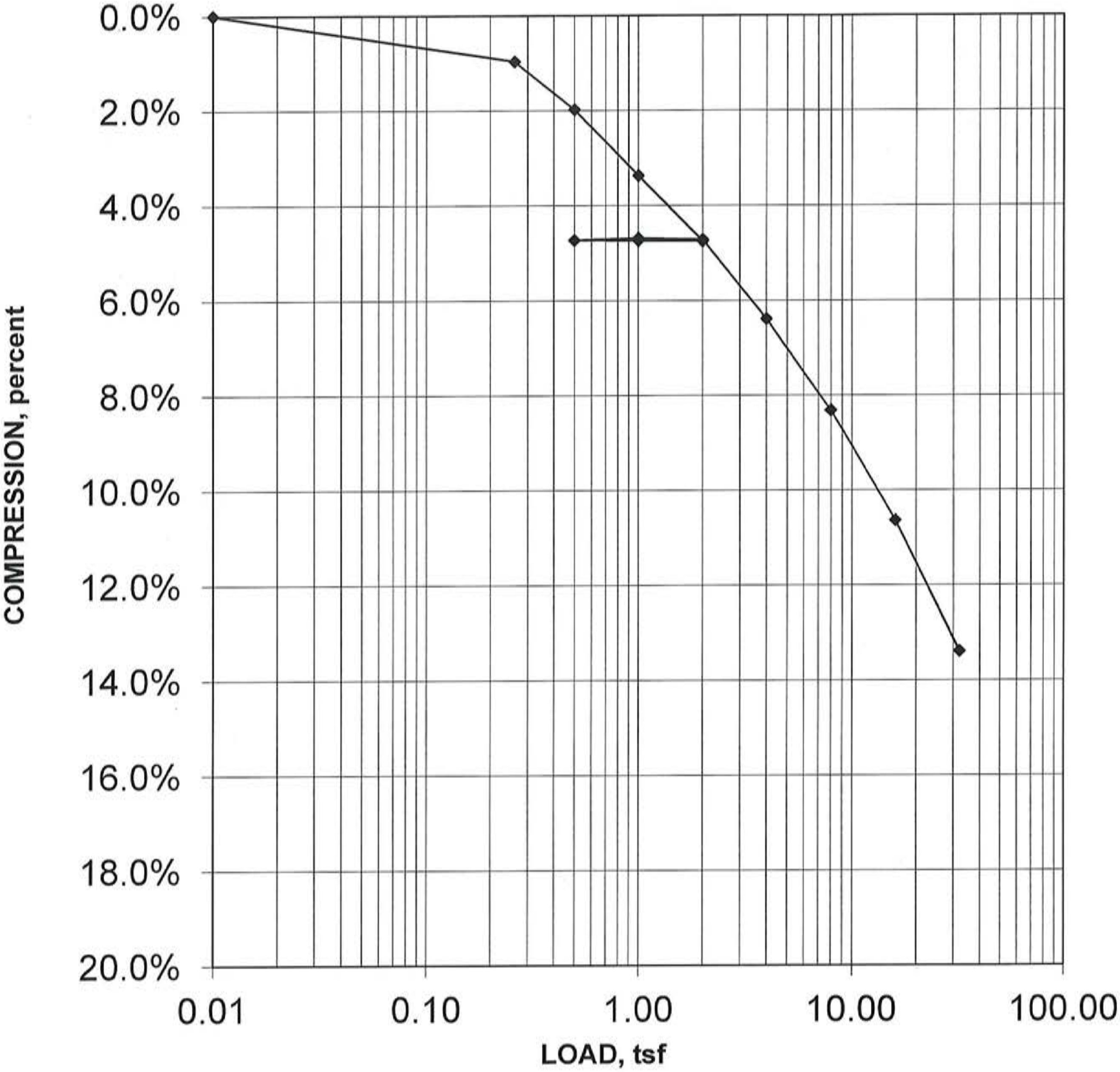
TIME PLOTS
HA-B5
U1

October 2015 41-1-37431-003

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

CONSOLIDATION TEST



Load, tsf	Coefficient of Consolidation, mm^2/second	Load, tsf	Coefficient of Consolidation, mm^2/second
0.26	2.9E+00	2.0	NA
0.5	2.3E+00	4.0	1.7E+00
1.0	2.1E+00	8.0	1.8E+00
2.0	2.1E+00	16.0	1.5E+00
1.0	NA	32.0	6.3E-01
0.5	NA		
1.0	NA		

AECI Structural Integrity Assessment
Marston, Missouri

SETTLEMENT PLOTS

HA-B5

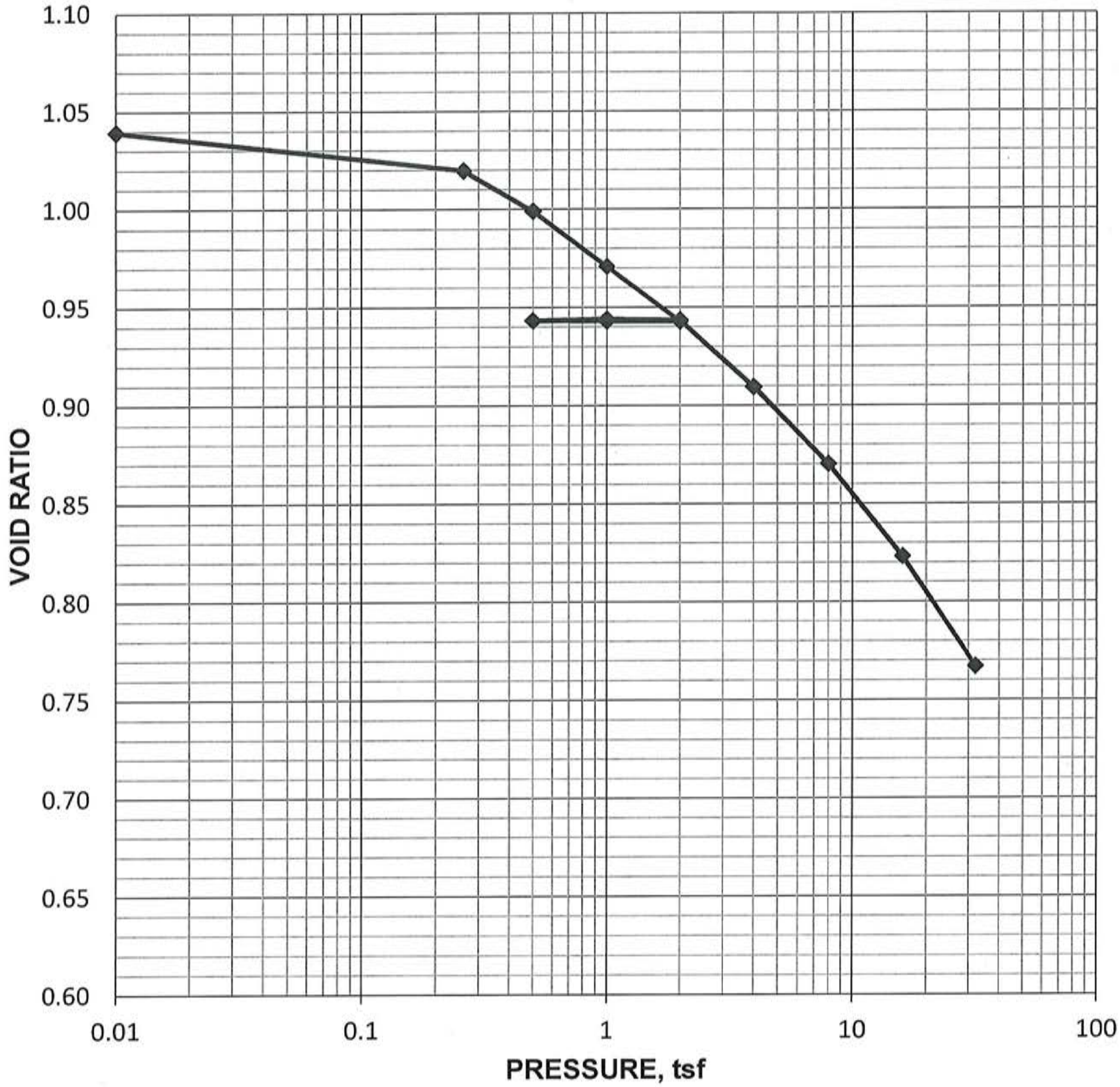
U1

October 2015 41-1-37431-003

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

CONSOLIDATION TEST



Load, tsf	Coefficient of Consolidation, mm²/second	Load, tsf	Coefficient of Consolidation, mm²/second
0.26	2.9E+00	2.0	NA
0.5	2.3E+00	4.0	1.7E+00
1.0	2.1E+00	8.0	1.8E+00
2.0	2.1E+00	16.0	1.5E+00
1.0	NA	32.0	6.3E-01
0.5	NA		
1.0	NA		

AECI Structural Integrity Assessment
Marston, Missouri

VOID RATIO PLOT

HA-B5

U1

October 2015 41-1-37431-003

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

CONSOLIDATION TEST

Sheet 1

Project	AECI Structural Integrity Assessment			Client	Haley & Aldrich, Inc.	
Location	Marston, Missouri			Tested By / Date	CMB	10/21/15
Job Number	41-1-37431-003			Calculated By / Date	CMB	10/30/15
Boring	HA-B5			Checked By / Date	JTB	11/2/15
Sample	U2			File	41-1-37431-003 HA-B5 U2 D2435	
Depth (ft)	21.4			Procedure	ASTM D2435	

	Initial Data		*Final Data*				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	1.005	2.504	0.903	inches	Tare No.	C-5	
Measured Reading 2	1.004	2.502	0.908	inches	Tare Weight	2.49	
Measured Reading 3	1.004	2.505	0.909	inches	Wet Weight	36.19	
Measured Reading 4	1.006	2.506	0.902	inches	Dry Weight	26.35	
Average Reading	1.005	2.504	0.906	inches	M.C. %	41.2%	
Wet Weight + Ring	289.07	Wet+Ring+Tare	366.23	grams	*Trimmings #2*		
Weight of Ring	146.30	Dry+Ring+Tare	332.71	grams	Tare No.	C-6	
Specific Gravity	2.70	Tare Weight	84.36	grams	Tare Weight	2.56	
Sample Volume	81.10		71.38	cm^3	Wet Weight	36.74	
Height of Solids	0.469		0.469	inches	Dry Weight	26.99	
Void Ratio	1.14		0.89		M.C. %	39.9%	
Saturation	94.2		100.0	percent	Ring Number	440	
Weight of Water	40.72		33.52	grams	Inundated @	0.26	tsf
Moisture Content	39.9		32.8	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	109.9		118.6	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	78.6		89.3	pcf	Method Used	A or B	
Notes: The specific gravity is computed assuming saturation at the end of the test.					Computed Ht.	0.884	inches

Load 1		Load 2		Load 3		Load 4	
Air Press.	1.7	Air Press.	2.5	Air Press.	4.0	Air Press.	7.2
Load, tsf	0.26	Load, tsf	0.5	Load, tsf	1.0	Load, tsf	2.0
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	41	0.1	86	0.1	142	0.1	247
0.25	43	0.25	88	0.25	145	0.25	252
0.5	46	0.5	89	0.5	147	0.5	256
1	47	1	90	1	151	1	261
2	48	2	93	2	153	2	265
4	49	4	95	4	154	4	270
8	50	8	97	8	158	8	273
17	51	15	98	15	160	15	278
30	54	30	101	30	162	30	281
60		60		60		60	286
120		120		120		120	289
240		240		240		240	293
480		480		480		370	295
1440		1440		1440		1305	303

Load 5		Load 6		Load 7		Load 8	
Air Press.	4.0	Air Press.	2.5	Air Press.	4.0	Air Press.	7.2
Load, tsf	1.0	Load, tsf	0.5	Load, tsf	1.0	Load, tsf	2.0
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	294	0.1	281	0.1	282	0.1	301
0.25	293	0.25	280	0.25	282	0.25	302
0.5	293	0.5	280	0.5	282	0.5	302
1	292	1	279	1	282	1	302
2	291	2	278	2	283	2	303
4	291	4	278	4	283	4	303
8	290	8	278	8	283	8	304
15	290	15	277	15	284	15	304
30		30		30		30	305
60		60		60		60	
120		120		120		120	
240		240		240		240	
480		480		480		480	
1440		1440		1440		1440	

CONSOLIDATION TEST

Sheet 2

Project	AECI Structural Integrity Assessment			Client		Haley & Aldrich, Inc.	
Location	Marston, Missouri			Tested By / Date		CMB	10/21/15
Job Number	41-1-37431-003			Calculated By / Date		CMB	10/30/15
Boring	HA-B5			Checked By / Date		JTB	11/2/15
Sample	U2			File		41-1-37431-003 HA-B5 U2 D2435	
Depth (ft)	21.4			Procedure		ASTM D2435	
	Initial Data		*Final Data*				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	1.005	2.504	0.903	inches	Tare No.	C-5	
Measured Reading 2	1.004	2.502	0.908	inches	Tare Weight	2.49	
Measured Reading 3	1.004	2.505	0.909	inches	Wet Weight	36.19	
Measured Reading 4	1.006	2.506	0.902	inches	Dry Weight	26.35	
Average Reading	1.005	2.504	0.906	inches	M.C. %	41.2%	
Wet Weight + Ring	289.07	Wet+Ring+Tare	366.23	grams	*Trimmings #2*		
Weight of Ring	146.30	Dry+Ring+Tare	332.71	grams	Tare No.	C-6	
Specific Gravity	2.70	Tare Weight	84.36	grams	Tare Weight	2.56	
Sample Volume	81.10		71.38	cm^3	Wet Weight	36.74	
Height of Solids	0.469		0.469	inches	Dry Weight	26.99	
Void Ratio	1.14		0.89		M.C. %	39.9%	
Saturation	94.2		100.0	percent	Ring Number	440	
Weight of Water	40.72		33.52	grams	Inundated @	0.26	tsf
Moisture Content	39.9		32.8	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	109.9		118.6	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	78.6		89.3	pcf	Method Used	A or B	
Notes: The specific gravity is computed assuming saturation at the end of the test.					Computed Ht.	0.884	inches

Load 9		Load 10		Load 11		Load 12	
Air Press.	12.9	Air Press.	26.2	Air Press.	51.2	Air Press.	101.8
Load, tsf	4.0	Load, tsf	8.0	Load, tsf	16.0	Load, tsf	32.0
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	404	0.1	678	0.1	966	0.1	1274
0.25	414	0.25	690	0.25	978	0.25	1287
0.5	421	0.5	698	0.5	988	0.5	1294
1	426	1	707	1	997	1	1302
2	433	2	716	2	1005	2	1310
4	439	4	723	4	1011	4	1316
8	445	8	730	8	1018	8	1322
15	449	15	737	15	1025	15	1329
30	455	30	744	30	1032	30	1336
60	458	60	751	60	1039	60	1343
120	464	120	757	120	1044	120	1347
240	470	240	762	240	1050	240	1353
410	473	480	769	480	1056	480	1360
4245	489	1440	777	1440	1065	1440	1369

CONSOLIDATION TEST

Sheet 3

Project	AECI Structural Integrity Assessment			Client		Haley & Aldrich, Inc.	
Location	Marston, Missouri			Tested By / Date		CMB	10/21/15
Job Number	41-1-37431-003			Calculated By / Date		CMB	10/30/15
Boring	HA-B5			Checked By / Date		JTB	11/2/15
Sample	U2			File		41-1-37431-003 HA-B5 U2 D2435	
Depth (ft)	21.4			Procedure		ASTM D2435	
	Initial Data		*Final Data*				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	1.005	2.504	0.903	inches	Tare No.	C-5	
Measured Reading 2	1.004	2.502	0.908	inches	Tare Weight	2.49	
Measured Reading 3	1.004	2.505	0.909	inches	Wet Weight	36.19	
Measured Reading 4	1.006	2.506	0.902	inches	Dry Weight	26.35	
Average Reading	1.005	2.504	0.906	inches	M.C. %	41.2%	
Wet Weight + Ring	289.07	Wet+Ring+Tare	366.23	grams	*Trimmings #2*		
Weight of Ring	146.30	Dry+Ring+Tare	332.71	grams	Tare No.	C-6	
Specific Gravity	2.70	Tare Weight	84.36	grams	Tare Weight	2.56	
Sample Volume	81.10		71.38	cm^3	Wet Weight	36.74	
Height of Solids	0.469		0.469	inches	Dry Weight	26.99	
Void Ratio	1.14		0.89		M.C. %	39.9%	
Saturation	94.2		100.0	percent	Ring Number	440	
Weight of Water	40.72		33.52	grams	Inundated @	0.26	tsf
Moisture Content	39.9		32.8	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	109.9		118.6	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	78.6		89.3	pcf	Method Used	A or B	
Notes: The specific gravity is computed assuming saturation at the end of the test.					Computed Ht.	0.884	inches

CALIBRATION OF CONSOLIDATION DEFORMATION

Procedure SWCP-15 (Reference ASTM D2435 AASHTO T216)

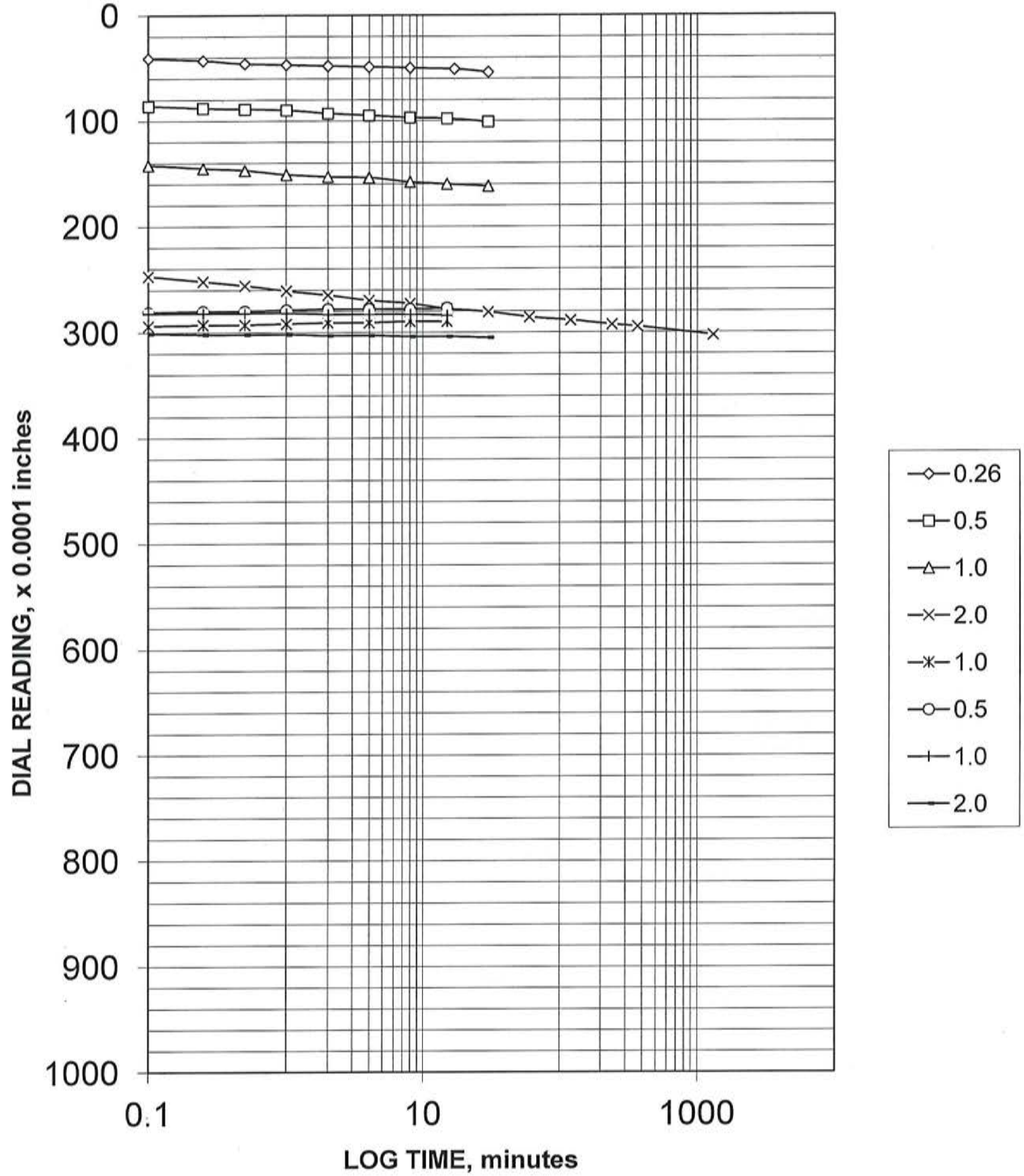
Equipment Calibrated:	Consolidation Deformation	Date Calibrated:	10/29/15
Reason for Calibration:	Test Completion	Next Calibration Due:	Next Test
Equipment Used:	Consolidation Appartus	Calibrated By:	CMB
	Steel Calibration Disk	Checked By:	CMB

Machine Number: 440

Load tsf	Machine Def x 10^{-4}	Correction Factor x 10^{-4}	U-100 x 10^{-4}	Corr. U-100 x 10^{-4}	Compression, Percent	C_v	Void Ratio
0.01	0	0	0	0	0.00%	0	1.14
0.26	23	0	46.0	23	0.23%	2.7E+00	1.14
0.5	38	0	88.0	50	0.50%	3.3E+00	1.13
1.0	55	0	145.0	90	0.90%	5.2E+00	1.12
2.0	74	0	261.0	187	1.87%	2.0E+00	1.10
1.0	70	42	293.0	181	1.81%	NA	1.10
0.5	62	42	280.0	176	1.76%	NA	1.10
1.0	66	42	283.0	175	1.75%	NA	1.10
2.0	78	42	302.0	182	1.82%	NA	1.10
4.0	96	0	420.0	324	3.24%	2.6E+00	1.07
8.0	119	0	710.0	591	5.91%	1.6E+00	1.02
16.0	139	0	1000.0	861	8.61%	1.6E+00	0.96
32.0	165	0	1299.0	1134	11.34%	1.8E+00	0.90

