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REPORT ON

INITIAL SAFETY FACTOR ASSESSMENT
THOMAS HILL ENERGY CENTER
CELL 001, CELL 003, AND CELL 004
CLIFTON HILL, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Springfield, Missouri

File No. 128064-003
October 2016

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17 October 2016
File No. 128064-003

Associated Electric Cooperative, Inc.
2814 South Golden Avenue
P.O. Box 754
Springfield, Missouri 65801

Attention: Kim Dickerson
Senior Environmental Analyst

Subject: Report on Initial Safety Factor Assessment
Cells 001, 003, and 004
Thomas Hill Energy Center
Clifton Hill, Missouri

Ms. Dickerson:

We are pleased to submit herewith our report entitled, "Report on Initial Safety Factor Assessment, Cells 001, 003, and 004, Thomas Hill Energy Center, Clifton Hill, Missouri." This report includes background information regarding the project, the results of our field investigation program, and the results of our initial safety factor assessment.

This work was performed by Haley & Aldrich, Inc. (Haley & Aldrich) on behalf of Associated Electric Cooperative, Inc. (AECI) in accordance with the United States Environmental Protection Agency's Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities, 40 CFR Part 257, specifically §257.73(e).

The scope of our work consisted of the following: 1) reviewing readily available reports, investigations, plans and data pertaining to the surface impoundments; 2) performing engineering evaluations related to liquefaction and slope stability; and 3) preparing and submitting this report presenting the results of our assessment.

Thank you for inviting us to complete this assessment and please feel free to contact us if you wish to discuss the contents of the report.

Sincerely yours,
HALEY & ALDRICH, INC.

Derrick A. Shelton
Geotechnical Program Manager | Senior Associate

Steven F. Putrich, P.E.
Principal

Enclosures

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1. Introduction

1.1 GENERAL

Haley & Aldrich, Inc. (Haley & Aldrich) has been contracted by Associated Electric Cooperative, Inc. (AECI) to perform the Initial Safety Factor Assessment for Slag Pond 001 Cells 001, 003, and 004 located at Thomas Hill Energy Center in Clifton Hill, Missouri. This work was completed in accordance with the United States Environmental Protection Agency's (EPA's) Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals (CCR) from Electric Utilities, 40 CFR Part 257, specifically §257.73(e) (EPA, 2015).

1.2 PURPOSE OF SAFETY FACTOR ASSESSMENT

The purpose of this study was to evaluate 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 assessment included the tasks listed below.

- Reviewing readily available reports, investigations, plans and data pertaining to the surface impoundments.

- Evaluating liquefaction susceptibility of material used to construct the impoundment embankments.

- Performing static and seismic stability analyses for rotational failure surfaces using limit equilibrium methods.

1.3 ELEVATION DATUM AND HORIZONTAL CONTROL

The elevations referenced in this report are in feet and are based on the National Geodetic Vertical Datum of 1929 (NGVD29) unless otherwise noted. The horizontal control is the Missouri State Plane North Coordinate System (NAD 83) datum unless otherwise noted.

2. Description of Ponds

A summary of relevant information associated with each pond is provided below. Additional details can be found in the Initial Structural Stability Assessment Reports prepared by AECI under separate cover. Refer to Figure 1, "Project Locus" for the general site location.

2.1 DESCRIPTION OF CELL 001

Cell 001 is a CCR surface impoundment used for settling and temporary wet storage of bottom ash and boiler slag sluiced from Thomas Hill Units 1 and 2. CCR slurry is pumped from the power plant and discharges into the southwest corner of Cell 001 through two approximate 14-in. diameter pipes. After initial settling, water and suspended CCR enter a rectangular concrete decant structure equipped with 60-inch wide concrete stop logs, and flow via a 30-in. diameter concrete outlet pipe to a drainage channel which discharges into Cell 003.

It is understood that Cell 001 was originally designed by Burn & McDonnell in 1978-1979 and constructed shortly thereafter. In 2015, AECI constructed a CCR Processing and Containment Pad to allow continued removal and dewatering of CCR from Cell 001. The processing and containment pad was designed to allow removal and dewatering of CCR from Cell 001, with free liquids from the dredged CCR draining back into Cell 001. The construction included a 5-ft high containment berm to prevent CCR and free liquids from migrating outside the pad. Fill for the processing pad and containment berm consisted of clayey fill obtained from on-site borrow sources. The clay fill was keyed into the underlying natural clays, and a 2-ft thick compacted clay liner was placed below the processing and containment pad.

Cell 001 impoundment has an area of approximately 2.3 acres. Cell 001 embankments are generally 10 ft or less in height, with a crest width generally ranging from 15 to 20 ft. The containment berm defines the southern edge of the processing and containment pad. Beyond the containment berm, ground surface slopes downward to Cell 002 with a slope height of up to 30 ft.

2.2 DESCRIPTION OF CELL 003

Cell 003 is a CCR surface impoundment located to the south of the Thomas Hill power plant. Cell 003 was originally designed by Burn & McDonnell in 1978-1979 and constructed shortly thereafter. It is understood that Cell 003 was modified in 1984. On the south side, an embankment with 16-ft crest width separates Cells 003 and Cell 004. The embankment is constructed from clay fill obtained from an on-site borrow source. The south interior and exterior slopes are typically 3H:1V. In 1984, the current south embankment was constructed and the original embankment was abandoned and left in place. The abandoned embankment is submerged at normal pool level.

Cell 003 receives decant water and suspended coal combustion residuals (CCR) from Cell 001 via an earthen bypass channel which flows from Cell 001 and around Cell 002, discharging into the northwest corner of Cell 003. In addition, stormwater and non-CCR process water from Cell 002 East flows to Cell 003, discharging from an underwater pipe in the northeast corner of the impoundment. During the 2015 modifications to Cell 002 West, a 15-in. corrugated metal pipe was installed through the embankment between Cell 002 and 003 to convey water from Cell 002 to Cell 003. This pipe remains inactive as Cell 002 is maintained in a dry condition to facilitate the ongoing CCR removal from the impoundment.

The outlet structure from Cell 003 consists of a rectangular concrete drop inlet tower equipped with 60-in. wide concrete stop logs. Decant water entering the structure flows through a pipe that penetrates the common embankment between Cell 003 and 004 and discharges underwater into Cell 004. The Cell 003 emergency spillway consists of an 18-ft wide riprap-lined channel which is approximately 2 ft in depth located across the crest of the south dike. To provide vehicle access across the riprapped channel, the riprap has been topped off with a layer of crushed stone within the limits of access road.

Cell 003 is used for wet storage of fly ash, bottom ash, boiler slag and sediments from the coal pile runoff. Cell 003 is incised on the east and west sides. On the north side, an embankment with 18-ft crest width separates Cell 003 and Cell 002. Accumulated CCR is periodically dredged from Cell 003, generally on an approximate 2 to 4-year cycle.

The north interior slope of Cell 003 varies from about 3 Horizontal to 1 Vertical (3H:1V) to 2H:1V, while the north exterior slope is typically 3H:1V. Cell 003 has a surface area of approximately 13 acres and total storage capacity of approximately 160 acre-ft.

2.3 DESCRIPTION OF CELL 004

Cell 004 is a CCR surface impoundment located to the south of the Thomas Hill power plant. Cell 004 was originally designed by Burn & McDonnell in 1978-1979 and constructed shortly thereafter. It is understood that Cell 004 was modified in the 1980's.

Cell 004 is the final settling pond and stores decant water from Cell 003 and a limited quantity of CCR material. The impoundment is surrounded by earthen berms on all sides. Maximum embankment height is approximately 24 ft based on the ground surface elevation contour lines on Figure 2. Exterior slopes range from approximately 4H:1V to 5H:1V with some flatter areas. Interior slopes are typically 3H:1V. Crest width varies from approximately 14 to 16 ft.

Cell 004 has a surface area of approximately 12 acres and total storage capacity of approximately 125 acre-feet as stated in the Initial Annual Inspection.

The outlet structure from Cell 004 consists of a rectangular concrete drop inlet tower equipped with 60-in. wide concrete stop logs. Decant water enters the structure and flows through a 48-in. diameter steel pipe that penetrates the Cell 004 south embankment and discharges from the NPDES-permitted Outfall #001 into a concrete open channel before discharging into the Middle Fork of the Little Chariton River.

The Cell 004 emergency spillway consists of an 18-ft wide riprap-lined channel which is approximately 2 ft in depth located across the crest of the south embankment. To provide vehicle access across the riprapped channel, the riprap has been topped off with a layer of crushed stone within the limits of access road.

3. Field Investigation Program

3.1 PREVIOUS EXPLORATIONS AND LABORATORY TESTING PERFORMED BY OTHERS

Several subsurface exploration and laboratory testing programs were previously completed at the site by others. The approximate locations of the relevant historic subsurface explorations performed by others are shown on the attached Figure 2. A brief summary of the explorations is provided below and details of relevant explorations are presented in Table I[1]. Note that the term "relevant" explorations refers to explorations from previous investigations by others that were directly used in our safety factor assessment.

- Three (3) test borings were drilled and one (1) temporary piezometer was installed by Geotechnology, Inc. (Geotechnology) during the period 7 November 2011 to 8 November 2011 as part of a slope stability and seepage analysis for Cell 001. The test boring logs and laboratory test results associated with this investigation are included in Appendix A.

- Two (2) test borings were performed by Geotechnology during the period 13 January 2010 to 14 January 2010 as part of a slope stability evaluation of Cell 003. The test boring logs and laboratory test results associated with this investigation are included in Appendix A

- Two (2) cone penetrometer soundings were performed by Stratigraphics, Inc. on 3 February 2010 as part of a global stability evaluation of Cell 003. The logs associated with this investigation are included in Appendix A.

- Two (2) test borings were drilled and one (1) temporary piezometer was installed by Geotechnology on 8 November 2011 as part of a slope stability and seepage analysis for Cell 004. The test boring logs and laboratory test results associated with this investigation are included in Appendix A

3.2 CURRENT SUBSURFACE EXPLORATION PROGRAM

A subsurface exploration program was conducted at the project site during the period 19 August 2015 to 27 August 2015 and on 2 August 2016 by Haley & Aldrich. The program consisted of installing six (6) piezometers. The piezometers were installed by Bulldog Drilling of Dupo, Illinois using an ATV-mounted drill rig. A Haley & Aldrich representative was present in the field to observe the piezometer installation activities. The locations of the test borings associated with the piezometers are shown on Figure 2. The as-drilled locations and elevations of the piezometers were determined in the field by Gredell Resources Engineering, Inc. (Gredell) of Jefferson City, Missouri 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 II.

The test borings associated with the piezometers were drilled to depths ranging from 19.4 ft to 34.5 ft below ground surface. The borings were advanced using hollow stem augers. Standard penetration tests were not performed, but the auger cuttings were used to evaluate the subsurface soil conditions encountered.

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

The observation well installation reports are presented in Appendix B. The installation reports and related information depict subsurface conditions only at the specific locations and at the particular time designated on the installation reports. 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.

4. Subsurface Conditions

4.1 GEOLOGY

Thomas Hill Energy Center is located within the Dissected Till Plains subprovince of the Central Lowlands physiographic province and is underlain by recent alluvium and glacial till deposits. These deposits are underlain regionally by a sequence of bedrock formations ranging in age from Cambrian to Pennsylvanian (Miller and Vandike, 1997).

Alluvium and glacial till deposits underlying the ponds typically consist of clay, silty clay, silty clay with trace sand and gravel, and clayey to sandy silt. Siltstone and shale bedrock is present at a depth ranging from 27 to 36 feet (Geotechnology, 2010, 2012a, 2012b).

4.2 SUBSURFACE CONDITIONS

Descriptions of the soil conditions encountered during the historic subsurface exploration programs 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 in Appendix A for specific descriptions of soil samples obtained from the historic borings.

The subsurface conditions identified by the historic CPT soundings do not represent material classifications based on grain-size distributions, index tests, or visual observation. Rather, the historic 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 only based on classifications of samples obtained from historic test borings and the results of historic laboratory testing.

- *EMBANKMENT FILL* – Below the ground surface at all test boring locations, there is a stratum of man-placed EMBANKMENT FILL primarily described as lean clay (CL) with varying amounts of silt, sand, and gravel. This stratum was fully penetrated by all borings. The thickness of this stratum ranged from approximately 3 to 20 ft. The consistency of fine grained soils encountered in this stratum ranged from soft to stiff, but was generally medium stiff.

- *CLAY* - Below the EMBANKMENT FILL, there is a stratum of natural soil primarily described as fat CLAY (CH) and lean CLAY (CL) with varying amounts silt, sand and gravel. This stratum was encountered in all borings. Where encountered, this stratum was fully penetrated in borings B-1, B-2, B-3 and C-1. Where encountered, the thickness of this stratum ranged from 8.5 to 17 ft. The consistency of fine grained soils encountered in this stratum ranged from soft to very stiff but was generally medium stiff to stiff.

- *WEATHERED BEDROCK* – Below the CLAY in borings B-4, B-5, and C-2, there is a stratum natural material described as WEATHERED BEDROCK. Where encountered, this stratum was not fully penetrated in any of the test borings. It should be noted that boring B-2 encountered auger refusal at 16 ft below ground surface and refusal was assumed to occur due to encountering bedrock (Geotechnology, 2012a).

4.3 GROUNDWATER CONDITIONS

Water levels at the site discussed herein are based on the water levels encountered in historic test borings, historic piezometers, and recent piezometers installed by Haley & Aldrich in 2015 and 2016. Measured water levels in the historic test borings are summarized in Table I and measured water levels in historic and current piezometers are summarized in Table IV. A brief summary of measured water levels is provided below.

- At Cell 001, measured water levels in the historic test borings ranged from 5.5 ft to 9.3 ft below ground surface. In temporary piezometer P-1, measured water levels ranged from 9.3 ft to 9.4 ft below ground surface.

- At Cell 003, measured water levels at piezometer TPZ-3 ranged from 4.6 ft to 6.8 ft below ground surface.

- At Cell 004, measured water levels in the historic test borings ranged from 9.7 ft to 15.0 ft below ground surface. In the temporary and recent piezometers, measured water levels ranged from 1.1 ft to 19.6 ft below ground surface.

Water level readings have been made in the subsurface explorations and piezometers 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.

5. 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 a CCR unit to determine calculated factors of safety for each CCR unit relative to the minimum prescribed safety factors for the critical cross section of the embankment. The minimum required safety factors are defined as follows:

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

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 embankments were performed for rotational failures using limit equilibrium methods. Limit equilibrium methods compare forces, moments, and stresses which cause instability of the mass of the embankment 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 details of the analyses performed for the impoundments are presented in the following sections of this report.

5.1 DESIGN WATER LEVELS

In accordance with the CCR Rule, the water retained in an 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. A summary of the maximum storage pool and surcharge pool water levels at each impoundment are provided below.

Location	Crest	Maximum Storage Pool Level	Maximum Surcharge Pool Level	Available Freeboard
Cell 001	El. 744	El. 739	El. 744	5 ft.
Cell 003	El. 718	El. 710	El. 715	8 ft.
Cell 004	El. 706	El. 700	El. 703	6 ft.

The elevation of the phreatic surface within the embankments and at the toe of slope were estimated based on conditions encountered in nearby subsurface explorations and observation wells. Additionally, there is no current evidence of seepage emanating from the exterior slopes of the embankments, suggesting that the phreatic surface is contained within and/or below the embankments.

Given the prescribed impoundment pool levels and the observed static groundwater levels discussed above, a seepage analysis was performed to determine the piezometric head between the upstream slope of the impoundment embankments and the downstream toe of the embankments. The computer software program, Slide 6.029, developed by RocScience, Inc., was used to perform the seepage analyses. Permeability values for each material layer were estimated from typical published values based on material description and correlations to grain size. During the course of the seepage analyses, minor adjustments were made to the permeability values and isotropic permeability ratios to best model the conditions observed in the field. Results from the seepage analysis provided pore pressure values within the seepage model that were then imported into the slope stability model.

The seepage models suggest that much of the seepage emanating from the impoundments is moving downward into the more permeable foundation soils and establishing a groundwater table several feet below ground surface rather than moving laterally through the embankments and discharging from the downstream slope. The phreatic surfaces used in the slope stability models are shown on the slope stability graphical output included in Appendix C.

5.2 MATERIAL PROPERTIES

The material properties used in our analyses have been evaluated using the results of the historic analyses performed by Geotechnology, historic subsurface explorations, and historic laboratory testing. In cases where subsurface explorations, laboratory test data, and historic properties did not exist for certain materials, properties were estimated based on typical values developed from Haley & Aldrich's experience with similar materials as indicated below.

- Bottom Ash/Boiler Slag/Fly Ash – typical values.
- Clay Liner – typical values

Refer to Table V for a summary of material properties and Appendix C for additional details of soil property characterization.

TABLE V
MATERIAL PROPERTIES

Material	Material Strength	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)	Su (psf)	Vertical Stress Ratio	Minimum Shear Strength (psf)
Bottom Ash/Boiler Slag	Drained	90	0	30	--	--	--
	Undrained	90	750	0	--	--	--
Fly Ash/Bottom Ash/Boiler Slag	Drained	90	0	30	--	--	--
	Undrained	90	750	0	--	--	--
Embankment Fill and Embankment Fill (2015)	Drained	125	200	25	--	--	--
	Undrained	125	--	--	--	0.360	600
Clay	Drained	120	125	26	--	--	--
	Undrained	120	--	--	--	0.253	800
Clay Liner	Drained	125	0	28	--	--	--
	Undrained	125	--	--	1,300	--	--
Weathered Bedrock	Drained	130	0	38	--	--	--
	Undrained	130	0	38	--	--	--

5.3 DESIGN SEISMIC EVENT

In accordance with Section §257.53 of the CCR Rule, the seismic safety factor is defined as the factor of safety determined under earthquake conditions using the peak ground acceleration for a seismic event with a 2% probability of exceedance in 50 years (2,500-year return period). The gridded hazard map data associated with the latest USGS National Seismic Hazard maps developed in 2014 indicates that the bedrock peak ground acceleration (PGA) at the site for the 2,500-year earthquake event is 0.057g, with the greatest contribution to the hazard coming from an earthquake with a modal magnitude of 7.7 as indicated on the deaggregation chart included in Appendix C. The bedrock PGA value was adjusted by the USGS site coefficient, F_{PGA}, of 1.6 for Site Class D to determine the peak free field ground acceleration, k_{max}, of 0.091g. Note that the value of k_{max} corresponds to the peak ground acceleration at the base of the impoundment embankment.

5.4 LIQUEFACTION POTENTIAL 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), evaluations have been performed to assess the potential for liquefaction of the soils used to construct the impoundment embankments.

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 the historic subsurface explorations performed at the site indicate that the majority of soils used to construct the impoundment embankments consist of lean CLAY and fat CLAY with varying amounts of sand. Generally, these materials are not considered to be liquefiable. However, since limited laboratory sieve analyses were performed during the historic investigations, we performed liquefaction triggering analyses using the historic test boring data to determine if the soils were susceptible to liquefaction. Details of the liquefaction triggering analysis are included in Appendix C and indicate that the materials used to construct the embankments at Cells 001, 003, and 004 have factors of safety against liquefaction triggering that are greater than 1.2, and are not susceptible to liquefaction.

5.5 STABILITY ANALYSIS

5.5.1 Methodology for Analyses

The computer software program Slide 6.029 was used to evaluate the static and seismic stability of the impoundment embankments. Analyses were performed to evaluate static drained (long-term) and undrained (short-term) strength conditions for circular and translational (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). Translational failures were analyzed where subsurface conditions included a relatively weak foundation layer underlain by a relatively strong foundation layer (DeHavilland, 2004).

Seismic stability was evaluated using pseudo-static analyses. Pseudo-static analyses model 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 20 percent reduction in material strength was incorporated in the pseudo-static analyses to represent the approximate threshold between large and small strains induced by cyclic loading (Duncan, 2014). 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.

5.5.2 Pseudo-static Coefficient

The pseudo-static coefficient, k_s, used in our seismic analyses was calculated using the equation below, which uses the peak free field acceleration discussed above and a reduction factor of 0.50 (Hynes-Griffin and Franklin, 1984).

$$k_s = 0.50 \times \frac{k_{\max}}{\mathrm{g}} = 0.50 \times \frac{0.091\mathrm{g}}{\mathrm{g}} = 0.05$$

5.5.3 Results of Stability Evaluation

The critical cross section is defined as that which is anticipated to be most susceptible to failure amongst all cross sections. To identify the critical cross section 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 embankment 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 embankments; and
e. presence or lack of reinforcing measures in front of the embankments.

Examination of the conditions noted above resulted in the identification of one critical cross section at each impoundment. The locations of the critical cross sections are shown on Figure 2. The results of our analyses are presented below in Table VI and are shown on the Slide output files included in Appendix C.

As shown below, the static safety factors are above the minimum required values for the critical cross sections. Similarly, the pseudo-static analyses for the analyzed sections indicate an acceptable seismic safety factor.

TABLE VI SUMMARY OF STATIC AND SEISMIC STABILITY EVALUATIONS							
Impoundment	Cross Section	Condition[1]	Earthquake Event	Soil Strength	Required Safety Factor	Safety Factor	
						Rotational Failure Surface	Block Failure Surface
Cell 001	1A-1A'	Static	-	Drained	1.50	1.89	2.18
				Undrained	1.40	1.89	2.07
		Seismic	2,500-year	Undrained[2]	1.00	1.33	1.42
Cell 003	3A-3A'	Static	-	Drained	1.50	1.62	2.05
				Undrained	1.40	1.86	2.05
		Seismic	2,500-year	Undrained[2]	1.00	1.27	1.39
Cell 004	4A-4A'	Static	-	Drained	1.50	1.93	2.00
				Undrained	1.40	1.80	1.72
		Seismic	2,500-year	Undrained[2]	1.00	1.21	1.10

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

5.6 CONCLUSIONS

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

- §257.73(e)(1)(i) - *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 value for the critical section analyzed. Accordingly, this requirement has been met.

- §257.73(e)(1)(ii) - *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 value for the critical section analyzed. Accordingly, this requirement has been met.

- §257.73(e)(1)(iii) - *The calculated seismic factor of safety must equal or exceed 1.00.*

  As shown in Table VI, the calculated seismic safety factor is above the minimum required value for the critical section analyzed. Accordingly, this requirement has been met.

- §257.73(e)(1)(iv) - *For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.*

The results of the subsurface investigations and liquefaction triggering evaluation indicate that the material used to construct the impoundment embankments are not susceptible to liquefaction. Accordingly, this requirement has been met.

6. 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 section of the impoundment embankments meet the minimum factors of safety specified in §257.73(e)(1)(i) through (iv) of the EPA's CCR Rule.

Certification Statement – Cell 001

I certify that the Initial Safety Factor Assessment for Cell 001 at the Thomas Hill Energy Center 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 – Cell 003

I certify that the Initial Safety Factor Assessment for Cell 003 at the Thomas Hill Energy Center 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 – Cell 004

I certify that the Initial Safety Factor Assessment for Cell 004 at the Thomas Hill Energy Center 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:

STATE OF MISSOURI
STEVEN F.
PUTRICH
NUMBER
PE-2014035813
10-17-16
PROFESSIONAL ENGINEER

References

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TABLES

TABLE I
SUMMARY OF RELEVANT HISTORIC SUBSURFACE EXPLORATIONS
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

Exploration Designation[1]	Performed By	Year Drilled	Ground Surface El.[2] (ft)	Total Exploration Depth (ft)	Water[3] Depth Below Ground Surface
TEST BORINGS					
B-1	Geotechnology, Inc.	2011	750.0	20.0	9.3
B-2	Geotechnology, Inc.	2011	745.0	16.0	5.5
B-3	Geotechnology, Inc.	2011	757.0	20.0	Not Encountered
B-4	Geotechnology, Inc.	2011	711.0	34.3	9.7
B-5	Geotechnology, Inc.	2011	697.0	29.7	15.0
C-1	Geotechnology, Inc.	2010	735.0	50.0	Not Measured
C-2	Geotechnology, Inc.	2010	725.0	37.2	Not Encountered
CONE PENETROMETER SOUNDINGS					
CC01	Stratigraphics, Inc.	2010	728.4	49.8	Unknown
CC02	Stratigraphics, Inc.	2010	717.9	52.5	Unknown
TEMPORARY PIEZOMETERS					
P-1	Geotechnology, Inc.	2011	750.0	10.5	See Table IV
P-2	Geotechnology, Inc.	2011	710.0	23.0	See Table IV

Notes:
1) Technical monitoring of historic subsurface explorations was performed by others.
2) The elevation data are provided in feet and the vetical datum is unknown. Ground surface elevations of historic test borings were taken from boring logs prepared by Geotechnology, Inc. Ground surface elevations of historic cone penetrometer soundings and piezometers were determined by linear interpolation between ground surface contour lines shown on Figure 2.

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

TABLE II
SUMMARY OF CURRENT SUBSURFACE EXPLORATIONS
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

Exploration Designation[1]	Ground Surface El.[2] (ft)	Northing[2]	Easting[2]	Total Exploration Depth (ft)	Water
					Depth Below Ground Surface
PIEZOMETERS					
TPZ-3	730.7	1351172.00	460709.39	28.5	See Table IV
TPZ-9	714.4	1350109.76	461128.86	18.0	See Table IV
TPZ-10	702.7	1350264.13	459992.76	24.5	See Table IV
TPZ-11	704.7	1349882.31	460851.28	19.4	See Table IV
TPZ-12	689.0	1349532.33	460183.30	33.9	See Table IV
TPZ-14	681.5	1349757.46	459870.66	34.5	See Table IV

Notes:
1) Technical monitoring of piezometers installed during the period 19 August 2015 through 2 August 2016 was performed by Haley & Aldrich, Inc.
2) As drilled locations and ground surface elevations of piezometers were determined in the field by Gredell Engineering Resources Inc. of Jefferson City, Missouri by optical survey. The coordinates are provided in units of feet, relative to the Missouri State Plane North Coordinate System (NAD27). The elevation data are provided in feet above sea level, relative to NAVD29.