P:\37xxx\37400\37431\Phase 003\41-1-37431-003 HA-B5 U2 D2435 10/30/2015

CONSOLIDATION TEST



AECI Structural Integrity Assessment
Marston, Missouri

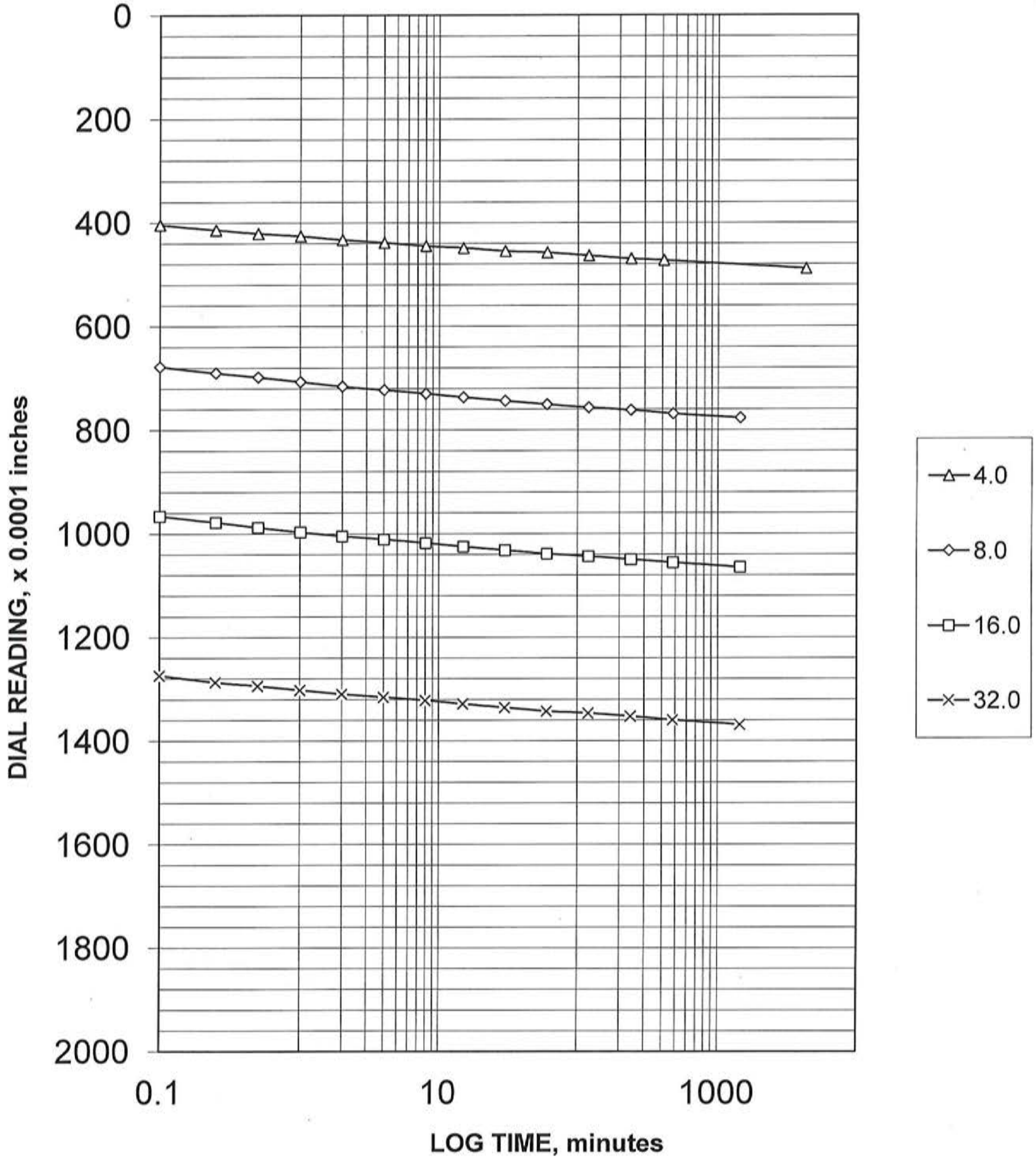
TIME PLOTS
HA-B5
U2

October 2015 41-1-37431-003

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

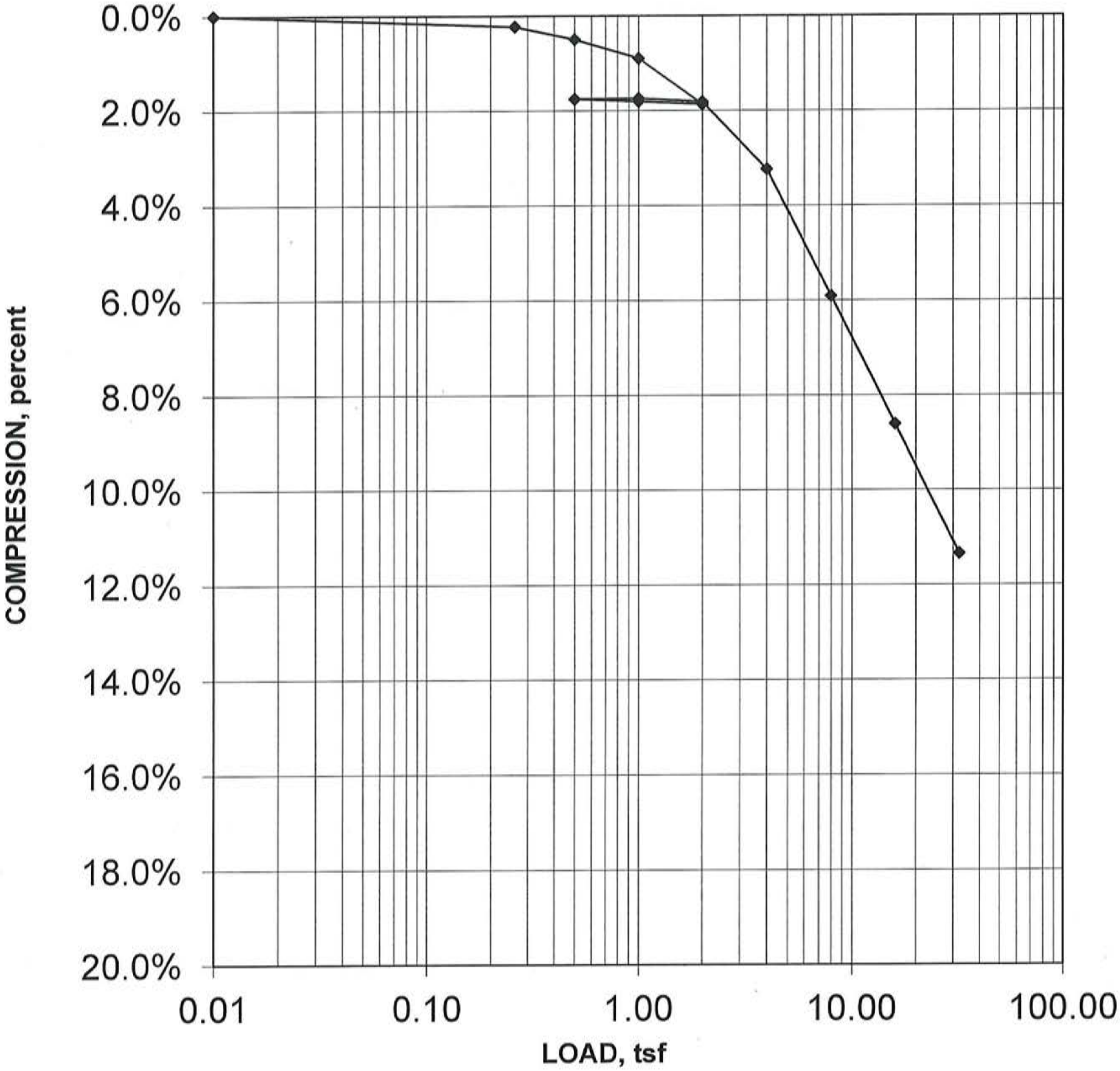
FIG.

CONSOLIDATION TEST



	AECI Structural Integrity Assessment Marston, Missouri
	TIME PLOTS **HA-B5** **U2**
	October 2015 41-1-37431-003
	SHANNON & WILSON, INC. Geotechnical and Environmental Consultants / **FIG.**

CONSOLIDATION TEST



Load, tsf	Coefficient of Consolidation, mm^2/second	Load, tsf	Coefficient of Consolidation, mm^2/second
0.26	2.7E+00	2.0	NA
0.5	3.3E+00	4.0	2.6E+00
1.0	5.2E+00	8.0	1.6E+00
2.0	2.0E+00	16.0	1.6E+00
1.0	NA	32.0	1.8E+00
0.5	NA		
1.0	NA		

AECI Structural Integrity Assessment
Marston, Missouri

SETTLEMENT PLOTS

HA-B5

U2

October 2015 41-1-37431-003

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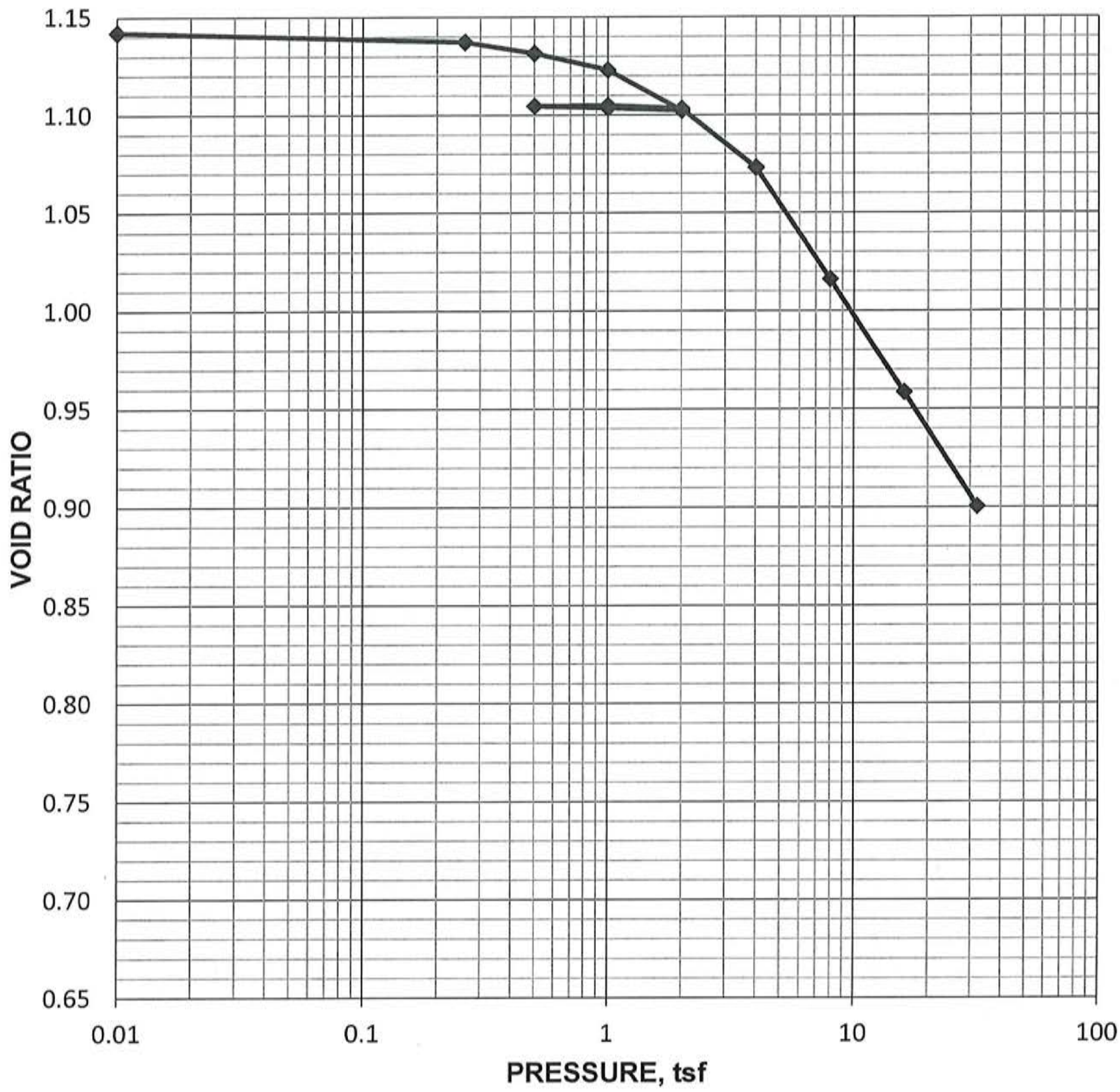
FIG.

CONSOLIDATION TEST



Load, tsf	Coefficient of Consolidation, mm²/second	Load, tsf	Coefficient of Consolidation, mm²/second
0.26	2.7E+00	2.0	NA
0.5	3.3E+00	4.0	2.6E+00
1.0	5.2E+00	8.0	1.6E+00
2.0	2.0E+00	16.0	1.6E+00
1.0	NA	32.0	1.8E+00
0.5	NA		
1.0	NA		

AECI Structural Integrity Assessment
Marston, Missouri

VOID RATIO PLOT

HA-B5

U2

October 2015 41-1-37431-003

SHANNON & WILSON, INC.
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FIG.

UNCONSOLIDATED, UNDRAINED STRENGTH IN TRIAXIAL COMPRESSION

Project	AECI Structural Integrity Assessment	Client	Haley & Aldrich	
Location	Marston, Missouri			Date
Job No.	41-1-37431-003	Tested by	CMB	10/09/15
Boring	HA-B5	Calculated by	CMB	10/12/15
Sample	U2	Checked by	CMB	10/12/15
Depth (ft)	20.3 - 20.8	File	41-1-37431-003-HA-B5-U2 D2850	
Undisturbed/Remold	Undisturbed	Procedure	ASTM D2850	
Description (D2487 + symbol)	Dark gray, Silt (ML) (Ash).			

Sample Data

Diameter	2.862	inches
Height	6.001	inches
Wet wt.	1045.11	grams

Initial Deflection (Before Confinement)

0.000 inches

Initial Deflection (After Confinement)

0.000 inches

Height Change (After Confinement)

0.000 inches

Test Setup Data

Confinement	7.5	psi
Deflection	0.001	inch/division
Load Cons.	1	lb/division

After Test Data

Tare No.	4	
Tare Wt.	103.53	grams
Wet wt.	1128.14	grams
Dry wt.	830.38	grams
Sp. Gravity	2.68	*assumed*

Photograph of Failure

REMARKS:

NOTE: The moisture content is taken from the entire sample after testing is completed.

Test Data

Time	Cell Pressure	Deflection	Load
hr-min	psi	div (in 0.001 in.)	div
0:00:00	7.5	0	0
0:00:08	7.5	5	5.6
0:00:15	7.5	10	8.4
0:00:23	7.5	15	11.1
0:00:30	7.5	20	13.5
0:00:45	7.5	30	17.7
0:01:15	7.5	50	22.3
0:01:53	7.5	75	29.3
0:02:30	7.5	100	34.8
0:03:23	7.5	135	42.8
0:03:45	7.5	150	44.9
0:04:23	7.5	175	47.9
0:05:00	7.5	200	50.6
0:05:53	7.5	235	53.0
0:06:15	7.5	250	54.2
0:07:30	7.5	300	56.7
0:08:45	7.5	350	59.1
0:10:00	7.5	400	60.1
0:11:15	7.5	450	61.7
0:12:30	7.5	500	62.8
0:13:45	7.5	550	63.0
0:15:00	7.5	600	63.3
0:16:15	7.5	650	64.2
0:17:30	7.5	700	64.5
0:18:45	7.5	750	64.8
0:20:00	7.5	800	64.8
0:21:15	7.5	850	66.1
0:22:30	7.5	900	67.0

UNCONSOLIDATED, UNDRAINED STRENGTH IN TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

			By	Date
Boring	HA-B5			
Sample	U2	Tested by	CMB	10/09/15
Depth (ft)	20.3 - 20.8	Calculated by	CMB	10/12/15
Description	Dark gray, Silt (ML) (Ash).	Checked by	CMB	10/12/15

Specimen Data

Height	6.001	inches
Diameter	2.862	inches
H/D ratio	2.097	
Volume	632.6	cc
Wet wt.	1045.11	grams
Bulk Density	103.1	pcf
Dry Density	73.1	pcf
M.C.	41.0%	percent
Saturation	85.3%	percent
Void ratio	1.287	
Gs	2.68	assumed

Instrument Constants

Deformation	0.001	inches/div
Load	1	lb/div.
Confinment	7.5	psi

Peak values

p	0.866	tsf
q	0.326	tsf
strain	15.0%	%
strain rate	0.040	in. per min.

Deformation div.	Load div.	Strain %	Load lb	Stress tsf	p tsf	q tsf
0.000	0	0.0%	0	0.000	0.540	0.000
0.005	5.6	0.1%	5.6	0.063	0.571	0.031
0.010	8.4	0.2%	8.4	0.094	0.587	0.047
0.015	11.1	0.2%	11.1	0.124	0.602	0.062
0.020	13.5	0.3%	13.5	0.151	0.615	0.075
0.030	17.7	0.5%	17.7	0.197	0.639	0.099
0.050	22.3	0.8%	22.3	0.248	0.664	0.124
0.075	29.3	1.2%	29.3	0.324	0.702	0.162
0.100	34.8	1.7%	34.8	0.383	0.732	0.192
0.135	42.8	2.2%	42.8	0.468	0.774	0.234
0.150	44.9	2.5%	44.9	0.490	0.785	0.245
0.175	47.9	2.9%	47.9	0.521	0.800	0.260
0.200	50.6	3.3%	50.6	0.548	0.814	0.274
0.235	53.0	3.9%	53.0	0.571	0.825	0.285
0.250	54.2	4.2%	54.2	0.582	0.831	0.291
0.300	56.7	5.0%	56.7	0.604	0.842	0.302
0.350	59.1	5.8%	59.1	0.625	0.852	0.312
0.400	60.1	6.7%	60.1	0.631	0.855	0.315
0.450	61.7	7.5%	61.7	0.642	0.861	0.321
0.500	62.8	8.3%	62.8	0.649	0.864	0.324
0.550	63.0	9.2%	63.0	0.646	0.863	0.323
0.600	63.3	10.0%	63.3	0.644	0.862	0.322
0.650	64.2	10.8%	64.2	0.648	0.864	0.324
0.700	64.5	11.7%	64.5	0.646	0.863	0.323
0.750	64.8	12.5%	64.8	0.645	0.862	0.322
0.800	64.8	13.3%	64.8	0.640	0.860	0.320
0.850	66.1	14.2%	66.1	0.648	0.864	0.324
0.900	67	15.0%	67.0	0.652	0.866	0.326

AECI Structural Integrity Assessment
Marston, Missouri

UNCONSOLIDATED, UNDRAINED STRENGTH
IN TRIAXIAL COMPRESSION
BORING - HA-B5 : SAMPLE - U2

October 2015 — 41-1-37431-003

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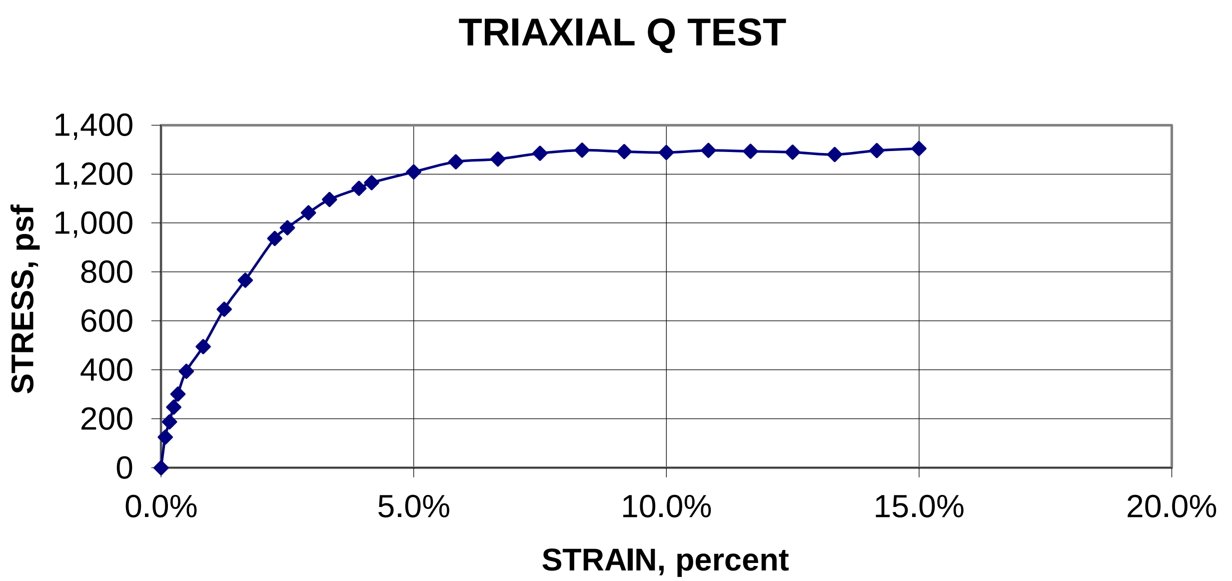
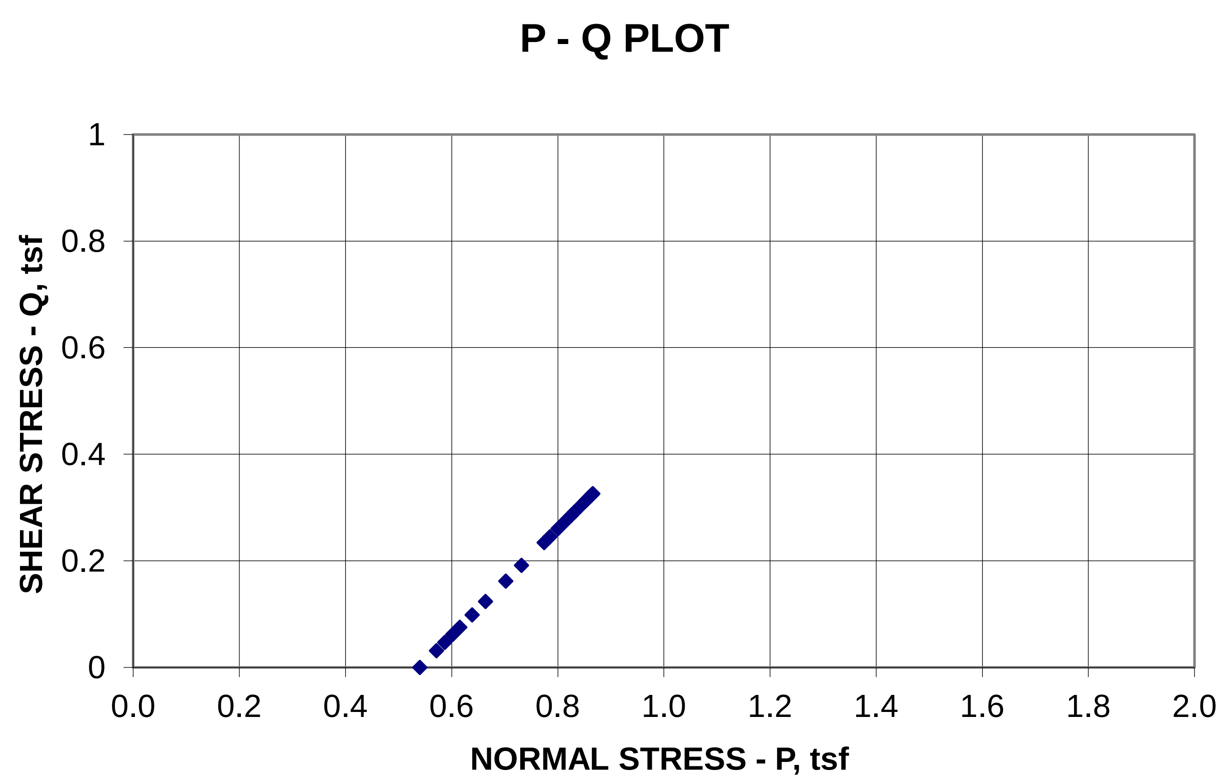
FIG.

UNCONSOLIDATED, UNDRAINED STRENGTH IN TRIAXIAL COMPRESSION
PLOT OF TEST DATA

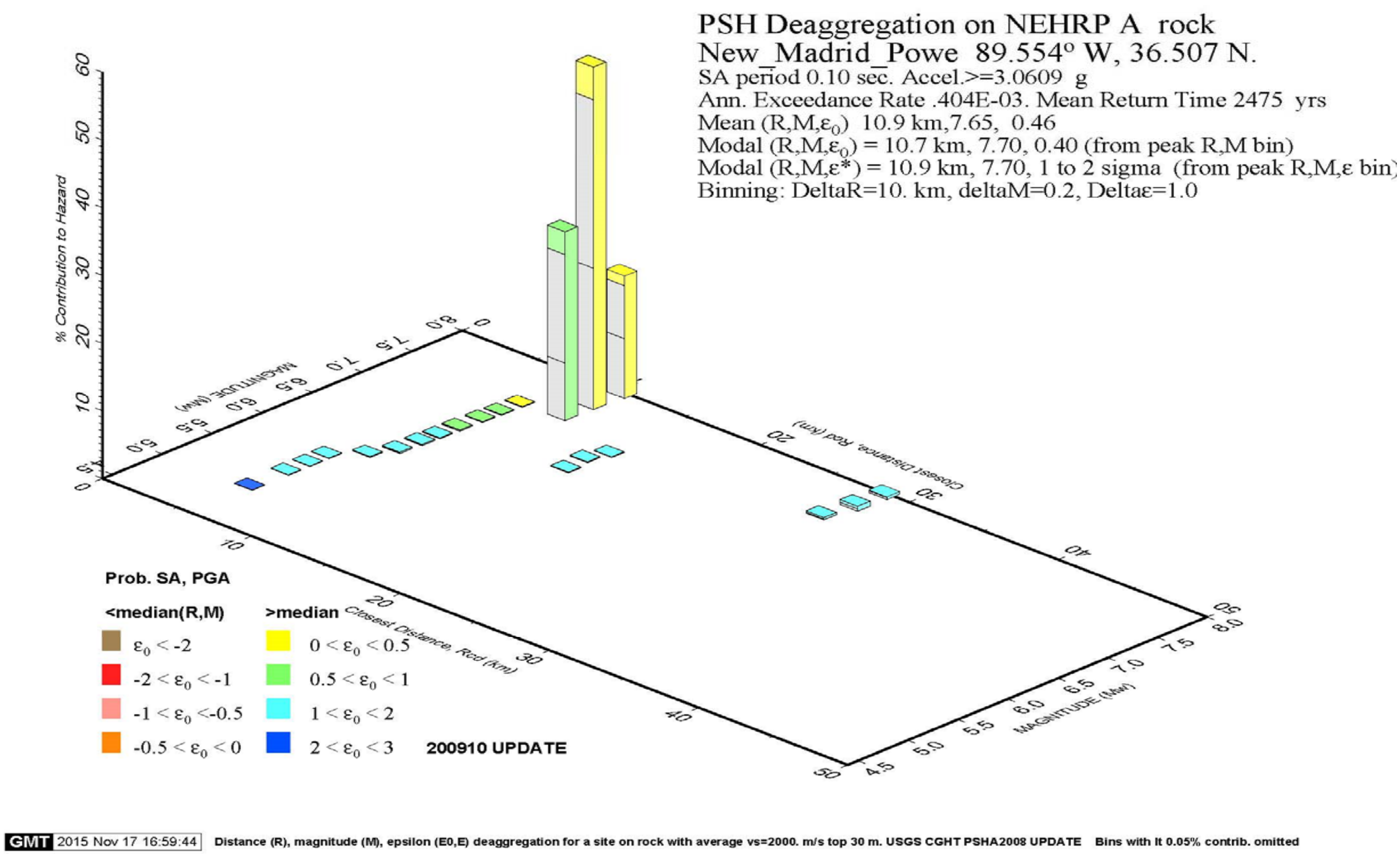




AECI Structural Integrity Assessment Marston, Missouri	
UNCONSOLIDATED, UNDRAINED STRENGTH **IN TRIAXIAL COMPRESSION** **BORING - HA-B5 : SAMPLE - U2**	
October 2015	41-1-37431-003
SHANNON & WILSON, INC. Geotechnical and Environmental	**FIG.**