TABLE III
SUMMARY OF HISTORIC LABORATORY TEST RESULTS
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

Boring Designation	Pond	Sample Number	Sample Depth (ft)	USCS Symbol	Material Type/Stratum	Moisture Content (%)	LL	PL	PI	Tube Density		Unconfined Compression		CU Triaxial	
										Average Moisture Content (%)	Average Total Density (pcf)	Moisture Content (%)	Undrained Shear Strength (psf)	c' (psf)	ϕ' (degrees)
HISTORIC TESTING BY GEOTECHNOLOGY, INC. IN FEBRUARY 2012															
B-1	1	ST2	3.0-5.0	CL	EMBANKMENT FILL					17	128.7				
B-1	1	ST2	3.0-5.0	CL	EMBANKMENT FILL					17	127.7			600	23
B-1	1	ST3	5.0-7.00	CL	EMBANKMENT FILL		50	17	33	16	133.4				
B-2	1	ST4	7.0-9.0	CH	CLAY					24	124.0				
B-2	1	ST4	7.0-9.0	CH	CLAY		65	20	45	24	122.8			500	27
B-2	1	ST4	7.0-9.0	CH	CLAY					23	100.0				
B-2	1	ST5	9.0-11.0	CH	CLAY					20	129.6	20	1600		
B-3	1	SS1	1.0-2.5	CL	EMBANKMENT FILL	34	92	27	65						
B-3	1	SS3	6.0-7.5	CH	CLAY	21	60	20	40						
B-3	1	SS5	13.5-15.0	CL	CLAY	17	36	16	20						
HISTORIC TESTING BY GEOTECHNOLOGY, INC. IN FEBRUARY 2012															
B-4	4	SS3	6.0-7.5	CH	EMBANKMENT FILL	29	72	23	49						
B-4	4	ST5	11.0-13.0	CH	EMBANKMENT FILL					30	120.9				
B-4	4	ST6	13.0-15.0	CH	CLAY					27	116.8			400	26
B-4	4	ST7	16.0-18.0	CH	CLAY		58	20	38	30	118.3			400	26
B-5	4	ST3	6.0-8.0	CL	EMBANKMENT FILL					25	122.5		1000		
B-5	4	ST4	8.0-10.0	CL	EMBANKMENT FILL					30	118.3			400	26
B-5	4	SS6	13.5-15.0	CL	CLAY	25	44	18	26						
HISTORIC TESTING BY GEOTECHNOLOGY, INC. IN APRIL 2010															
C-1	2	SS3	6.0-7.5	CH	EMBANKMENT FILL	24	52	28	24						
C-1	2	SS4	8.5-10.0	CH	EMBANKMENT FILL	23									
C-1	2	ST5	11.0-13.0	CH	CLAY	14									
C-1	2	ST6	13.5-15.5	CH	CLAY		51	25	26	30	126.1			0	26
C-1	2	ST6	13.5-15.5	CH	CLAY					22	120.8				
C-1	2	SS10	33.5-35.0	CL	CLAY	24	44	18	26						
C-2	3	SS3	6.0-7.5	CL	EMBANKMENT FILL	27	45	17	28						
C-2	3	ST7	18.0-20.0	CH	EMBANKMENT FILL					24	124.0				
C-2	3	ST8	20.0-22.0	CH	CLAY		62	23	39					0	25
C-2	3	SS10	28.5-30.0	CH	CLAY	25	52	20	32						

TABLE IV
SUMMARY OF GROUNDWATER LEVEL MEASUREMENTS
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

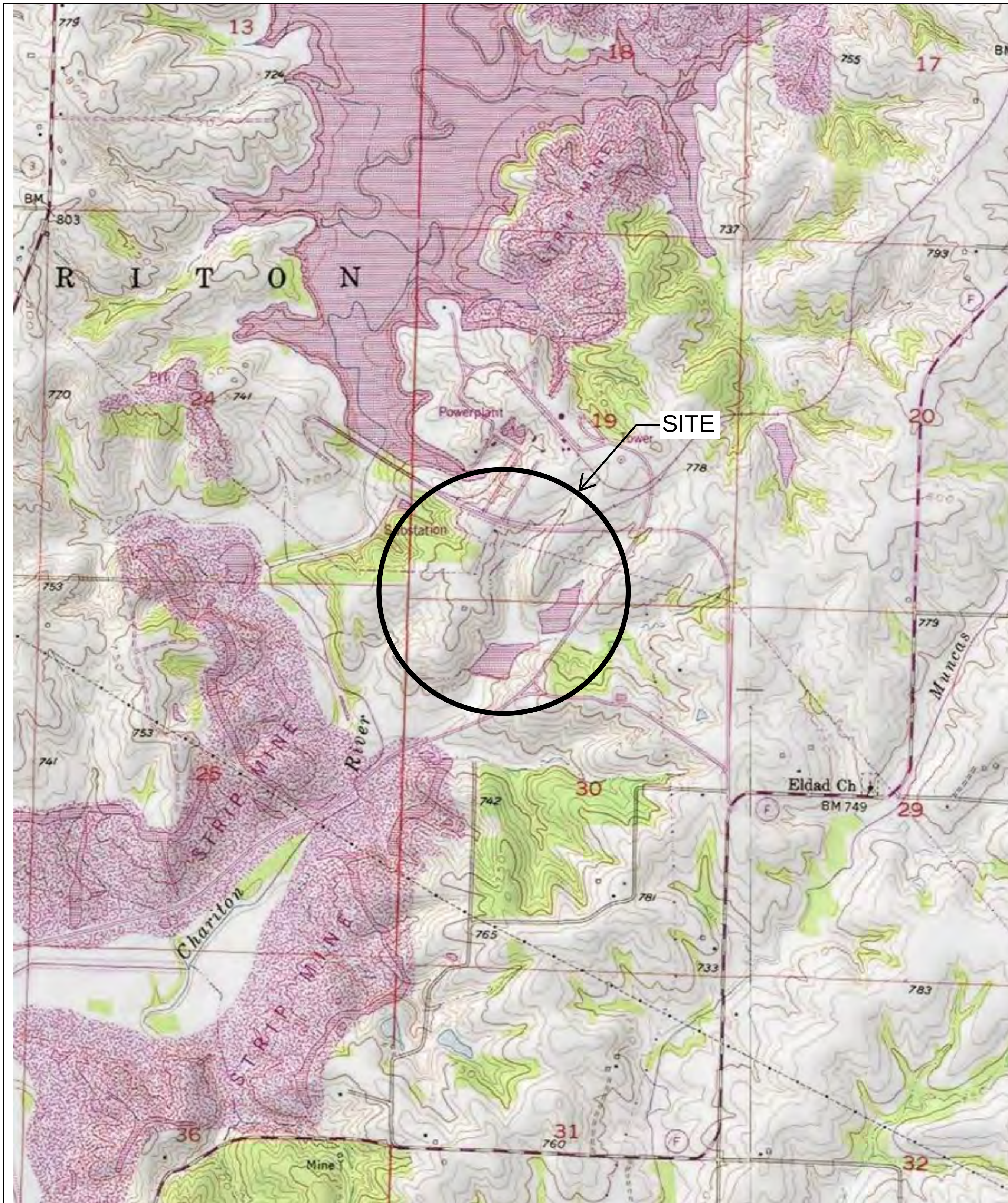
Observation Well Designation	Top of Casing Elevation (ft)[1]	Well Depth (ft)	Measurement Date	Depth to Water[2] (ft)	Groundwater Elevation (ft)	Well Installation Notes
TPZ-3	733.2	28.5	8/28/2015	7.1	726.1	Well installed 8/26/15 by Bulldog Drilling.
			9/16/2015	8.6	724.6	
			9/30/2015	9.3	723.9	
			8/2 to 8/3/16	8.0	725.2	
TPZ-9	716.9	18.0	8/28/2015	3.6	713.2	Well installed 8/24/15 by Bulldog Drilling.
			9/16/2015	3.9	713.0	
			9/30/2015	4.0	712.9	
			8/2 to 8/3/16	3.6	713.2	
TPZ-10	705.2	24.5	8/28/2015	9.5	695.7	Well installed 8/25/15 by Bulldog Drilling.
			9/16/2015	10.6	694.6	
			9/30/2015	14.1	691.1	
			8/2 to 8/3/16	9.8	695.4	
TPZ-11	707.2	19.4	8/28/2015	5.8	701.4	Well installed 8/27/15 by Bulldog Drilling.
			9/16/2015	5.6	701.6	
			9/30/2015	6.7	700.5	
			8/2 to 8/3/16	5.0	702.3	
TPZ-12	691.5	33.9	8/28/2015	3.8	687.7	Well installed 8/19/15 by Bulldog Drilling.
			9/16/2015	4.5	687.1	
			9/30/2015	5.0	686.5	
			8/2 to 8/3/16	4.4	687.1	
TPZ-14	683.7	34.5	8/2 to 8/3/16	6.2	677.6	Well installed 8/2/16 by Bulldog Drilling.
P-1	750.0	10.5	11/7/2011	9.4	740.6	Well installed on 11/7/11 by Geotechnology, Inc.
			11/9/2011	9.3	740.8	
P-2	712.7	23.0	11/8/2011	22.1	690.6	Well installed 11/8/11 by Geotechnology, Inc.
			11/9/2011	12.4	700.3	

Notes:

1) Top of casing elevations of piezometers installed by Bulldog Drilling were determined in the field by Gredell Engineering Resources, Inc. of Jefferson City, Missouri by optical survey, and the elevation data provided are in feet above sea level relative to NGVD29. Top of casing elevations of piezometers installed by Geotechnology, Inc. were taken from boring logs provided by Geotechnology, Inc. and the elevation datum is unknown.

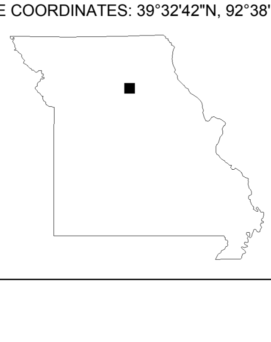
2) Groundwater level readings have been made in the wells at times and under conditions discussed herein. However it must be noted that fluctuations in the level of the groundwater may occur due to variations in season, rainfall, plant sluicing activities, temperature, and other factors not evident at the time measurements were made and reported.

FIGURES



MAP SOURCE: ESRI

SITE COORDINATES: 39°32'42"N, 92°38'14"W



HALEY ALDRICH

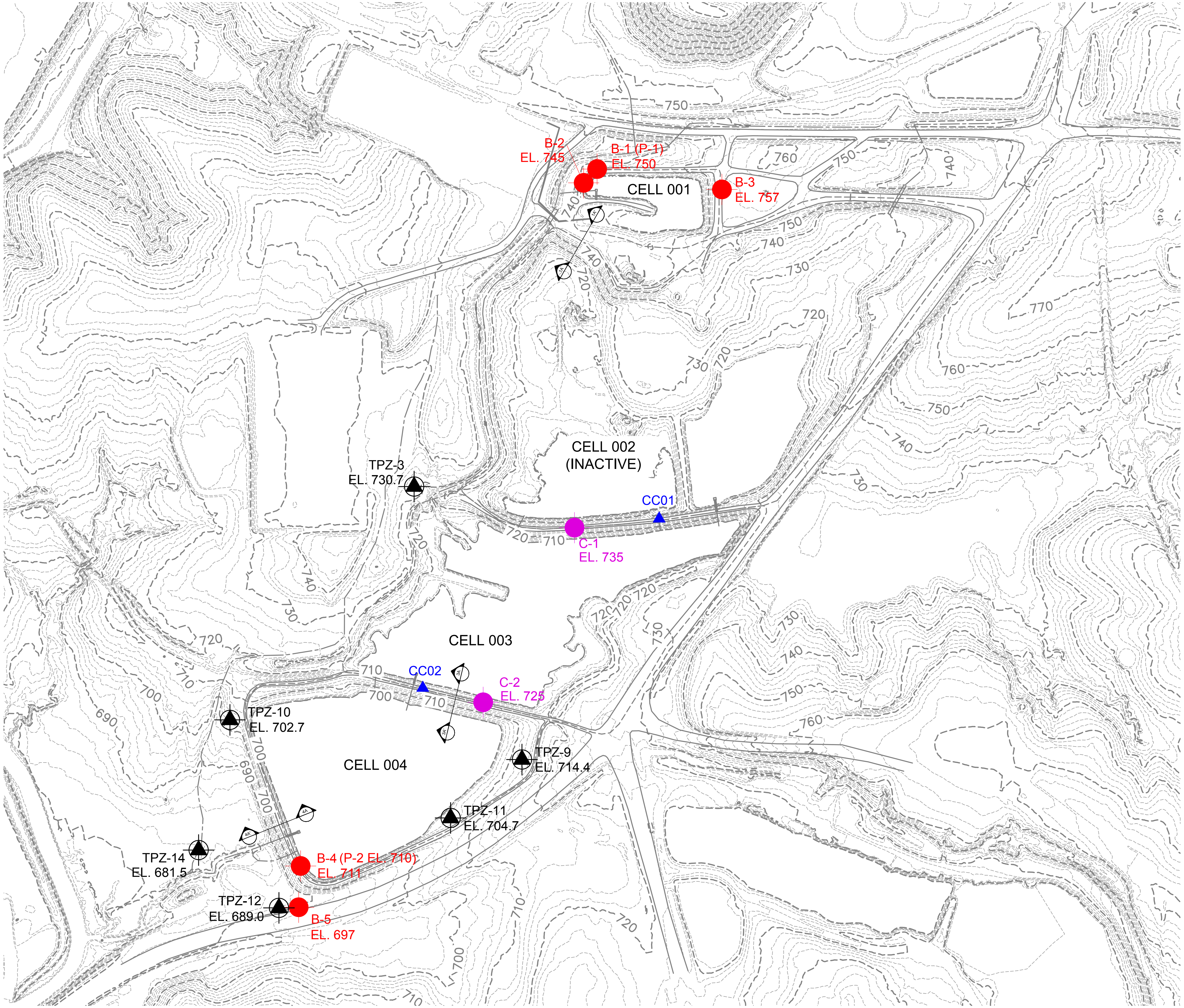
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
OCTOBER 2016

FIGURE 1

40616_000_1_LOCUS.PDF



LEGEND

B-1 (P-1) EL. 750 — DESIGNATION, LOCATION AND GROUND SURFACE ELEVATION OF TEST BORINGS PERFORMED BY GEOTECHNOLOGY, INC. OF ST. LOUIS, MISSOURI DURING THE PERIOD NOVEMBER 7 TO NOVEMBER 8, 2011. A "P" DESIGNATION INDICATES TEMPORARY PIEZOMETER WAS INSTALLED IMMEDIATELY ADJACENT TO CORRESPONDING TEST BORING.

CC-1 — DESIGNATION AND APPROXIMATE LOCATION OF CONE PENETROMETER SOUNDING PERFORMED BY STRATIGRAPHIC, INC. OF PROPHETSTOWN, ILLINOIS ON FEBRUARY 3, 2010.

C-1 EL. 735 — DESIGNATION AND APPROXIMATE LOCATION OF TEST BORINGS PERFORMED BY GEOTECHNOLOGY, INC. OF ST. LOUIS, MISSOURI DURING THE PERIOD JANUARY 13 TO 14, 2010.

TPZ-1 EL. 750.5 — DESIGNATION, LOCATION, AND GROUND SURFACE ELEVATION OF PIEZOMETERS INSTALLED BY BULLDOG DRILLING OF DUPO, ILLINOIS DURING THE PERIOD OF AUGUST 19, 2015 TO AUGUST 27, 2015 AND AUGUST 2, 2016 TO AUGUST 3, 2016.

SLOPE STABILITY CROSS-SECTION

NOTES

1. AERIAL SURVEY USED TO DEVELOP TOPOGRAPHY WAS PERFORMED BY PICTOMETRY INTERNATIONAL CORP. OF ROCHESTER, NEW YORK BETWEEN FEBRUARY 29,2016 AND APRIL 11, 2016.
   - HORIZONTAL CONTROL IS MISSOURI STATE PLANE NORTH COORDINATE SYSTEM (NAD 83).
   - ELEVATIONS IN THIS DRAWING ARE SHOWN IN FEET. THE VERTICAL DATUM FOR GROUND SURFACE ELEVATION CONTOUR LINES IS NGVD 29.
2. AS DRILLED LOCATIONS AND GROUND SURFACE ELEVATIONS OF PIEZOMETERS INSTALLED BY BULLDOG DRILLING WERE SURVEYED BY GREDELL RESOURCES ENGINEERING, INC. OF JEFFERSON CITY, MISSOURI BY OPTICAL SURVEY.
3. AS-DRILLED LOCATIONS OF TEST BORINGS PERFORMED BY GEOTECHNOLOGY, INC. AND CONE PENETROMETER SOUNDINGS PERFORMED BY STRATIGRAPHICS, INC. HAVE BEEN APPROXIMATED. GROUND SURFACE ELEVATIONS OF TEST BORINGS PERFORMED BY GEOTECHNOLOGY, INC. ARE FROM BORING LOGS PREPARED BY GEOTECHNOLOGY, INC.
4. TECHNICAL MONITORING OF PIEZOMETERS INSTALLED BY BULLDOG DRILLING WAS PERFORMED BY HALEY & ALDRICH.
5. TECHNICAL MONITORING OF SUBSURFACE EXPLORATIONS PERFORMED BY GEOTECHNOLOGY, INC. AND STRATIGRAPHICS, INC. WAS PERFORMED BY OTHERS.

0 400 800
SCALE IN FEET

HALEY ALDRICH

ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MO

SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
OCTOBER 2016

FIGURE 2

APPENDIX A

Historic Test Boring Logs and Laboratory Test Results

Surface Elevation: 750 Completion Date: 11/7/11

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	FILL: tan clay with sand, gravel, and slag			
			2-3-5	SS1
			110 111	ST2
5			115	ST3
			1-3-5	SS4
10	black slag layer			
12	Stiff, brown and gray CLAY, trace sand and gravel - CH (TILL)			
15			1-6-7	SS5
17	Stiff, orange to green, shaley CLAY - CH			
			3-4-5	SS6
20	Boring terminated at 20 feet.			
25				
30				
35				

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 ▯ - SV

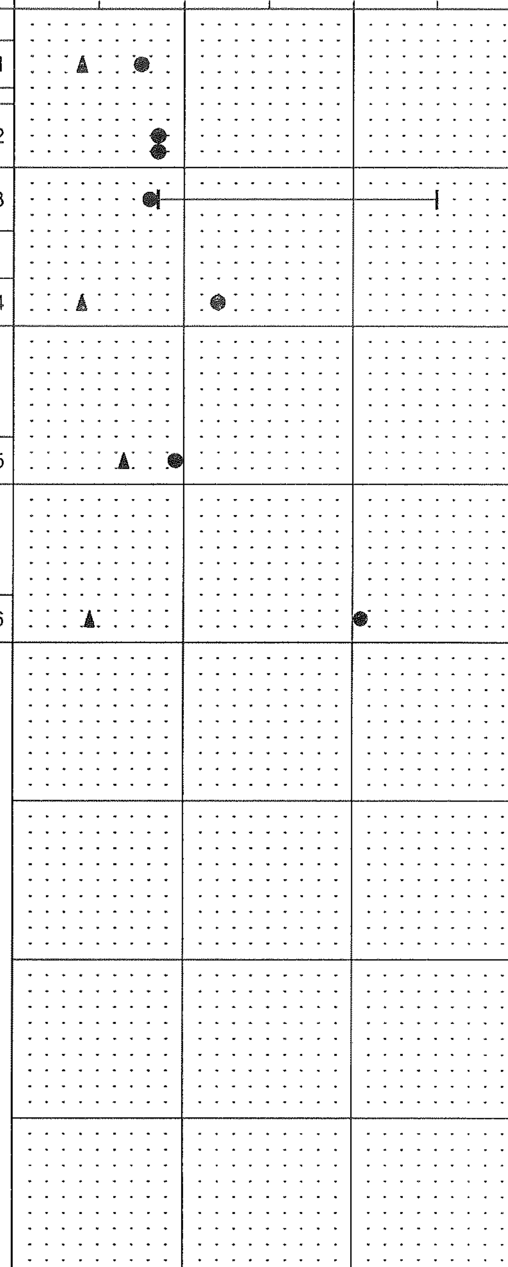
0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE
▲ N-VALUE (BLOWS PER FOOT)
(ASTM D 1586)

WATER CONTENT, %

PL ├──●──┤ LL

10 20 30 40 50



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 9.5 FEET ▽

AT 9.25 FEET AFTER 48 HOURS ▼

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER EED LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS: Multi-point consolidated-undrained triaxial compression test conducted on ST2 and ST3.

Drawn by: KA	Checked by: [signature]	App'vd. by: MHM
Date: 11/16/11	Date: 12/15/11	Date: 12/15/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Slag Dewatering Basin
Thomas Hill Energy Center

LOG OF BORING: B-1

Project No. J011309.02

LOG OF BORING 2002 WL J011309.02 - AECI B1-3.GPJ 00 CLONE ME.GPJ 12/15/11

Surface Elevation: 745

Datum msl

Completion Date: 11/8/11

SHEAR STRENGTH, tsf: Δ - UU/2, O - QU/2, ▯ - SV (0.5, 1.0, 1.5, 2.0, 2.5)

STANDARD PENETRATION RESISTANCE ▲ N-VALUE (BLOWS PER FOOT) (ASTM D 1586)

WATER CONTENT, % PL ⊢—●—⊣ LL (10, 20, 30, 40, 50)

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	FILL: tan clay with gravel and slag		
		1-2-4	SS1
		1-2-3	SS2
5	∇		ST3
	Stiff, brown and gray CLAY, trace sand and gravel - (CH) (TILL)	100 99 100	ST4 (65 >>)
10		108	ST5
	Medium stiff, orange and green, shaley CLAY - CH		
15		1-2-5	SS6
16	Auger refusal at 16 feet.	50/3"	SS7 (S-3")

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 5.5 FEET ∇

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER EED LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS: Multi-point consolidated-undrained triaxial compression test conducted on ST4.

Drawn by: KA	Checked by: DRB	App'vd. by: MHM
Date: 11/16/11	Date: 12/12/11	Date: 12/13/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Slag Dewatering Basin
Thomas Hill Energy Center

LOG OF BORING: B-2

Project No. J011309.02

Surface Elevation: 757 | Completion Date: 11/8/11

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES	SHEAR STRENGTH, tsf / STANDARD PENETRATION RESISTANCE / WATER CONTENT, %
0	FILL: blackish-brown clay with sand, gravel, and slag		1-2-3	SS1	92
3	Stiff, orange-brown to brown and gray CLAY, trace sand and gravel - (CH) (TILL)		1-5-6	SS2	
5			1-3-7	SS3	60
10			3-4-7	SS4	
12	Stiff, brown and gray to tan, silty CLAY, trace sand and gravel - (CL) (TILL)		1-5-6	SS5	
19	tan		4-5-6	SS6	
20	Boring terminated at 20 feet.				

Legend: Δ - UU/2, O - QU/2, ▯ - SV; shear strength scale 0.5, 1.0, 1.5, 2.0, 2.5

▲ N-VALUE (BLOWS PER FOOT) (ASTM D 1586)

Water content: PL ⊢—●—⊣ LL; scale 10, 20, 30, 40, 50

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

PH DRILLER EED LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KA	Checked by: [signature]	App'vd. by: MHM
Date: 11/16/11	Date: 12/12/11	Date: 12/13/11

GEOTECHNOLOGY INC FROM THE GROUND UP

Slag Dewatering Basin
Thomas Hill Energy Center

LOG OF BORING: B-3

Project No. J011309.02

Surface Elevation: 711 | Completion Date: 11/8/11

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	FILL: brown to tan clay, some to trace gravel with depth		0-3-4	SS1
			2-3-4	SS2
5			1-2-3	SS3
10	▼		1-1-3	SS4
			93	ST5
	Stiff, tan and gray CLAY, trace sand and gravel (CH)		92	ST6
15			91	ST7
			4-5-6	SS8
20	Stiff, blackish-gray, silty CLAY, trace gravel - CL		1-3-6	SS9
25	Soft, tan, highly to moderately weathered SILTSTONE		26-38-30	SS10
30			20-50/4"	SS11
35	Sampler refusal at 34.3 feet.			

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 ▯ - SV

0.5 1.0 1.5 2.0 2.5

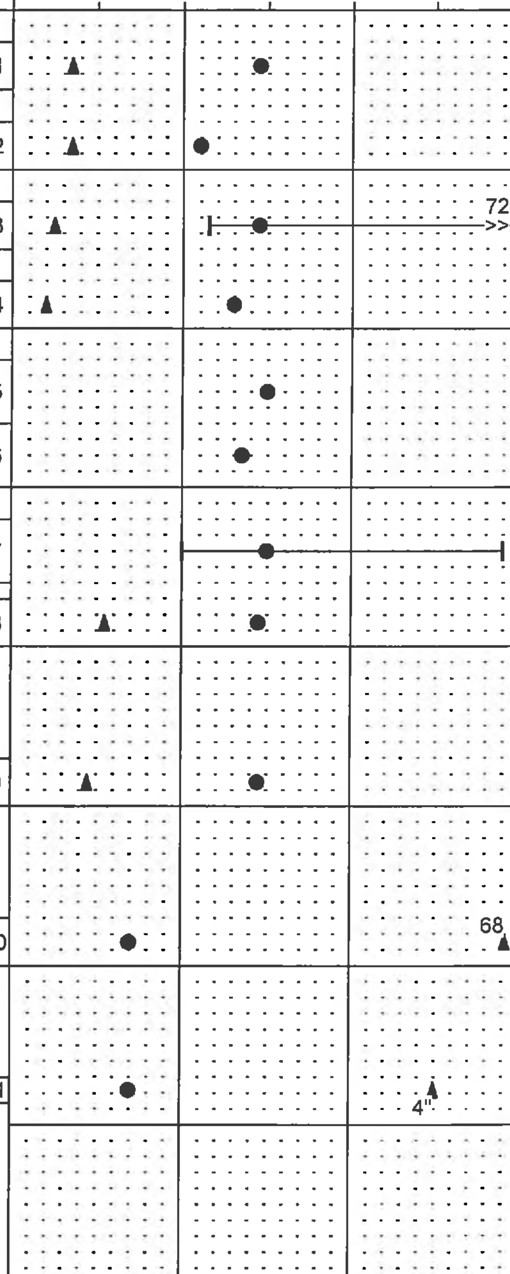
STANDARD PENETRATION RESISTANCE

▲ N-VALUE (BLOWS PER FOOT) (ASTM D 1586)

WATER CONTENT, %

PL ├──●──┤ LL

10 20 30 40 50



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

AT 9.7 FEET AFTER 24 HOURS ▼

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER EED LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS: Multi-point consolidated-undrained triaxial test conducted on ST6 and ST7.

Drawn by: KA	Checked by: DFB	App'vd. by: MHM
Date: 11/16/11	Date: 12/15/11	Date: 12/15/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ash Pond No. 3
Thomas Hill Energy Center

LOG OF BORING: B-4

Project No. J011309.02

LOG OF BORING 2002 WL J011309.02 - AECI B4-5.GPJ 00 CLONE ME.GPJ 12/15/11

Surface Elevation: 697 | Completion Date: 11/8/11

Datum msl

SHEAR STRENGTH, tsf: Δ - UU/2 | O - QU/2 | ☐ - SV (0.5, 1.0, 1.5, 2.0, 2.5)

STANDARD PENETRATION RESISTANCE ▲ N-VALUE (BLOWS PER FOOT) (ASTM D 1586)

WATER CONTENT, % PL |—●—| LL (10, 20, 30, 40, 50)

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	FILL: gray and brown clay, some gravel and coal			
			3-4-3	SS1
			3-5-4	SS2
5				
			98	ST3
			91	ST4
10	Medium stiff to soft, blackish-gray, silty CLAY, trace gravel - (CL)			
			1-2-4	SS5
			1-1-2	SS6
15	∇			
			1-1-2	SS7
20				
	some sand		0-1-2	SS8
25				
	Soft, gray, highly to moderately weathered SHALE			
			12-30 -50/4"	SS9
30	Sampler refusal at 29.7 feet.			
35				

80 / 10"

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 15 FEET ∇

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER EED LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KA	Checked by: NFB	App'vd. by: MHM
Date: 11/16/11	Date: 12/13/11	Date: 12/17/11

GEOTECHNOLOGY INC FROM THE GROUND UP

Ash Pond No. 3
Thomas Hill Energy Center

LOG OF BORING: B-5

Project No. J011309.02

Surface Elevation: 735

Datum msl

Completion Date: 1/13/10

SHEAR STRENGTH, tsf: Δ - UU/2 ○ - QU/2 ▯ - SV (0.5, 1.0, 1.5, 2.0, 2.5)

STANDARD PENETRATION RESISTANCE (ASTM D 1586) ▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, % PL ├─●─┤ LL (10, 20, 30, 40, 50)

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Crushed rock, slag and fly ash	4-4-6	SS1
2	FILL: brown and gray clay, trace silt and sand	3-4-4	SS2
5		3-4-5	SS3
		4-5-6	SS4
11	Very stiff, yellow, brown and gray CLAY - (CH)		ST5
15		97 99	ST6
17	Medium stiff to stiff, brown and gray CLAY with sand and gravel - CH	3-5-7	SS7
25		3-3-4	SS8
30		3-4-5	SS9
32	Stiff to medium stiff, gray, silty CLAY - (CL)	5-7-7	SS10
40		2-4-4	SS11

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 40 FEET

BS DRILLER RFW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: SK	App'vd. by: MHM
Date: 1/20/10	Date: 4/6/10	Date: 4/19/10

GEOTECHNOLOGY INC FROM THE GROUND UP

Thomas Hill
Ash Pond Evaluation

LOG OF BORING: C-1

Project No. J011309.01

Surface Elevation: 735 | Completion Date: 1/13/10

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES	N-VALUE (BLOWS PER FOOT)	WATER CONTENT, %
	Stiff to medium stiff, gray, silty CLAY - (CL) *(continued)*					
	Medium stiff to stiff, brown and gray CLAY, trace sand - CH					
			2-3-3	SS12	▲	●
45						
			3-4-4	SS13	▲	●
50	Boring terminated at 50 feet.					
55						
60						
65						
70						
75						

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 ▯ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE (ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL ├──●──┤ LL

10 20 30 40 50

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 40 FEET

BS DRILLER RFW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: SK	App'vd. by: MHM
Date: 1/20/10	Date: 4/6/10	Date: 4/19/10

GEOTECHNOLOGY INC

FROM THE GROUND UP

Thomas Hill
Ash Pond Evaluation

CONTINUATION OF
LOG OF BORING: C-1

Project No. J011309.01

Surface Elevation: 725 | Completion Date: 1/14/10

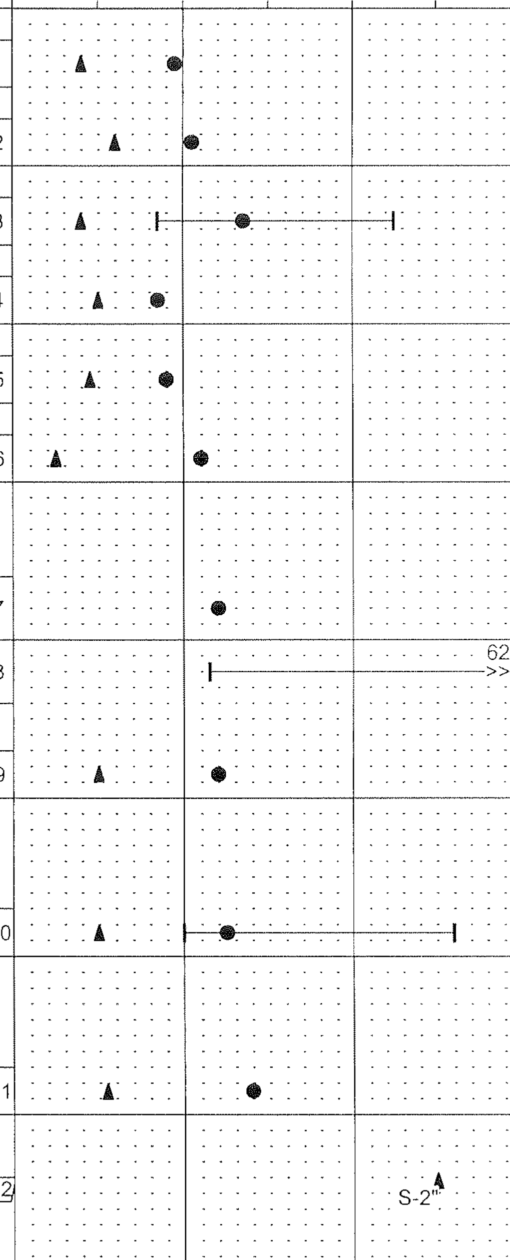
Datum: msl

SHEAR STRENGTH, tsf: Δ - UU/2, ○ - QU/2, □ - SV (0.5, 1.0, 1.5, 2.0, 2.5)