APPENDIX D

Analyses



HALEY ALDRICH

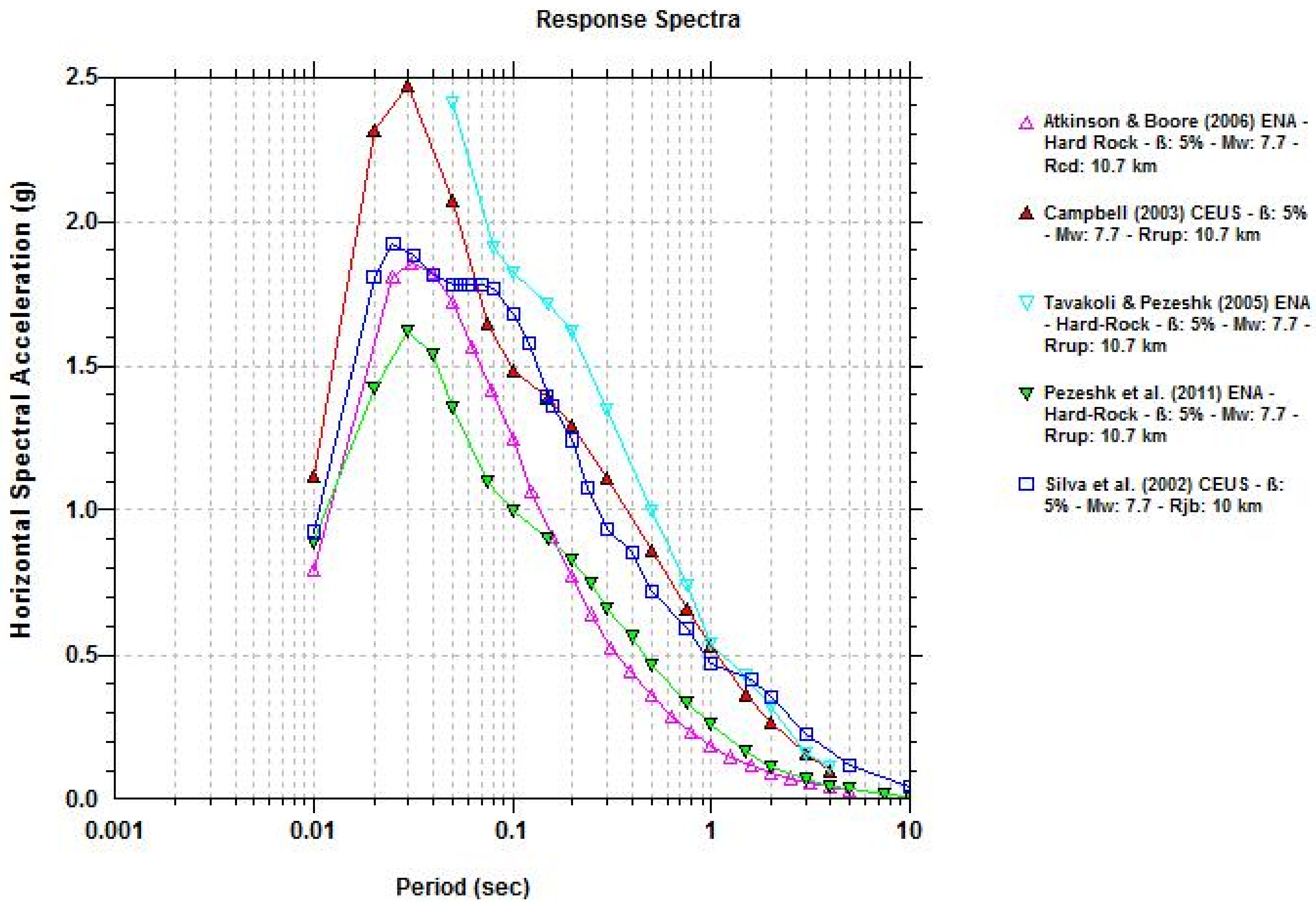
ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT
003 UNLINED POND AND 004 SLAG DEWATERING POND
MARSTON, MISSOURI

DEGRADATION PLOT AT PERIOD T=0.1s

SCALE : AS SHOWN
FEBRUARY 2016

FIGURE D-1

40616-300_FIG_D1.PPT



NOTES
1. Reference: SHAKE 2000

HALEY ALDRICH

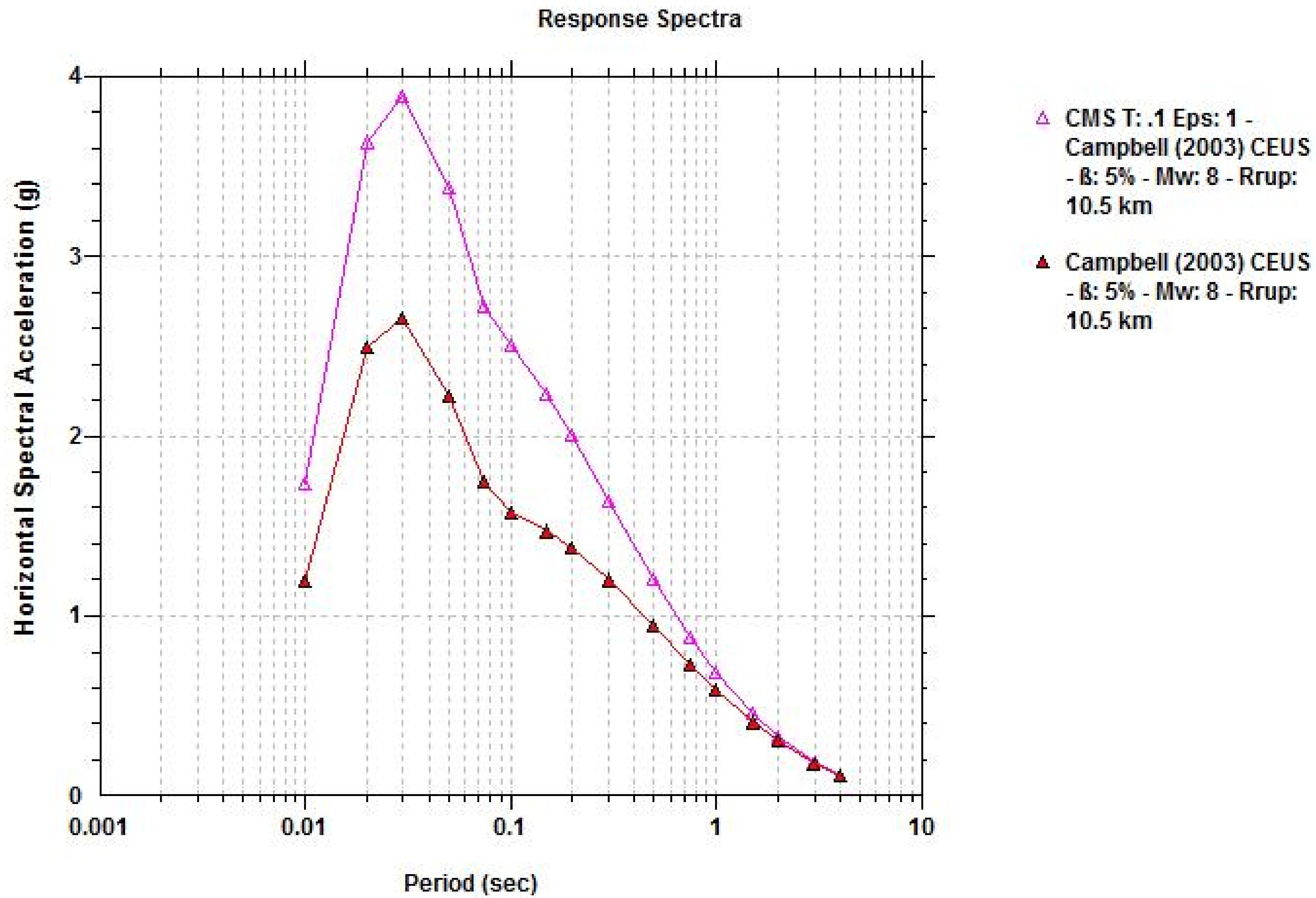
ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT
003 UNLINED POND AND 004 SLAG DEWATERING POND
MARSTON, MISSOURI

CENTRAL AND EASTERN U.S. GROUND MOTION ATTENUATION MODELS

SCALE : AS SHOWN
FEBRUARY 2016

FIGURE D-2

40616-300_FIG D2.PPT



NOTES
1. Reference: SHAKE 2000

HALEY ALDRICH

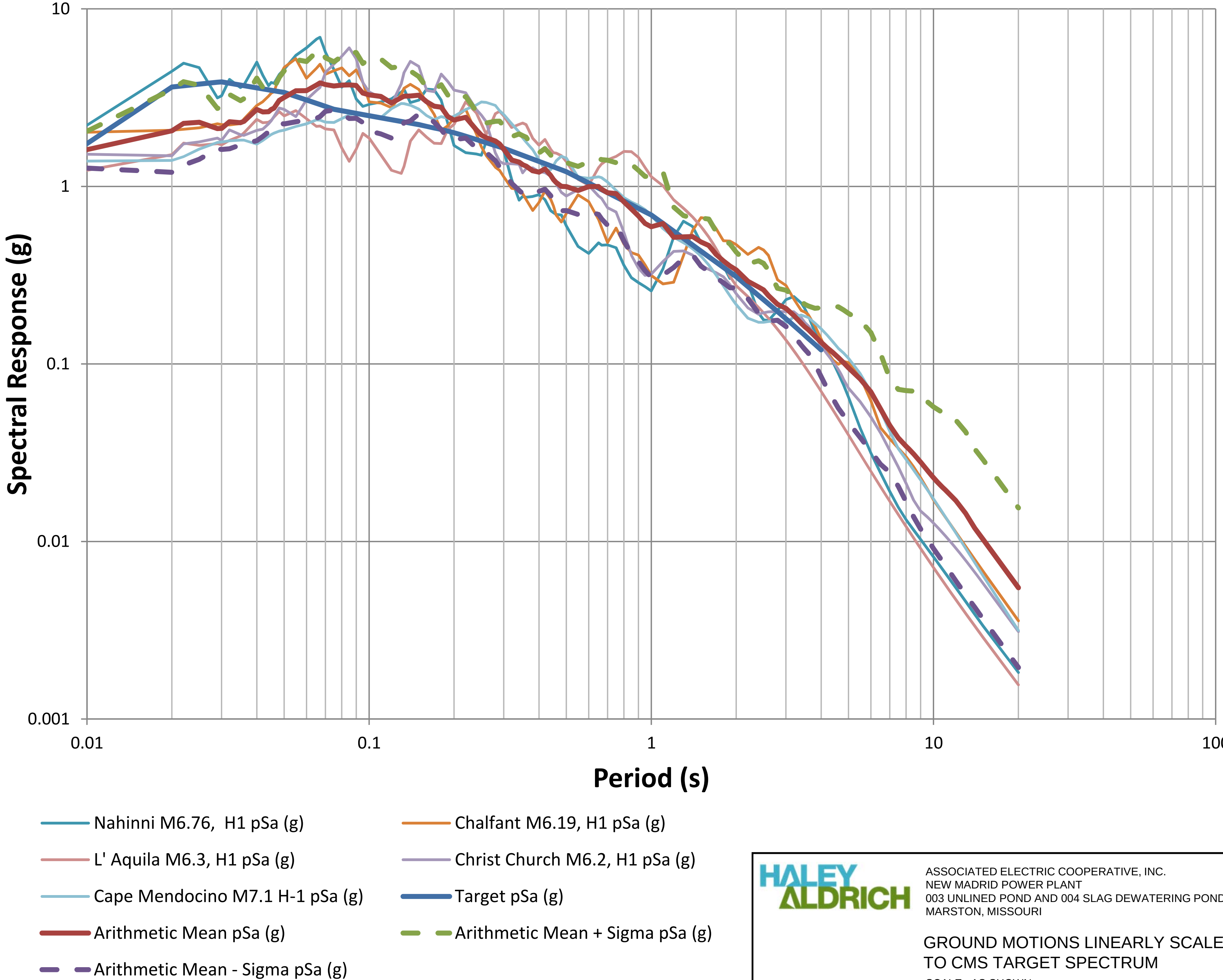
ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT
003 UNLINED POND AND 004 SLAG DEWATERING POND
MARSTON, MISSOURI

DETERMINISTIC CONDITIONAL MEAN SPECTRUM (CMS)

SCALE : AS SHOWN
FEBRUARY 2016

FIGURE D-3

40616-300_FIG D3.PPT



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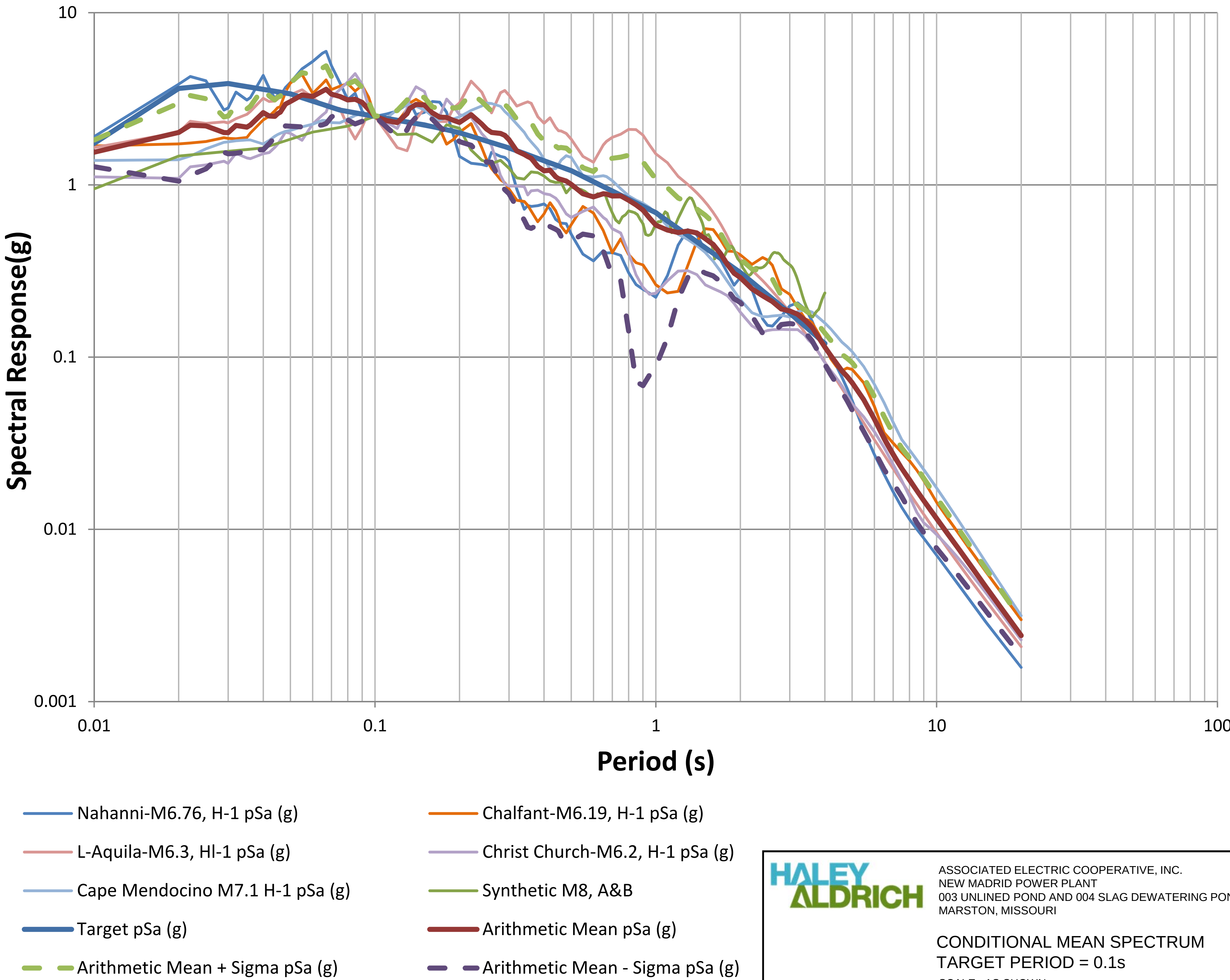
NEW MADRID POWER PLANT
003 UNLINED POND AND 004 SLAG DEWATERING POND
MARSTON, MISSOURI

GROUND MOTIONS LINEARLY SCALED TO CMS TARGET SPECTRUM

SCALE : AS SHOWN
FEBRUARY 2016

FIGURE D-4

40616-300_FIG D4.PPT



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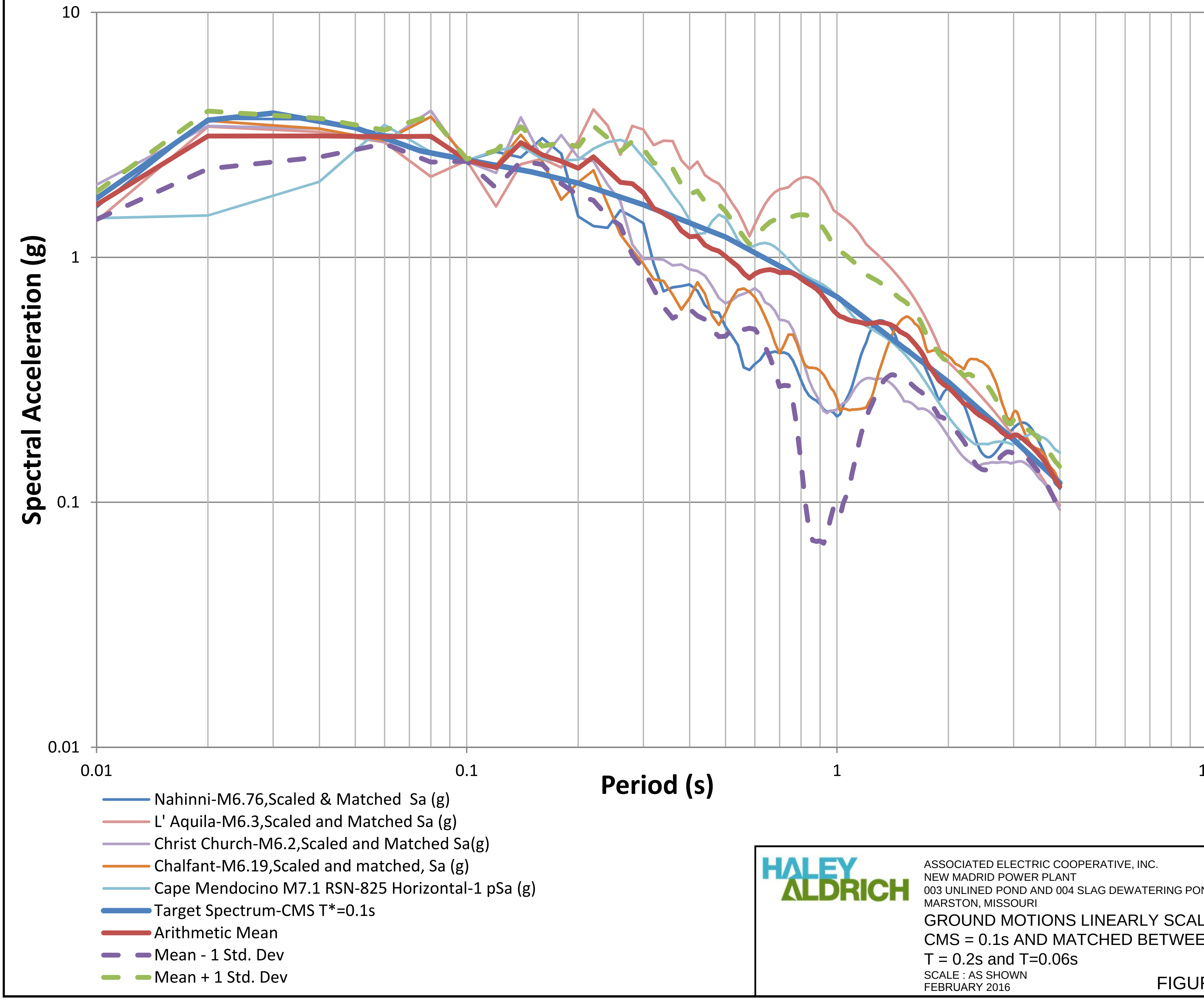
ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT
003 UNLINED POND AND 004 SLAG DEWATERING POND
MARSTON, MISSOURI

CONDITIONAL MEAN SPECTRUM
TARGET PERIOD = 0.1s

SCALE : AS SHOWN
FEBRUARY 2016

FIGURE D-5

40616-300_FIG D5.PPT



HALEY ALDRICH

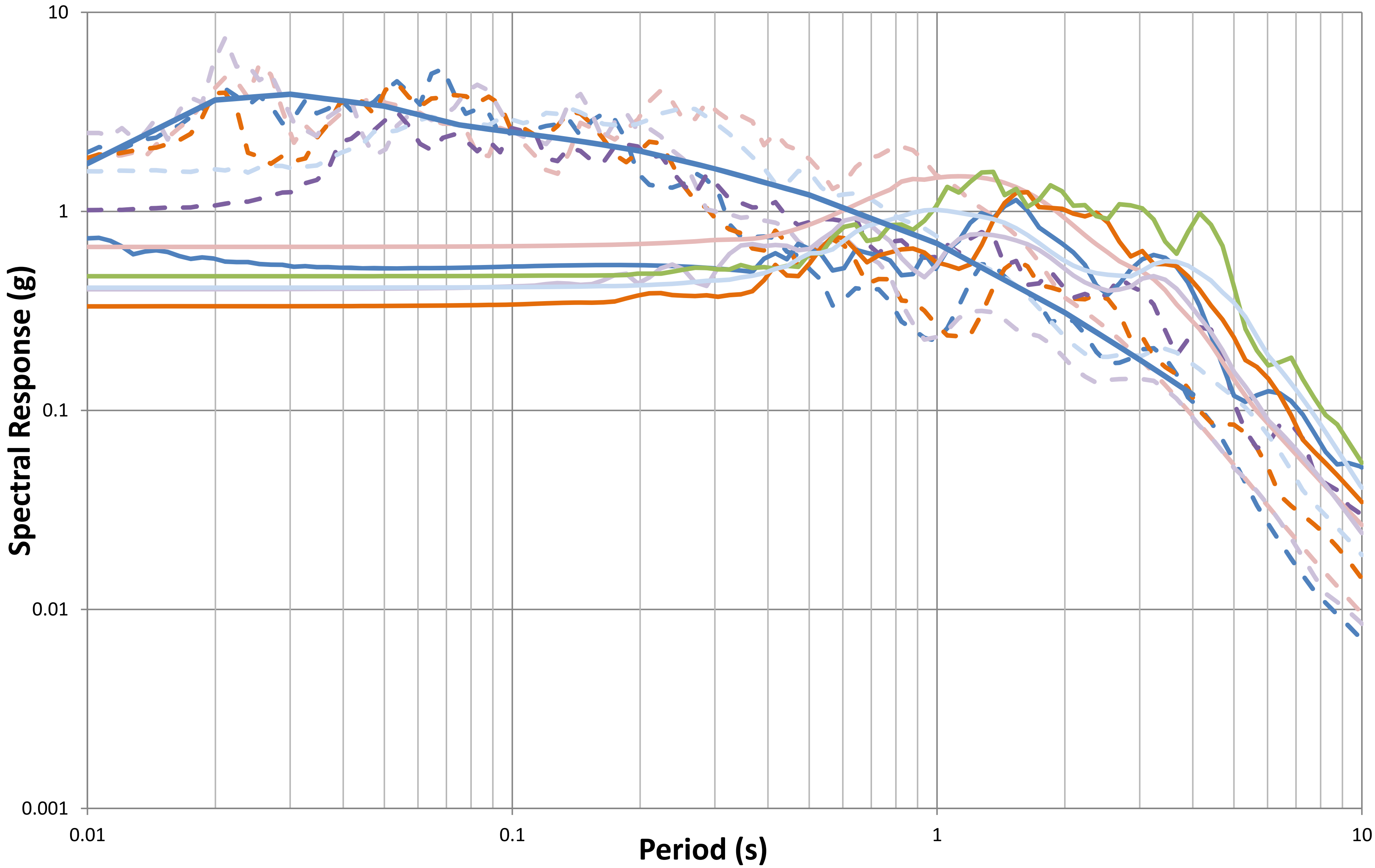
ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT
003 UNLINED POND AND 004 SLAG DEWATERING POND
MARSTON, MISSOURI

GROUND MOTIONS LINEARLY SCALED TO CMS = 0.1s AND MATCHED BETWEEN T = 0.2s and T=0.06s

SCALE : AS SHOWN
FEBRUARY 2016

FIGURE D-6

40616-300_FIG D6.PPT



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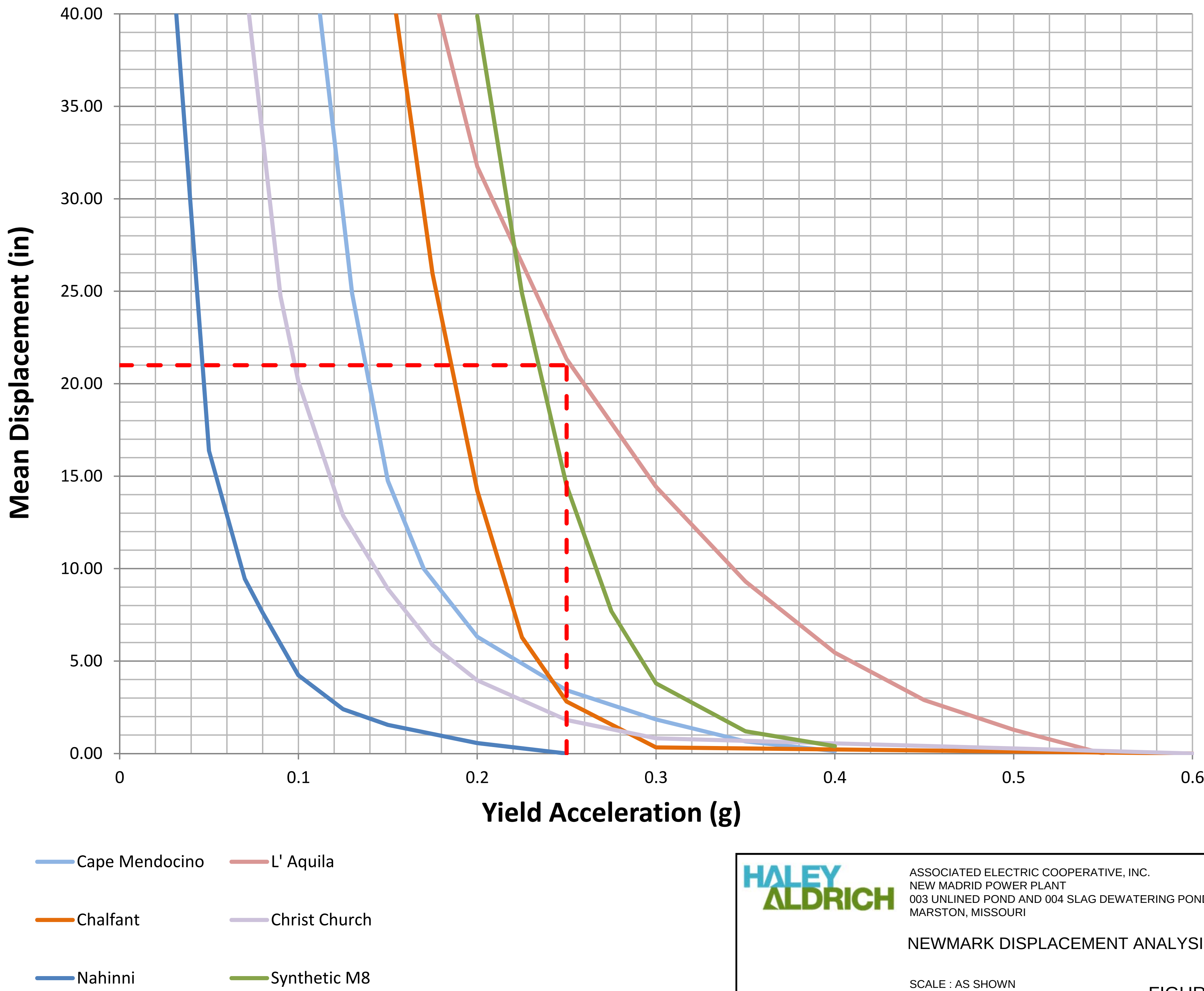
NEW MADRID POWER PLANT
003 UNLINED POND AND 004 SLAG DEWATERING POND
MARSTON, MISSOURI

MISSISSIPPI EMBAYMENT
BEDROCK vs SURFACE MOTIONS

SCALE : AS SHOWN
FEBRUARY 2016

FIGURE D-7

40616-300_FIG D7.PPT



HALEY ALDRICH

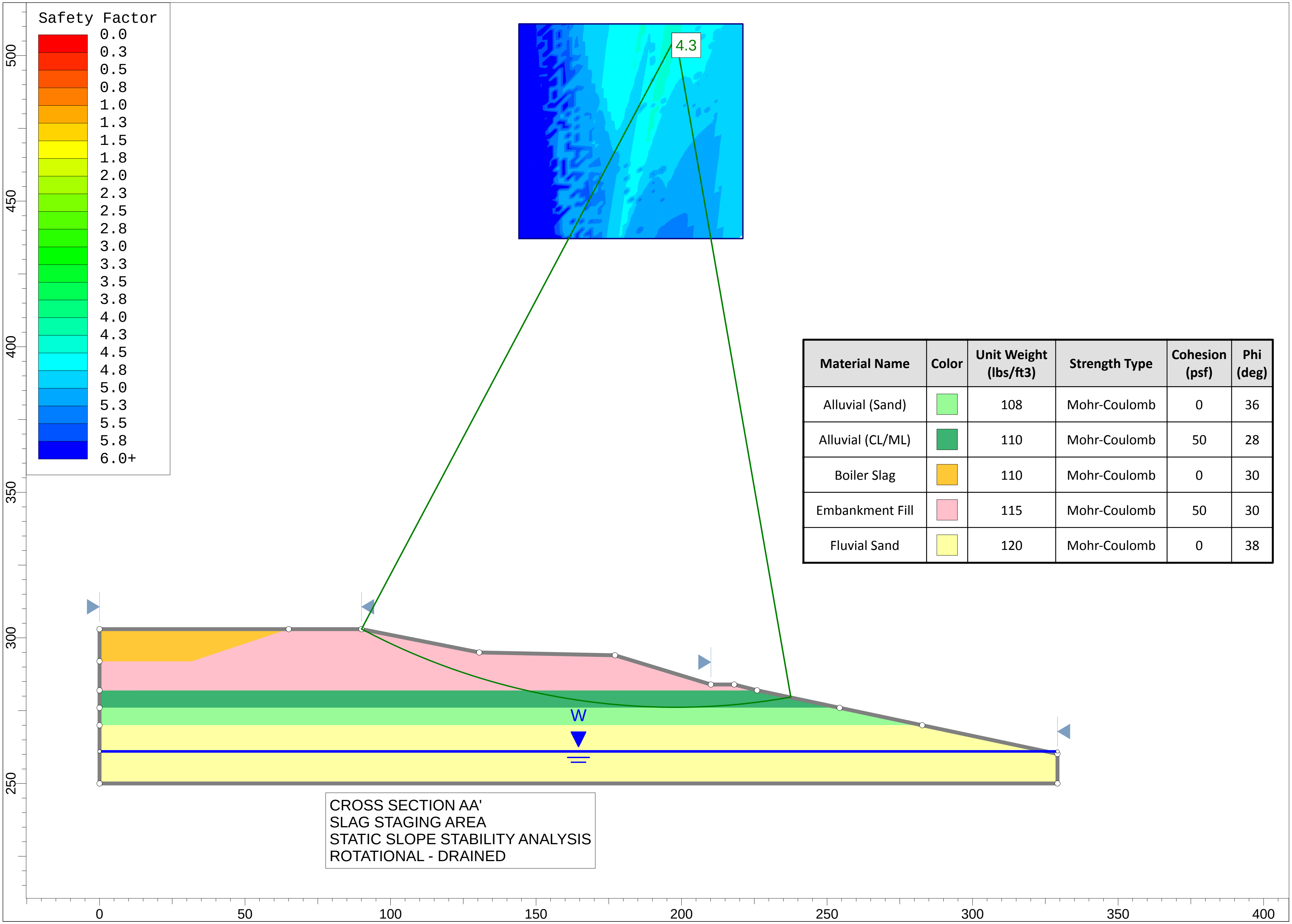
ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT
003 UNLINED POND AND 004 SLAG DEWATERING POND
MARSTON, MISSOURI

NEWMARK DISPLACEMENT ANALYSIS

SCALE : AS SHOWN
FEBRUARY 2016

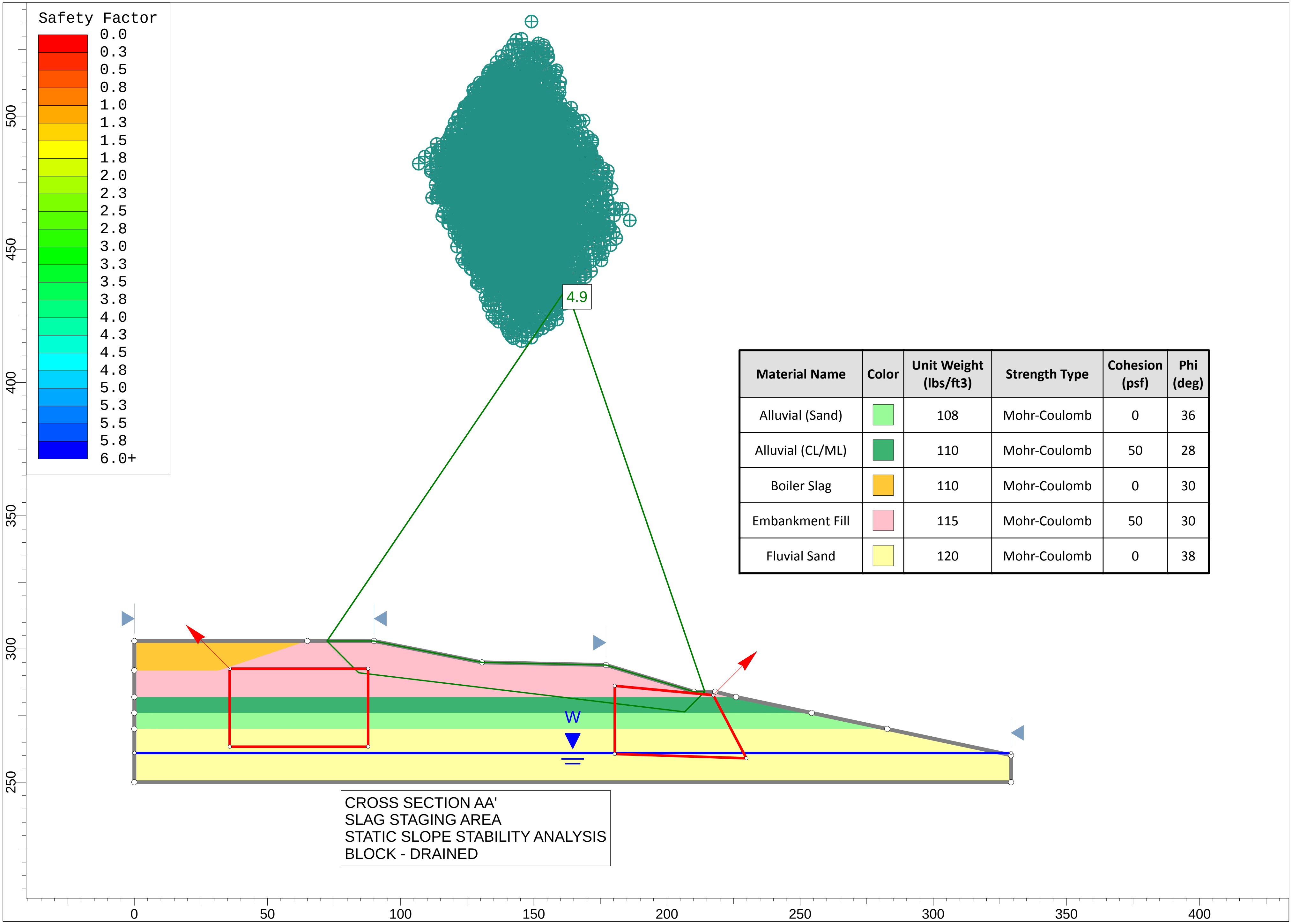
FIGURE D-8

40616-300_FIG D8.PPT

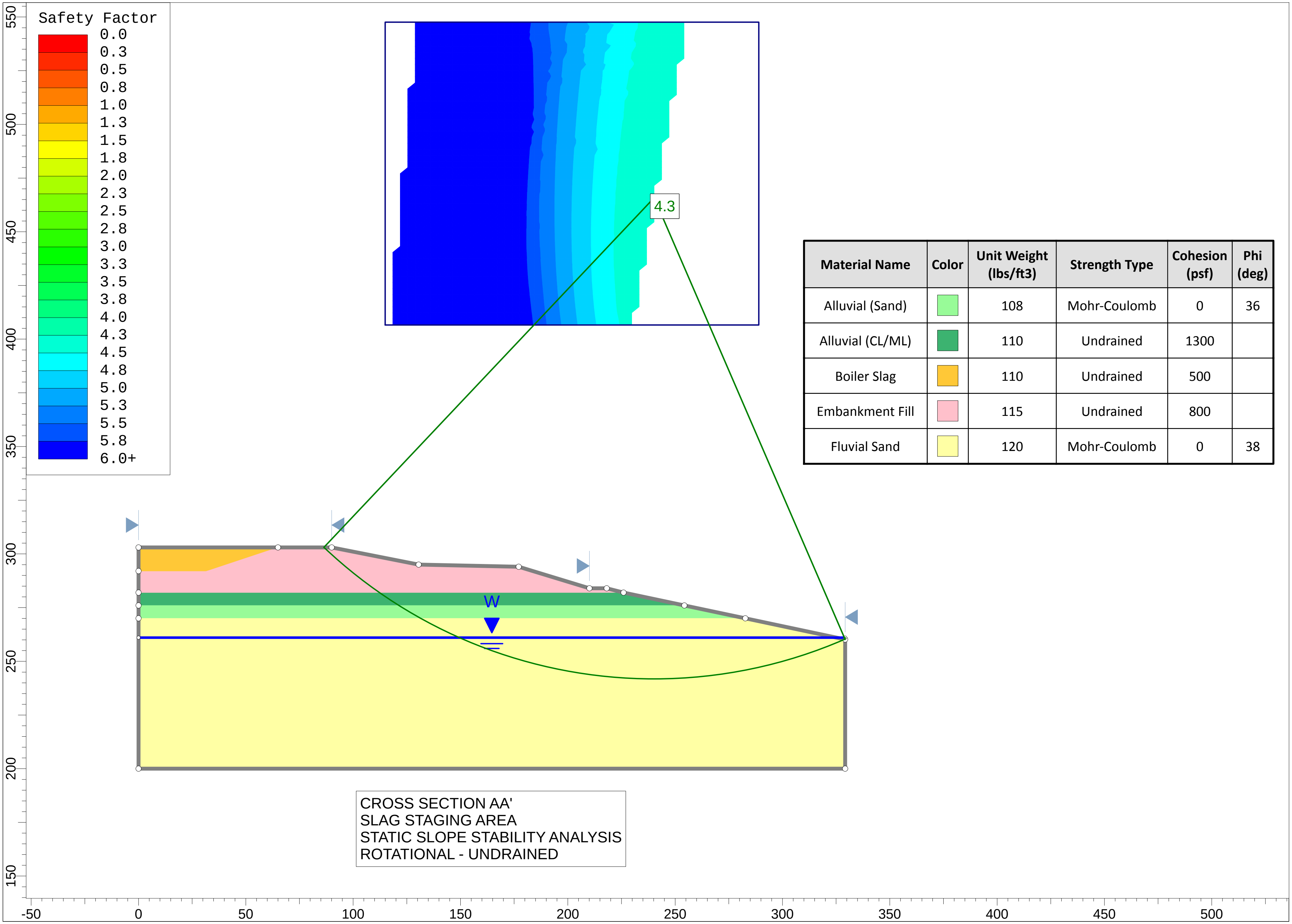


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	36
Alluvial (CL/ML)		110	Mohr-Coulomb	50	28
Boiler Slag		110	Mohr-Coulomb	0	30
Embankment Fill		115	Mohr-Coulomb	50	30
Fluvial Sand		120	Mohr-Coulomb	0	38

CROSS SECTION AA'
SLAG STAGING AREA
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - DRAINED

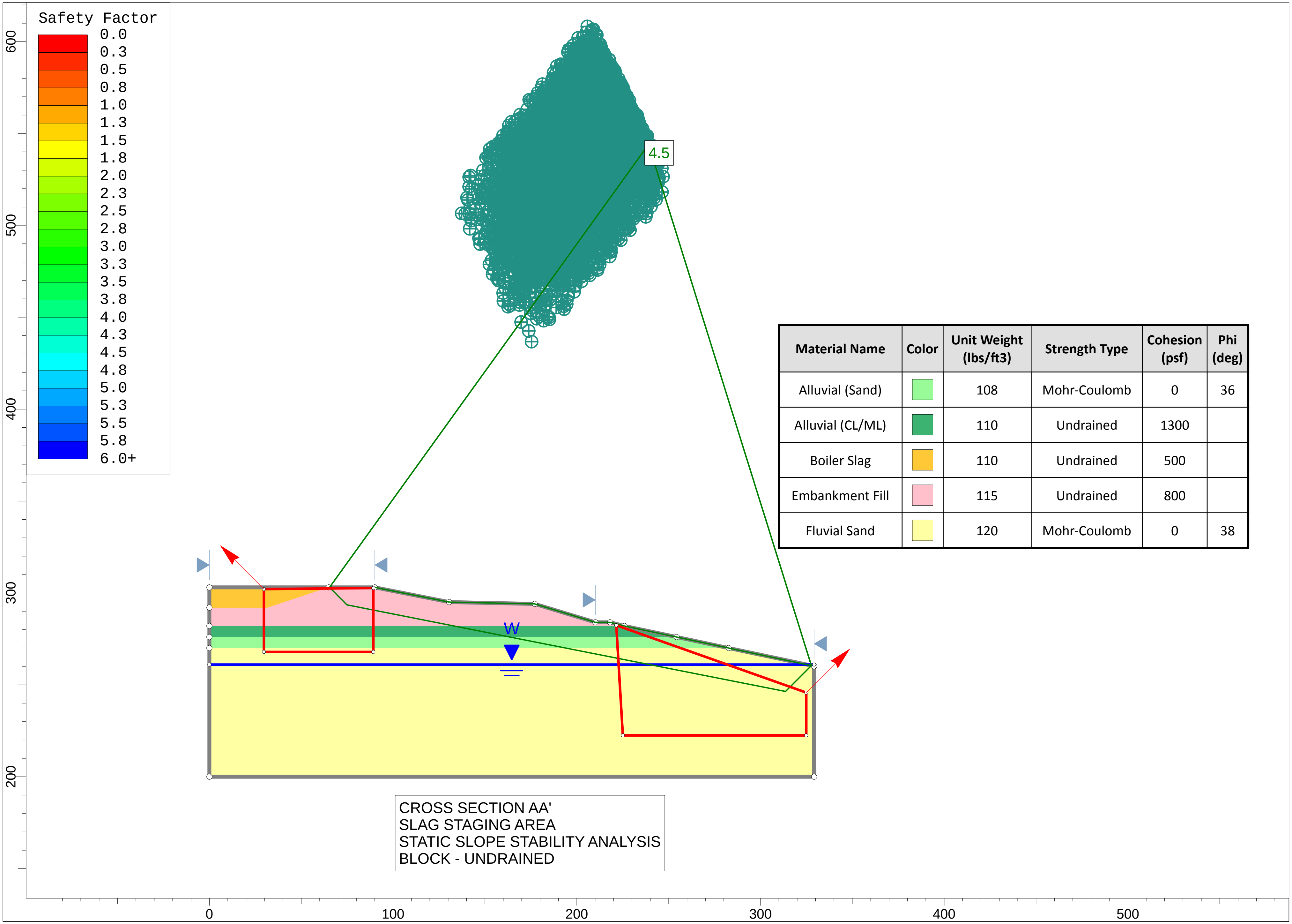


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	36
Alluvial (CL/ML)		110	Mohr-Coulomb	50	28
Boiler Slag		110	Mohr-Coulomb	0	30
Embankment Fill		115	Mohr-Coulomb	50	30
Fluvial Sand		120	Mohr-Coulomb	0	38



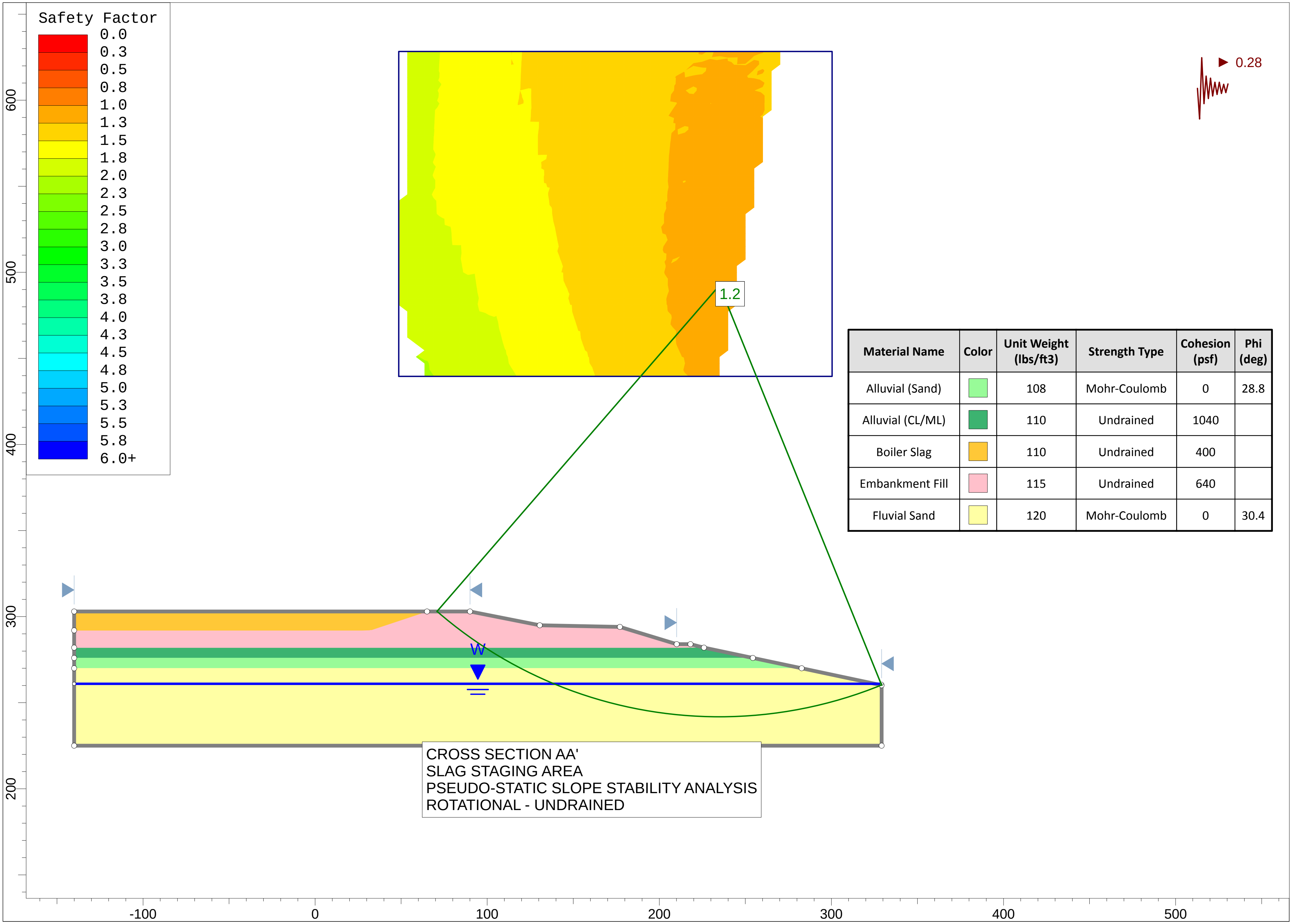
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	36
Alluvial (CL/ML)		110	Undrained	1300	
Boiler Slag		110	Undrained	500	
Embankment Fill		115	Undrained	800	
Fluvial Sand		120	Mohr-Coulomb	0	38

CROSS SECTION AA'
SLAG STAGING AREA
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