STANDARD PENETRATION RESISTANCE (ASTM D 1586) ▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, % PL |—●—| LL (10, 20, 30, 40, 50)

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Crushed rock and gravel		
	FILL: clay, sand and gravel		
	FILL: brown and gray clay with sand, trace gravel	5-4-4	SS1
		5-6-6	SS2
5	FILL: brown and gray, silty clay	4-4-4	SS3
		4-5-5	SS4
10	FILL: gray clay, trace silt, sand and gravel	3-4-5	SS5
		2-2-3	SS6
15		100	ST7
20	Stiff, brown and gray CLAY, trace sand - (CH)		ST8
		4-4-6	SS9
25		5-5-5	SS10
30		5-5-6	SS11
35	Weathered LIMESTONE		
	Auger and sampler refusal at 37.2 feet.	50/2"	SS12



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

BS DRILLER RFW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: SK	App'vd. by: MHM
Date: 1/20/10	Date: 4/6/10	Date: 4/19/10

GEOTECHNOLOGY INC
FROM THE GROUND UP

Thomas Hill
Ash Pond Evaluation

LOG OF BORING: C-2

Project No. J011309.01

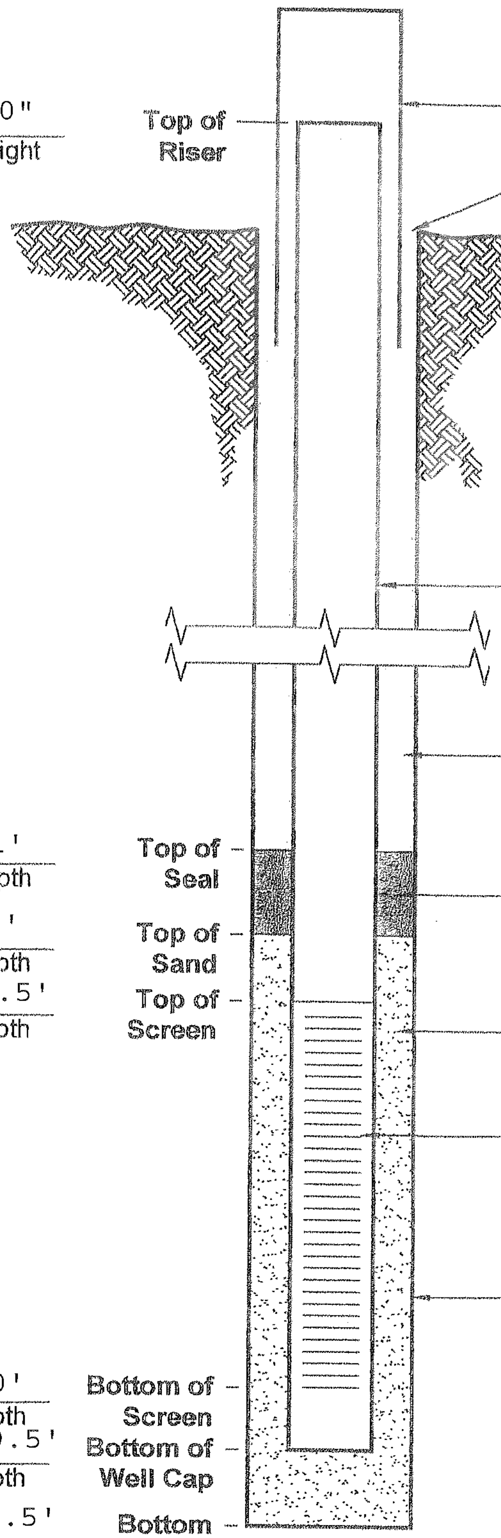
LOG OF BORING 2002 WL 11309.01 - ASH POND.GPJ GTINC 0638301.GPJ 4/20/10

PROJECT: AECI Thomas Hill Energy Center
Slag Dewatering Basin

NUMBER: J011309.02

P-1

Date Installed: 11/7/11
Date Developed: 11/7/11



Elev.	Height / Depth	
750	0" (Height)	Top of Riser
749	1'	Top of Seal
746	4'	Top of Sand
744.5	5.5'	Top of Screen
740	10'	Bottom of Screen
739.5	10.5'	Bottom of Well Cap
739.5	10.5'	Bottom of Hole

Protective Cover: Flush-mount
Location: P-1
Ground Elevation: 750 , Datum: msl
Determined By: 2005 topographic survey

WELL WATER LEVELS

DATE	DEPTH	REMARKS
11/7	9.4	after installation
11/9	9.25	

depth measured from top of riser

Riser Type: Schedule 40 PVC
Diameter: 2 inches
Length: 5 ft.

Backfill: holeplug bentonite

Seal: holeplug bentonite

Sand: Filtersil

Screen Diameter: 2"
Type: Schedule 40 PVC
Slot Size: 0.01 inch

Borehole Diameter: 8"
Drill Method: hollow-stem auger

REMARKS: Offset 5' west of Boring B-1

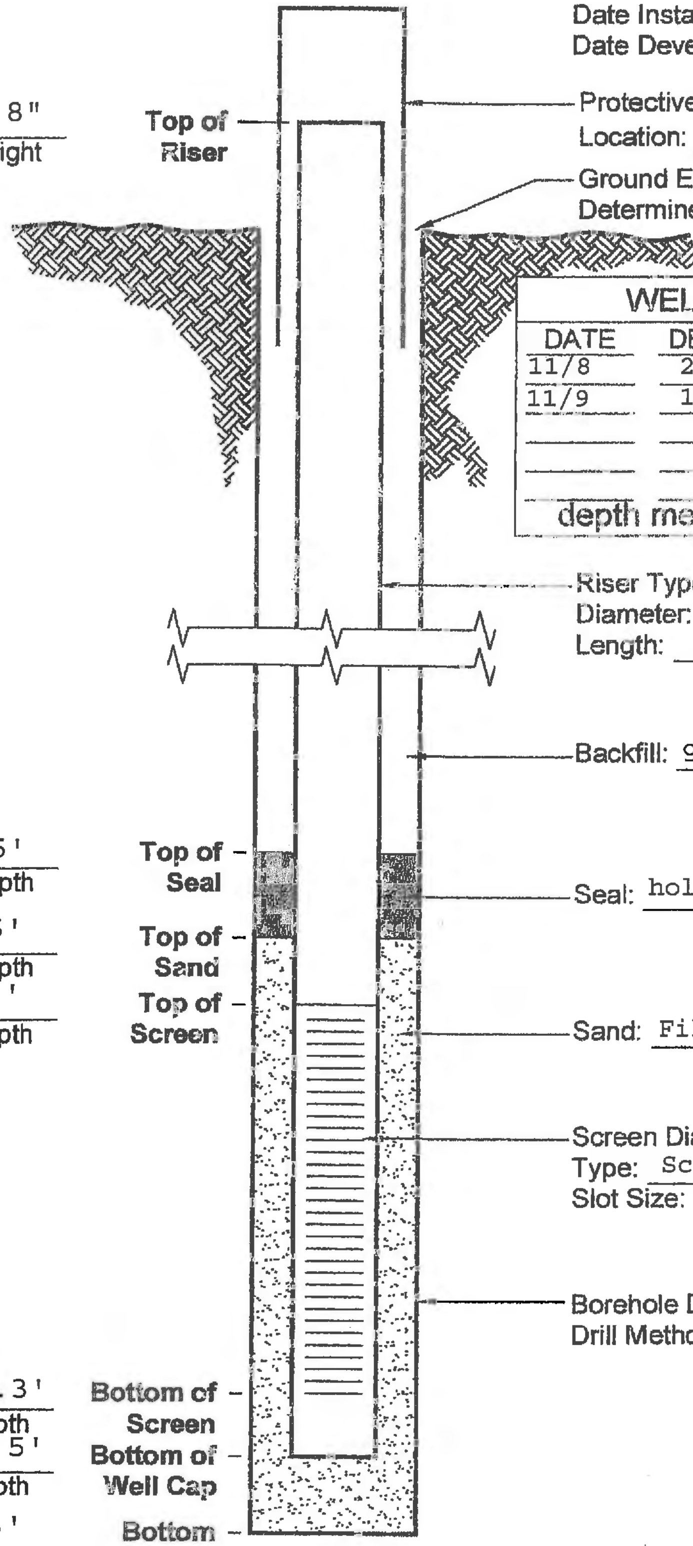
PIEZOMETER SCHEMATIC DIAGRAM

GEOTECHNOLOGY INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
ST. LOUIS • COLLINSVILLE

PROJECT: AECI Thomas Hill Energy Center
Ash Pond No.3

NUMBER: J011309.02

P-2



Date Installed: 11/8/11
Date Developed: 11/8/11

Protective Cover: None
Location: P-2
Ground Elevation: 710, Datum: msl
Determined By: 2005 topographic survey

Elev.	Height / Depth	
712.7	2'8" (Height)	Top of Riser
705	5'	Top of Seal
695	15'	Top of Sand
693	17'	Top of Screen
687.7	22.3'	Bottom of Screen
687.5	22.5'	Bottom of Well Cap
687	23'	Bottom of Hole

WELL WATER LEVELS

DATE	DEPTH	REMARKS
11/8	22.1	2 hrs. after installation
11/9	12.4	

depth measured from top of riser

Riser Type: Schedule 40 PVC
Diameter: 2 inches
Length: 15 ft.

Backfill: grout

Seal: holeplug bentonite

Sand: Filtersil

Screen Diameter: 2"
Type: Schedule 40 PVC
Slot Size: 0.01 inch

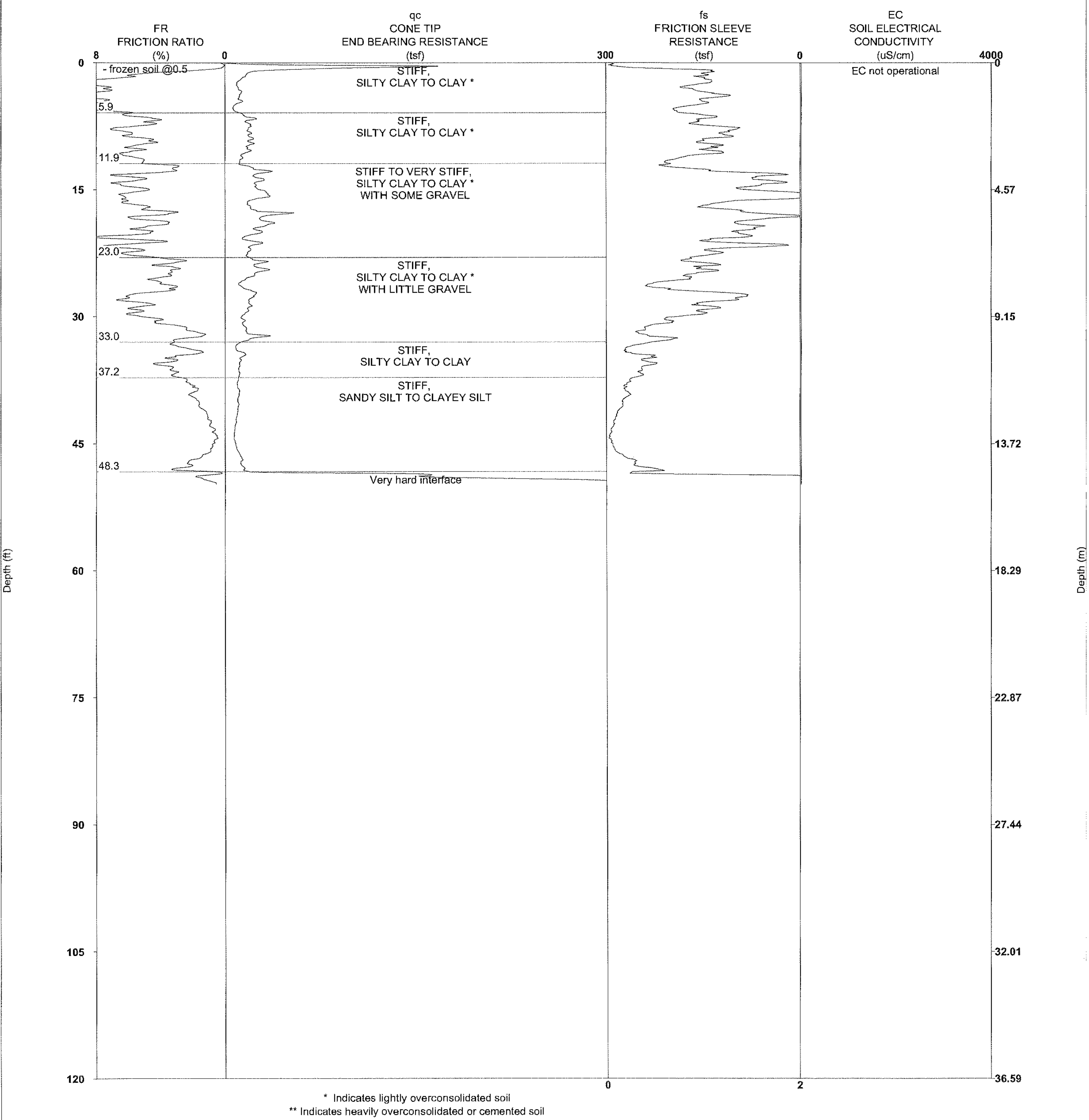
Borehole Diameter: 8"
Drill Method: hollow-stem auger

REMARKS: Offset 5' south of Boring B-4

PIEZOMETER SCHEMATIC DIAGRAM

GEOTECHNOLOGY INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
ST. LOUIS • COLLINSVILLE

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



* Indicates lightly overconsolidated soil
** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54378 Longitude: -92.63682

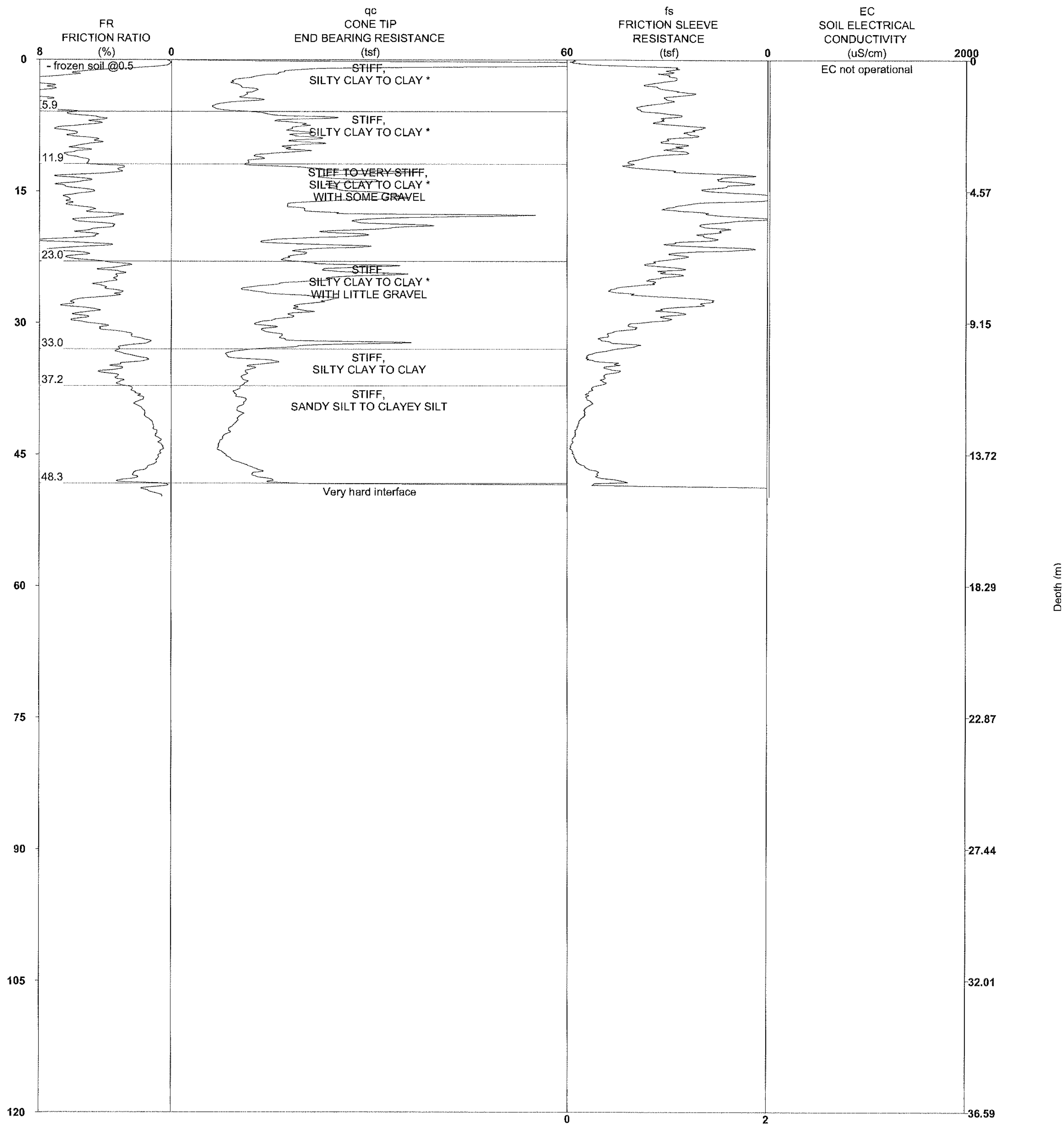
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:8:59 AM
SOUNDING NUMBER:CC-01

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



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Latitude: 39.54378 Longitude: -92.63682

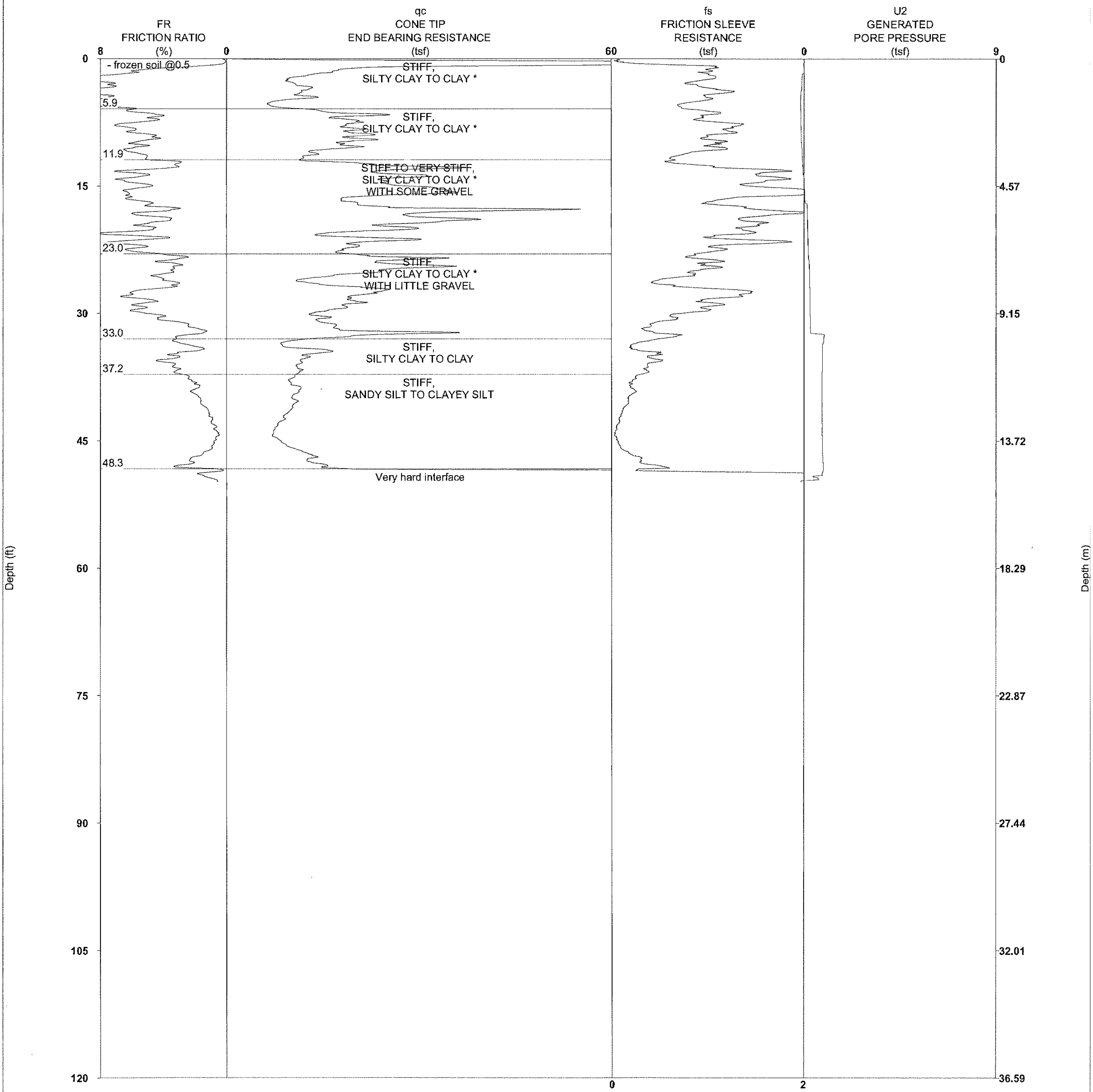
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:8:59 AM
SOUNDING NUMBER:CC-01

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



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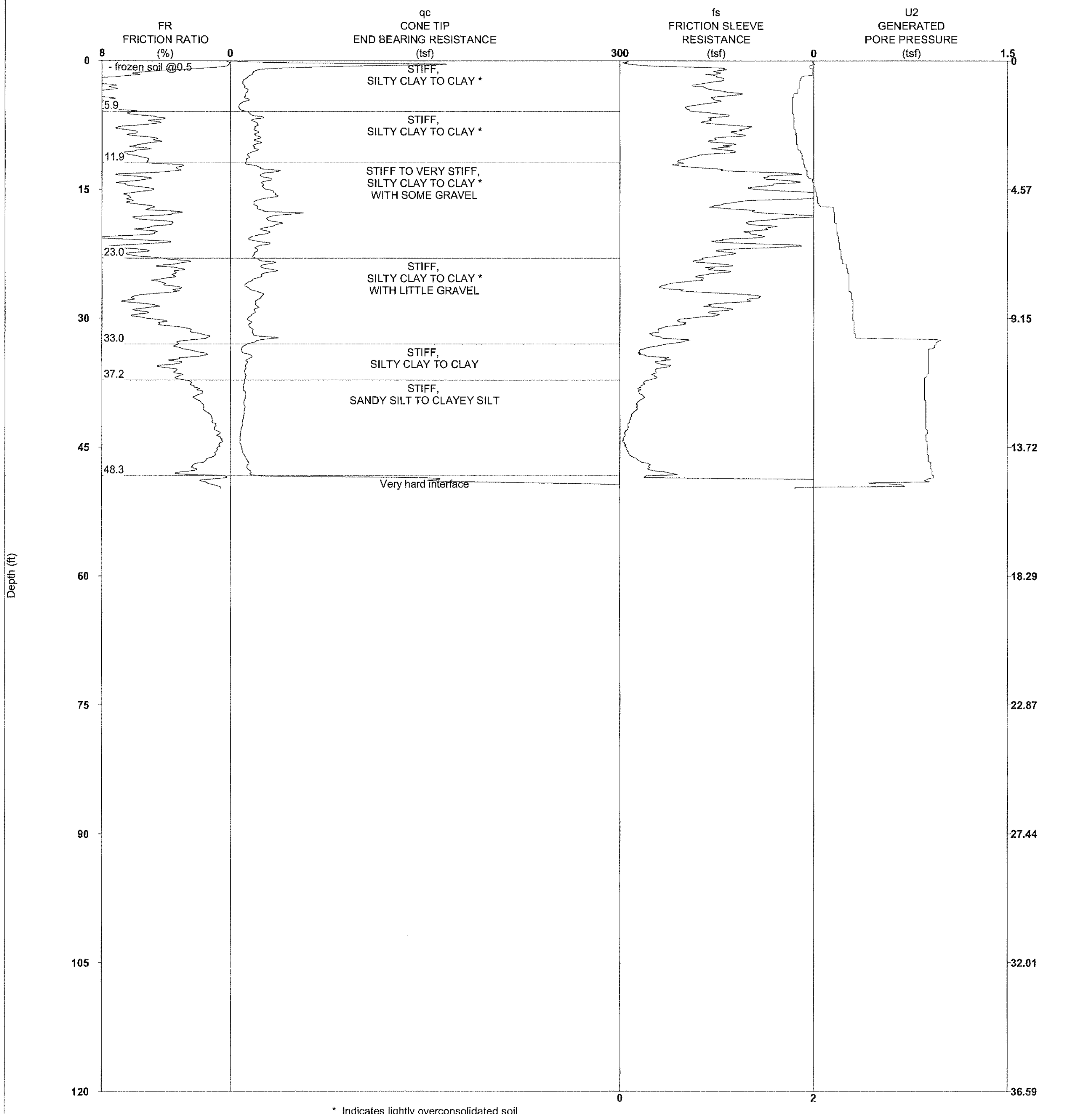
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:8:59 AM
SOUNDING NUMBER:CC-01

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



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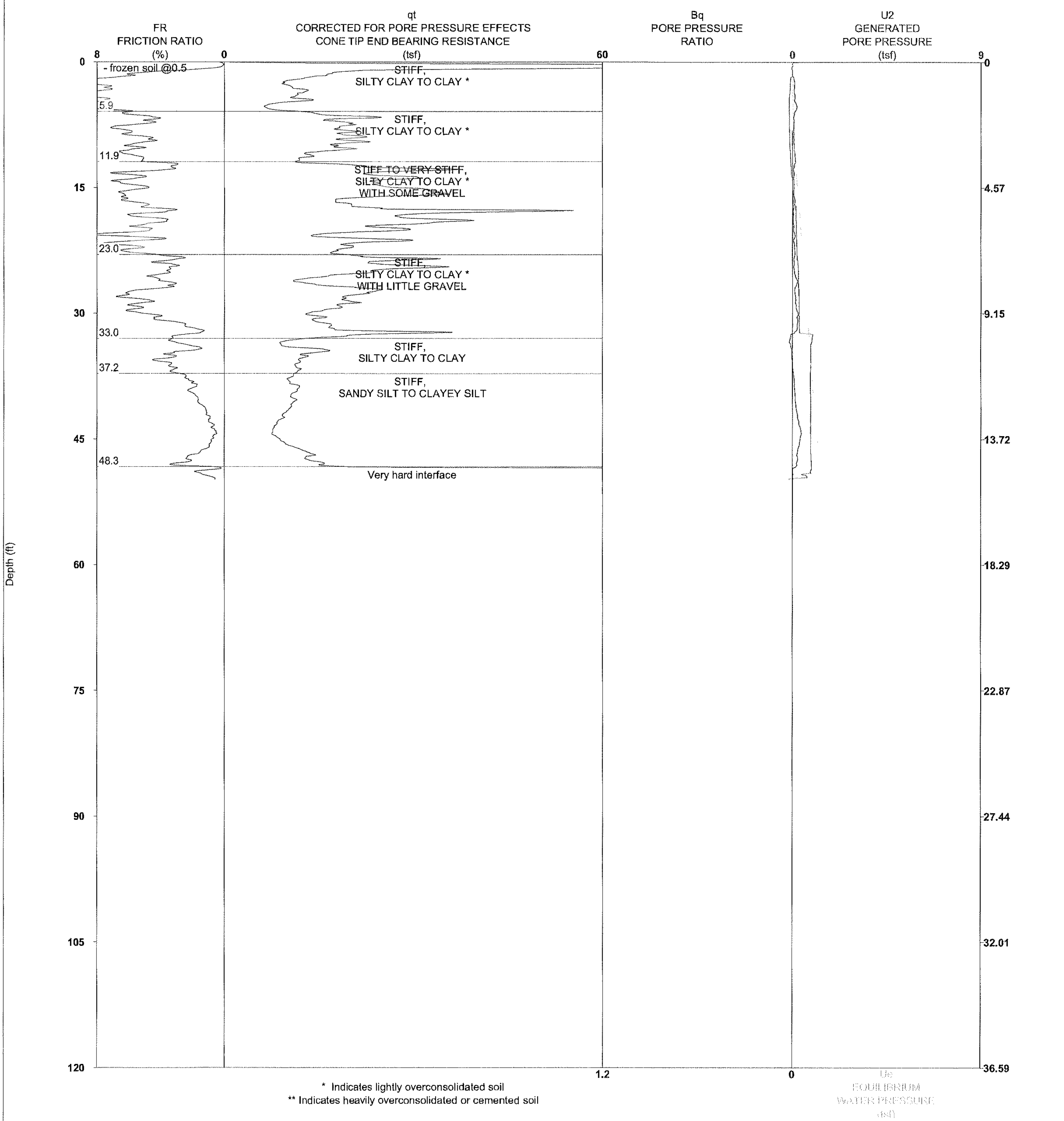
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:8:59 AM
SOUNDING NUMBER:CC-01

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



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Latitude: 39.54378 Longitude: -92.63682

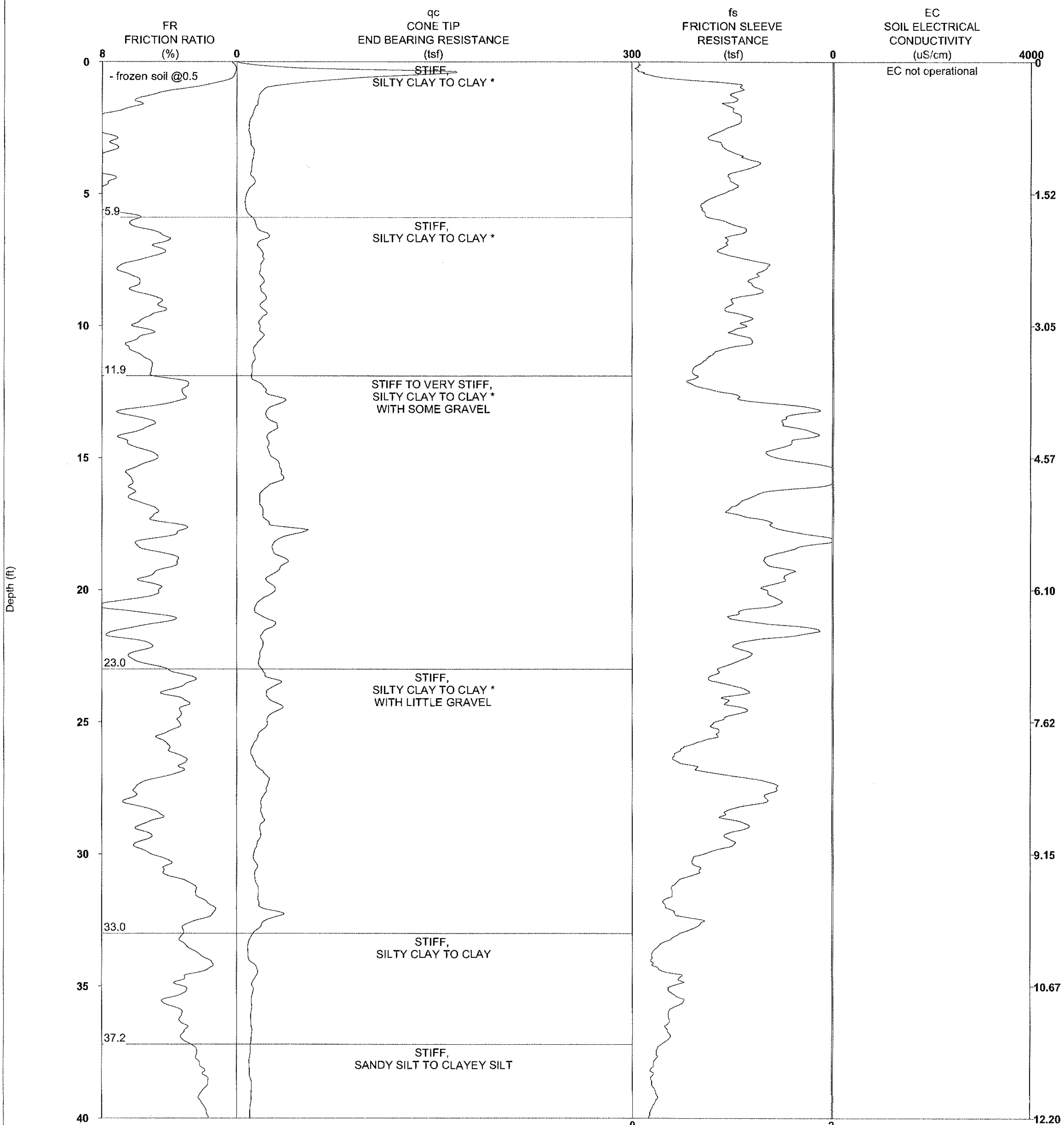
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:8:59 AM
SOUNDING NUMBER:CC-01

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



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Latitude: 39.54378 Longitude: -92.63682

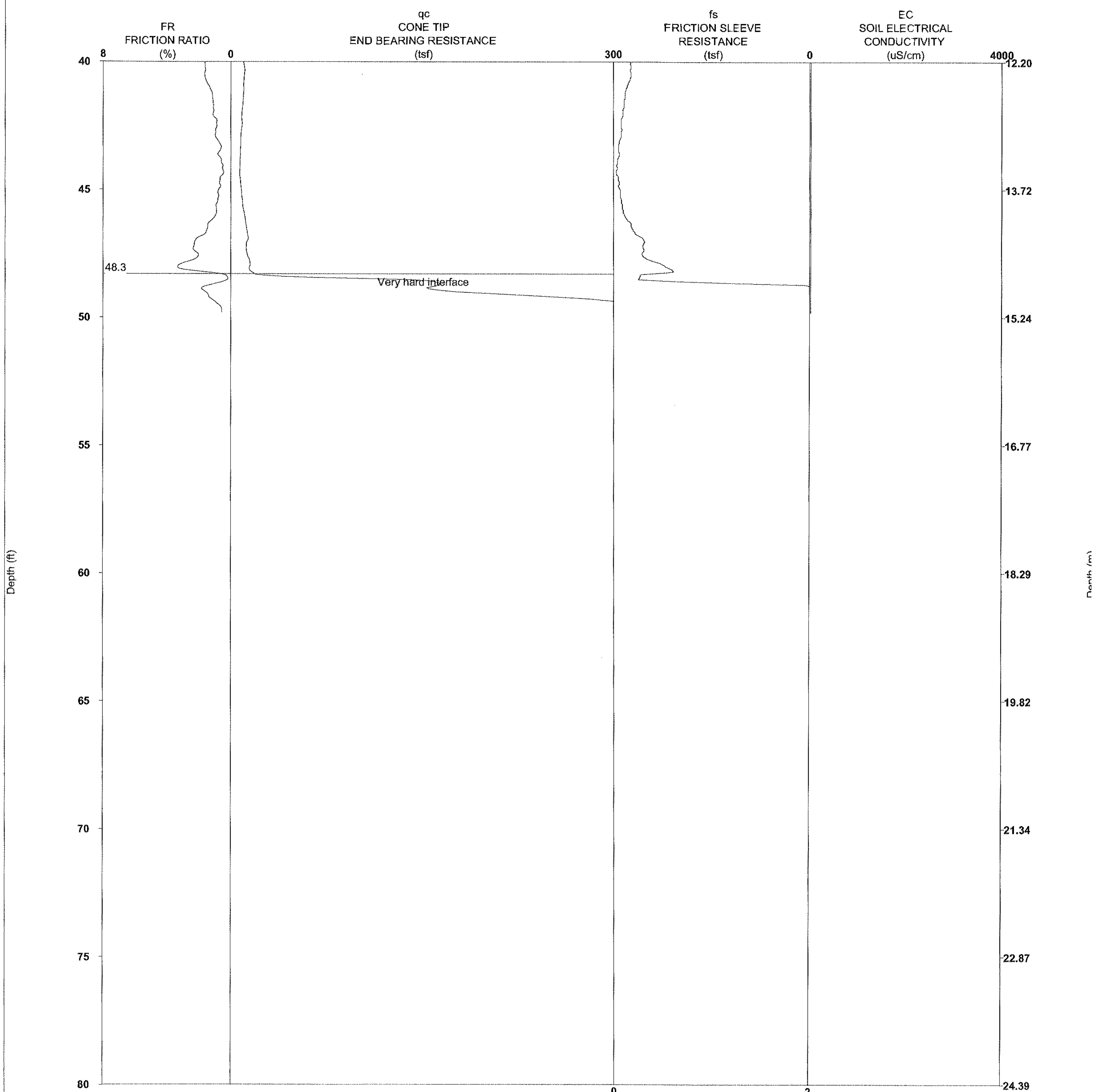
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:8:59 AM
SOUNDING NUMBER:CC-01

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



* Indicates lightly overconsolidated soil
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Latitude: 39.54378 Longitude: -92.63682

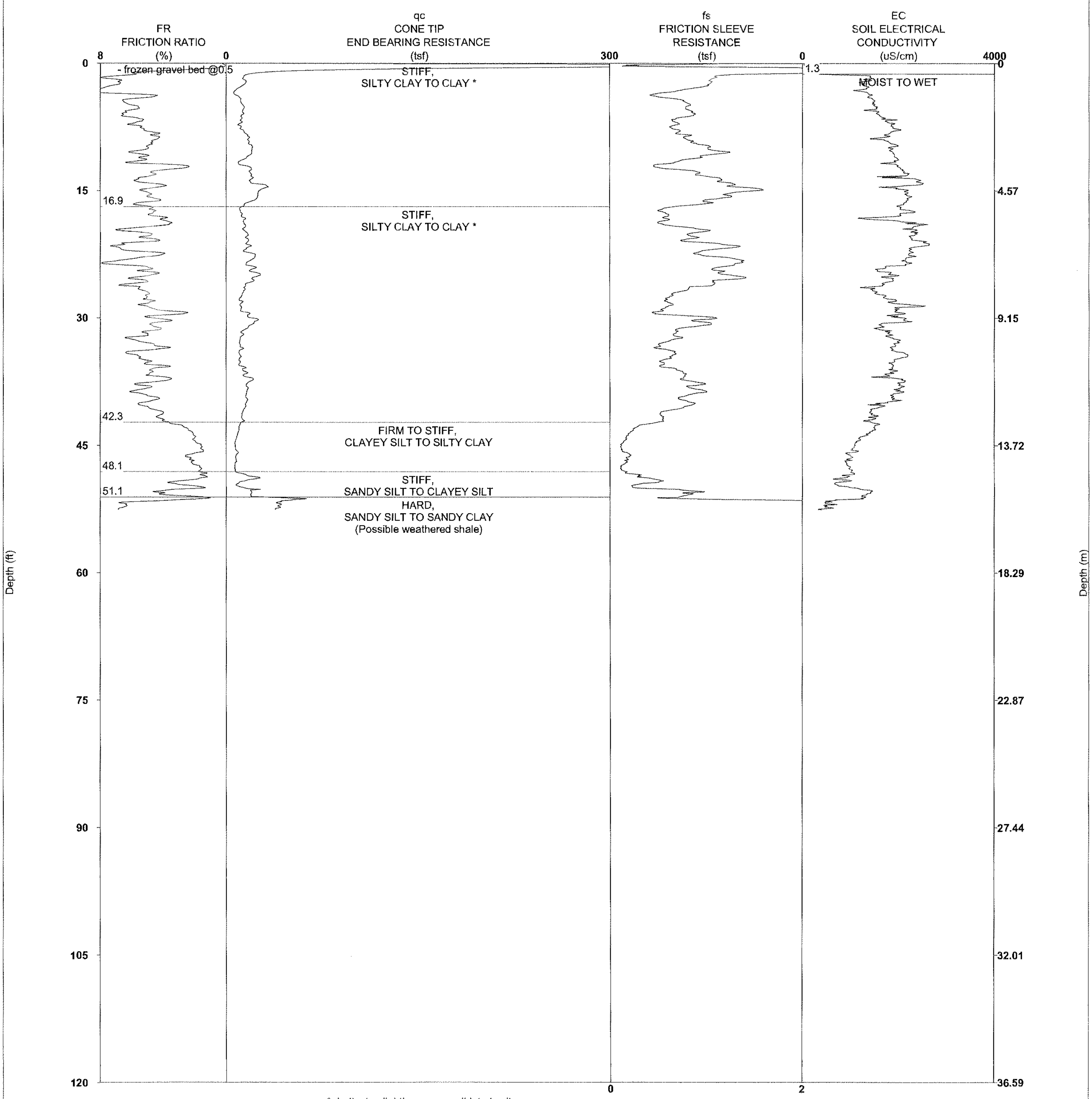
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:8:59 AM
SOUNDING NUMBER:CC-01

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



* Indicates lightly overconsolidated soil

** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54198 Longitude: -92.63939

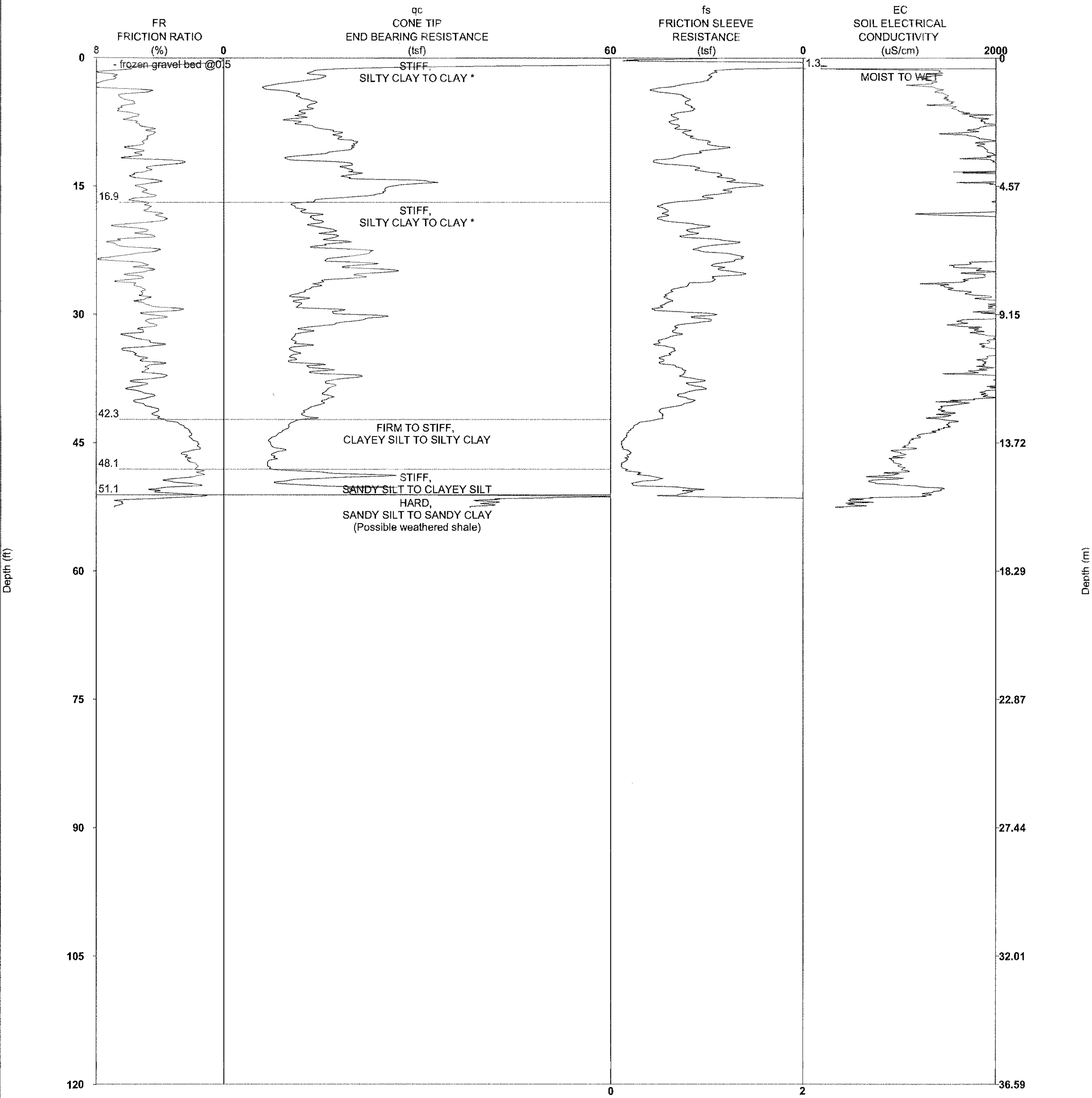
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:11:16 AM
SOUNDING NUMBER:CC-02

CPCC02

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



* Indicates lightly overconsolidated soil
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Latitude: 39.54198 Longitude: -92.63939

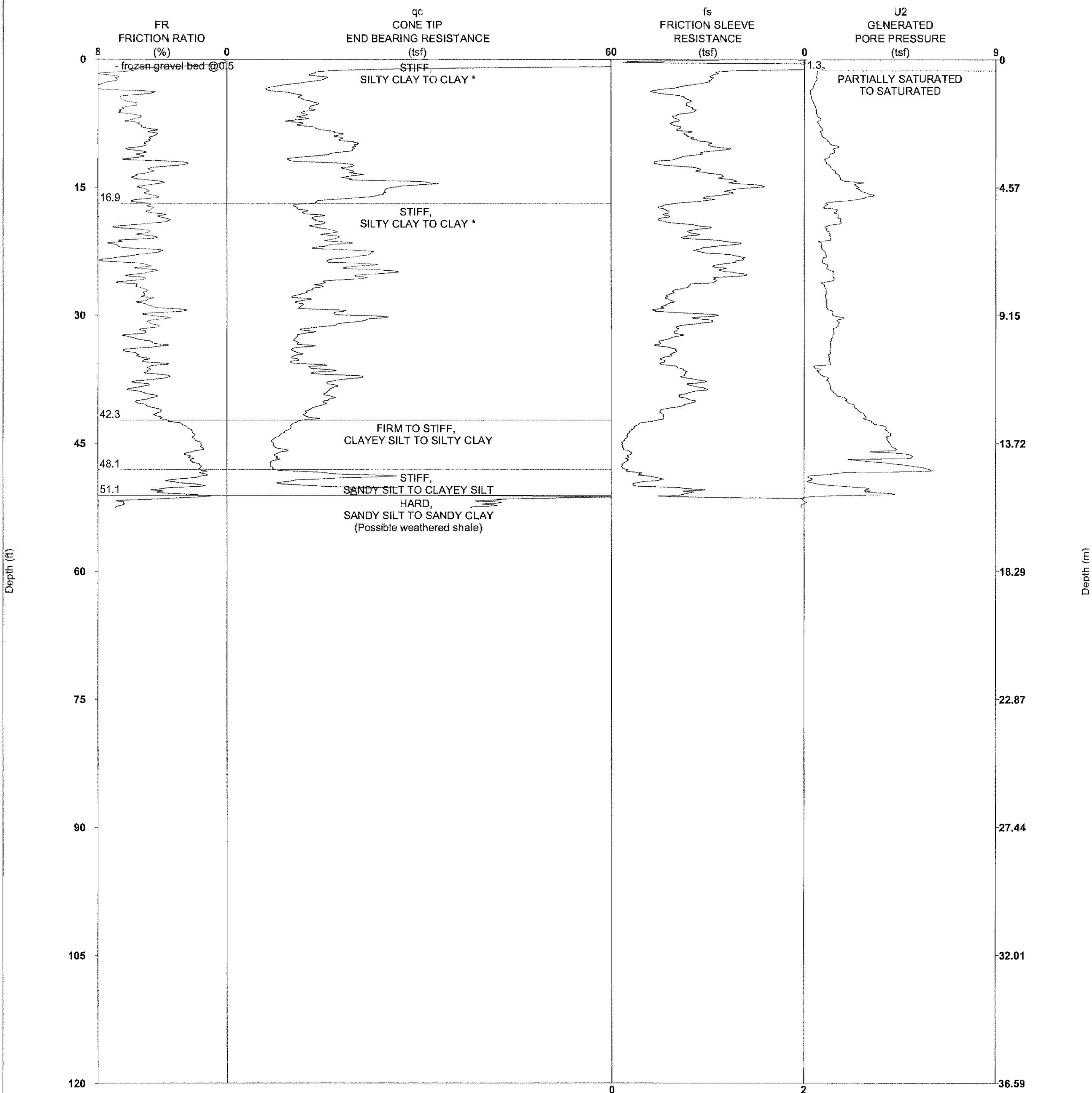
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:11:16 AM
SOUNDING NUMBER:CC-02

CPCC02

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



* Indicates lightly overconsolidated soil

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Latitude: 39.54198 Longitude: -92.63939

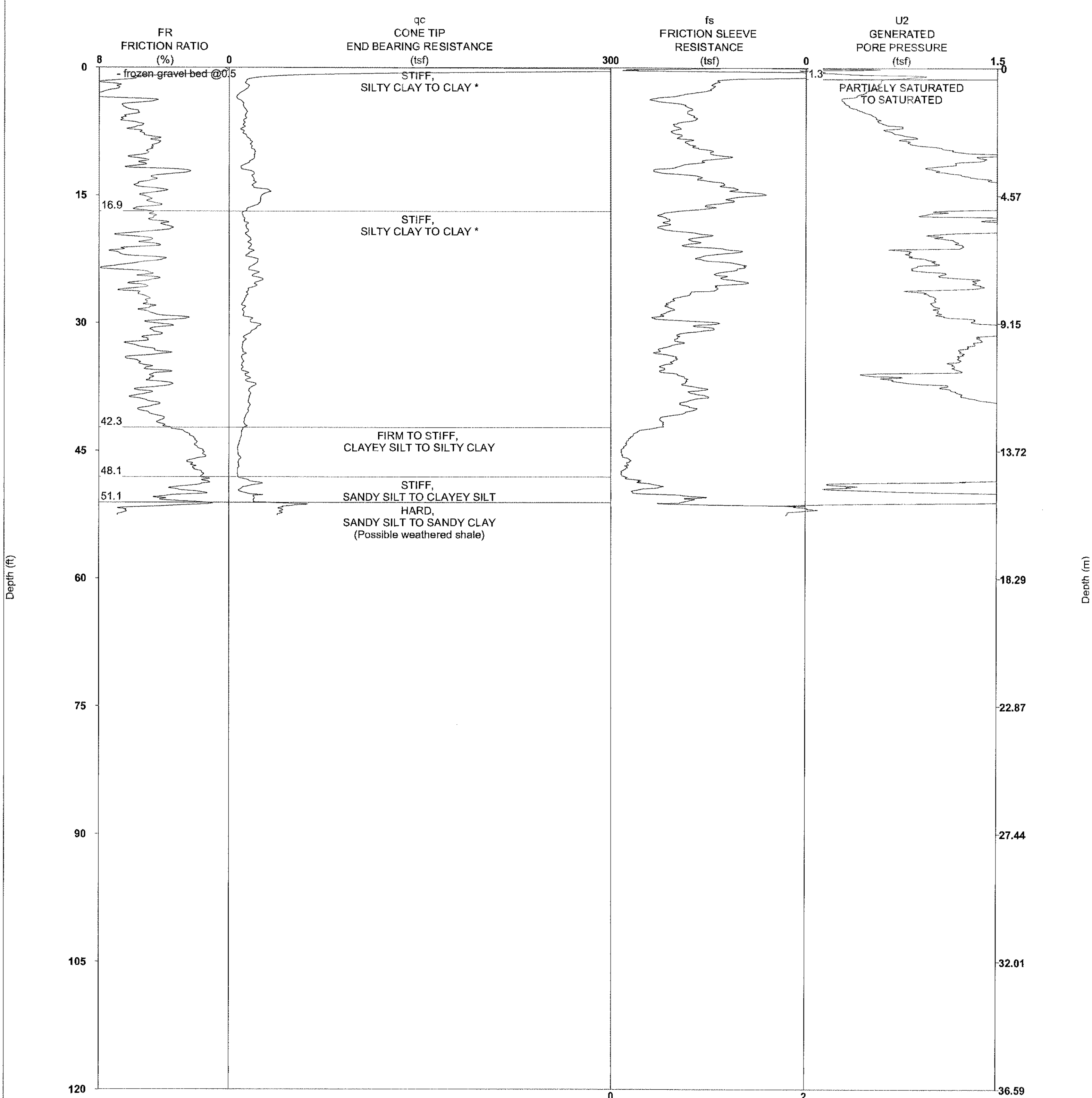
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:11:16 AM
SOUNDING NUMBER:CC-02

CPCC02

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



* Indicates lightly overconsolidated soil
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Latitude: 39.54198 Longitude: -92.63939

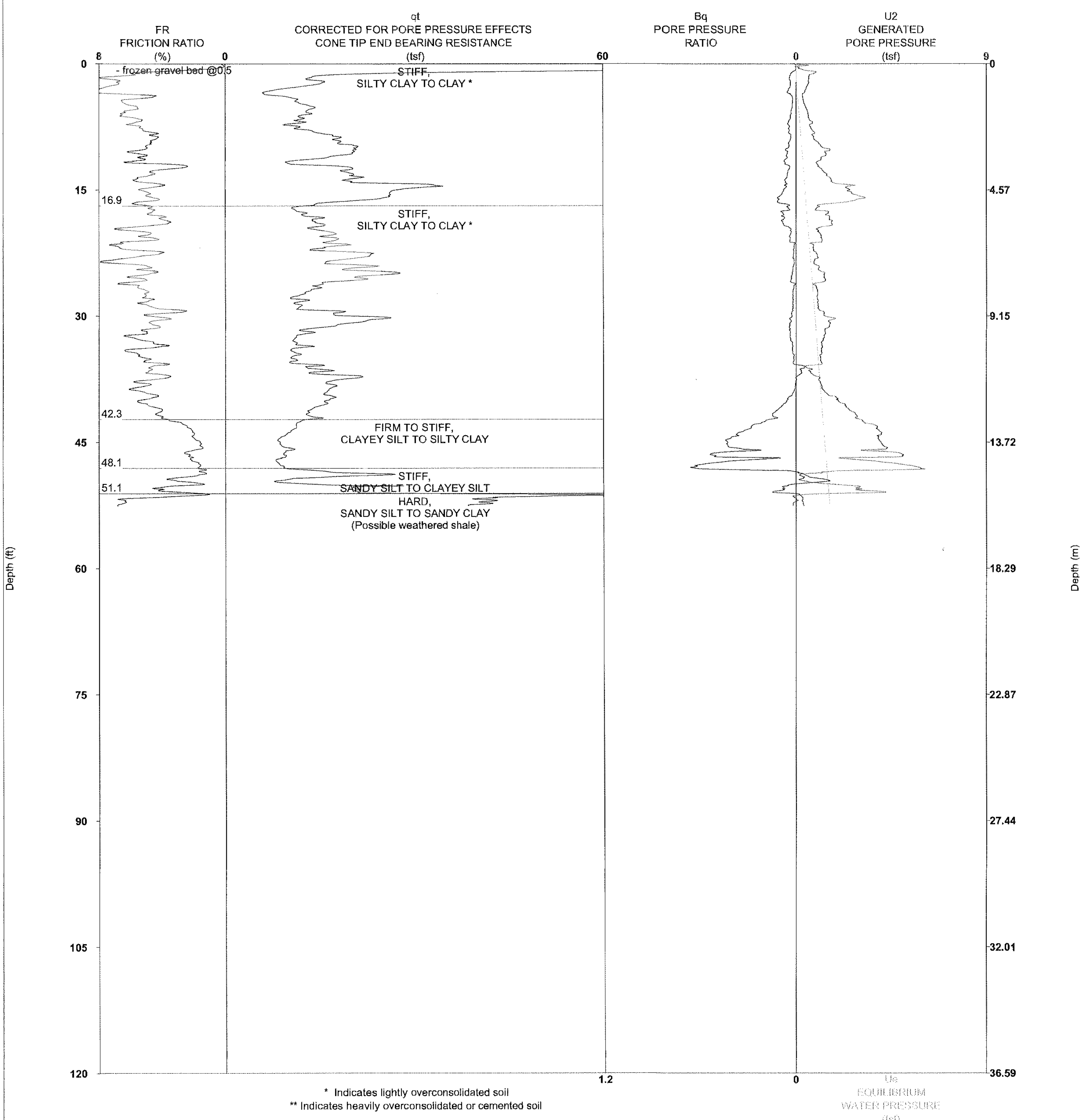
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:11:16 AM
SOUNDING NUMBER:CC-02

CPCC02

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



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Latitude: 39.54198 Longitude: -92.63939