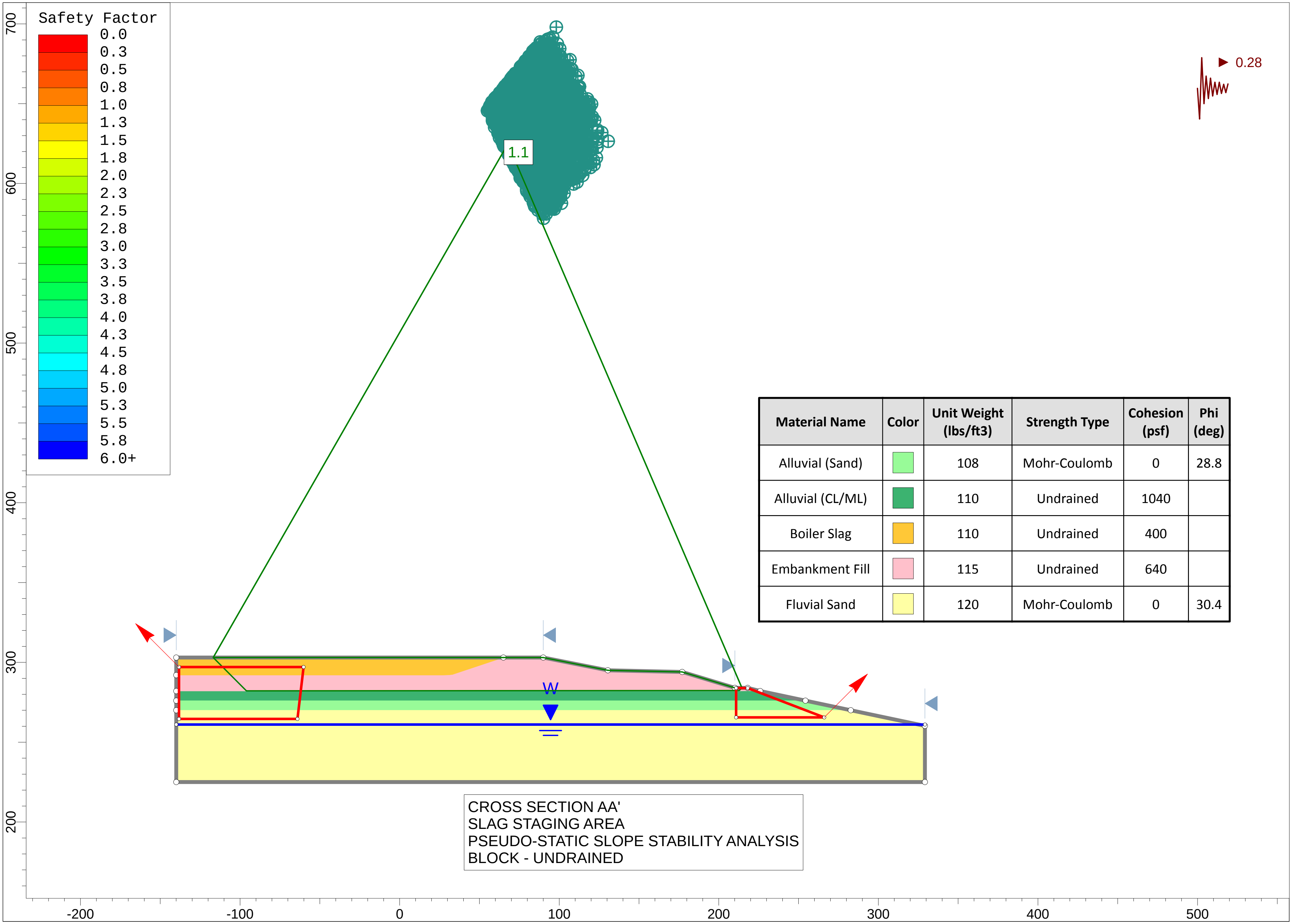
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	36
Alluvial (CL/ML)		110	Undrained	1300	
Boiler Slag		110	Undrained	500	
Embankment Fill		115	Undrained	800	
Fluvial Sand		120	Mohr-Coulomb	0	38

CROSS SECTION AA'
SLAG STAGING AREA
STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED



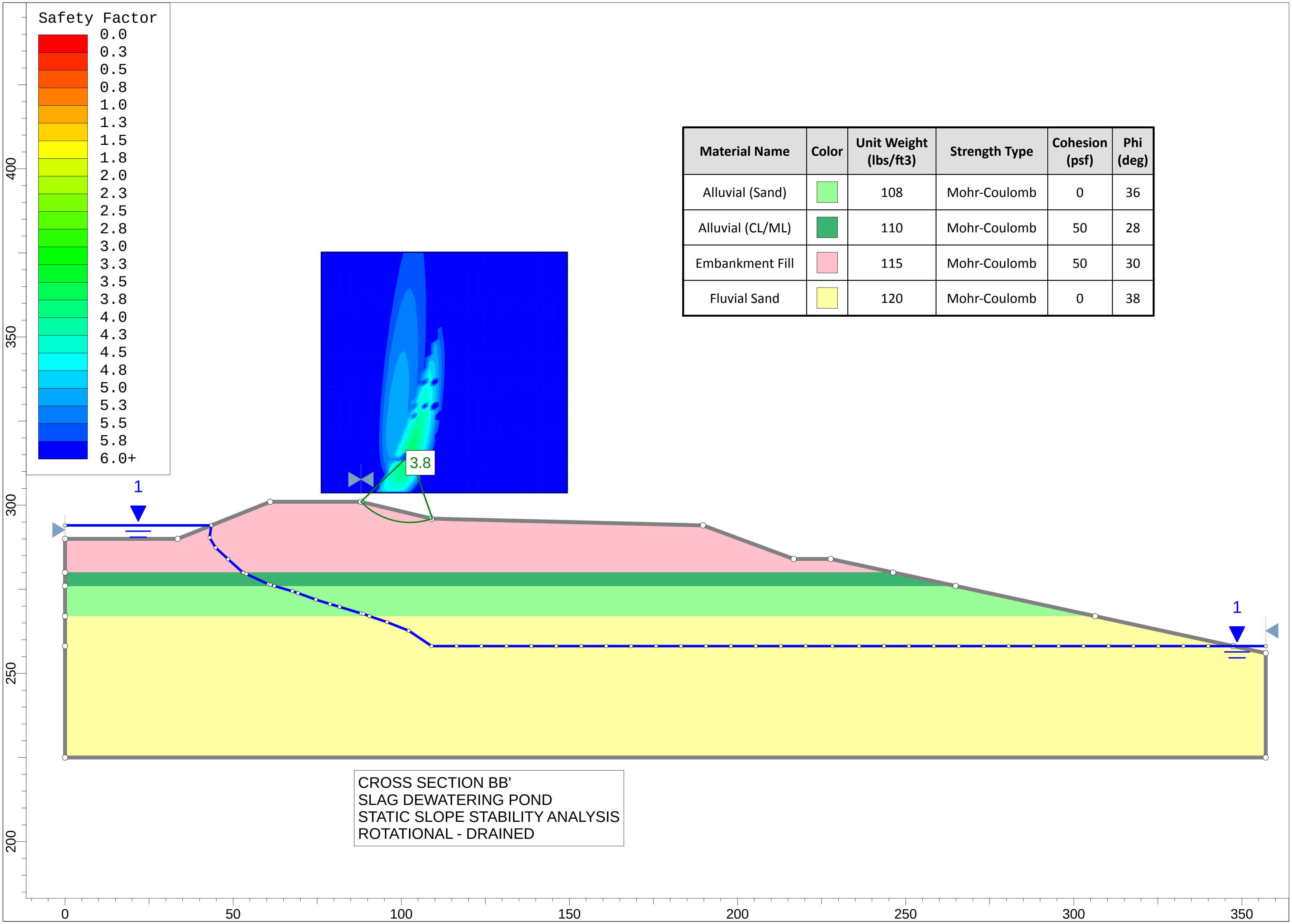
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	28.8
Alluvial (CL/ML)		110	Undrained	1040	
Boiler Slag		110	Undrained	400	
Embankment Fill		115	Undrained	640	
Fluvial Sand		120	Mohr-Coulomb	0	30.4

CROSS SECTION AA'
SLAG STAGING AREA
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED

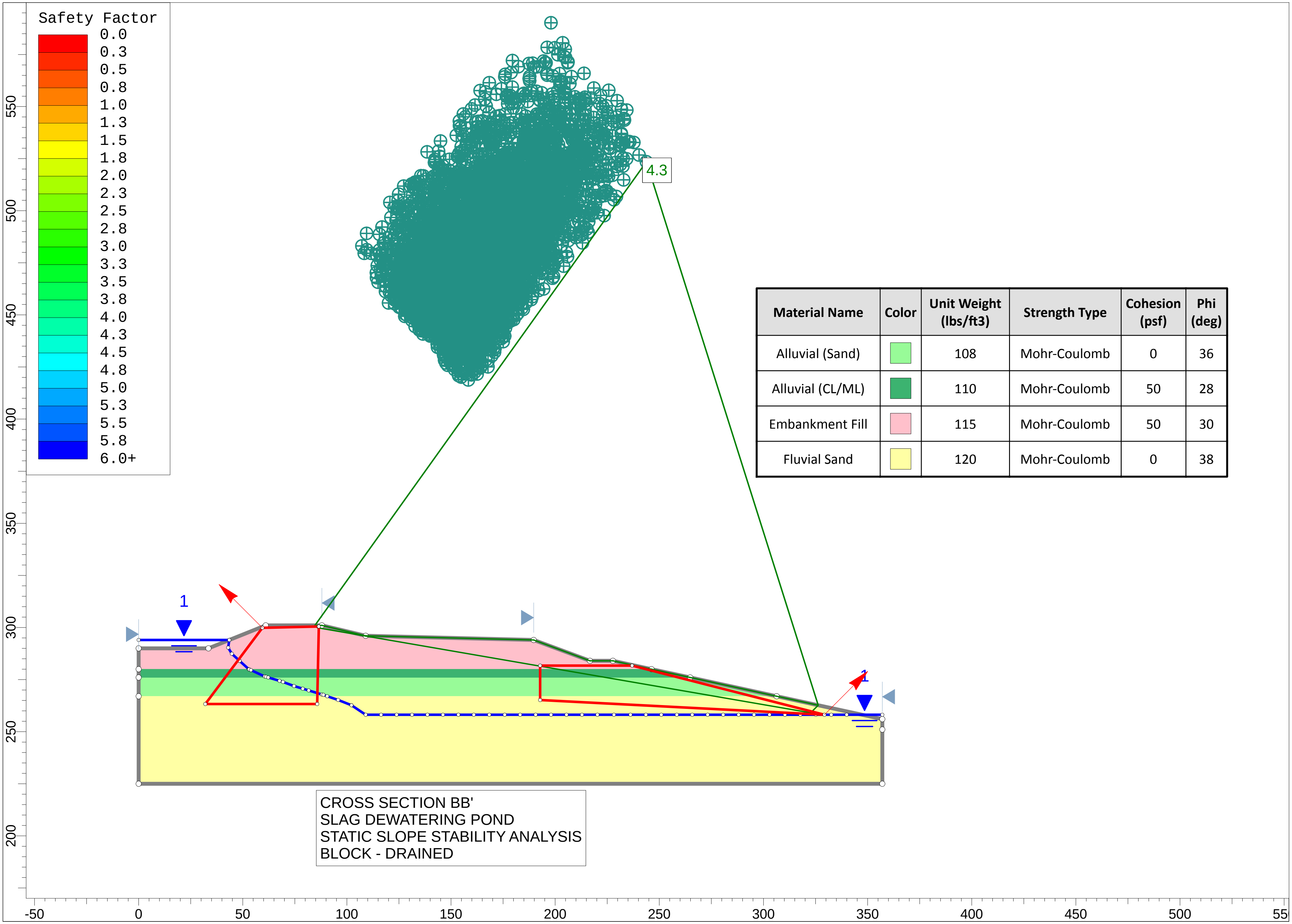


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	28.8
Alluvial (CL/ML)		110	Undrained	1040	
Boiler Slag		110	Undrained	400	
Embankment Fill		115	Undrained	640	
Fluvial Sand		120	Mohr-Coulomb	0	30.4

CROSS SECTION AA'
SLAG STAGING AREA
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED

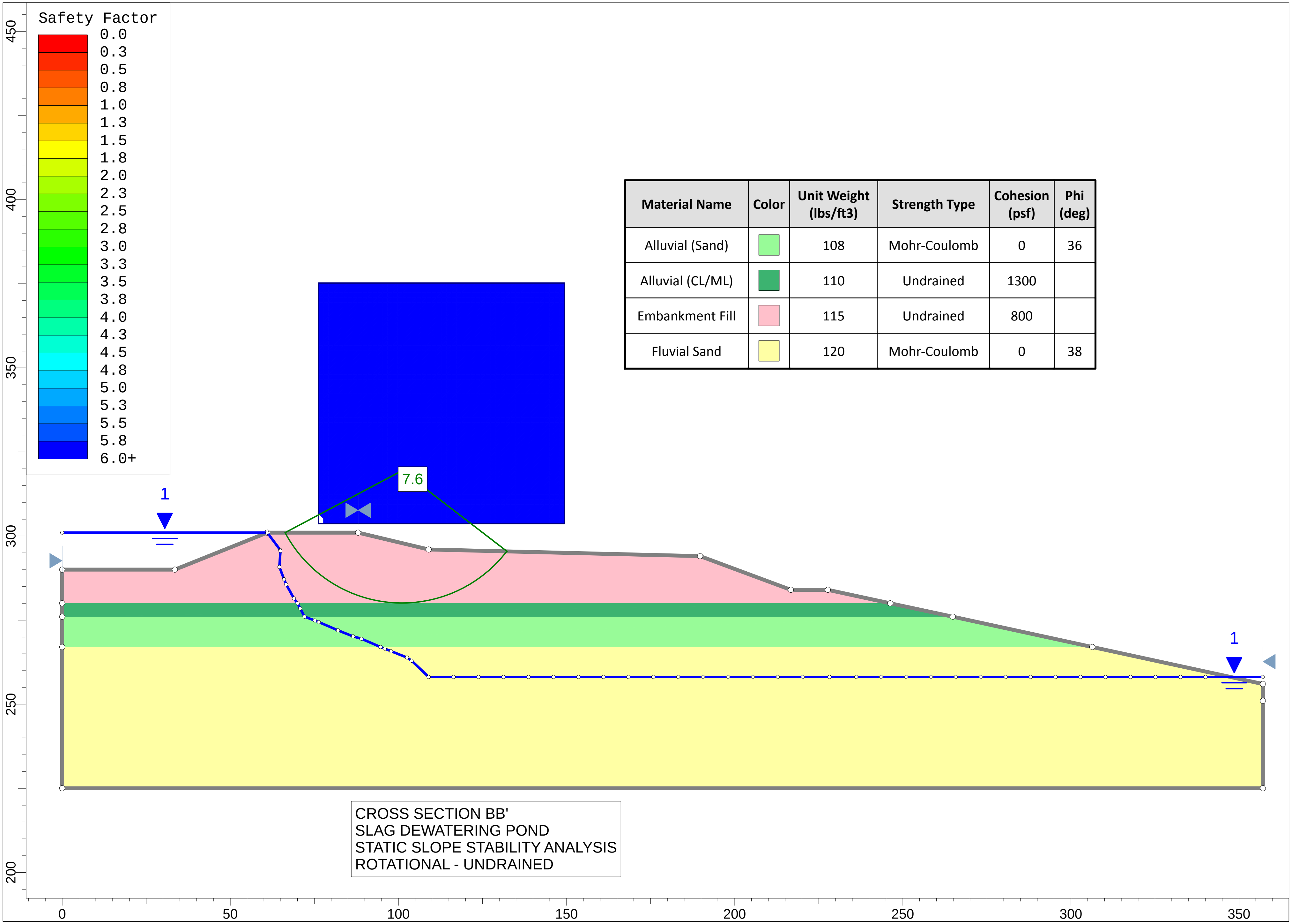


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	36
Alluvial (CL/ML)		110	Mohr-Coulomb	50	28
Embankment Fill		115	Mohr-Coulomb	50	30
Fluvial Sand		120	Mohr-Coulomb	0	38

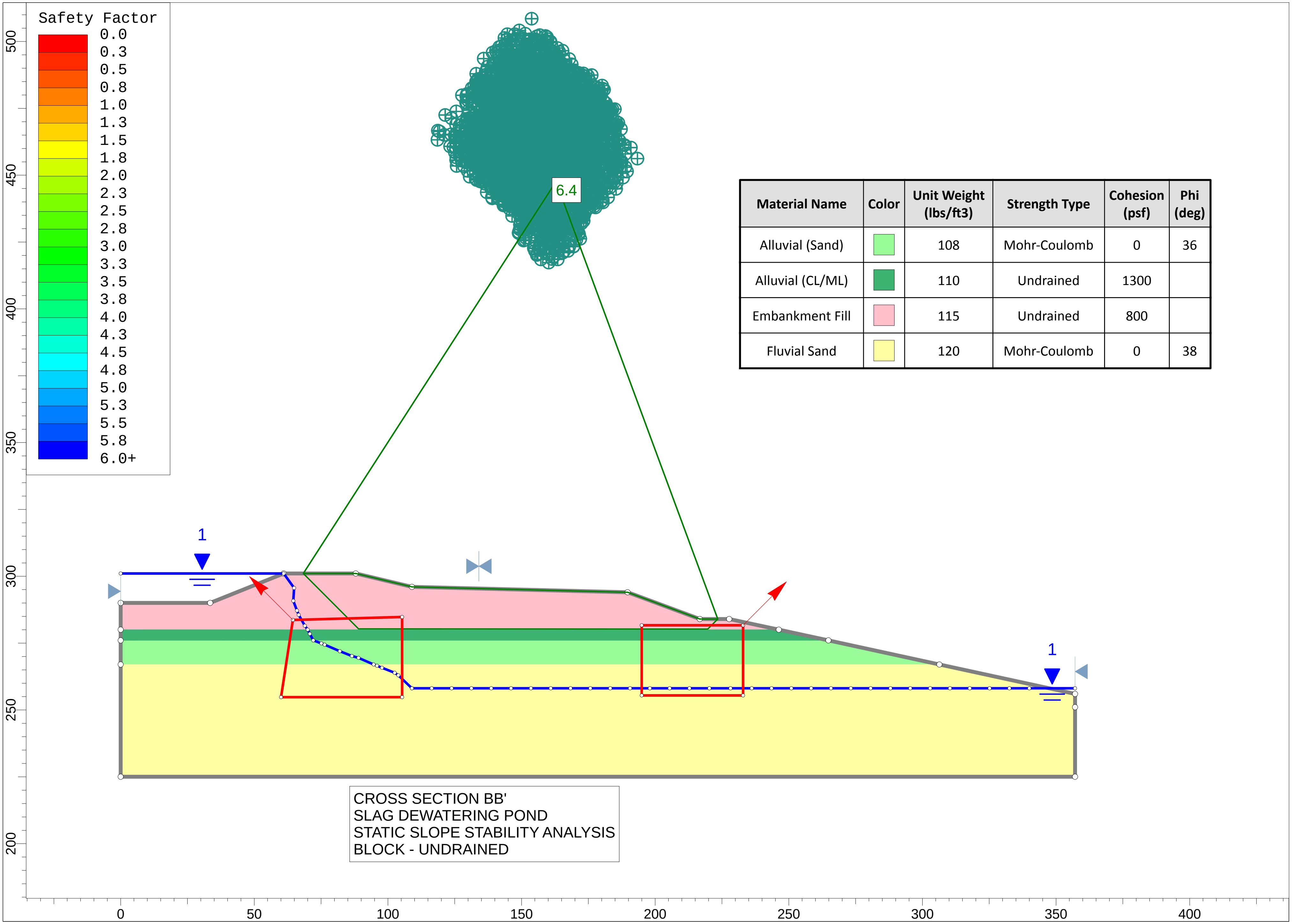


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	36
Alluvial (CL/ML)		110	Mohr-Coulomb	50	28
Embankment Fill		115	Mohr-Coulomb	50	30
Fluvial Sand		120	Mohr-Coulomb	0	38

CROSS SECTION BB'
SLAG DEWATERING POND
STATIC SLOPE STABILITY ANALYSIS
BLOCK - DRAINED

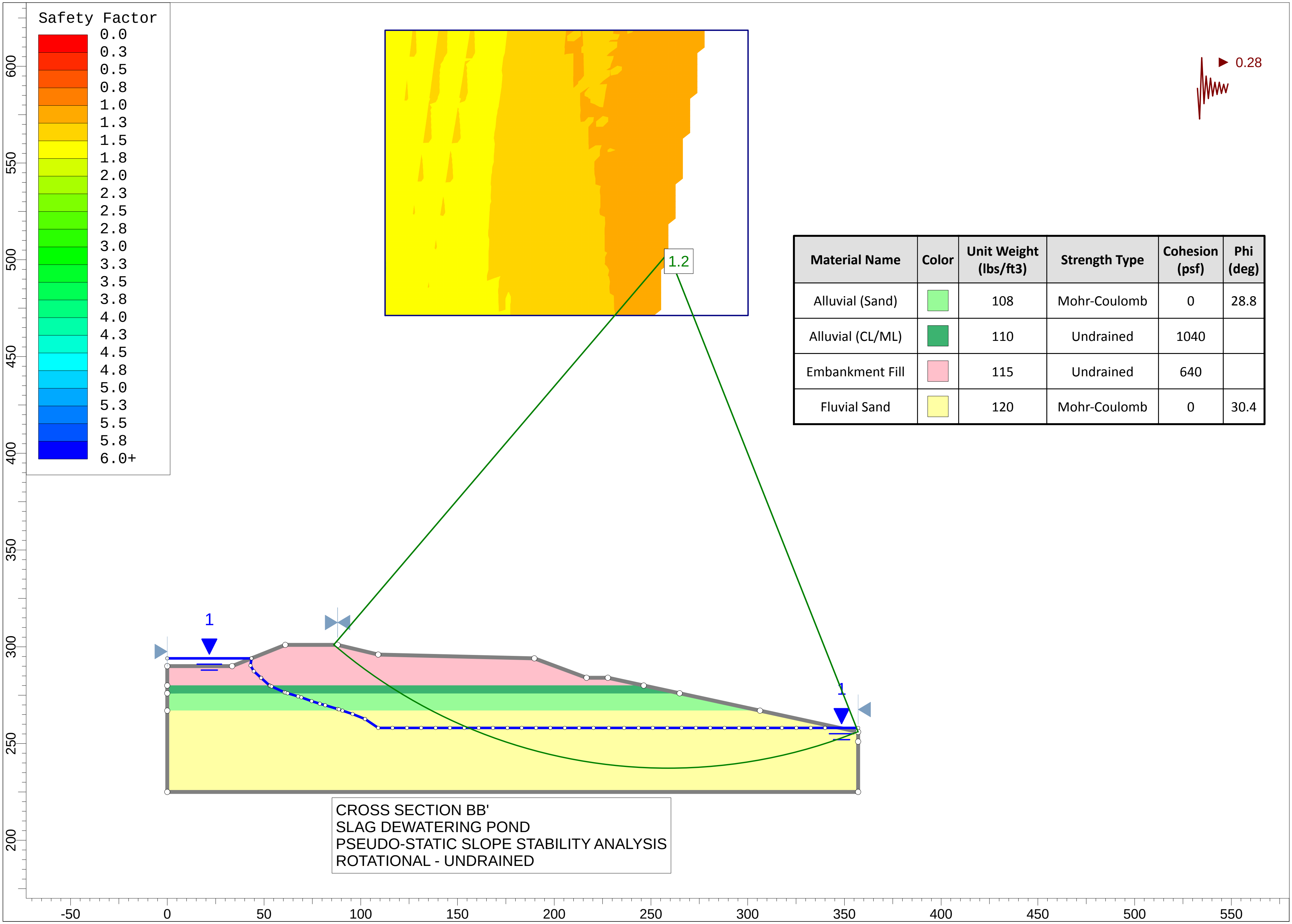


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	36
Alluvial (CL/ML)		110	Undrained	1300	
Embankment Fill		115	Undrained	800	
Fluvial Sand		120	Mohr-Coulomb	0	38



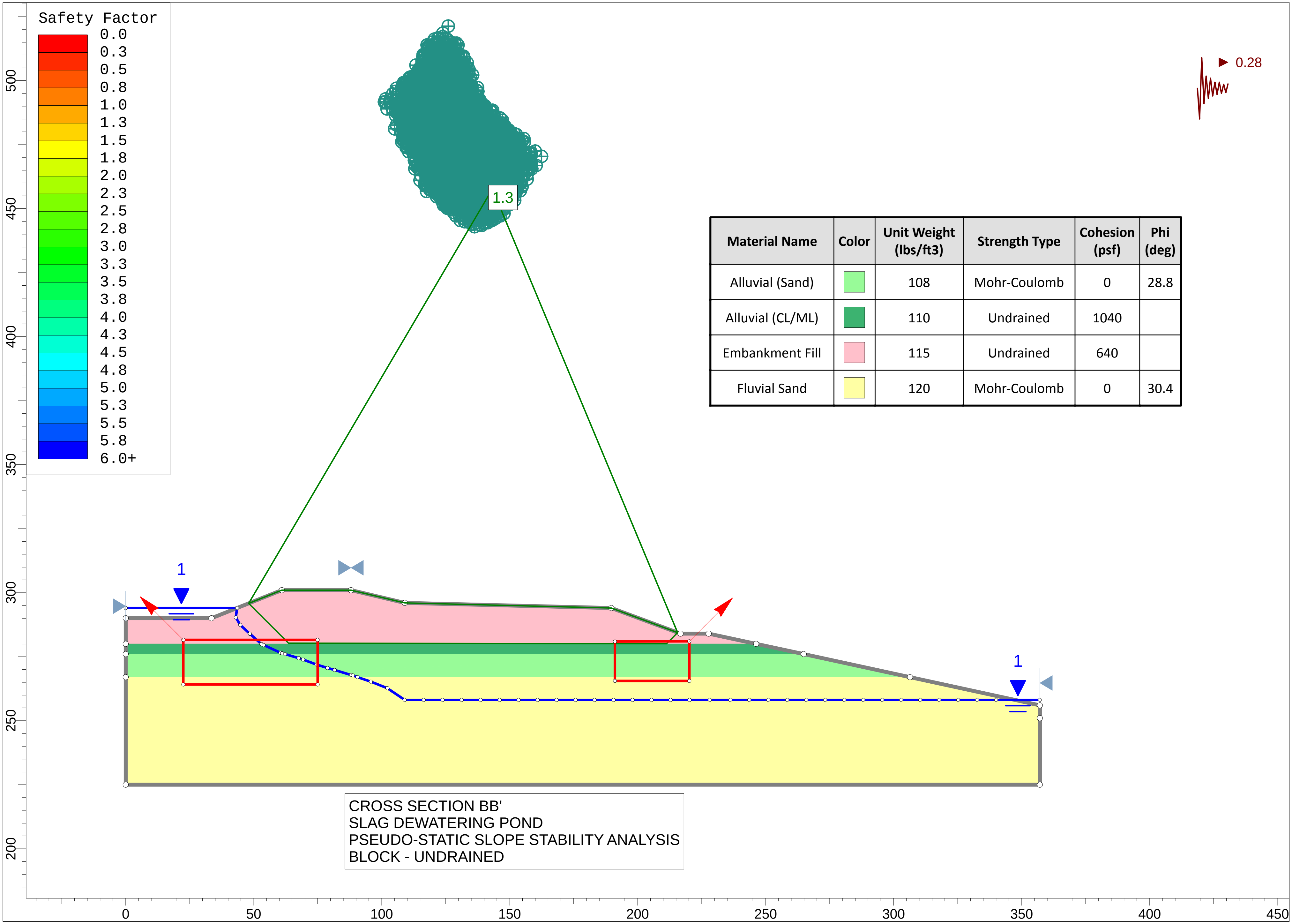
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	36
Alluvial (CL/ML)		110	Undrained	1300	
Embankment Fill		115	Undrained	800	
Fluvial Sand		120	Mohr-Coulomb	0	38