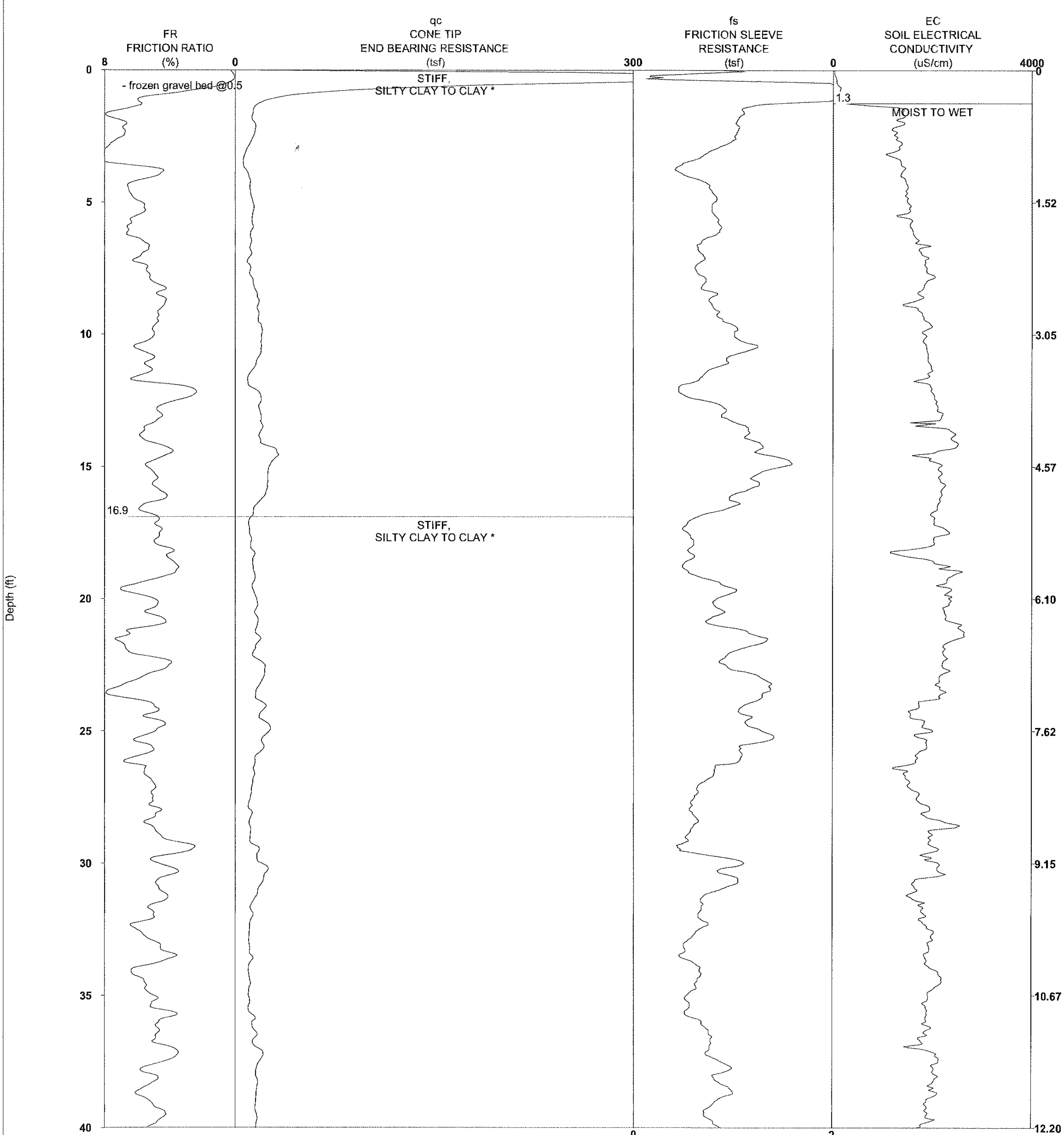
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:11:16 AM
SOUNDING NUMBER:CC-02

CPCC02

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



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Latitude: 39.54198 Longitude: -92.63939

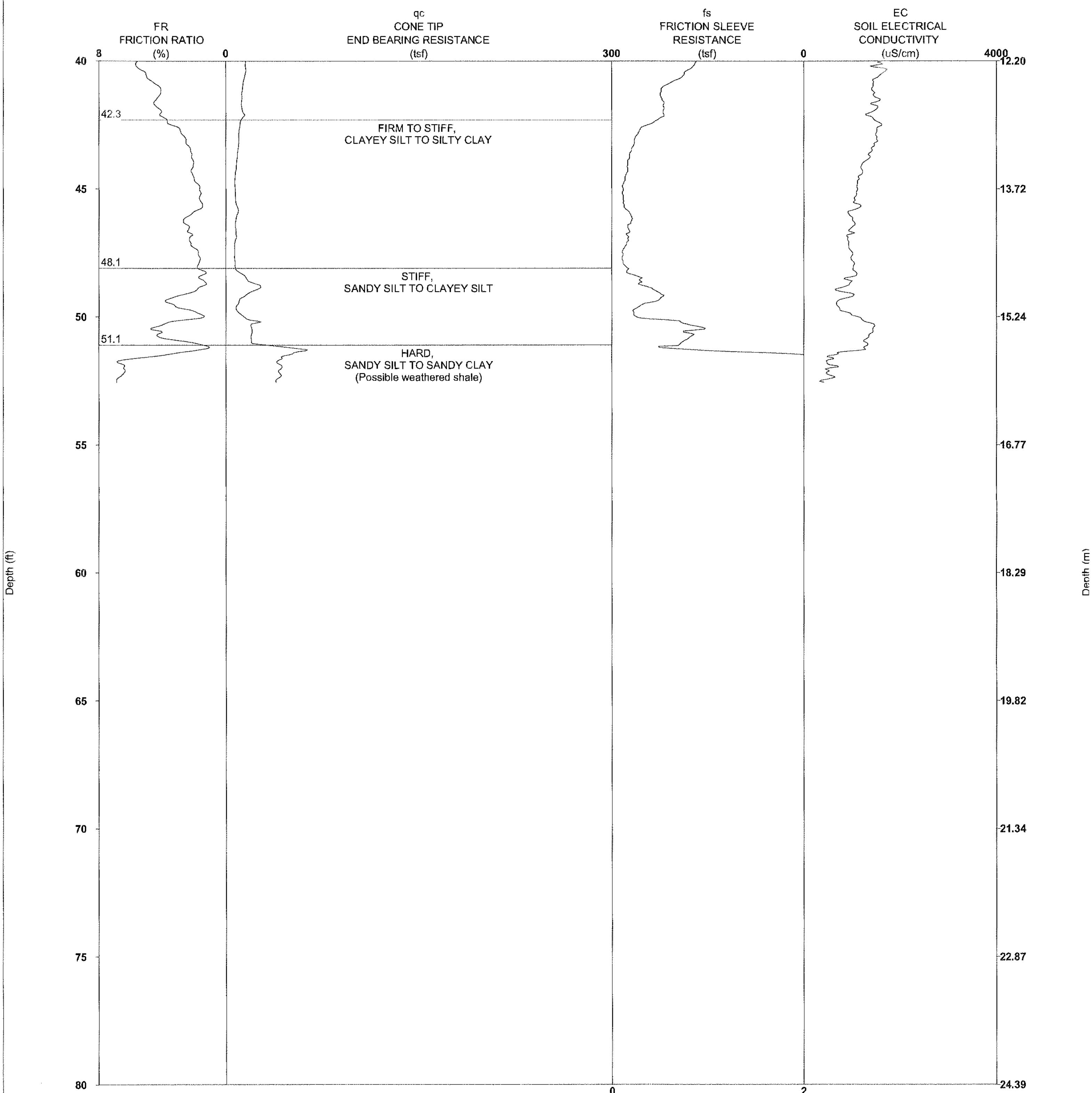
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:11:16 AM
SOUNDING NUMBER:CC-02

CPCC02

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



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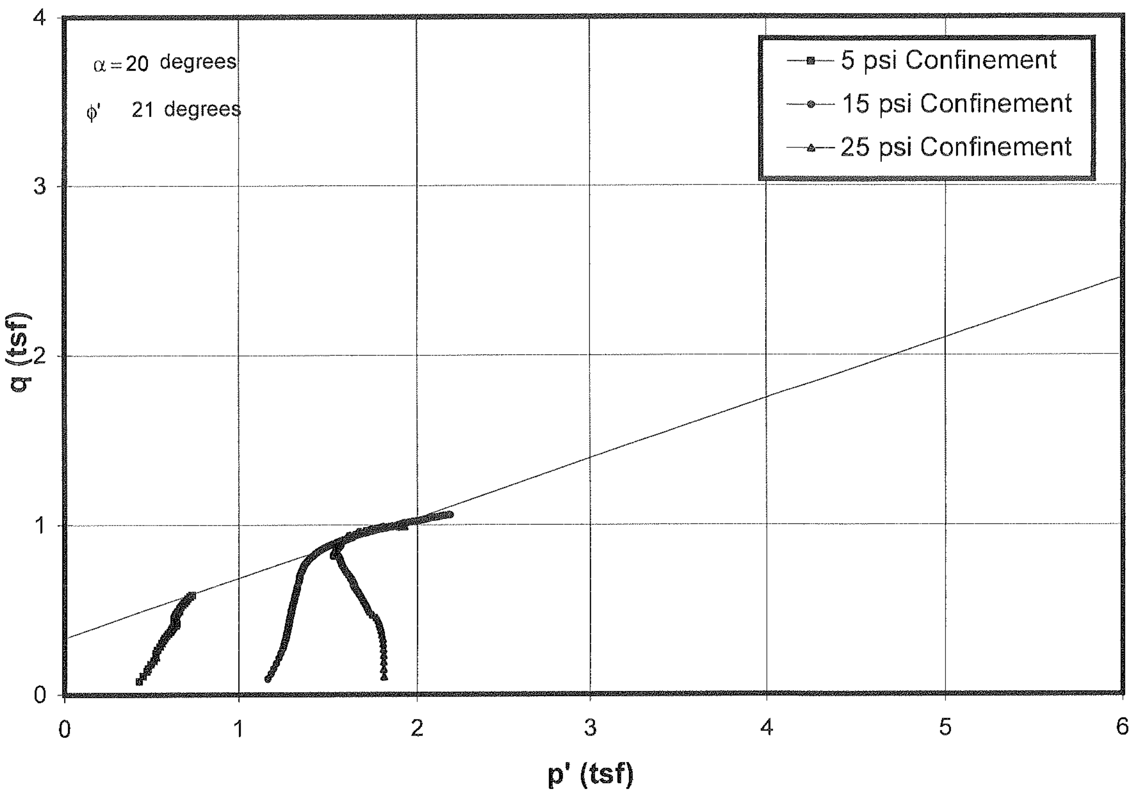
Latitude: 39.54198 Longitude: -92.63939

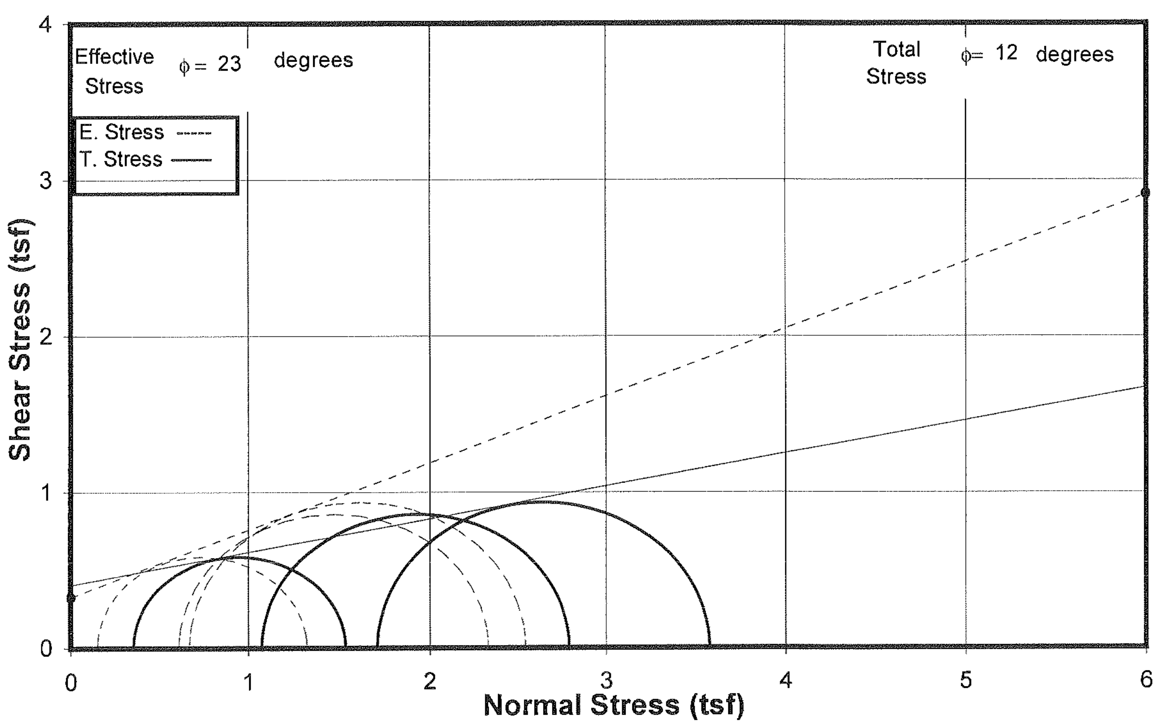
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:11:16 AM
SOUNDING NUMBER:CC-02

CPCC02





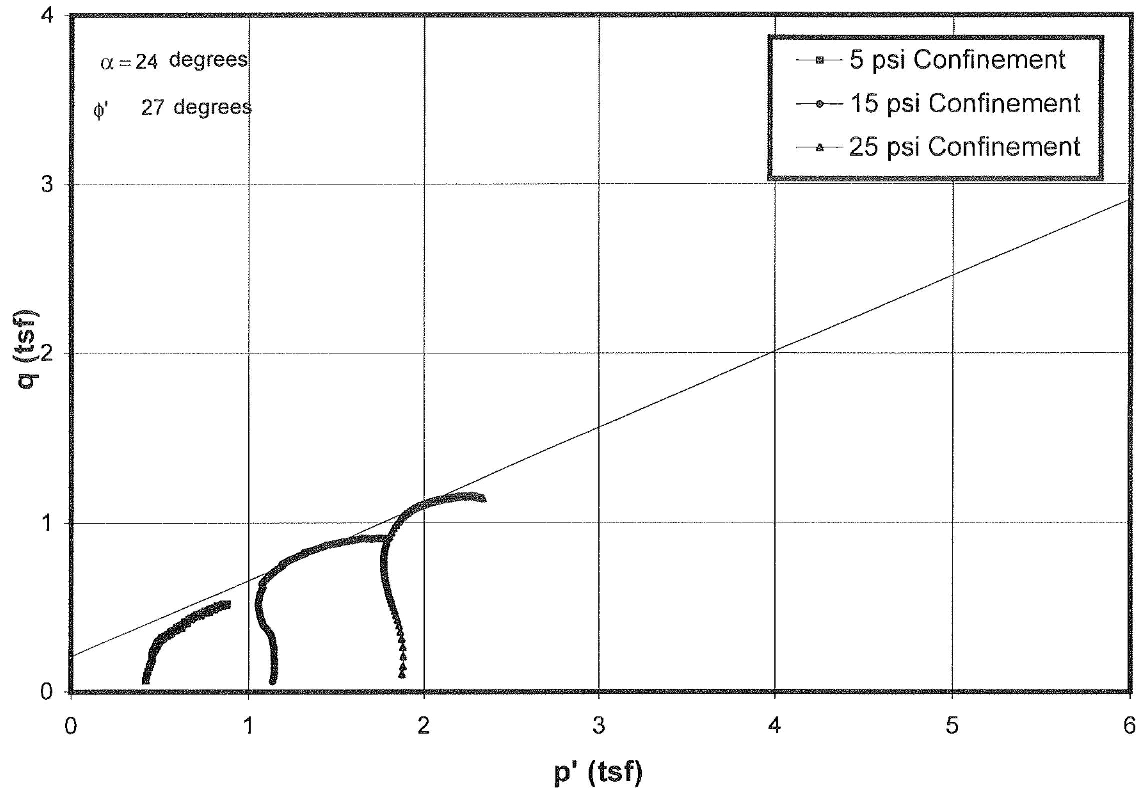
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

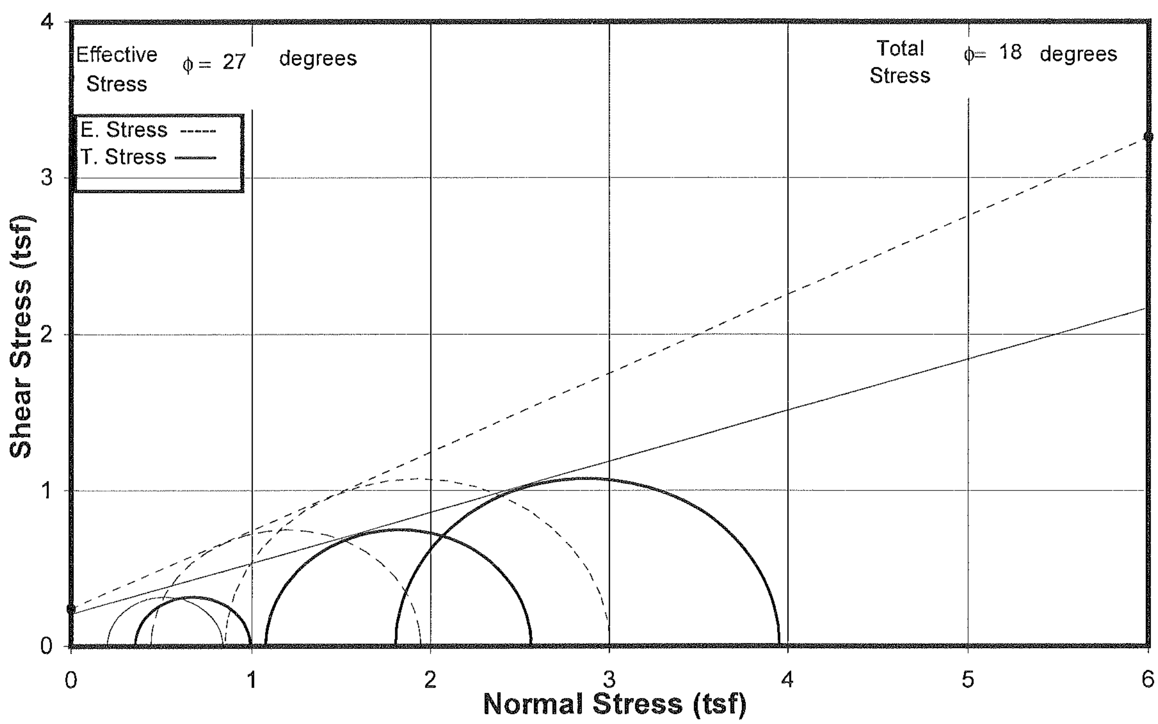
ASTM D 4767

Project No.: J011309.02

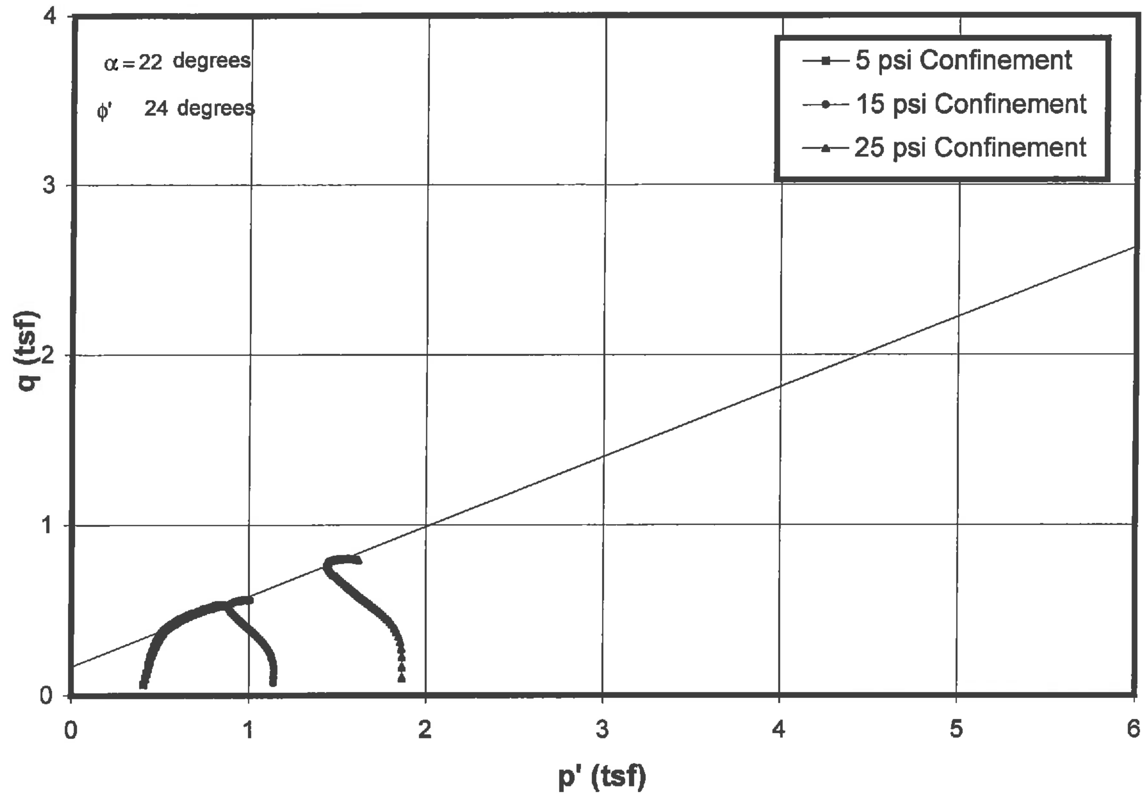
Boring: B-1

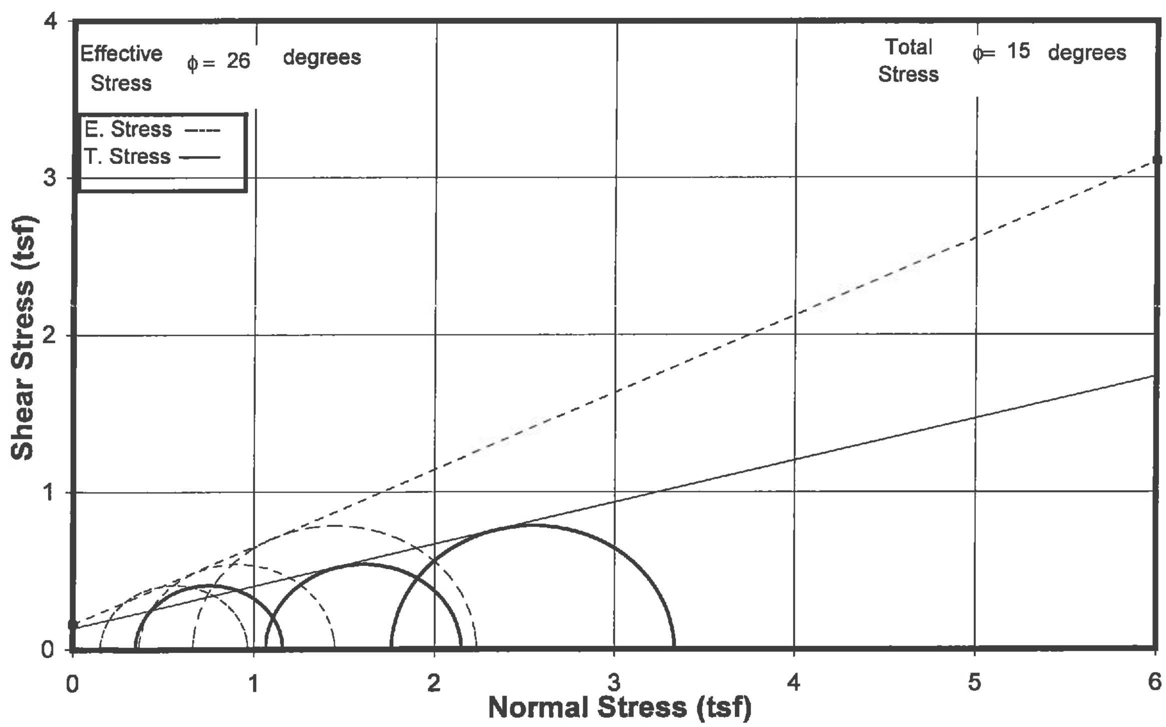
Sample: ST2, ST2, ST3 - Depth: 3, 3, 5





CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D 4767
Project No.: J011309.02
Boring: B-2
Sample: ST4 - Depth: 7





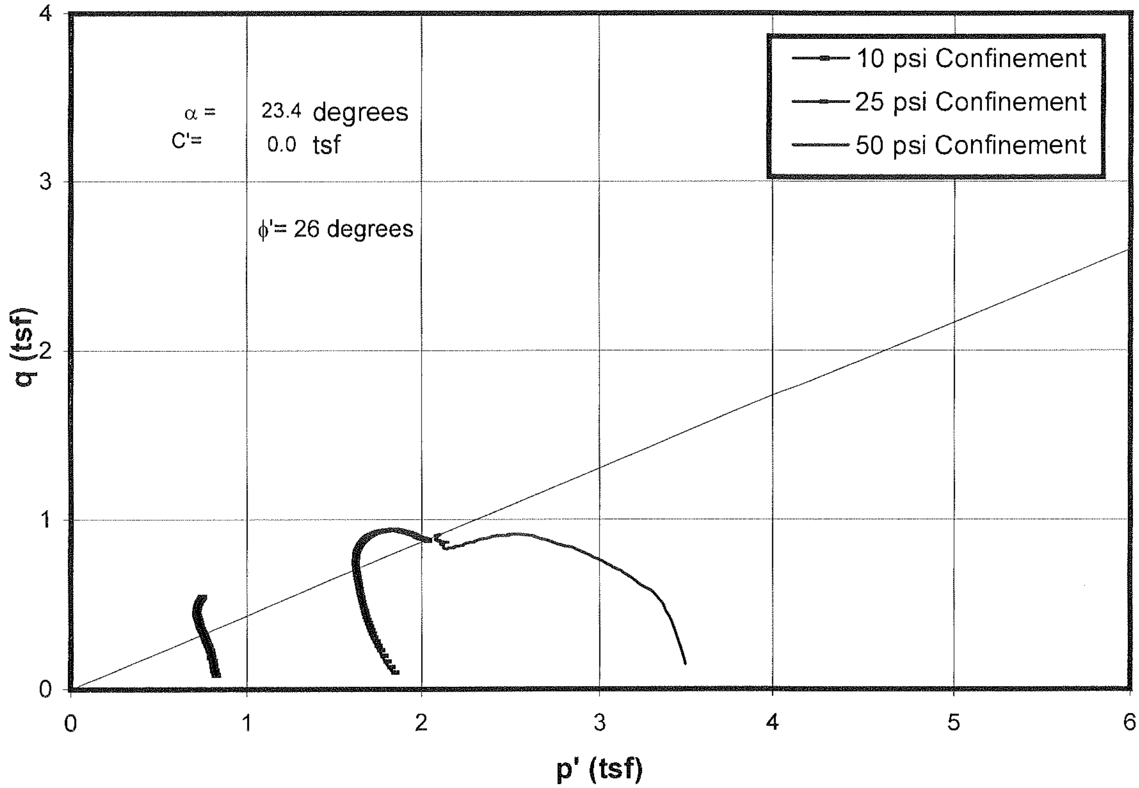
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