CROSS SECTION BB'
SLAG DEWATERING POND
STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED



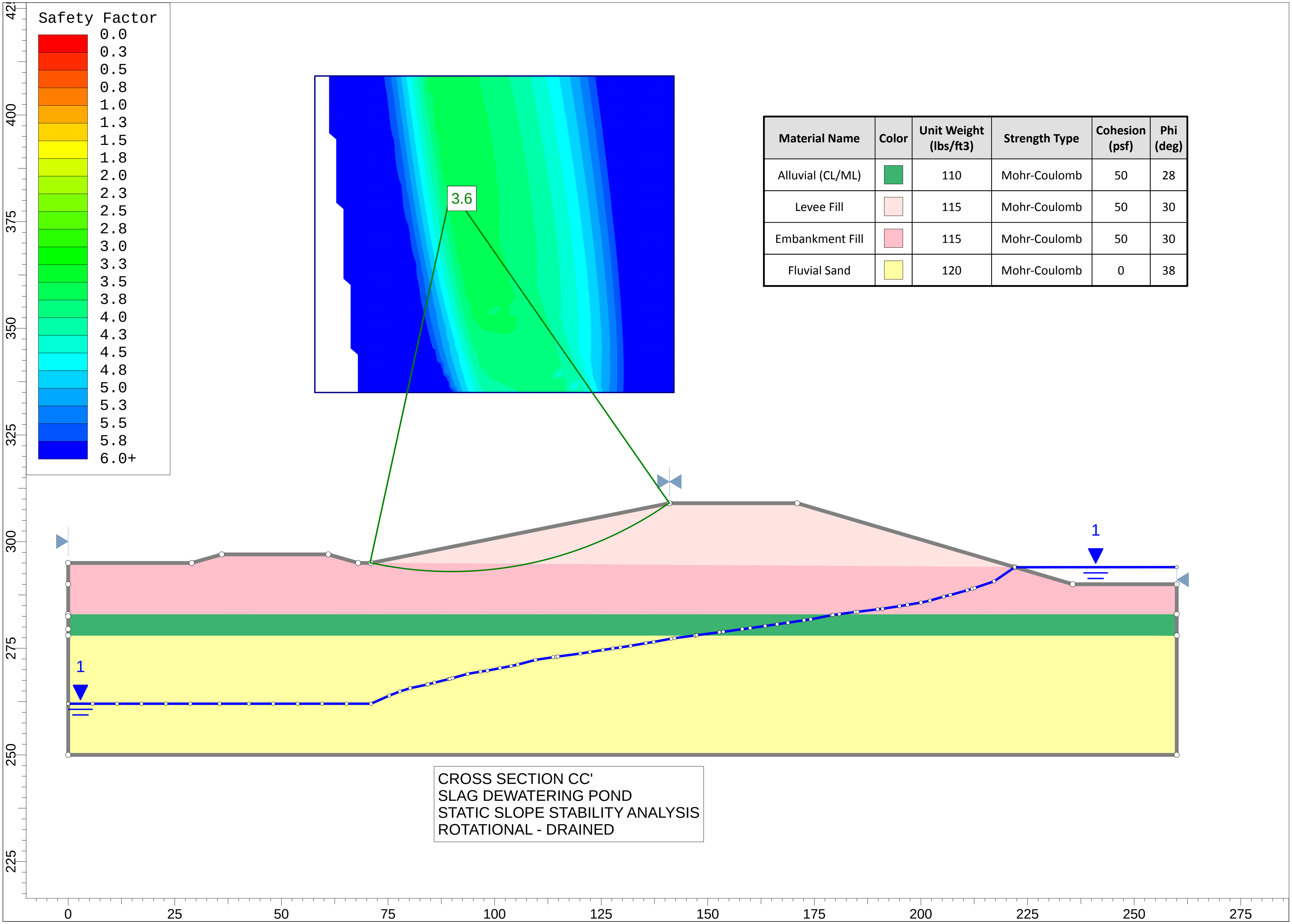
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	28.8
Alluvial (CL/ML)		110	Undrained	1040	
Embankment Fill		115	Undrained	640	
Fluvial Sand		120	Mohr-Coulomb	0	30.4

CROSS SECTION BB'
SLAG DEWATERING POND
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED

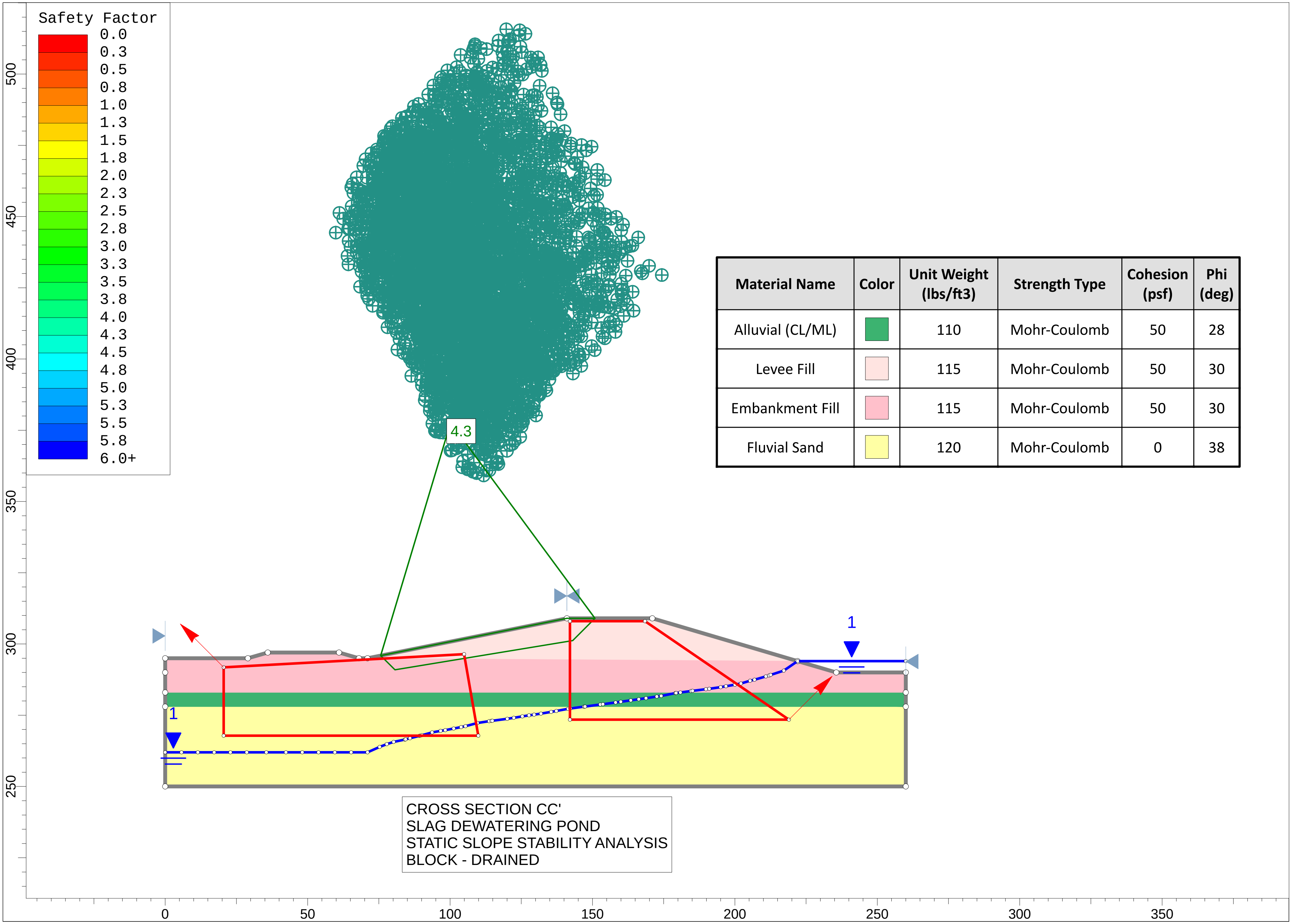


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	28.8
Alluvial (CL/ML)		110	Undrained	1040	
Embankment Fill		115	Undrained	640	
Fluvial Sand		120	Mohr-Coulomb	0	30.4

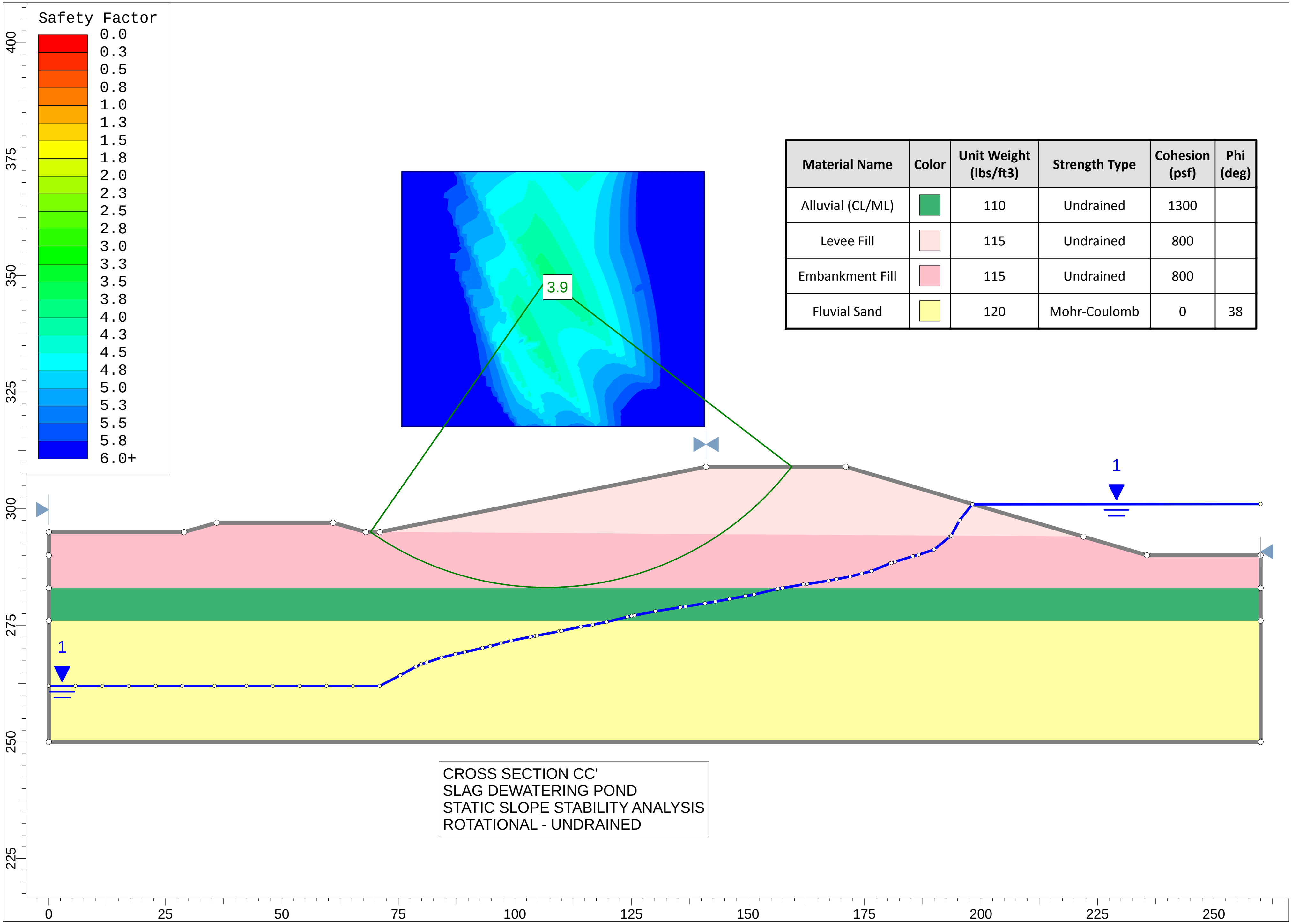
CROSS SECTION BB'
SLAG DEWATERING POND
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED



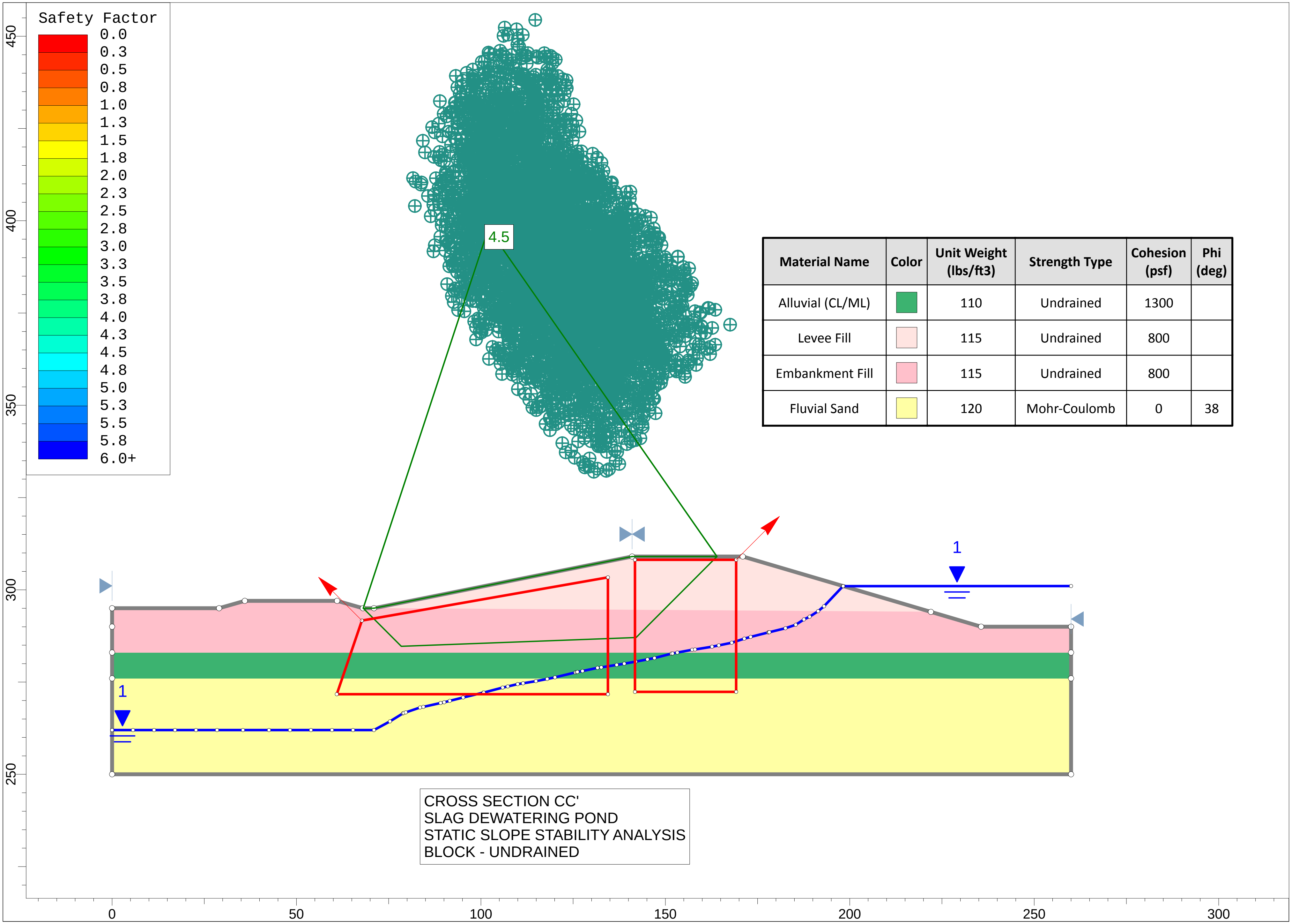
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (CL/ML)		110	Mohr-Coulomb	50	28
Levee Fill		115	Mohr-Coulomb	50	30
Embankment Fill		115	Mohr-Coulomb	50	30
Fluvial Sand		120	Mohr-Coulomb	0	38



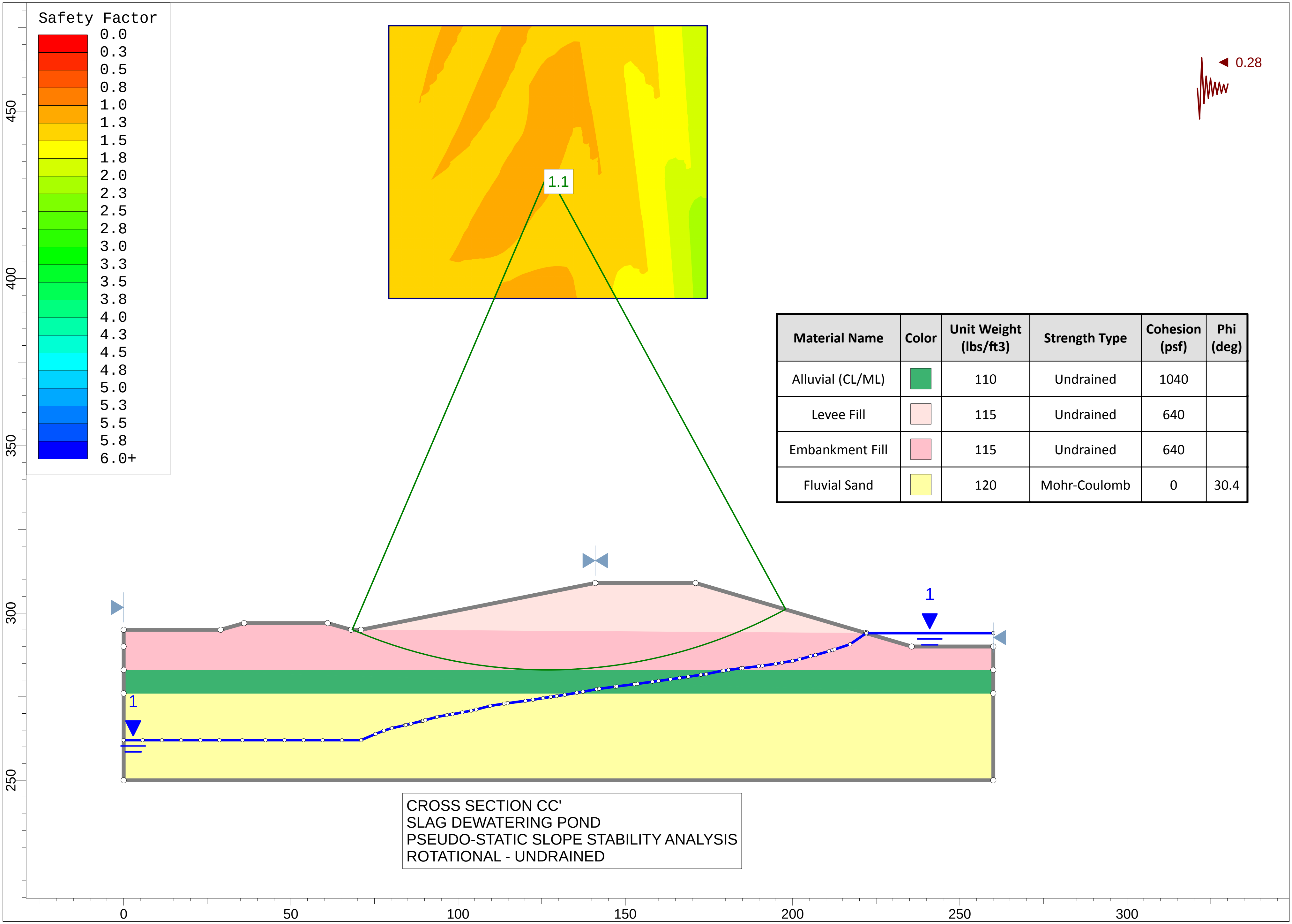
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (CL/ML)		110	Mohr-Coulomb	50	28
Levee Fill		115	Mohr-Coulomb	50	30
Embankment Fill		115	Mohr-Coulomb	50	30
Fluvial Sand		120	Mohr-Coulomb	0	38



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (CL/ML)		110	Undrained	1300	
Levee Fill		115	Undrained	800	
Embankment Fill		115	Undrained	800	
Fluvial Sand		120	Mohr-Coulomb	0	38

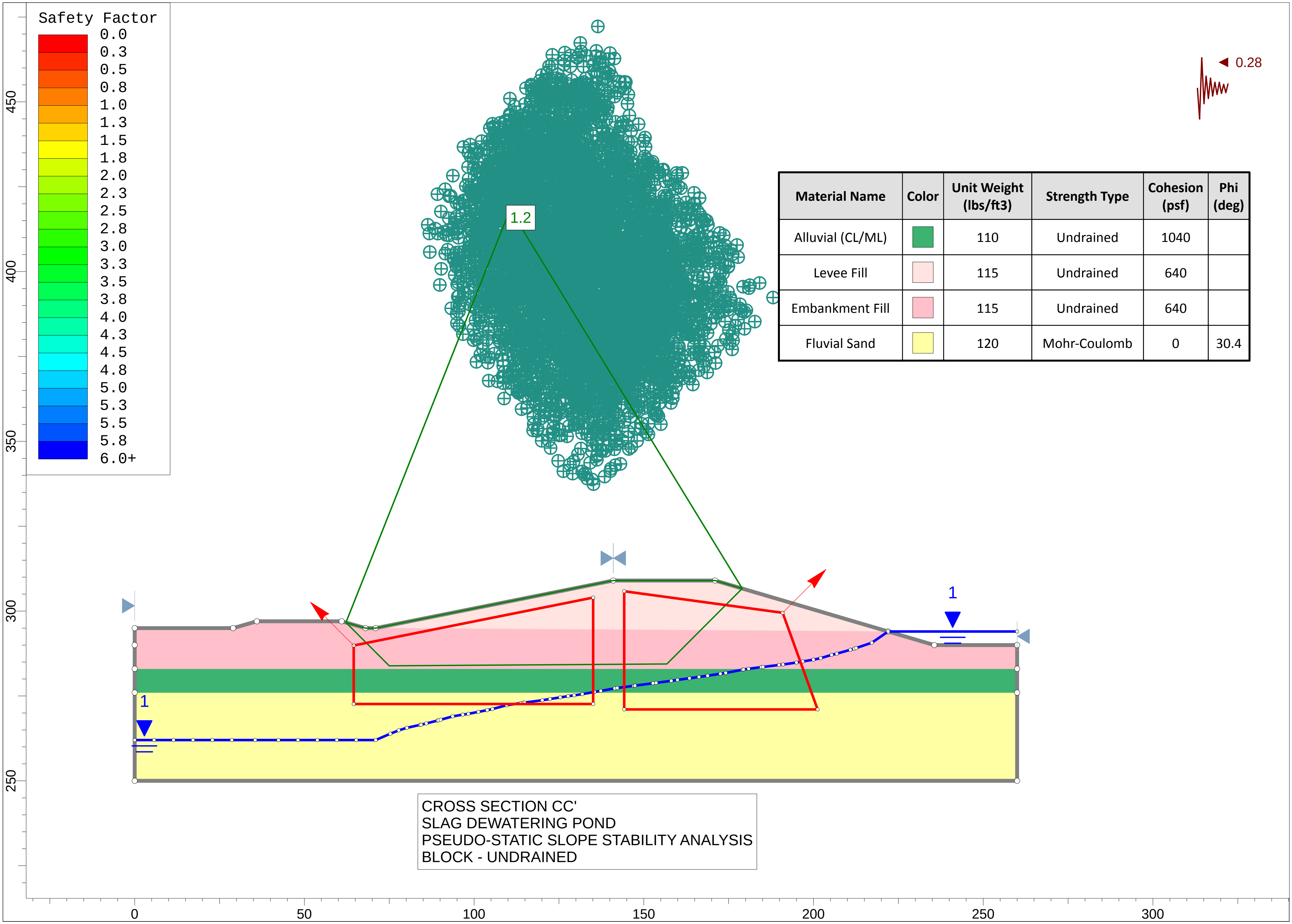


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (CL/ML)		110	Undrained	1300	
Levee Fill		115	Undrained	800	
Embankment Fill		115	Undrained	800	
Fluvial Sand		120	Mohr-Coulomb	0	38