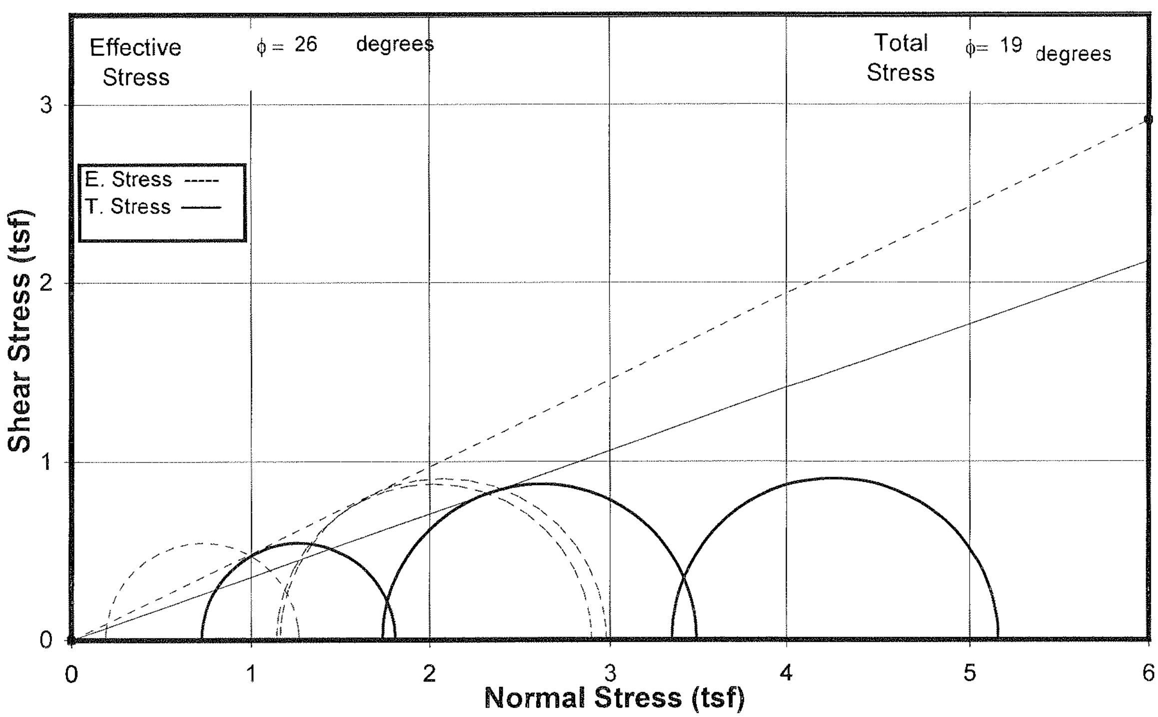
ASTM D 4767

Project No.: J011309.02

Boring: B-5, B-4, B-4

Sample: ST4,ST6,ST7 - Depth: 8, 13,16





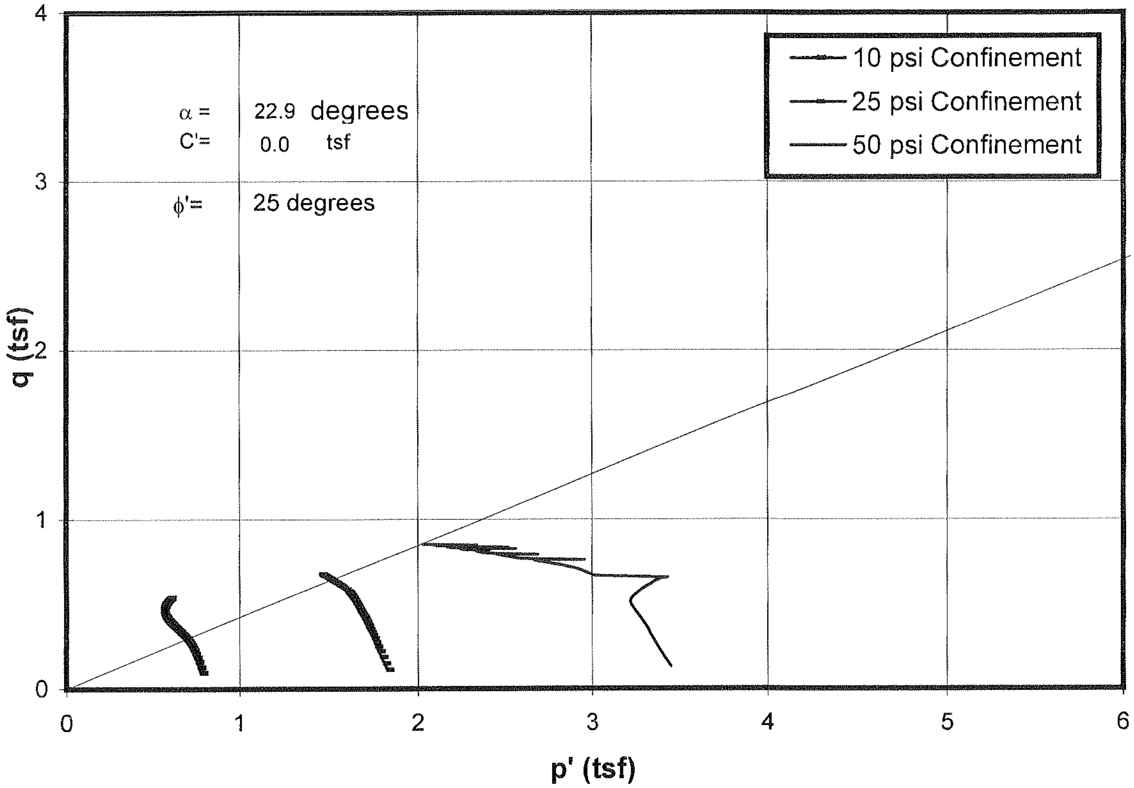
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

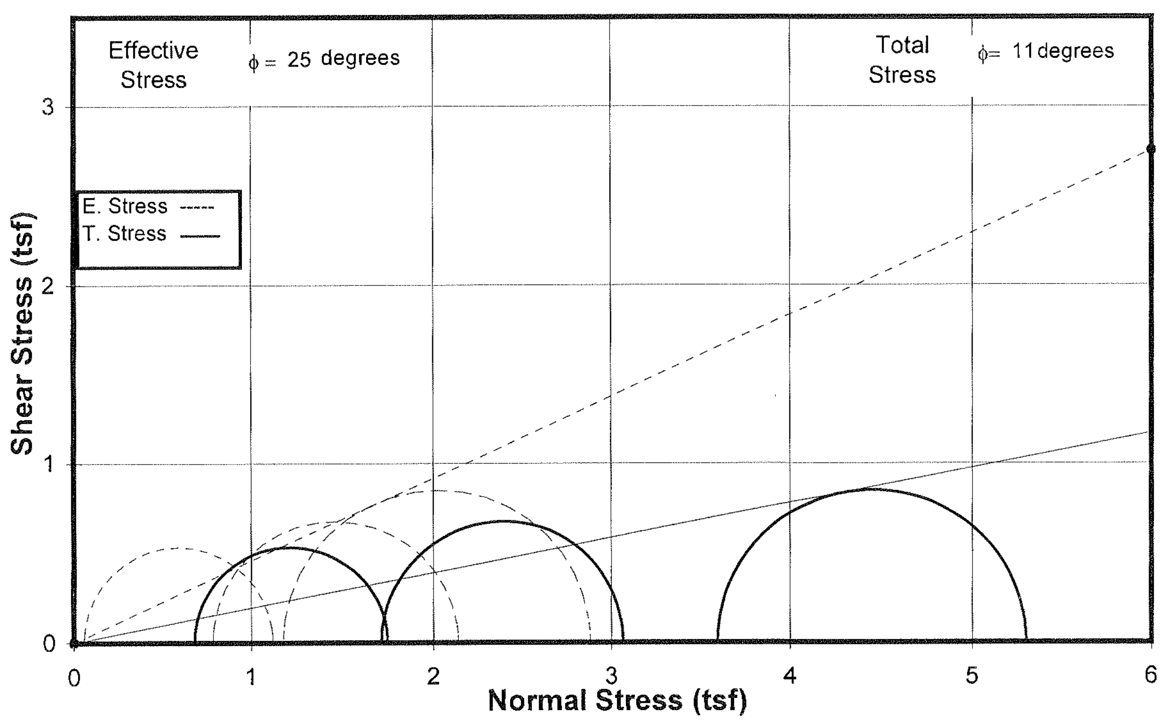
ASTM D 4767

Project No.: J011309.01

Boring: C-1

Sample: ST-6 - Depth: 13.5





CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

ASTM D 4767

Project No.: J011309.01

Boring: C-2

Sample: ST-8 - Depth: 20

APPENDIX B

Current Subsurface Exploration Logs

HALEY ALDRICH

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. TPZ-3

Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

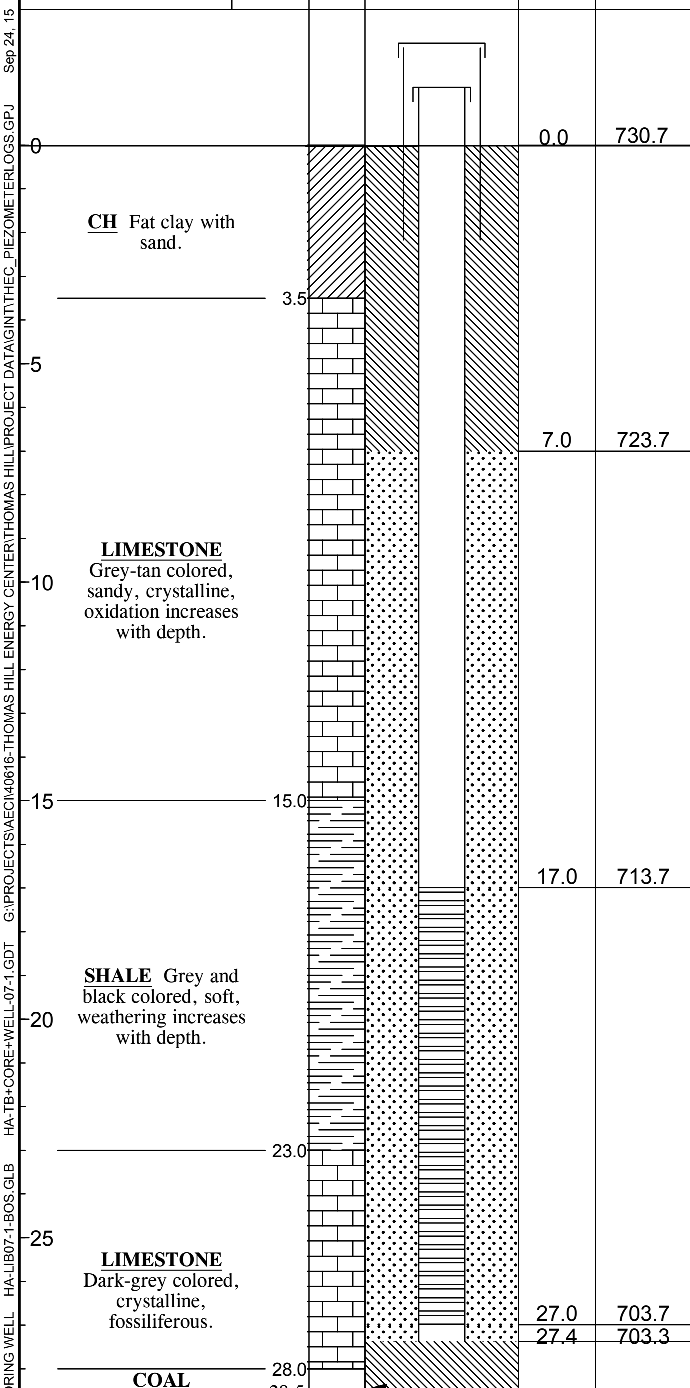
Well Diagram

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

File No.	40616-400
Date Installed	26 Aug 2015
H&A Rep.	D. Andersen
Location	See Plan
Ground El.	730.7
Datum	NGVD

SOIL/ROCK

CONDITIONS	DEPTH (ft.)
CH Fat clay with sand.	3.5
LIMESTONE Grey-tan colored, sandy, crystalline, oxidation increases with depth.	15.0
SHALE Grey and black colored, soft, weathering increases with depth.	23.0
LIMESTONE Dark-grey colored, crystalline, fossiliferous.	28.0
COAL	28.5



WELL DETAILS DEPTH (ft.)	ELEVATION (ft.)
0.0	730.7
7.0	723.7
17.0	713.7
27.0	703.7
27.4	703.3

WELL CONSTRUCTION DETAILS

Type of protective cover	LOCKING CAP
Height of Guard Pipe above ground surface	2.5 ft
Height of top of riser above ground surface	2.0 ft
Type of protective casing	Guard Pipe
Length	5.0 ft
Inside diameter	4 inches
Depth of bottom of Guard Pipe	2.5 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2 inch
Depth of bottom of riser pipe	17.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite	0.0 ft	7.0 ft
	-	-
	-	-

Diameter of borehole	9.5 inch
Depth to top of well screen	17.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2 inch
Type of Backfill around Screen	No. 12-20 silica sand
Depth to bottom of well screen	26.99 ft
Bottom of silt trap	NA
Depth of bottom of borehole	28.5 ft

HALEY ALDRICH

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. TPZ-9

Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

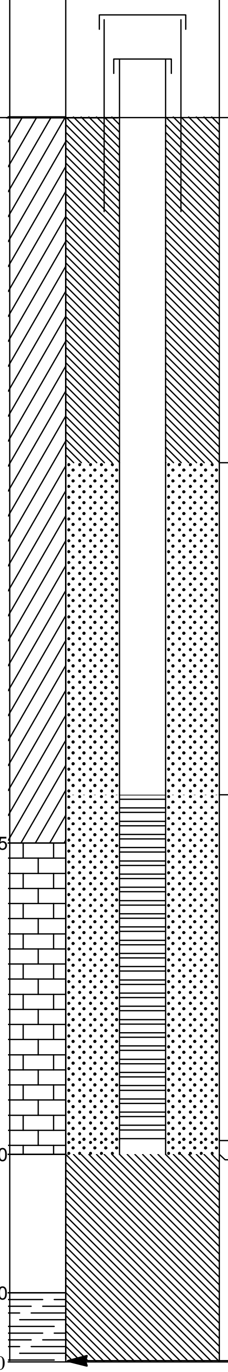
Well Diagram

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

File No.	40616-400
Date Installed	24 Aug 2015
H&A Rep.	D. Andersen
Location	See Plan
Ground El.	714.4
Datum	NGVD

SOIL/ROCK

CONDITIONS	DEPTH (ft.)
CL Lean clay with sand.	0 – 10.5
LIMESTONE Dark-grey colored, fossiliferous.	10.5 – 15.0
COAL	15.0 – 17.0
SHALE Grey colored.	17.0 – 18.0



WELL DETAILS DEPTH (ft.)	ELEVATION (ft.)
0.0	714.4
5.0	709.4
9.8	704.6
14.8	699.6
15.0	699.4
18.0	696.4

WELL CONSTRUCTION DETAILS

Type of protective cover	LOCKING CAP
Height of Guard Pipe above ground surface	2.5 ft
Height of top of riser above ground surface	2.0 ft
Type of protective casing	Guard Pipe
Length	5.0 ft
Inside diameter	4 inches
Depth of bottom of Guard Pipe	2.5 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2 inch
Depth of bottom of riser pipe	9.8 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite	0.0 ft	5.0 ft
	-	-
	-	-

Diameter of borehole	9.5 inch
Depth to top of well screen	9.8 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2 inch
Type of Backfill around Screen	No. 12-20 silica sand
Depth to bottom of well screen	14.8 ft
Bottom of silt trap	NA
Depth of bottom of borehole	18.0 ft

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. TPZ-10

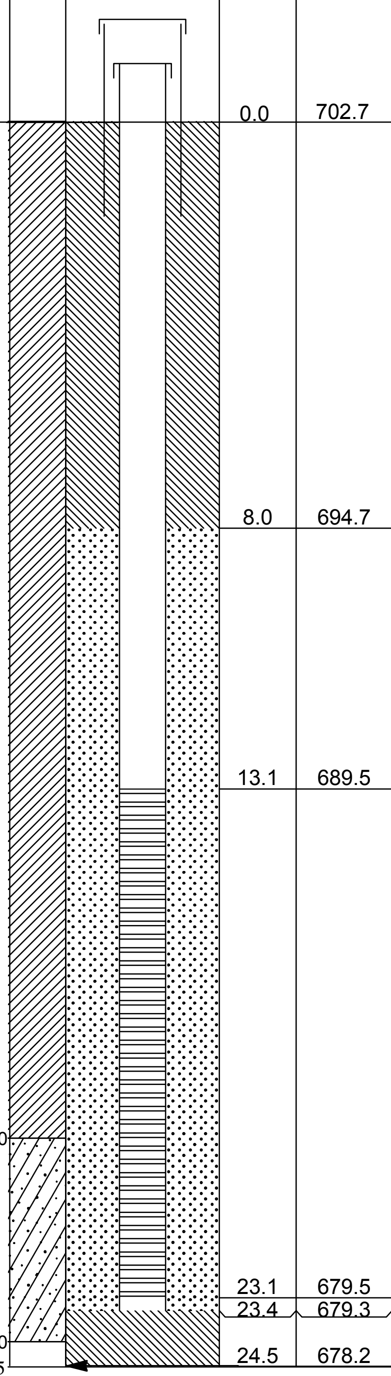
Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

Well Diagram

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

File No.	40616-400
Date Installed	25 Aug 2015
H&A Rep.	D. Andersen
Location	See Plan
Ground El.	702.7
Datum	NGVD

SOIL/ROCK CONDITIONS	DEPTH (ft.)
CH Fat clay with sand.	0 – 20.0
GC Clayey gravel with sand. Rounded quartzose river gravel and sub-angular feldspathic gravel	20.0 – 24.0
COAL	24.0 – 24.5



WELL DETAILS DEPTH (ft.)	ELEVATION (ft.)
0.0	702.7
8.0	694.7
13.1	689.5
23.1	679.5
23.4	679.3
24.5	678.2

WELL CONSTRUCTION DETAILS

Type of protective cover	LOCKING CAP
Height of Guard Pipe above ground surface	2.5 ft
Height of top of riser above ground surface	2.0 ft
Type of protective casing	Guard Pipe
Length	5.0 ft
Inside diameter	4 inches
Depth of bottom of Guard Pipe	2.5 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2 inch
Depth of bottom of riser pipe	13.1 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite	0.0 ft	8.0 ft
	-	-
	-	-

Diameter of borehole	9.5 inch
Depth to top of well screen	13.1 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2 inch
Type of Backfill around Screen	No. 12-20 silica sand
Depth to bottom of well screen	23.14 ft
Bottom of silt trap	NA
Depth of bottom of borehole	24.5 ft

MONITORING WELL HA-LIB07-1-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\PROJECTS\AEC\40616-THOMAS HILL ENERGY CENTER\THOMAS HILL\PROJECT DATA\GINT\THEC_PIEZOMETERLOGS.GPJ Sep 24, 15

HALEY ALDRICH

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. TPZ-11

Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

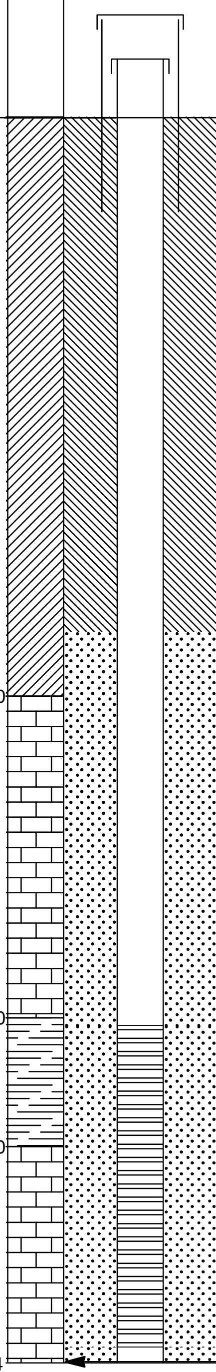
File No.	40616-400
Date Installed	27 Aug 2015
H&A Rep.	D. Andersen
Location	See Plan
Ground El.	704.7
Datum	NGVD

SOIL/ROCK

CONDITIONS	DEPTH (ft.)
CH Fat clay with sand.	9.0
LIMESTONE Dark-grey colored, crystalline, minor oxidation.	14.0
SHALE Dark-grey and black colored, silty, soft.	16.0
LIMESTONE Grey-maroon to brown colored, hard, some fossils present.	19.4

Depth scale: 0, 5, 10, 15

GRAPHIC / WELL DETAILS



DEPTH (ft.)	ELEVATION (ft.)
0.0	704.7
8.0	696.7
14.1	690.6
19.1	685.6

WELL CONSTRUCTION DETAILS

Type of protective cover	LOCKING CAP
Height of Guard Pipe above ground surface	2.5 ft
Height of top of riser above ground surface	2.0 ft
Type of protective casing	Guard Pipe
Length	5.0 ft
Inside diameter	4 inches
Depth of bottom of Guard Pipe	2.5 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2 inch
Depth of bottom of riser pipe	14.1 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite	0.0 ft	8.0 ft
	-	-
	-	-

Diameter of borehole	9.5 inch
Depth to top of well screen	14.1 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2 inch
Type of Backfill around Screen	No. 12-20 silica sand
Depth to bottom of well screen	19.11 ft
Bottom of silt trap	NA
Depth of bottom of borehole	19.4 ft

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. TPZ-12

Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

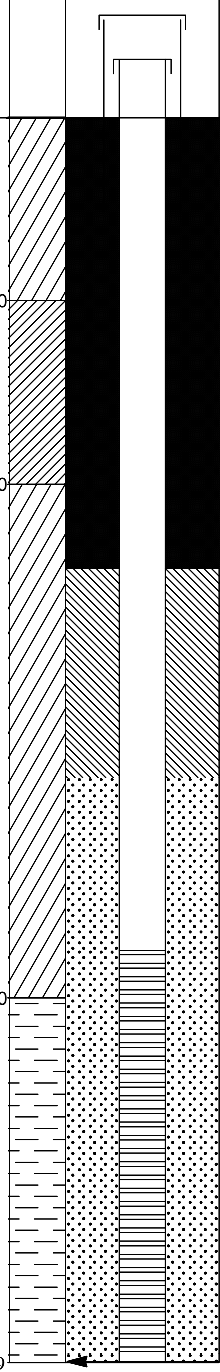
Well Diagram

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

File No.	40616-400
Date Installed	19 Aug 2015
H&A Rep.	D. Andersen
Location	See Plan
Ground El.	689.0
Datum	NGVD

SOIL/ROCK

CONDITIONS	DEPTH (ft.)
CL Lean clay with sand and gravel.	5.0
CH Fat clay with sand.	10.0
CL Lean clay with sand.	24.0
SC Clayey sand.	33.9



DEPTH (ft.)	ELEVATION (ft.)
0.0	689.0
12.3	676.7
18.0	671.0
22.7	666.3
33.7	655.3

WELL CONSTRUCTION DETAILS

Type of protective cover	LOCKING CAP
Height of Guard Pipe above ground surface	2.5 ft
Height of top of riser above ground surface	2.0 ft
Type of protective casing	Guard Pipe
Length	5.0 ft
Inside diameter	4 inches
Depth of bottom of Guard Pipe	2.5 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2 inch
Depth of bottom of riser pipe	22.7 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	0.0 ft	12.3 ft
Bentonite	12.3 ft	5.7 ft
	-	-

Diameter of borehole	8 inch
Depth to top of well screen	22.7 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2 inch
Type of Backfill around Screen	No. 12-20 silica sand
Depth to bottom of well screen	33.7 ft
Bottom of silt trap	NA
Depth of bottom of borehole	33.9 ft

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. TPZ-14

Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

Well Diagram

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

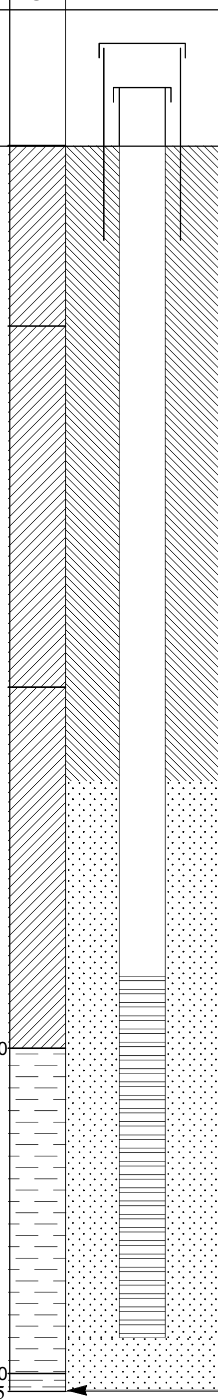
File No.	128064-001
Date Installed	02 Aug 2016
H&A Rep.	P. Kroger
Location	See Plan
Ground El.	
Datum	NGVD

SOIL/ROCK

CONDITIONS	DEPTH (ft.)
CH Fat clay with sand.	
CH Fat clay.	
CH Fat clay with sand.	25.0
SC Clayey sand.	34.0
SHALE	34.5

Depth scale: 0, 5, 10, 15, 20, 25, 30

GRAPHIC / WELL DETAILS



DEPTH (ft.): 0.0, 17.6, 23.0, 33.0, 34.5

ELEVATION (ft.)

WELL CONSTRUCTION DETAILS

Type of protective cover	LOCKING CAP
Height of Guard Pipe above ground surface	2.2 ft
Height of top of riser above ground surface	2.1 ft
Type of protective casing	Guard Pipe
Length	5.0 ft
Inside diameter	2 inches
Depth of bottom of Guard Pipe	2.8 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2 inch
Depth of bottom of riser pipe	23.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite	0.0 ft	17.6 ft
-	-	-
-		-

Diameter of borehole	10 inch
Depth to top of well screen	23.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2 inch
Type of Filter Pack around Screen	No. 12-20 silica sand
Depth to bottom of well screen	33 ft
Bottom of silt trap	NA
Depth of bottom of borehole	34.5 ft

MONITORING WELL HA-LIB07-1-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\PROJECTS\AECI\40616-THOMAS HILL ENERGY CENTER\THOMAS HILL\PROJECT DATA\GINT\THEC_PIEZOMETERLOGS_081116.GPJ Aug 12, 16

APPENDIX C

Analyses

Design Soil Properties

SOIL PROPERTY CHARACTERIZATION - THOMAS HILL ENERGY CENTER CELL 001

Material[2]	Total Unit Weight, γ_T				Undrained Shear Strength, S_u										Drained Shear Strength											
	CPT	Laboratory	Historic	Current	SPT		CPT		UU and CIU Trx	Historic		Current			SPT		CPT		Laboratory CIU Trx (Site-Wide)				Historic		Current	
	avg	Site-Wide Average	Design[1]	Design	avg	avg - 1σ	avg	avg - 1σ	(Site-Wide)	Design[1]		Design			avg	avg - 1σ	avg	avg - 1σ	avg		min.		Design[1]		Design	
	γ_T	γ_T	γ_T	γ_T	S_u	S_u	S_u	S_u	S_u	c	ϕ	c	ϕ	S_u	ϕ'		ϕ'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'
Bottom Ash/Boiler Slag	--	--	--	**90 pcf**	--	--	--	--	--	--	--	**--**	**--**	**750 psf**	--	--	--	--	--	--	--	--	--	--	**0 psf**	**30°**
Embankment Fill	--	125 psf	129 pcf	**125 pcf**	638 psf	487 psf	--	--	$S_{u,min}$ = 600 psf S_u/σ_v' = 0.360	600 psf	--	**--**	**--**	**$S_{u,min}$ = 600 psf S_u/σ_v' = 0.360**	--	--	--	--	500 psf	25°	400 psf	23°	20 psf	23°	**200 psf**	**25°**
Clay Liner	--	--	--	**125 pcf**	--	--	--	--	--	--	--	**--**	**--**	**1,300 psf**	--	--	--	--	--	--	--	--	--	--	**0 psf**	**28°**
Clay	--	120 pcf	120 to 124 pcf	**120 pcf**	2507 psf	1156 psf	--	--	$S_{u,min}$ = 800 psf S_u/σ_v' = 0.253	700 to 1000 psf	--	**--**	**--**	**$S_{u,min}$ = 800 psf S_u/σ_v' = 0.253**	--	--	--	--	260 psf	26°	0 psf	25°	0 psf	20° - 27°	**125 psf**	**26°**
Weathered Bedrock	--	--	--	**130 pcf**	6,000 psf	6000 psf	1531 psf	910 psf	--	'--	--	**--**	**38°**	**--**	--	--	--	--	--	--	--	--	--	--	**--**	**38°**

Notes:
1. Based on historic analyses performed by Geotechnology, Inc.
2. In cases where historic design properties, SPT/CPT correlations, and laboratory test data do not exist, the current design properties for these materials have been conservatively estimated using typical published values and Haley & Aldrich's experience with similar materials.

SOIL PROPERTY CHARACTERIZATION - THOMAS HILL ENERGY CENTER CELL 003

Material[2]	Total Unit Weight, γ_T				Undrained Shear Strength, S_u										Drained Shear Strength											
	CPT	Laboratory	Historic	Current	SPT		CPT		UU and CIU Trx	Historic		Current			SPT		CPT		Laboratory CIU Trx (Site-Wide)				Historic		Current	
	avg	Site-Wide Average	Design[1]	Design	avg	avg - 1σ	avg	avg - 1σ	avg	Design[1]		Design			avg	avg - 1σ	avg	avg - 1σ	avg		min.		Design[1]		Design	
	γ_T	γ_T	γ_T	γ_T	S_u	S_u	S_u	S_u	S_u	c	ϕ	c	ϕ	S_u	ϕ'		ϕ'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'
Bottom Ash/Boiler Slag/Fly Ash	--	--	--	**90 pcf**	--	--	--	--	--	--	--	**--**	**--**	**750 psf**	--	--	--	--	--	--	--	--	--	--	**0 psf**	**30°**
Embankment Fill	--	125 pcf	120 psf	**125 pcf**	865 psf	631 psf	1621 psf	1303 psf	$S_{u,min}$ = 600 psf S_u/σ_v' = 0.360	--	--	**--**	**--**	**$S_{u,min}$ = 600 psf S_u/σ_v' = 0.360**	--	--	--	--	500 psf	25°	400 psf	23°	100 psf	28°	**200 psf**	**25°**
Clay	--	120 pcf	120 pcf	**120 pcf**	2,612 psf	1,946 psf	1610 psf	1282 psf	$S_{u,min}$ = 800 psf S_u/σ_v' = 0.253	--	--	**--**	**--**	**$S_{u,min}$ = 800 psf S_u/σ_v' = 0.253**	--	--	--	--	260 psf	26°	0 psf	25°	50 psf	27°	**125 psf**	**26°**
Weathered Bedrock	--	--	--	**130 pcf**	6,000 psf	6000 psf	1531 psf	910 psf	--	--	--	**--**	**38°**	**--**	--	--	--	--	--	--	--	--	--	--	**--**	**38°**

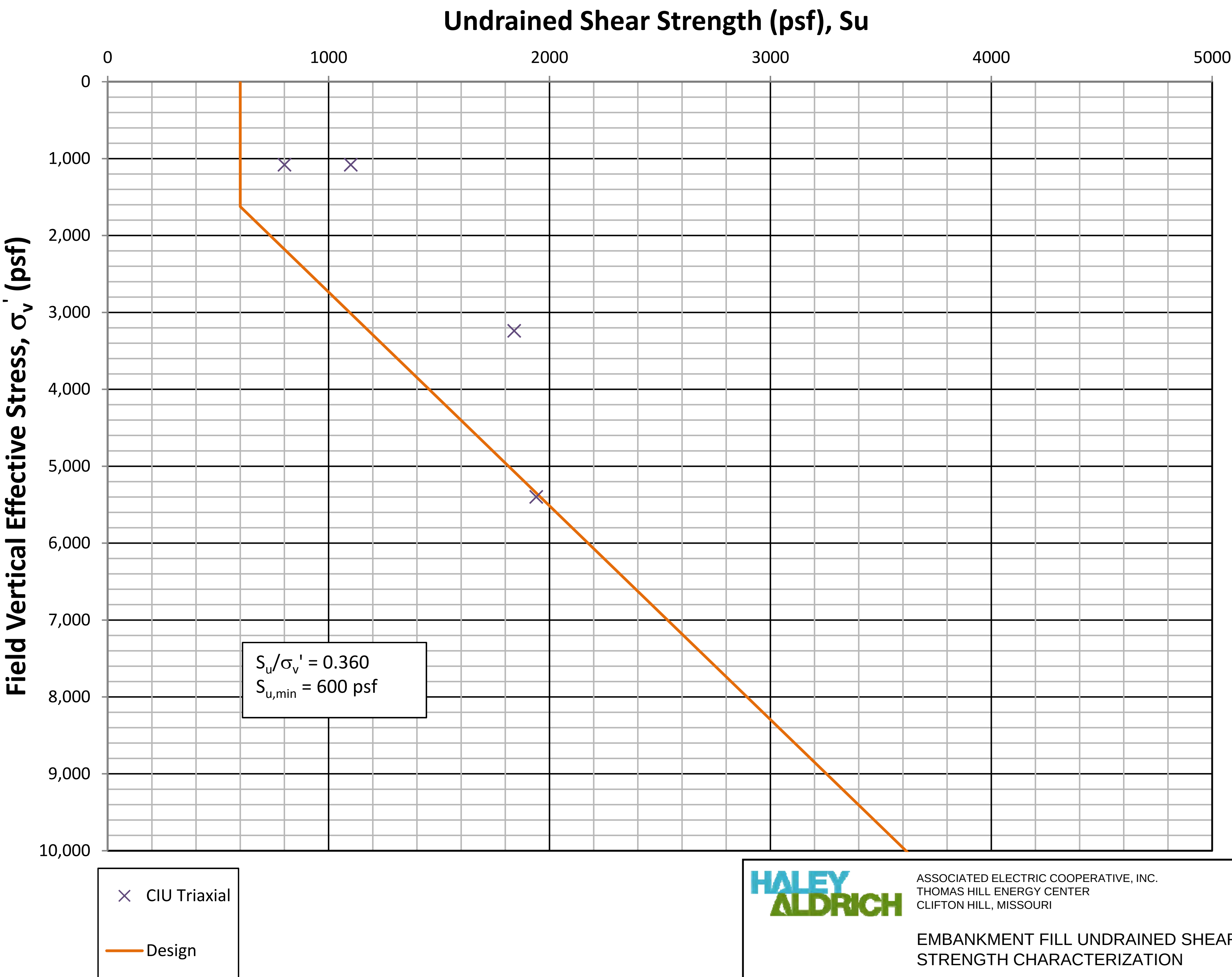
Notes:
1. Based on historic analyses performed by Geotechnology, Inc.
2. In cases where historic design properties, SPT/CPT correlations, and laboratory test data do not exist, the current design properties for these materials have been conservatively estimated using typical published values and Haley & Aldrich's experience with similar materials.

SOIL PROPERTY CHARACTERIZATION - THOMAS HILL ENERGY CENTER CELL 004

Material[2]	Total Unit Weight, γ_T				Undrained Shear Strength, S_u										Drained Shear Strength											
	CPT	Laboratory	Historic	Current	SPT		CPT		UU and CIU Trx	Historic		Current			SPT		CPT		Laboratory CIU Trx (Site-Wide)				Historic		Current	
	avg	Site-Wide Average	Design[1]	Design	avg	avg - 1σ	avg	avg - 1σ	avg	Design[1]		Design			avg	avg - 1σ	avg	avg - 1σ	avg		min.		Design[1]		Design	
	γ_T	γ_T	γ_T	γ_T	S_u	S_u	S_u	S_u	S_u	c	ϕ	c	ϕ	S_u	ϕ'		ϕ'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'
Embankment Fill	--	125 pcf	129 pcf	**125 pcf**	648 psf	473 psf	--	--	$S_{u,min}$ = 600 psf S_u/σ_v' = 0.360	700 psf	--	**--**	**--**	**$S_{u,min}$ = 600 psf S_u/σ_v' = 0.360**	--	--	--	--	500 psf	25°	400 psf	23°	20 psf	23°	**200 psf**	**25°**
Clay	--	120 pcf	118 pcf	**120 pcf**	738 psf	N/A	--	--	$S_{u,min}$ = 800 psf S_u/σ_v' = 0.253	400 to 900 psf	--	**--**	**--**	**$S_{u,min}$ = 800 psf S_u/σ_v' = 0.253**	--	--	--	--	260 psf	26°	0 psf	25°	0 psf	26°	**125 psf**	**26°**
Weathered Bedrock	--	--	--	**130 pcf**	6,000 psf	6,000 psf	--	--	--	--	--	**--**	**38°**	**--**	--	--	--	--	--	--	--	--	--	--	**--**	**38°**

Notes:

1. Based on historic analyses performed by Geotechnology, Inc.
2. In cases where historic design properties, SPT/CPT correlations, and laboratory test data do not exist, the current design properties for these materials have been conservatively estimated using typical published values and Haley & Aldrich's experience with similar materials.



HALEY ALDRICH

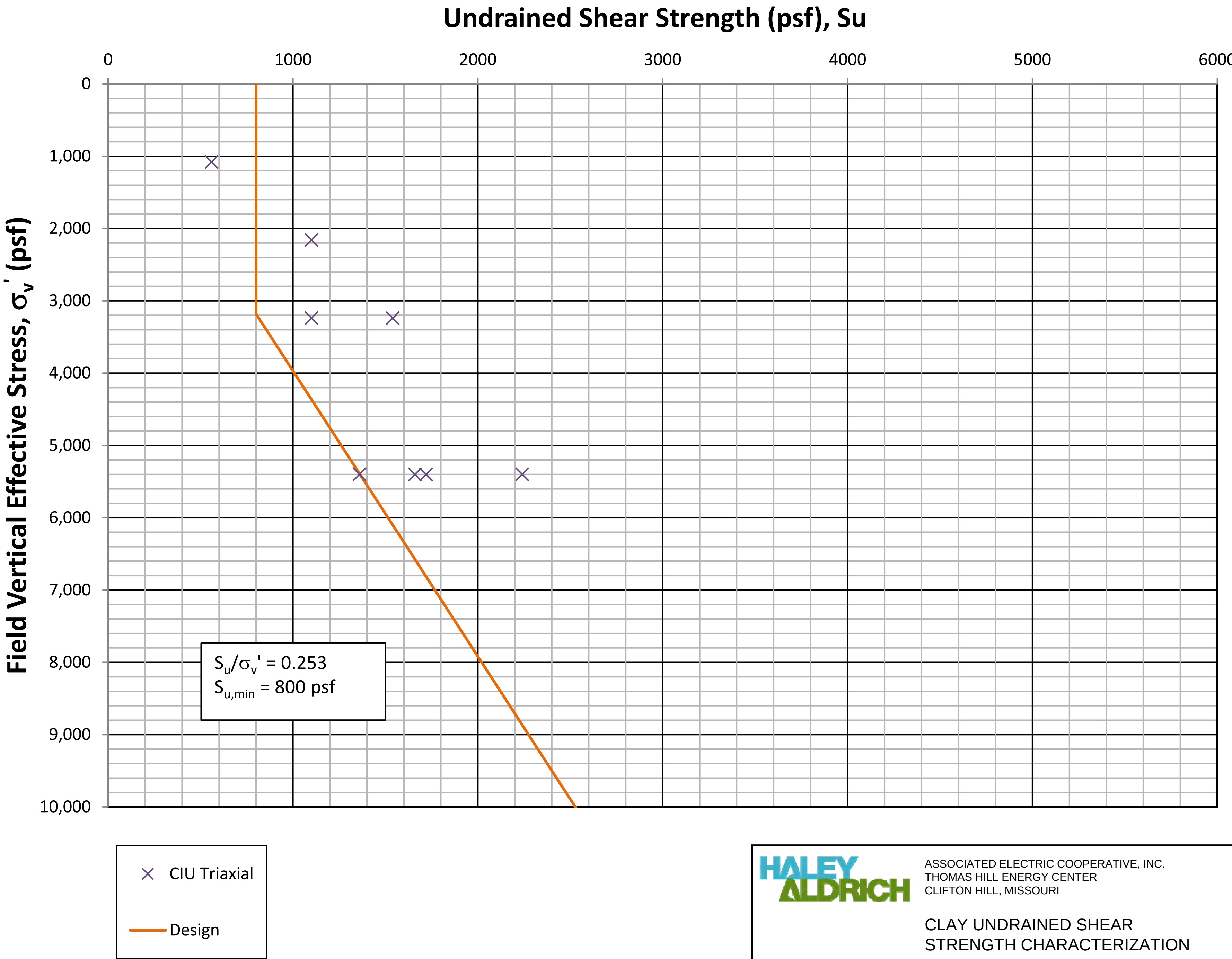
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

EMBANKMENT FILL UNDRAINED SHEAR STRENGTH CHARACTERIZATION

SCALE : AS SHOWN
OCTOBER 2016

FIGURE C1

128064-003_FIG C1.PPT



ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

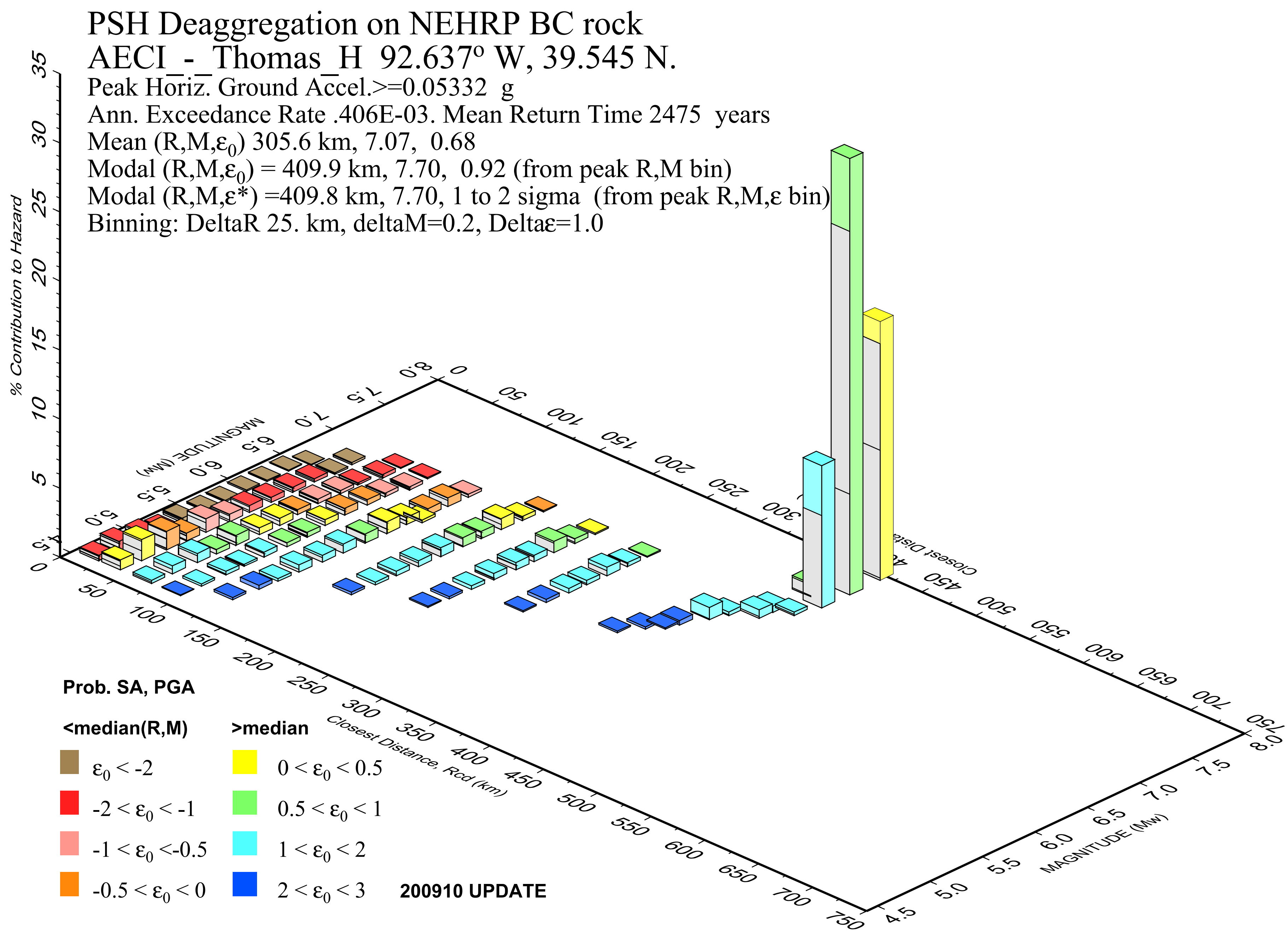
CLAY UNDRAINED SHEAR STRENGTH CHARACTERIZATION

SCALE : AS SHOWN
OCTOBER 2016

FIGURE C2

128064-003_FIG C2.PPT

Seismic Documents



GMT 2016 Sep 30 12:00:55 Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on rock with average vs= 760. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted

USGS Design Maps Detailed Report

ASCE 7-10 Standard (39.545°N, 92.637°W)

Site Class D – “Stiff Soil”, Risk Category IV (e.g. essential facilities)

Section 11.4.1 — Mapped Acceleration Parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2010 ASCE-7 Standard are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

From Figure 22-1 [1]	$S_S = 0.124$ g
From Figure 22-2 [2]	$S_1 = 0.077$ g

Section 11.4.2 — Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Chapter 20.

Table 20.3–1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ **or** $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index *PI* > 20, • Moisture content *w* ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

From Figure 22-7 [4]	PGA FROM 2014 HAZARD MAP = 0.057 g
Equation (11.8–1):	$PGA_M = F_{PGA}PGA = 1.600 \times 0.057 = 0.0912$ g

Table 11.8–1: Site Coefficient F_{PGA}

Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = D and PGA = 0.057 g, F_{PGA} = 1.600

Section 21.2.1.1 — Method 1 (from Chapter 21 – Site-Specific Ground Motion Procedures for Seismic Design)

From Figure 22-17 [5]	$C_{RS} = 0.866$
From Figure 22-18 [6]	$C_{R1} = 0.838$

Liquefaction Analysis

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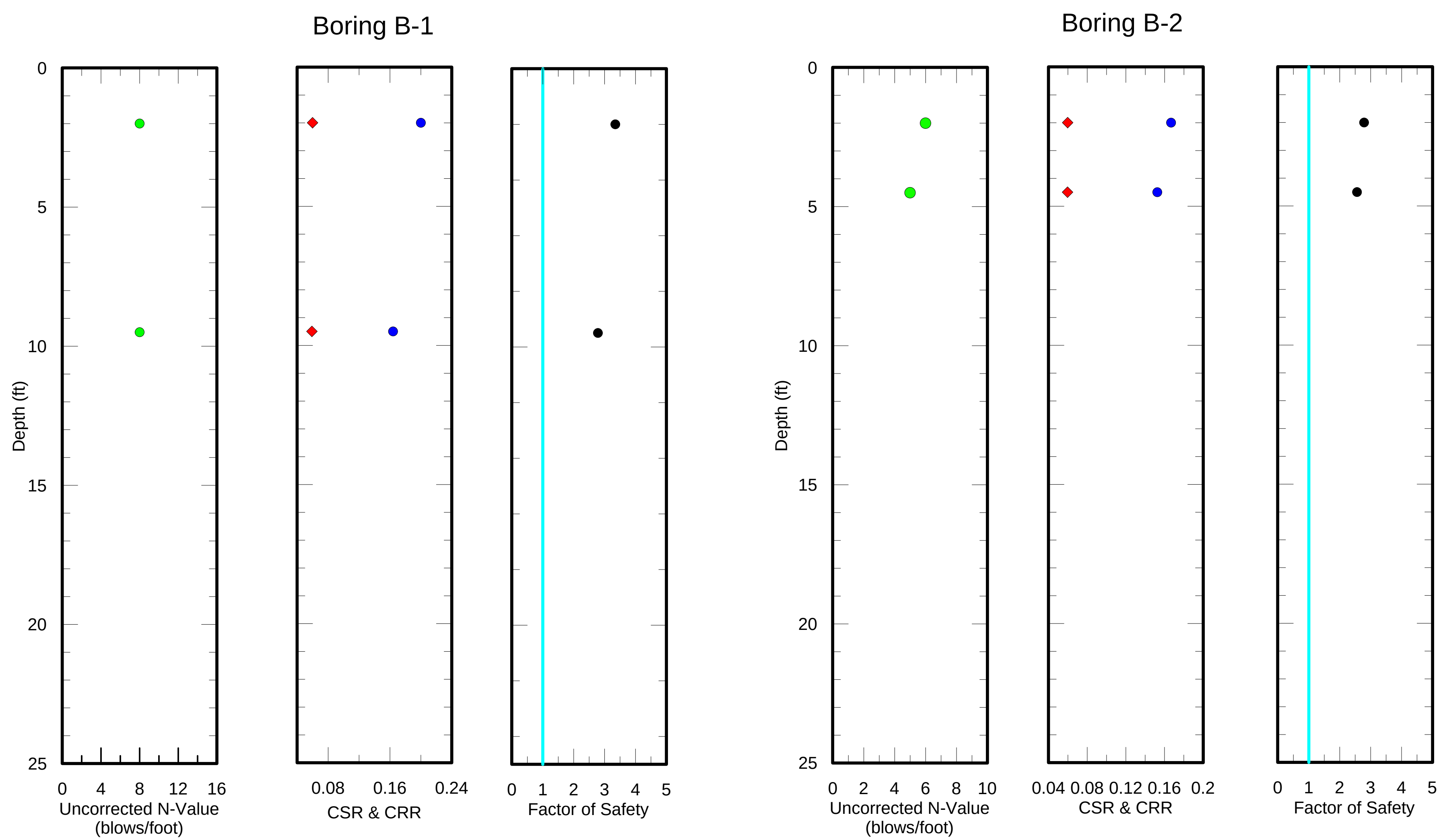


LEGEND

- Cyclic Stress Ratio$_{M,\sigma'_{vc}}$
- Cyclic Resistance Ratio$_{M,\sigma'_{vc}}$
- Factor of Safety

NOTES:
1) Cyclic Stress Ratio (CSR), Cyclic Resistance Ratio (CRR) and Factor of Safety (FS) values calculated using methods described in EERI's "Soil Liquefaction during Earthquakes" [Idriss & Boulanger, 2008].
2) Effective stresses used in CRR equations calculated based on depth of water at the time of boring advancement. Effective stresses used in CSR equations based on depth to water at maximum storage.
3) CSR values calculated for an earthquake having a PGA of 0.092g and a magnitude of 7.7.
4) CRR values were calcuated using an assumed fines content of 50%.
5) Calculated factors of safety are limited to a value of 5 for graphical representation.

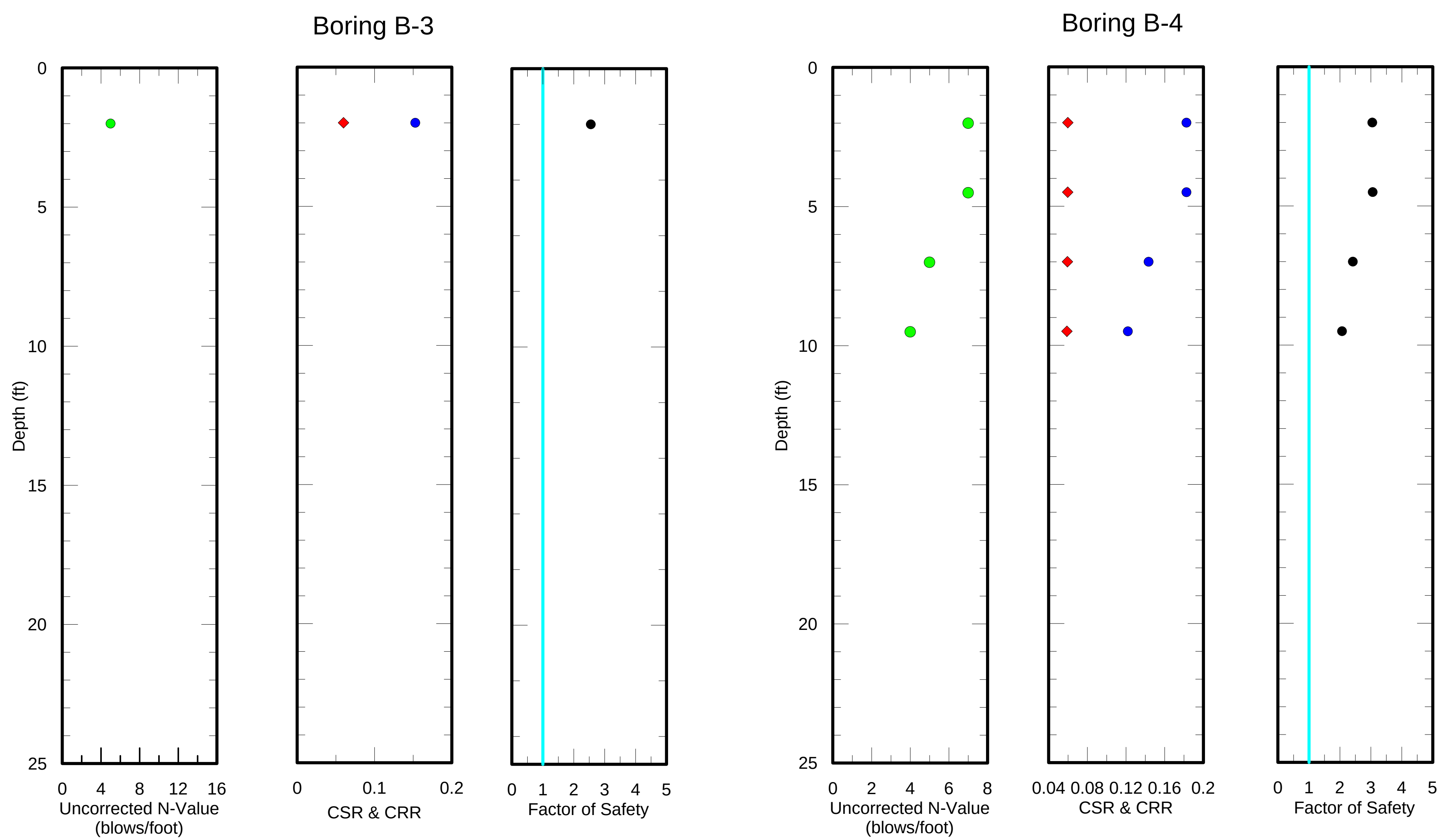
HALEY ALDRICH

Thomas Hill Energy Center Liquefaction Analysis

Liquefaction Triggering Evaluation
B-1 & B-2
2,500-Year Return Period

October 2016

FIGURE NO.



LEGEND

- Cyclic Stress Ratio$_{M,\sigma'_{vc}}$
- Cyclic Resistance Ratio$_{M,\sigma'_{vc}}$
- Factor of Safety

NOTES:
1) Cyclic Stress Ratio (CSR), Cyclic Resistance Ratio (CRR) and Factor of Safety (FS) values calculated using methods described in EERI's "Soil Liquefaction during Earthquakes" [Idriss & Boulanger, 2008].
2) Effective stresses used in CRR equations calculated based on depth of water at the time of boring advancement. Effective stresses used in CSR equations based on depth to water at maximum storage.
3) CSR values calculated for an earthquake having a PGA of 0.092g and a magnitude of 7.7.
4) CRR values were calcuated using an assumed fines content of 50%.
5) Calculated factors of safety are limited to a value of 5 for graphical representation.

HALEY ALDRICH

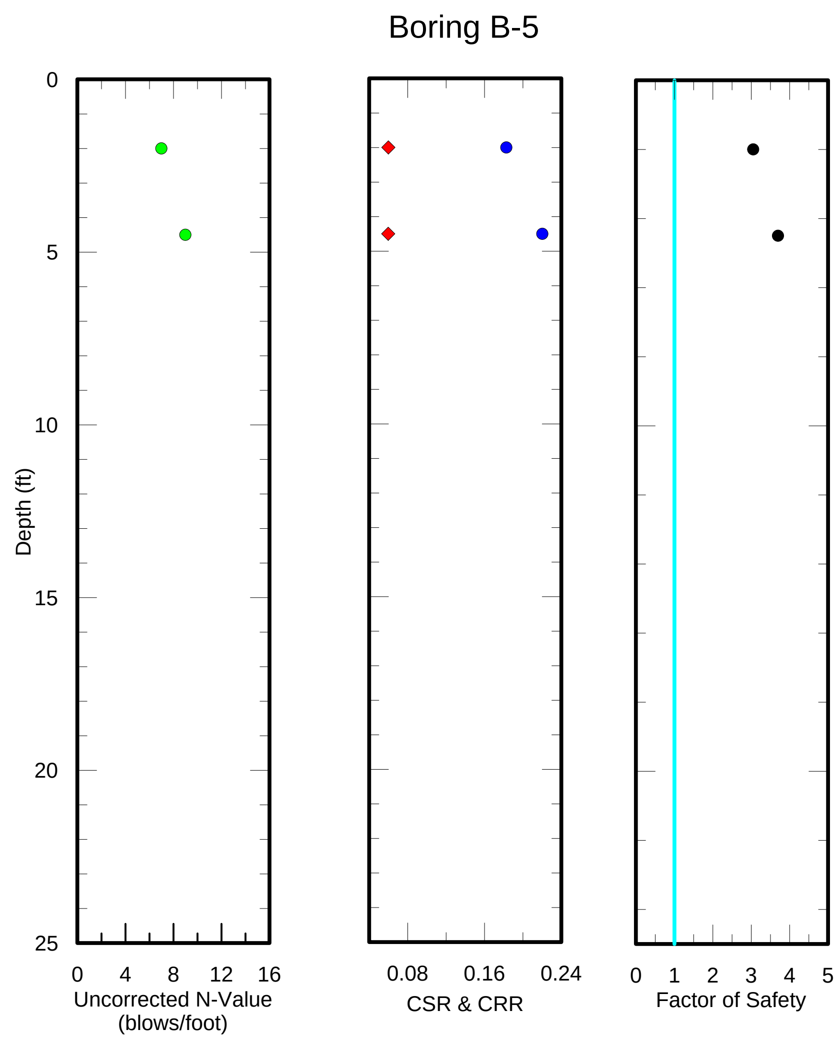
Thomas Hill Energy Center Liquefaction Analysis

Liquefaction Triggering Evaluation
B-3 & B-4
2,500-Year Return Period

October 2016

FIGURE NO.

\\was\Common\Projects\40616\-XXX TH SF Assessment\Analyses\Liquefaction\SPT_Liquefaction Triggering_2500 B-5.grf



LEGEND

- Cyclic Stress Ratio$_{M,\sigma'_{vc}}$
- Cyclic Resistance Ratio$_{M,\sigma'_{vc}}$
- Factor of Safety

NOTES:

1) Cyclic Stress Ratio (CSR), Cyclic Resistance Ratio (CRR) and Factor of Safety (FS) values calculated using methods described in EERI's "Soil Liquefaction during Earthquakes" [Idriss & Boulanger, 2008].
2) Effective stresses used in CRR equations calculated based on depth of water at the time of boring advancement. Effective stresses used in CSR equations based on depth to water at maximum storage.
3) CSR values calculated for an earthquake having a PGA of 0.092g and a magnitude of 7.7.
4) CRR values were calcuated using an assumed fines content of 50%.
5) Calculated factors of safety are limited to a value of 5 for graphical representation.