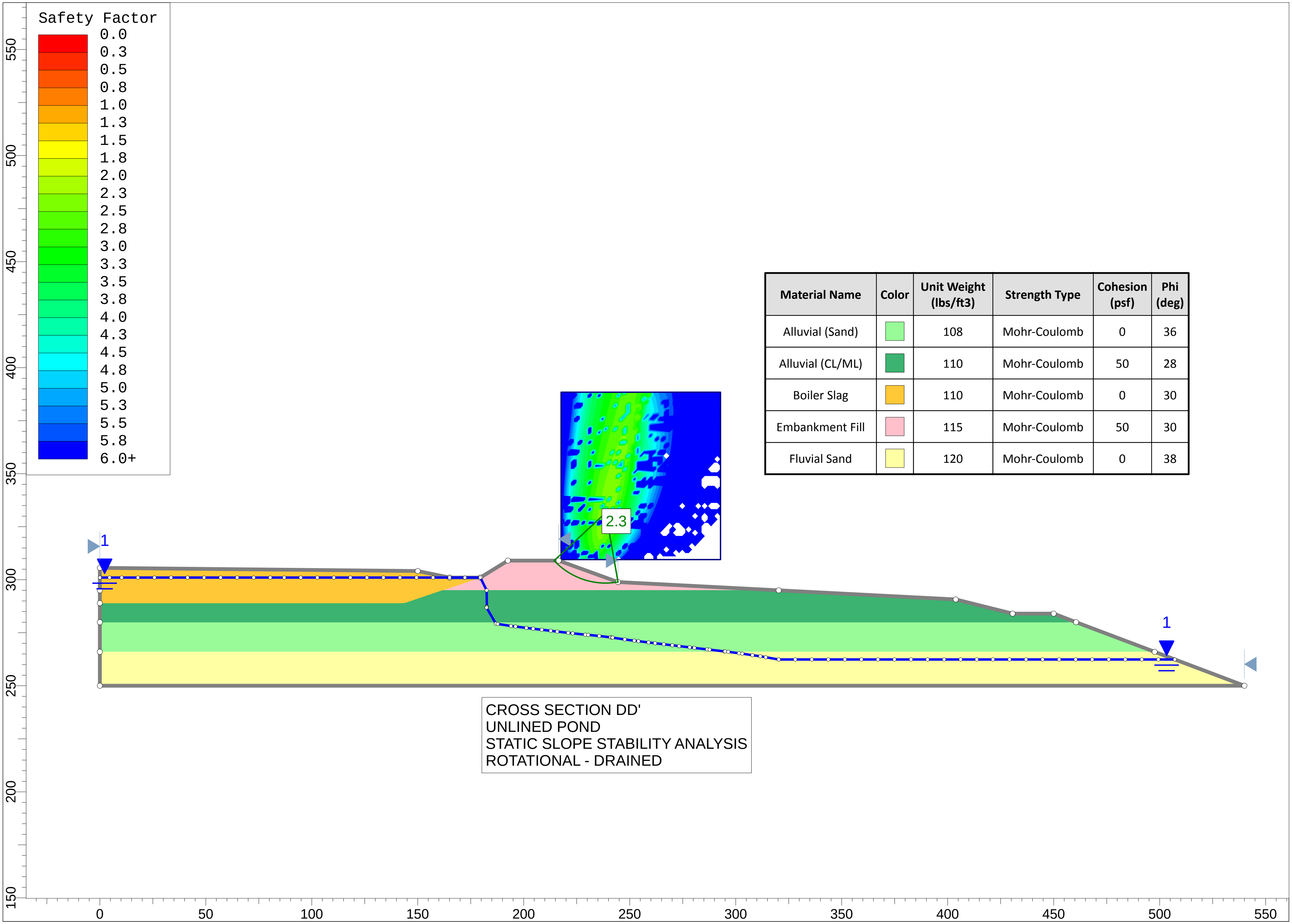


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (CL/ML)		110	Undrained	1040	
Levee Fill		115	Undrained	640	
Embankment Fill		115	Undrained	640	
Fluvial Sand		120	Mohr-Coulomb	0	30.4

CROSS SECTION CC'
SLAG DEWATERING POND
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED

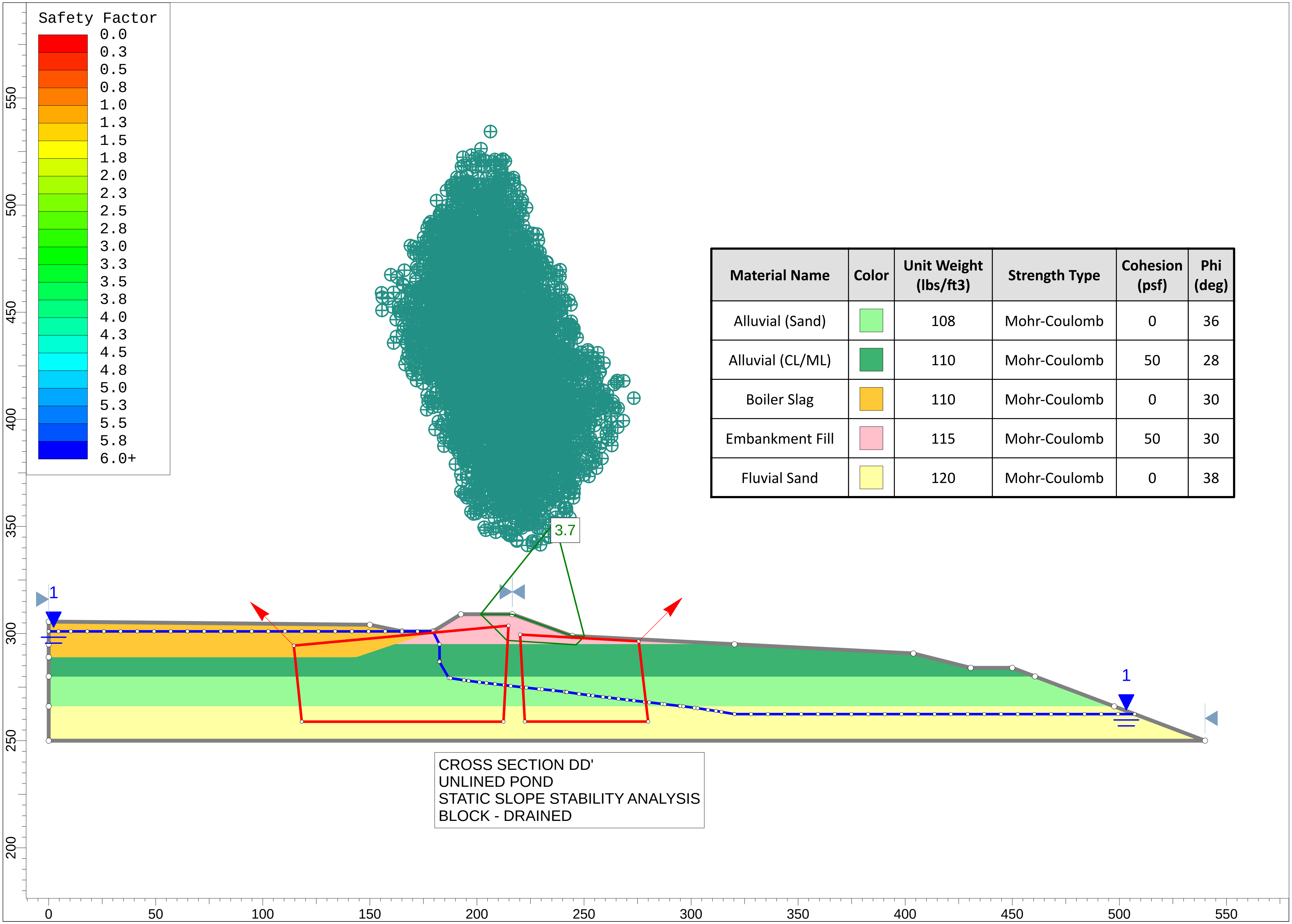


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (CL/ML)		110	Undrained	1040	
Levee Fill		115	Undrained	640	
Embankment Fill		115	Undrained	640	
Fluvial Sand		120	Mohr-Coulomb	0	30.4



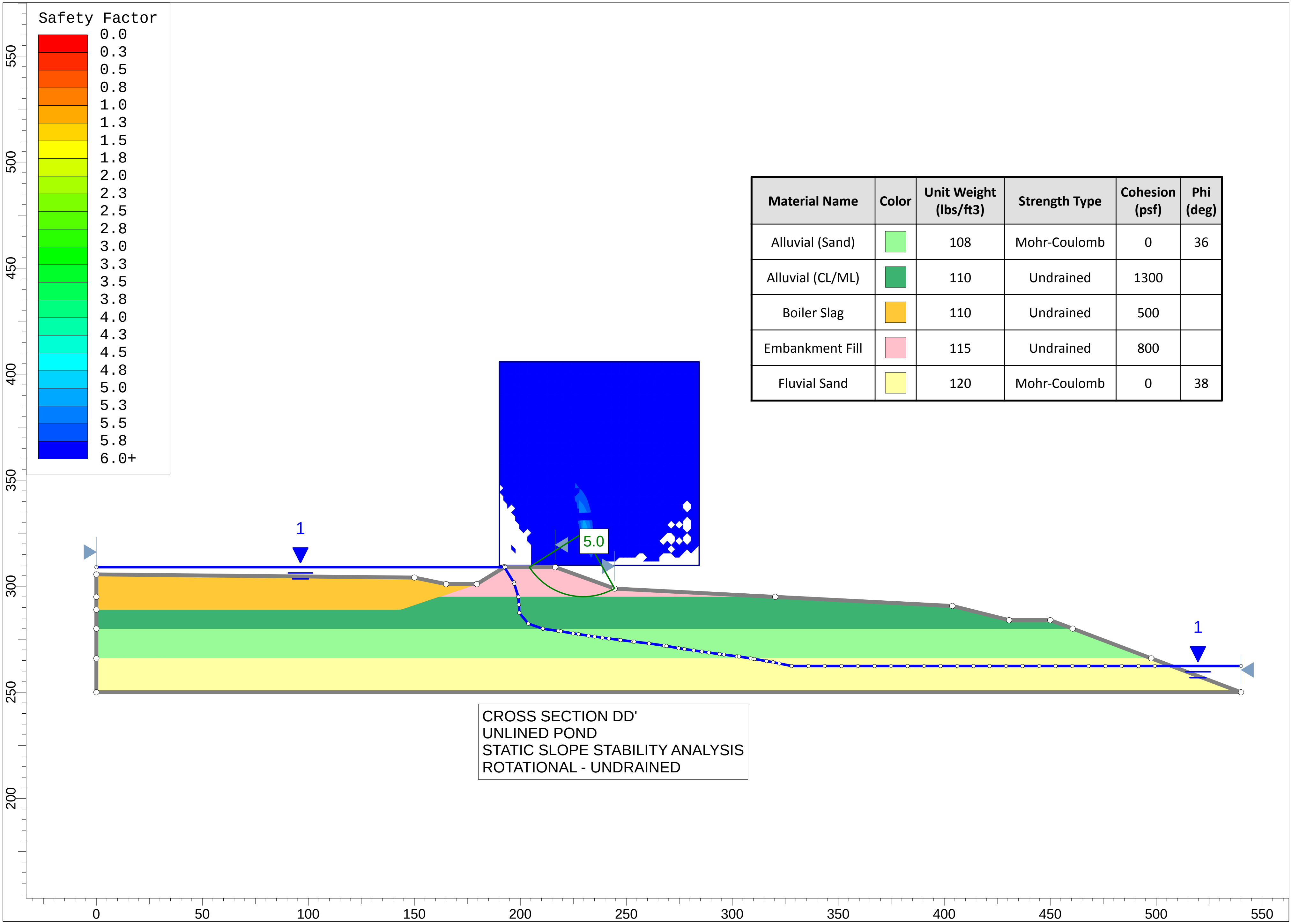
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	36
Alluvial (CL/ML)		110	Mohr-Coulomb	50	28
Boiler Slag		110	Mohr-Coulomb	0	30
Embankment Fill		115	Mohr-Coulomb	50	30
Fluvial Sand		120	Mohr-Coulomb	0	38

CROSS SECTION DD'
UNLINED POND
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - DRAINED



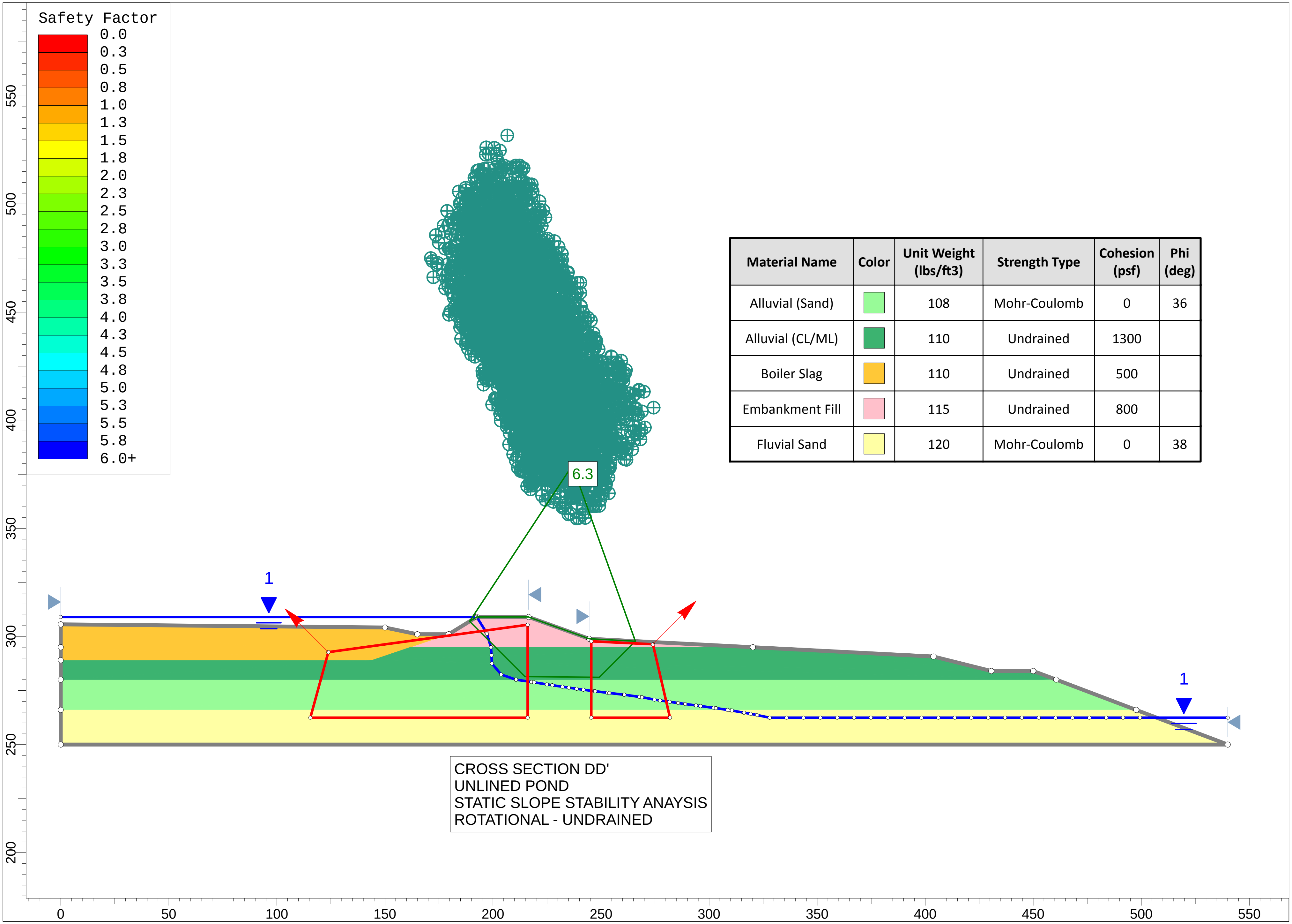
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	36
Alluvial (CL/ML)		110	Mohr-Coulomb	50	28
Boiler Slag		110	Mohr-Coulomb	0	30
Embankment Fill		115	Mohr-Coulomb	50	30
Fluvial Sand		120	Mohr-Coulomb	0	38

CROSS SECTION DD'
UNLINED POND
STATIC SLOPE STABILITY ANALYSIS
BLOCK - DRAINED

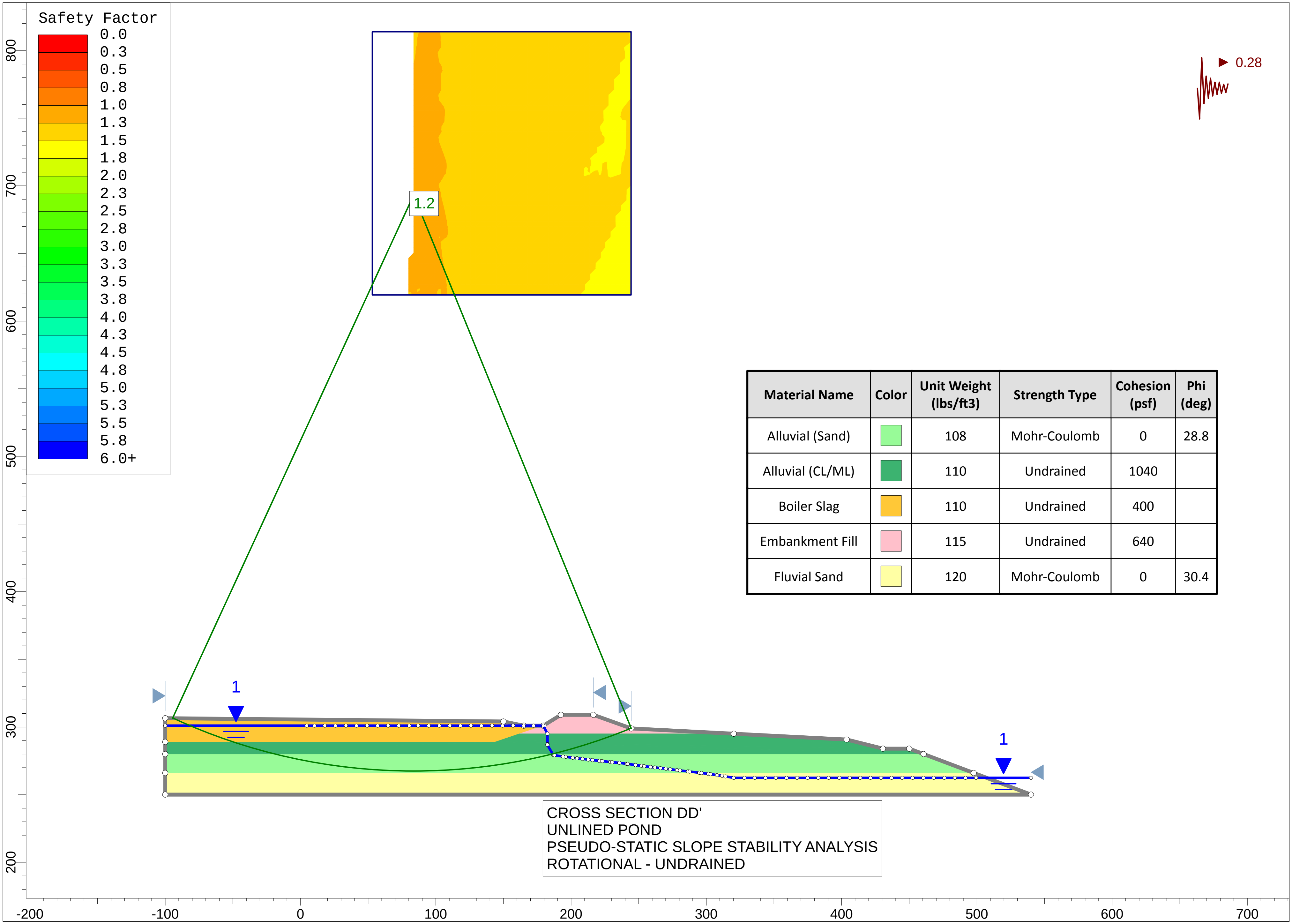


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	36
Alluvial (CL/ML)		110	Undrained	1300	
Boiler Slag		110	Undrained	500	
Embankment Fill		115	Undrained	800	
Fluvial Sand		120	Mohr-Coulomb	0	38

CROSS SECTION DD'
UNLINED POND
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED

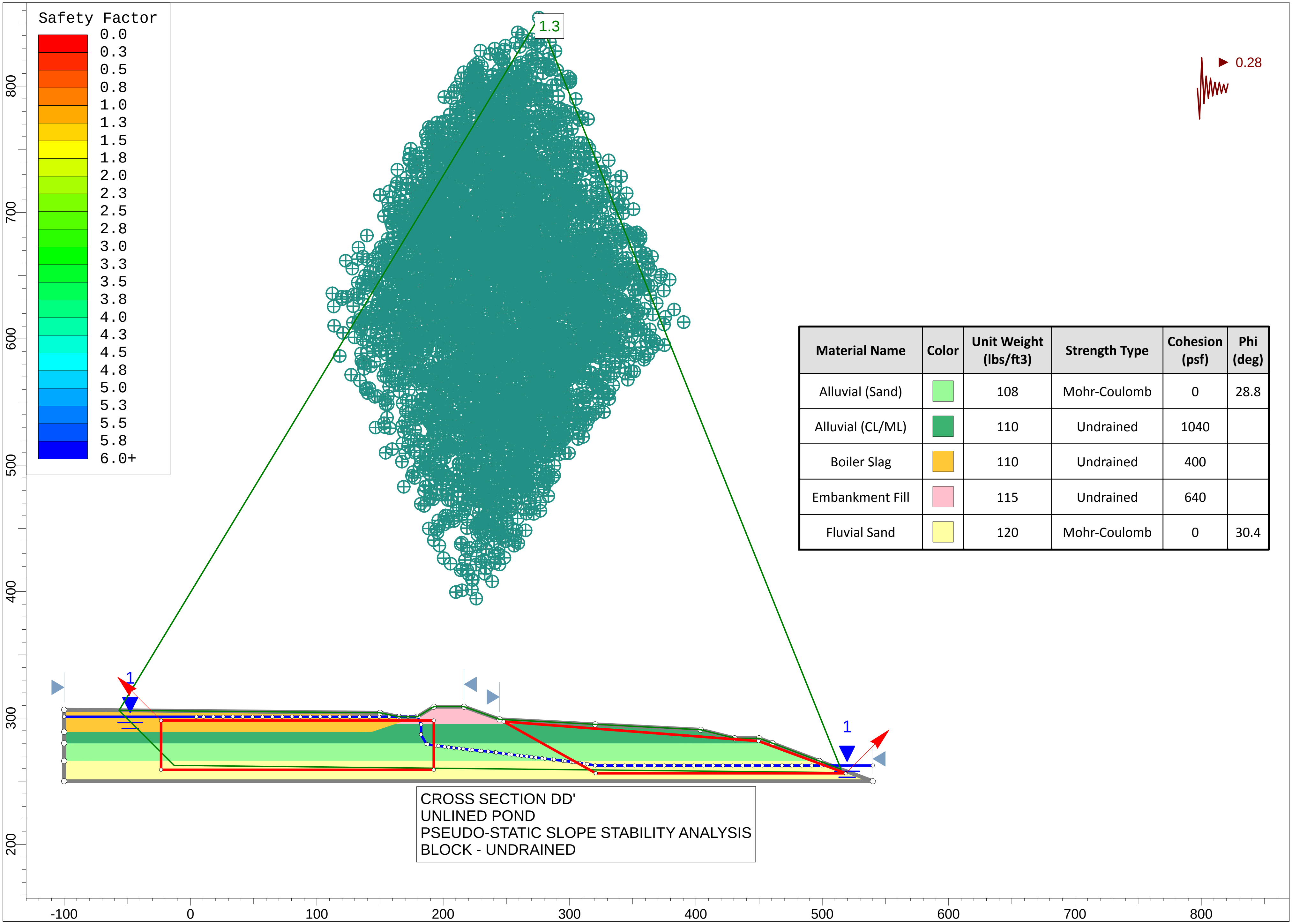


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	36
Alluvial (CL/ML)		110	Undrained	1300	
Boiler Slag		110	Undrained	500	
Embankment Fill		115	Undrained	800	
Fluvial Sand		120	Mohr-Coulomb	0	38