HALEY ALDRICH

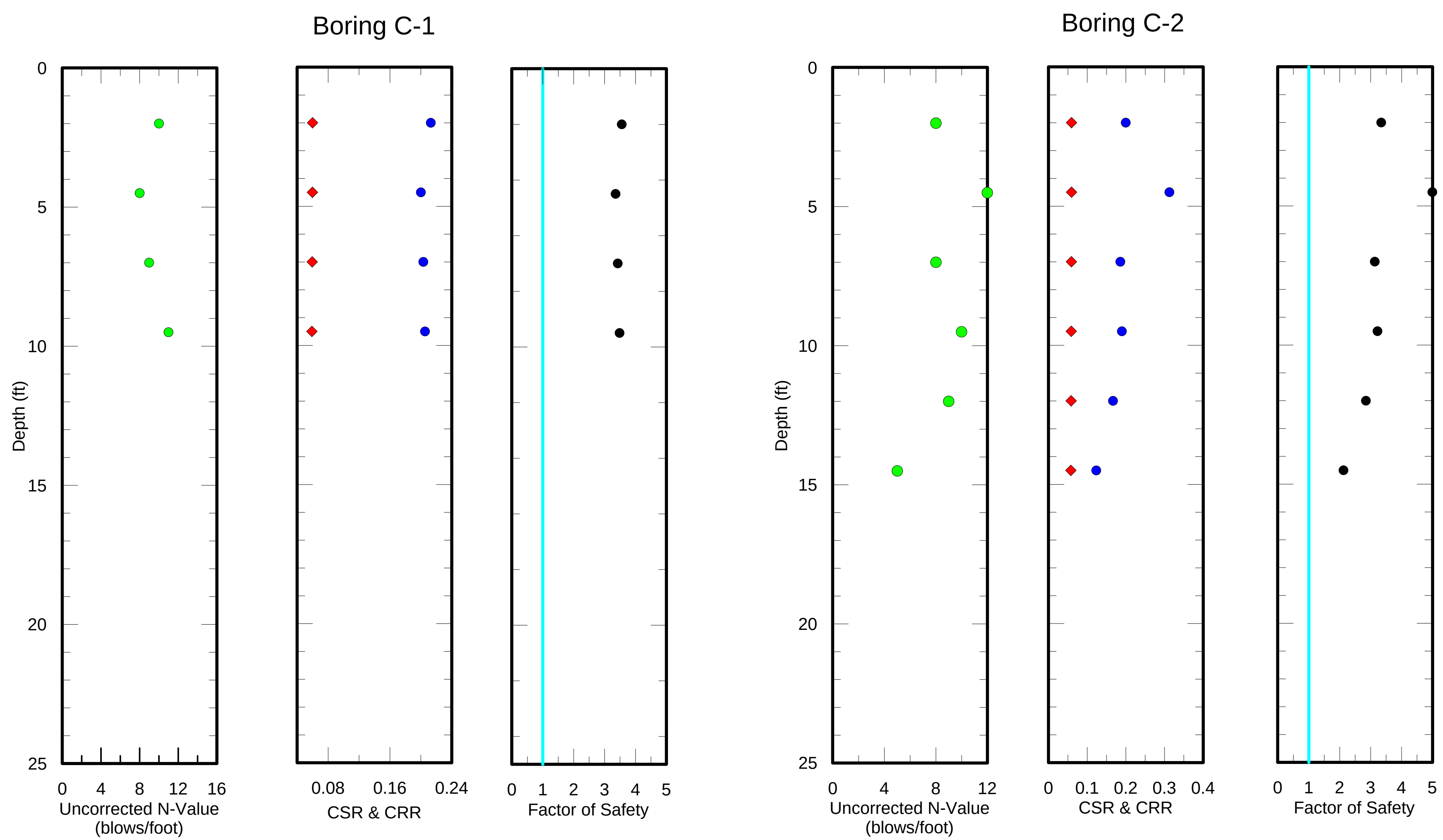
Thomas Hill Energy Center Liquefaction Analysis

Liquefaction Triggering Evaluation
B-5
2,500-Year Return Period

October 2016

FIGURE NO.

\\was\Common\Projects\40616\-XXX TH SF Assessment\Analyses\Liquefaction\SPT_Liquefaction Triggering_2500 C-1, C-2.grf



LEGEND

- Cyclic Stress Ratio$_{M,\sigma'_{vc}}$
- Cyclic Resistance Ratio$_{M,\sigma'_{vc}}$
- Factor of Safety

NOTES:

1) Cyclic Stress Ratio (CSR), Cyclic Resistance Ratio (CRR) and Factor of Safety (FS) values calculated using methods described in EERI's "Soil Liquefaction during Earthquakes" [Idriss & Boulanger, 2008].
2) Effective stresses used in CRR equations calculated based on depth of water at the time of boring advancement. Effective stresses used in CSR equations based on depth to water at maximum storage.
3) CSR values calculated for an earthquake having a PGA of 0.092g and a magnitude of 7.7.
4) CRR values were calcuated using an assumed fines content of 50%.
5) Calculated factors of safety are limited to a value of 5 for graphical representation.

HALEY ALDRICH

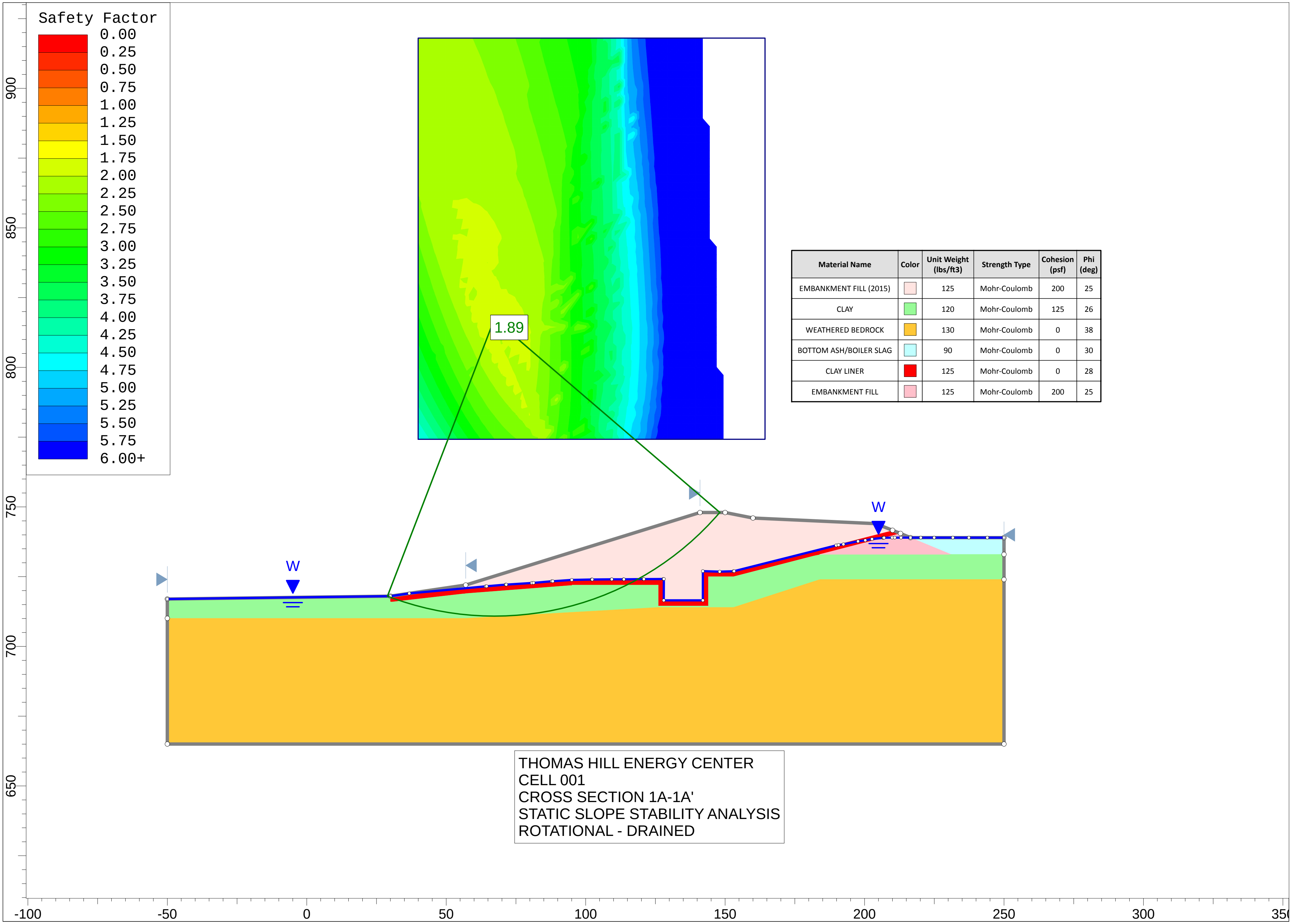
Thomas Hill Energy Center Liquefaction Analysis

Liquefaction Triggering Evaluation
C-1 & C-2
2,500-Year Return Period

October 2016

FIGURE NO.

Slope Stability



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL (2015)		125	Mohr-Coulomb	200	25
CLAY		120	Mohr-Coulomb	125	26
WEATHERED BEDROCK		130	Mohr-Coulomb	0	38
BOTTOM ASH/BOILER SLAG		90	Mohr-Coulomb	0	30
CLAY LINER		125	Mohr-Coulomb	0	28
EMBANKMENT FILL		125	Mohr-Coulomb	200	25

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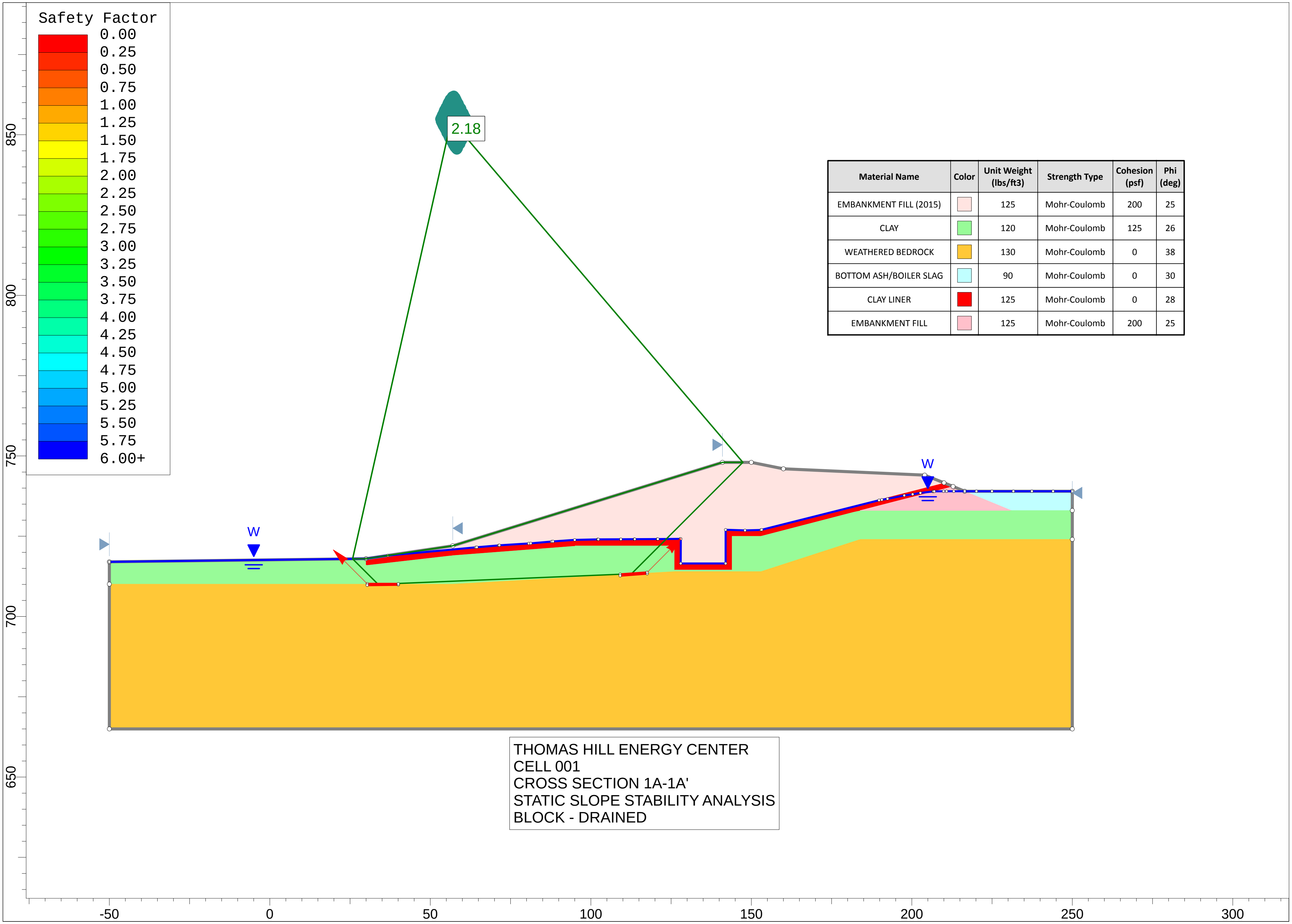
CELL 001
CROSS SECTION 1A-1A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - DRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL (2015)		125	Mohr-Coulomb	200	25
CLAY		120	Mohr-Coulomb	125	26
WEATHERED BEDROCK		130	Mohr-Coulomb	0	38
BOTTOM ASH/BOILER SLAG		90	Mohr-Coulomb	0	30
CLAY LINER		125	Mohr-Coulomb	0	28
EMBANKMENT FILL		125	Mohr-Coulomb	200	25

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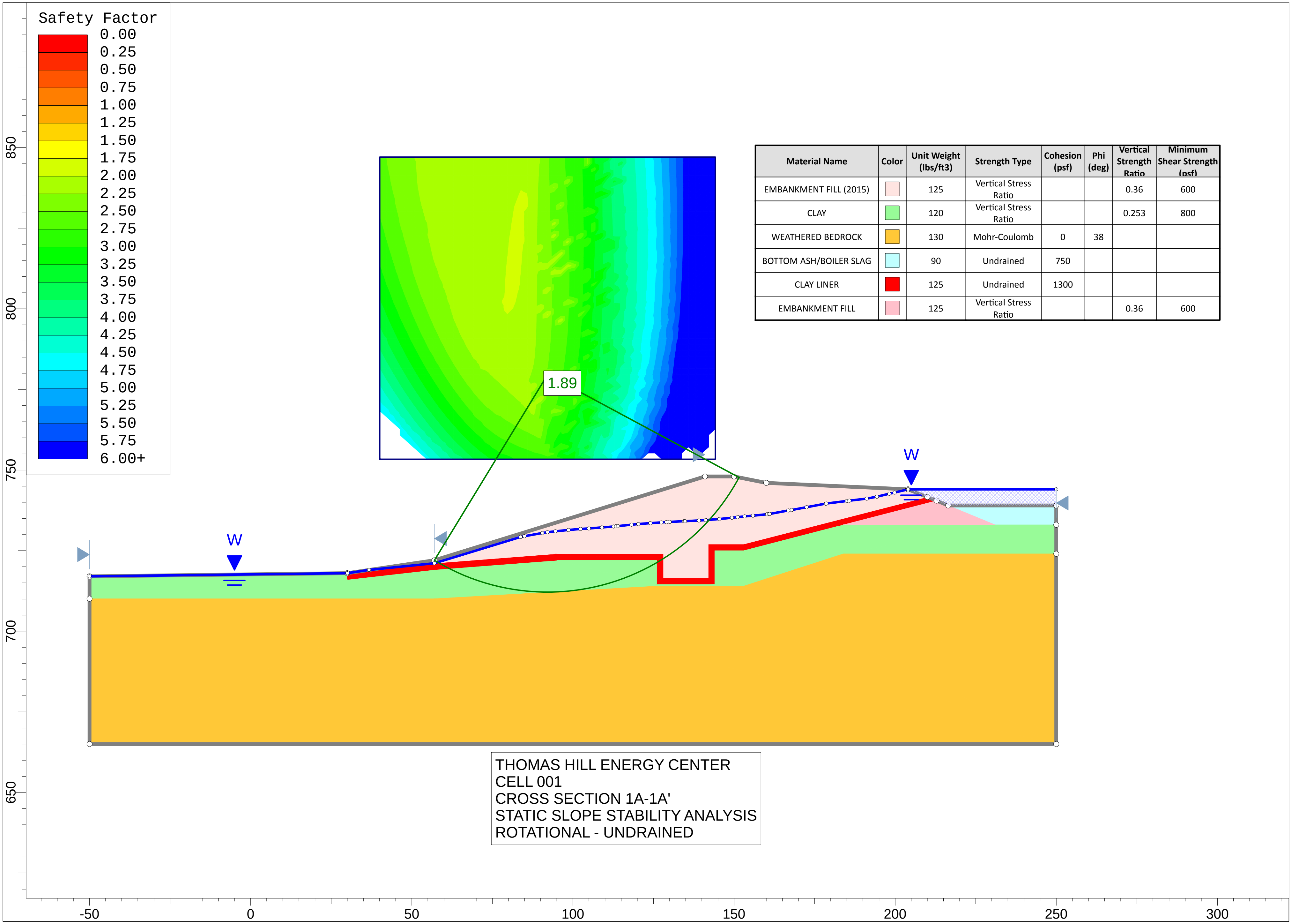
CROSS SECTION 1A-1A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - DRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL (2015)		125	Vertical Stress Ratio			0.36	600
CLAY		120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK		130	Mohr-Coulomb	0	38		
BOTTOM ASH/BOILER SLAG		90	Undrained	750			
CLAY LINER		125	Undrained	1300			
EMBANKMENT FILL		125	Vertical Stress Ratio			0.36	600

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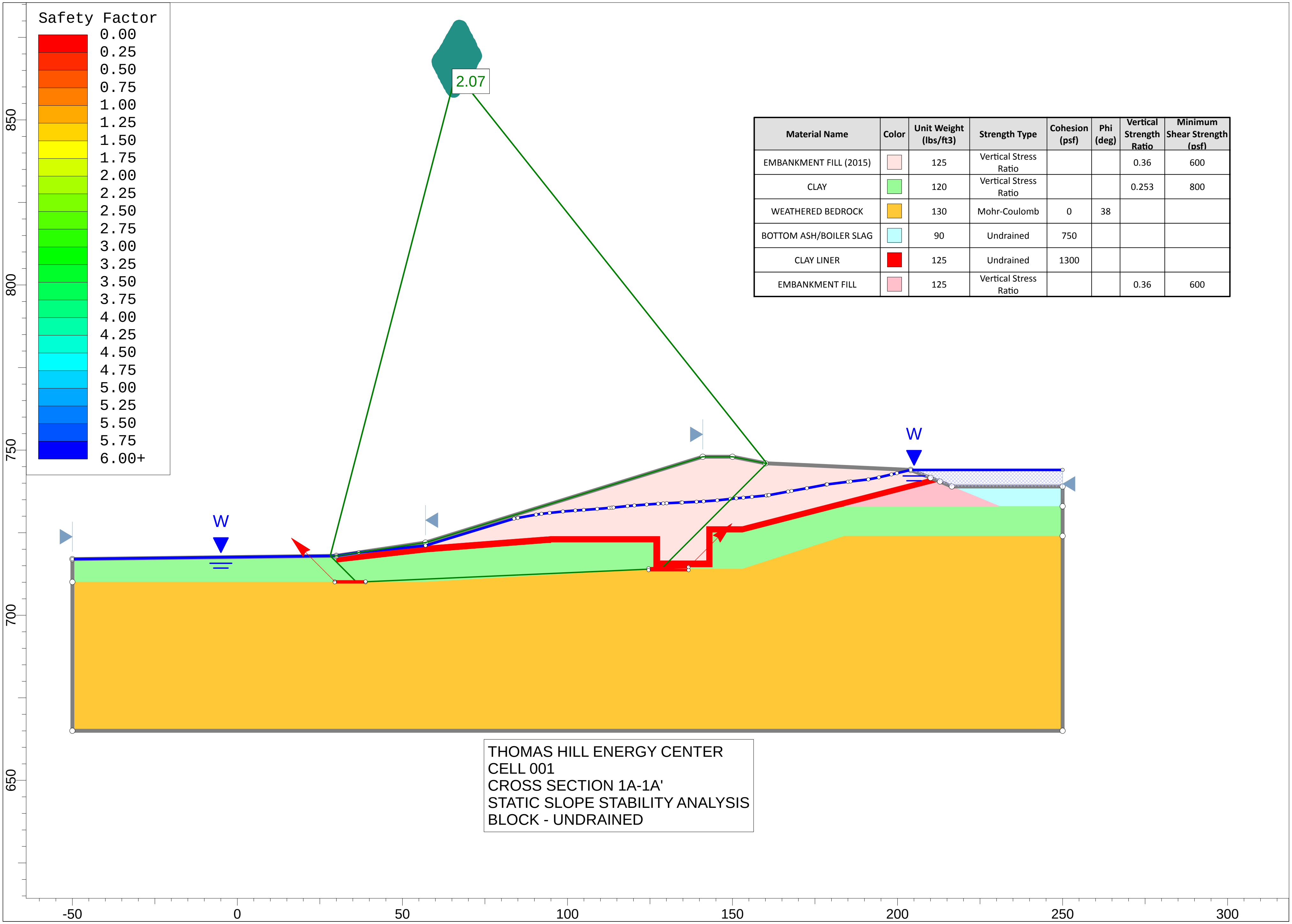
CELL 001
CROSS SECTION 1A-1A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL (2015)		125	Vertical Stress Ratio			0.36	600
CLAY		120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK		130	Mohr-Coulomb	0	38		
BOTTOM ASH/BOILER SLAG		90	Undrained	750			
CLAY LINER		125	Undrained	1300			
EMBANKMENT FILL		125	Vertical Stress Ratio			0.36	600

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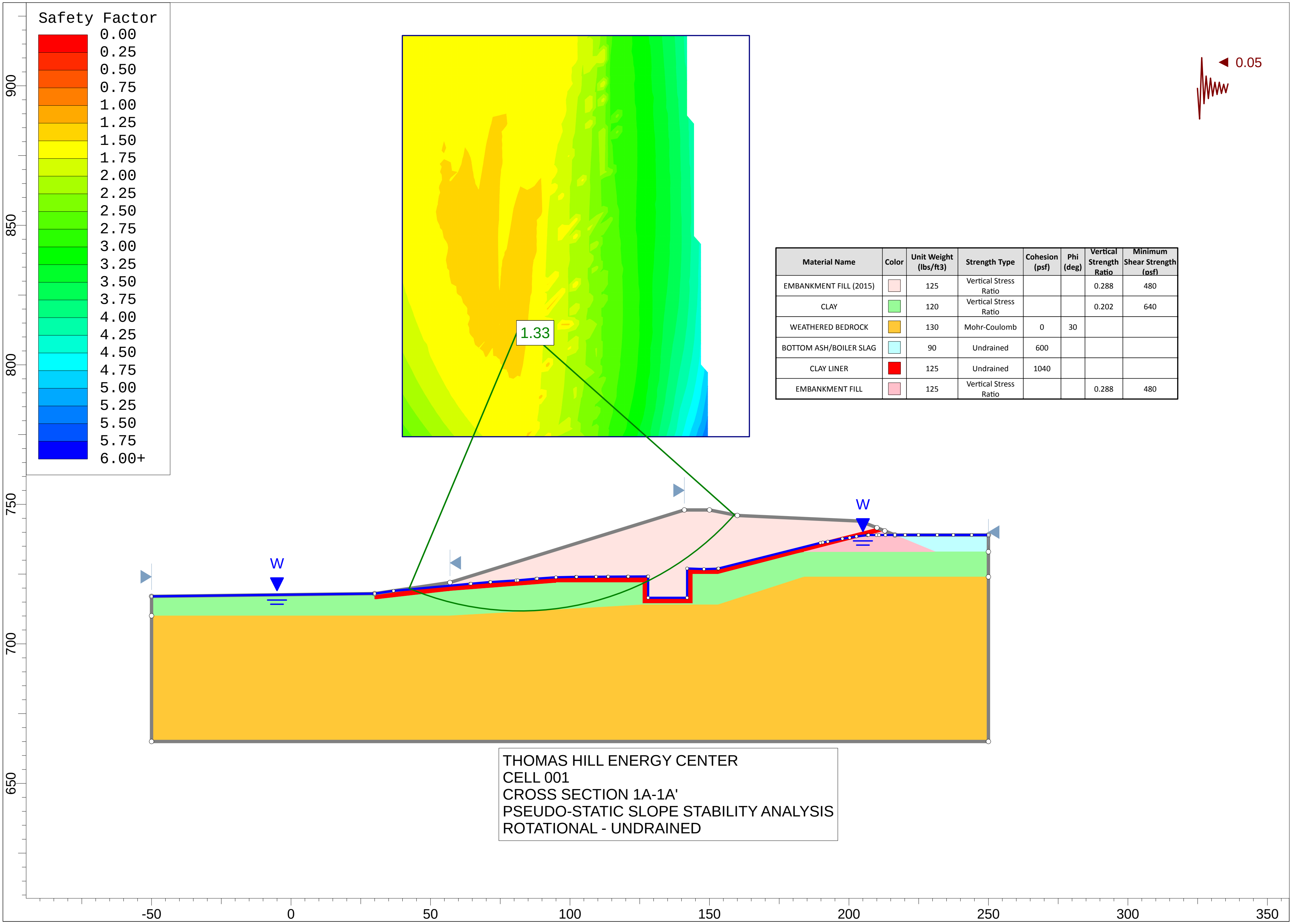
CELL 001
CROSS SECTION 1A-1A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL (2015)		125	Vertical Stress Ratio			0.288	480
CLAY		120	Vertical Stress Ratio			0.202	640
WEATHERED BEDROCK		130	Mohr-Coulomb	0	30		
BOTTOM ASH/BOILER SLAG		90	Undrained	600			
CLAY LINER		125	Undrained	1040			
EMBANKMENT FILL		125	Vertical Stress Ratio			0.288	480

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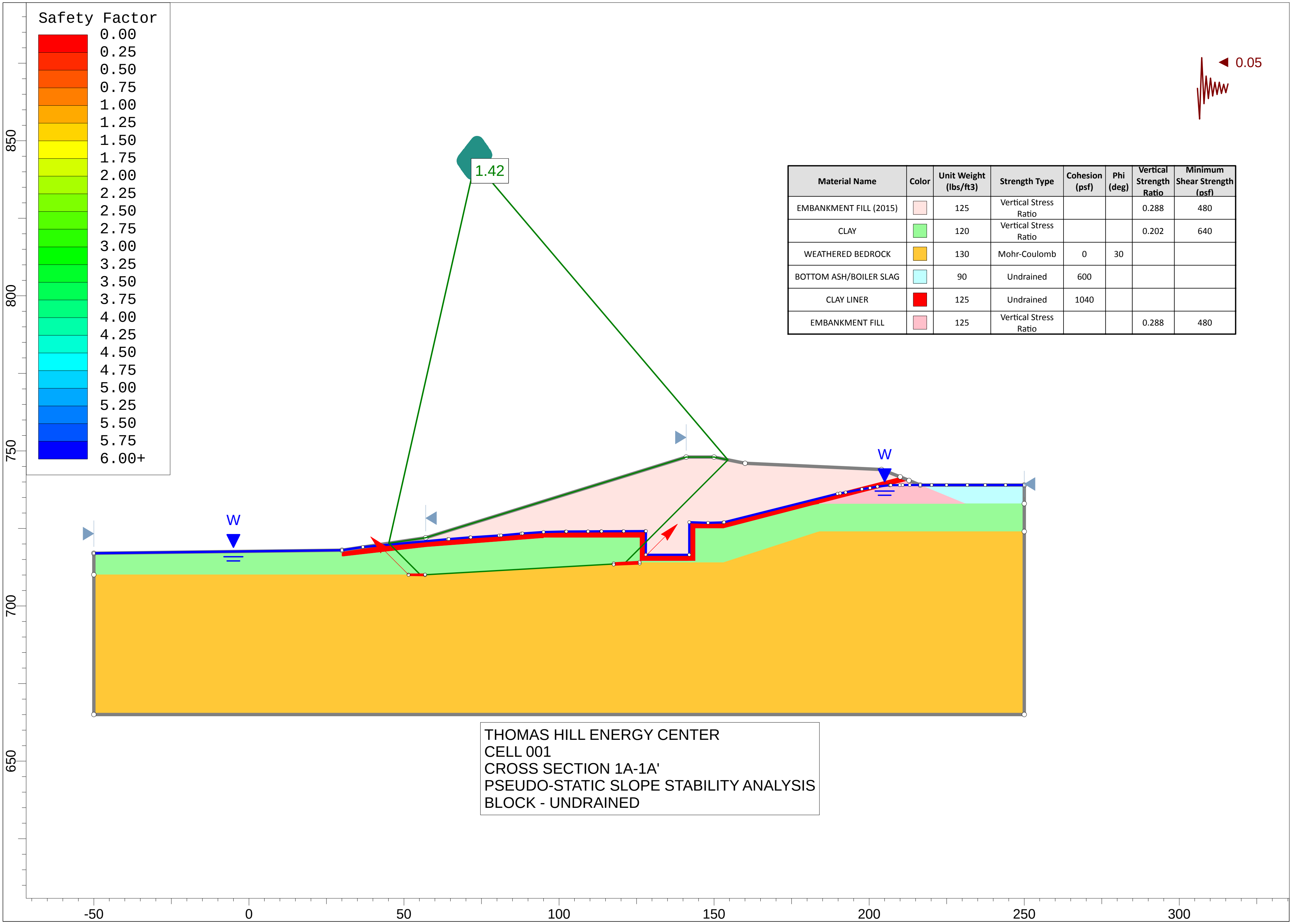
CROSS SECTION 1A-1A'
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL (2015)		125	Vertical Stress Ratio			0.288	480
CLAY		120	Vertical Stress Ratio			0.202	640
WEATHERED BEDROCK		130	Mohr-Coulomb	0	30		
BOTTOM ASH/BOILER SLAG		90	Undrained	600			
CLAY LINER		125	Undrained	1040			
EMBANKMENT FILL		125	Vertical Stress Ratio			0.288	480

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