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	28.8
Alluvial (CL/ML)		110	Undrained	1040	
Boiler Slag		110	Undrained	400	
Embankment Fill		115	Undrained	640	
Fluvial Sand		120	Mohr-Coulomb	0	30.4

CROSS SECTION DD'
UNLINED POND
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	28.8
Alluvial (CL/ML)		110	Undrained	1040	
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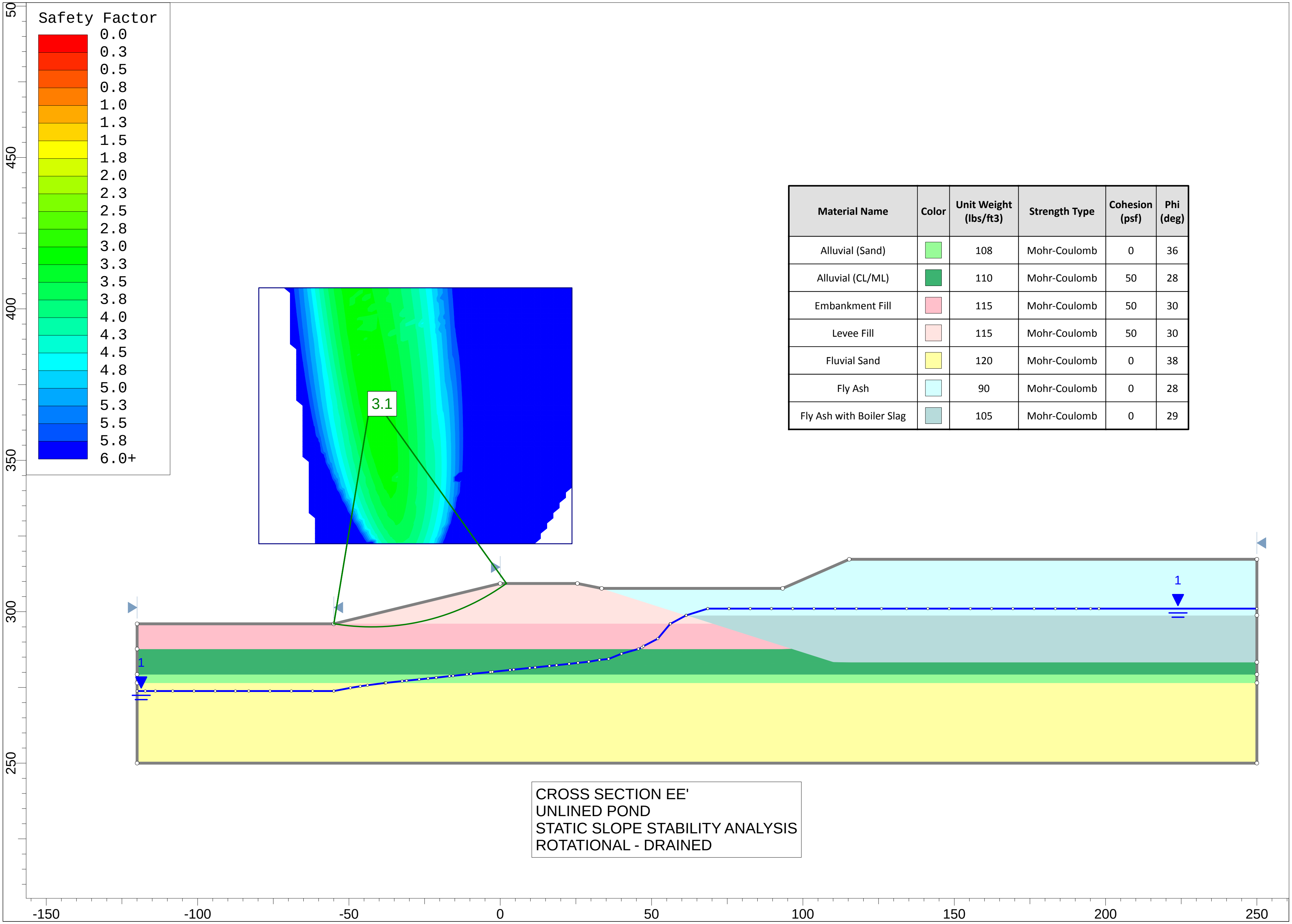
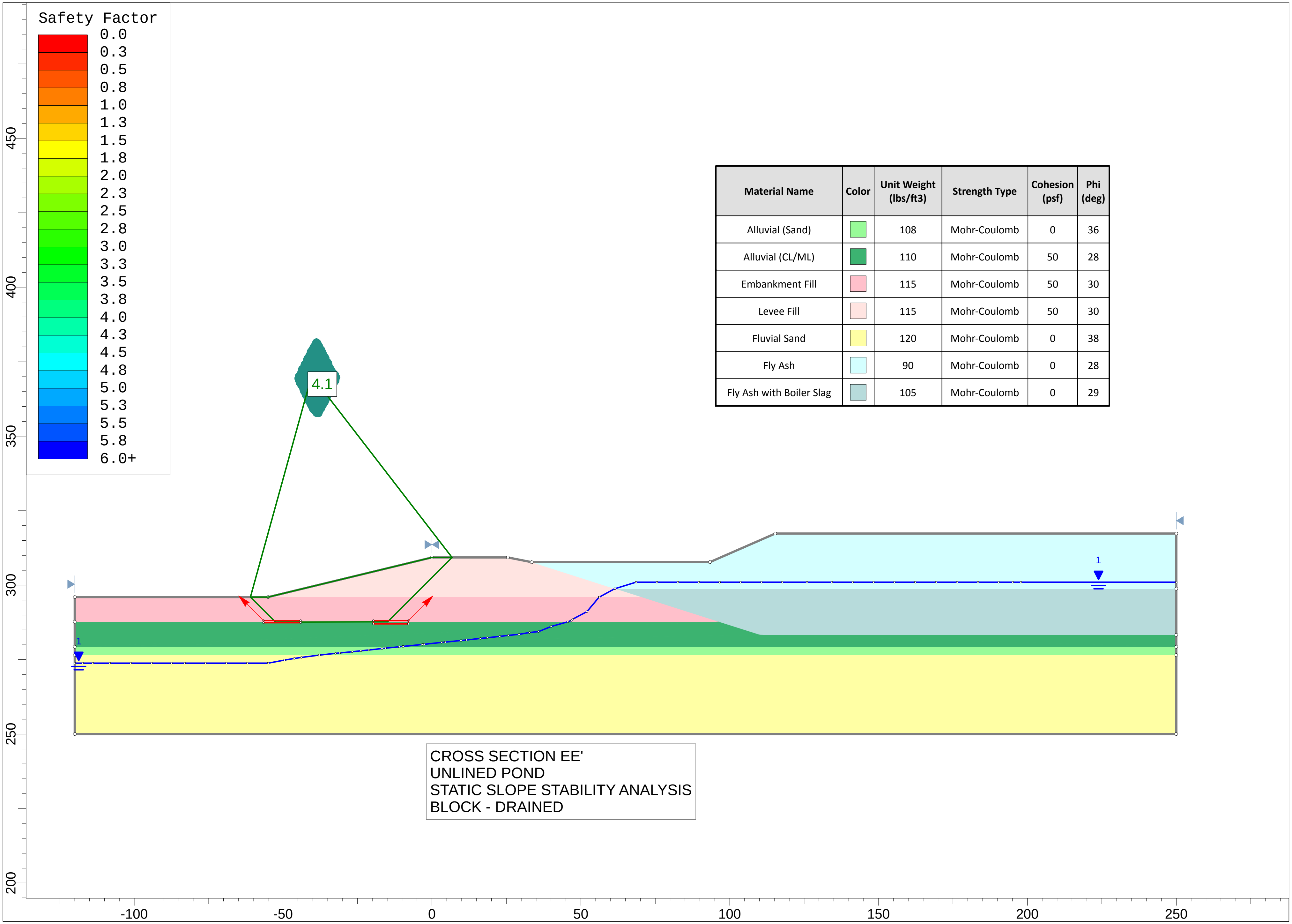
Embankment Fill		115	Undrained	640	
Fluvial Sand		120	Mohr-Coulomb	0	30.4



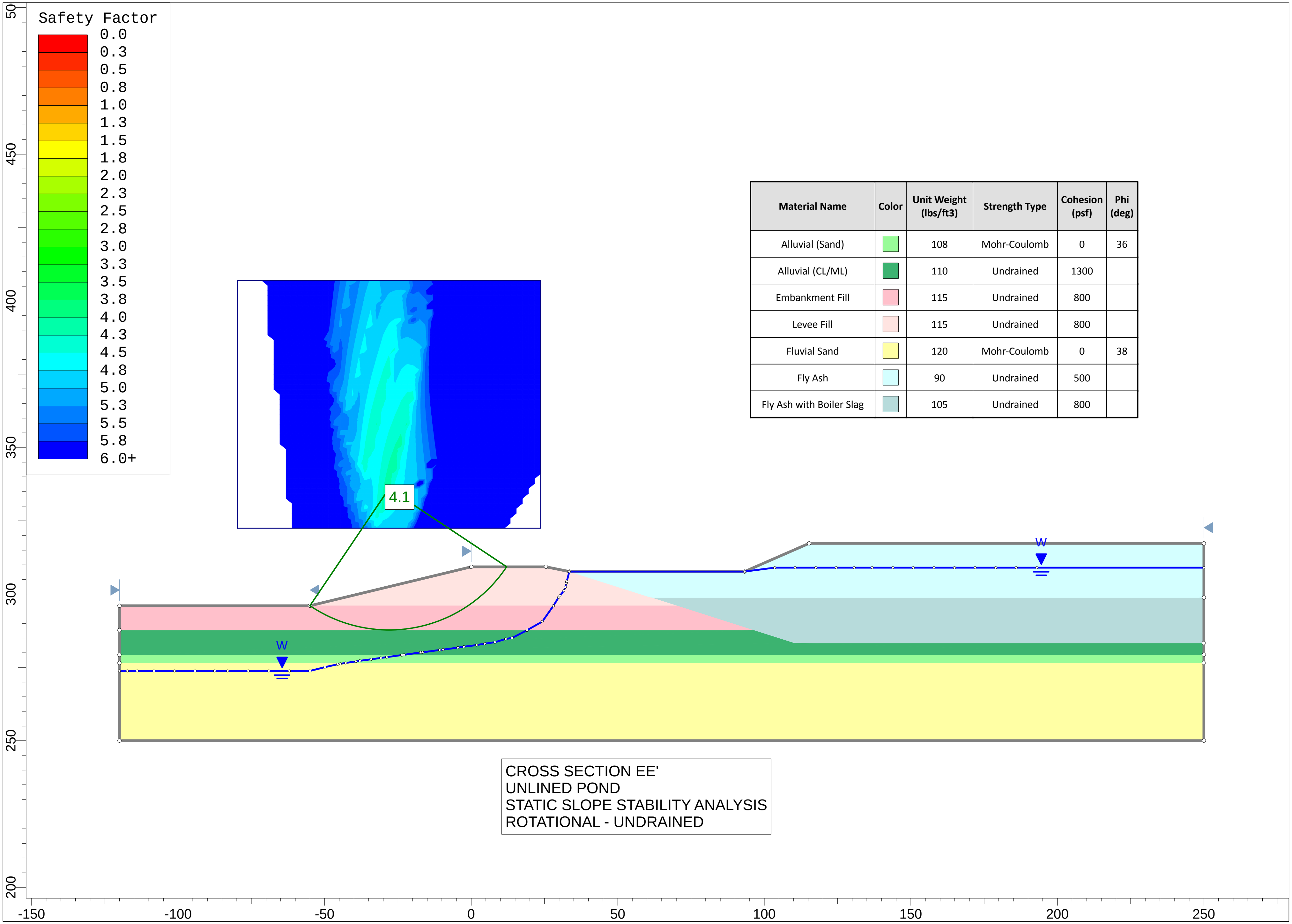
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	36
Alluvial (CL/ML)		110	Mohr-Coulomb	50	28
Embankment Fill		115	Mohr-Coulomb	50	30
Levee Fill		115	Mohr-Coulomb	50	30
Fluvial Sand		120	Mohr-Coulomb	0	38
Fly Ash		90	Mohr-Coulomb	0	28
Fly Ash with Boiler Slag		105	Mohr-Coulomb	0	29

CROSS SECTION EE'
UNLINED POND
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - DRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Sand)		108	Mohr-Coulomb	0	36
Alluvial (CL/ML)		110	Mohr-Coulomb	50	28
Embankment Fill		115	Mohr-Coulomb	50	30
Levee Fill		115	Mohr-Coulomb	50	30
Fluvial Sand		120	Mohr-Coulomb	0	38
Fly Ash		90	Mohr-Coulomb	0	28
Fly Ash with Boiler Slag		105	Mohr-Coulomb	0	29

CROSS SECTION EE'
UNLINED POND
STATIC SLOPE STABILITY ANALYSIS
BLOCK - DRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
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Alluvial (CL/ML)		110	Undrained	1300	
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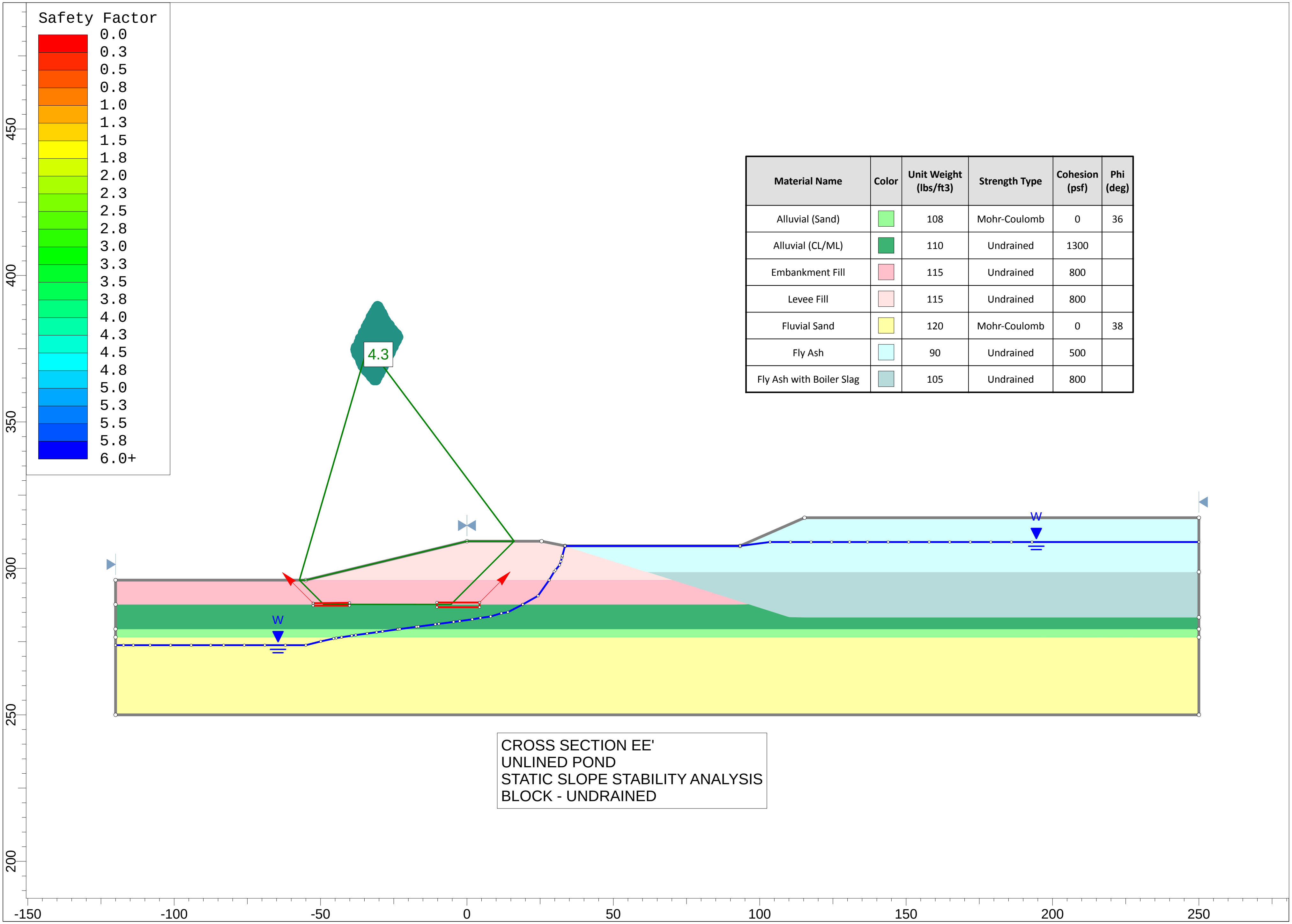
Levee Fill		115	Undrained	800	
Fluvial Sand		120	Mohr-Coulomb	0	38
Fly Ash		90	Undrained	500	
Fly Ash with Boiler Slag		105	Undrained	800	

CROSS SECTION EE'
UNLINED POND
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
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Alluvial (CL/ML)		110	Undrained	1300	
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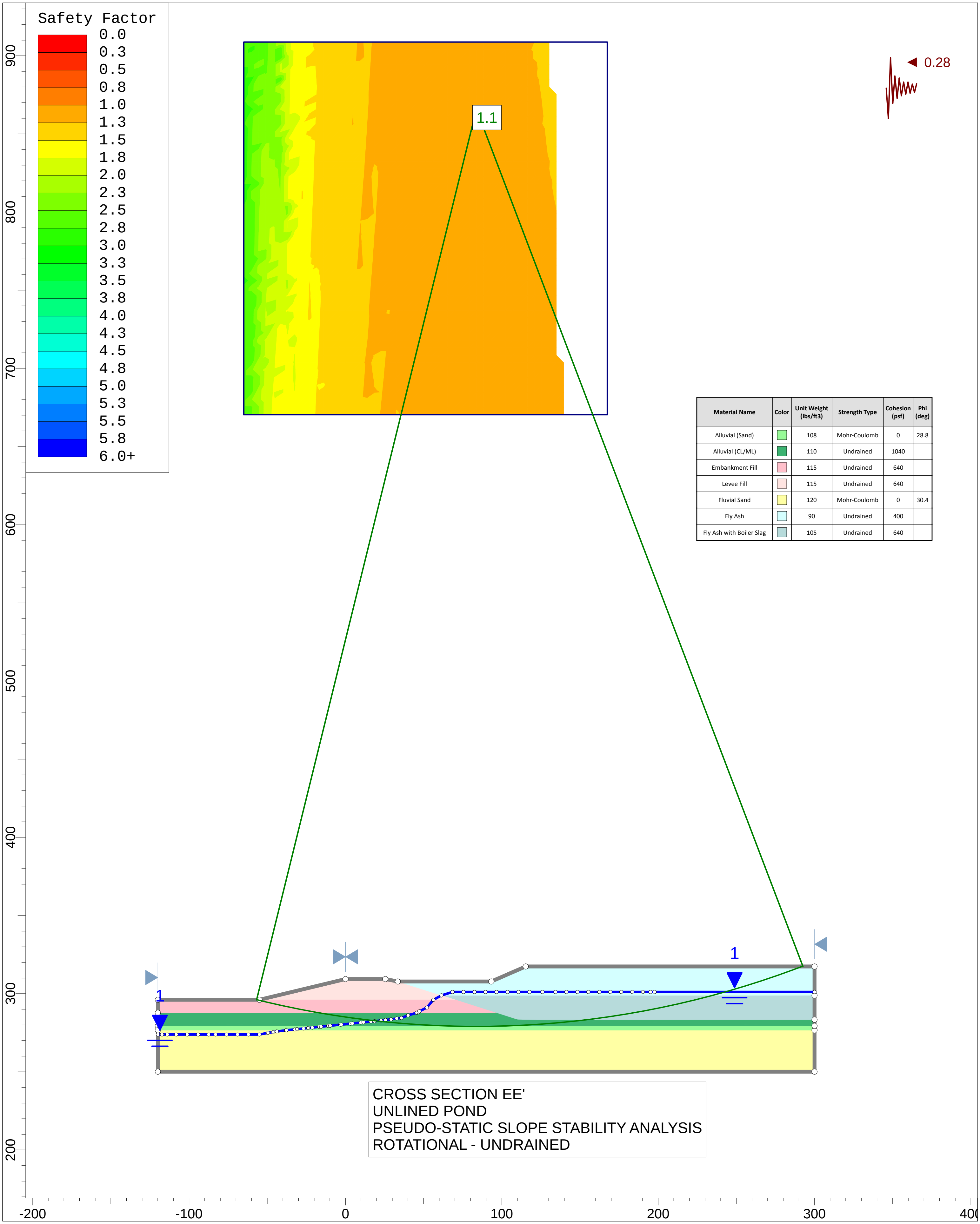
Levee Fill		115	Undrained	800	
Fluvial Sand		120	Mohr-Coulomb	0	38
Fly Ash		90	Undrained	500	
Fly Ash with Boiler Slag		105	Undrained	800	

CROSS SECTION EE'
UNLINED POND
STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
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Alluvial (CL/ML)		110	Undrained	1040	
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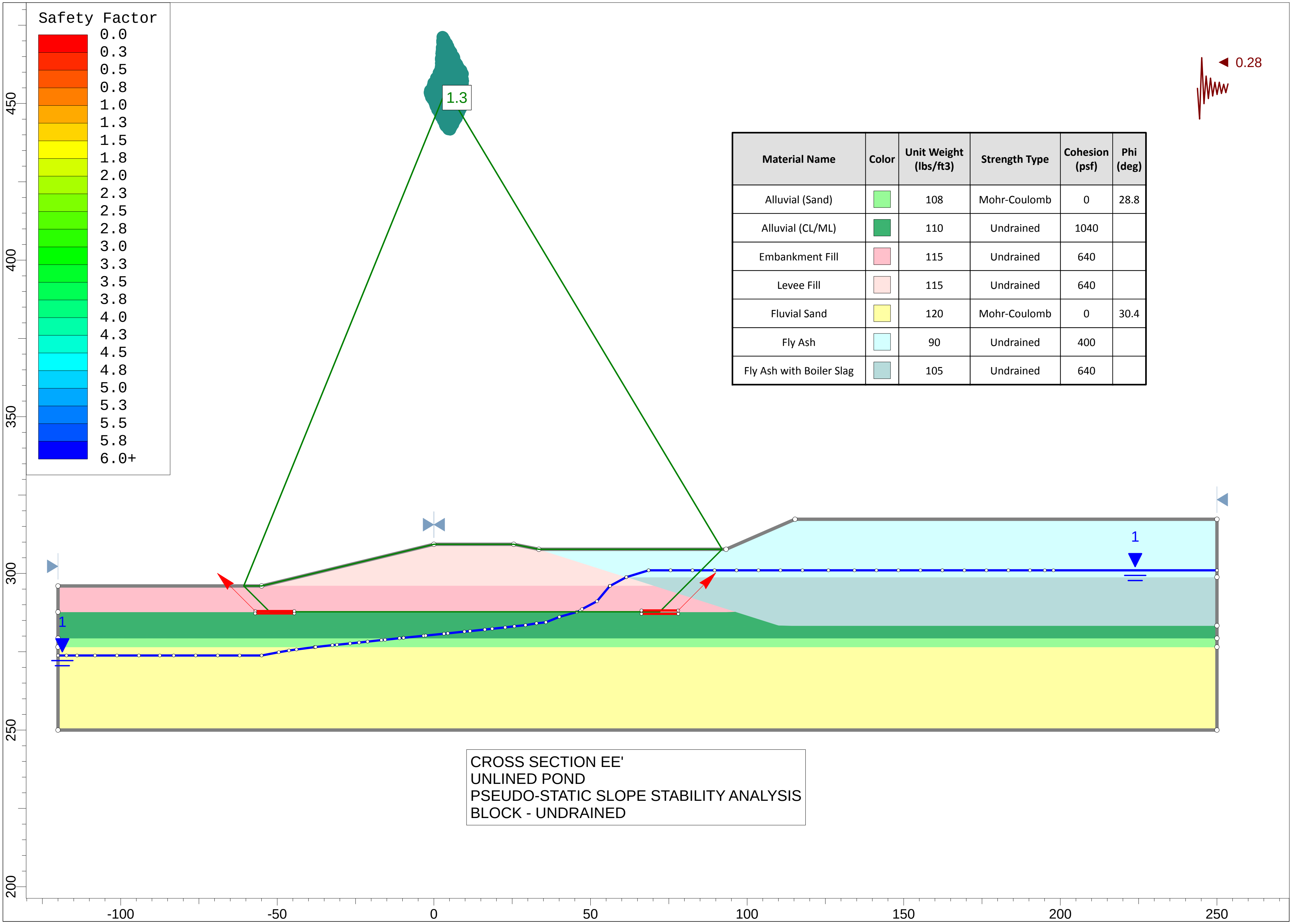
Levee Fill		115	Undrained	640	
Fluvial Sand		120	Mohr-Coulomb	0	30.4
Fly Ash		90	Undrained	400	
Fly Ash with Boiler Slag		105	Undrained	640	

CROSS SECTION EE'
UNLINED POND
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
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Fly Ash		90	Undrained	400	
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CROSS SECTION EE'
UNLINED POND
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED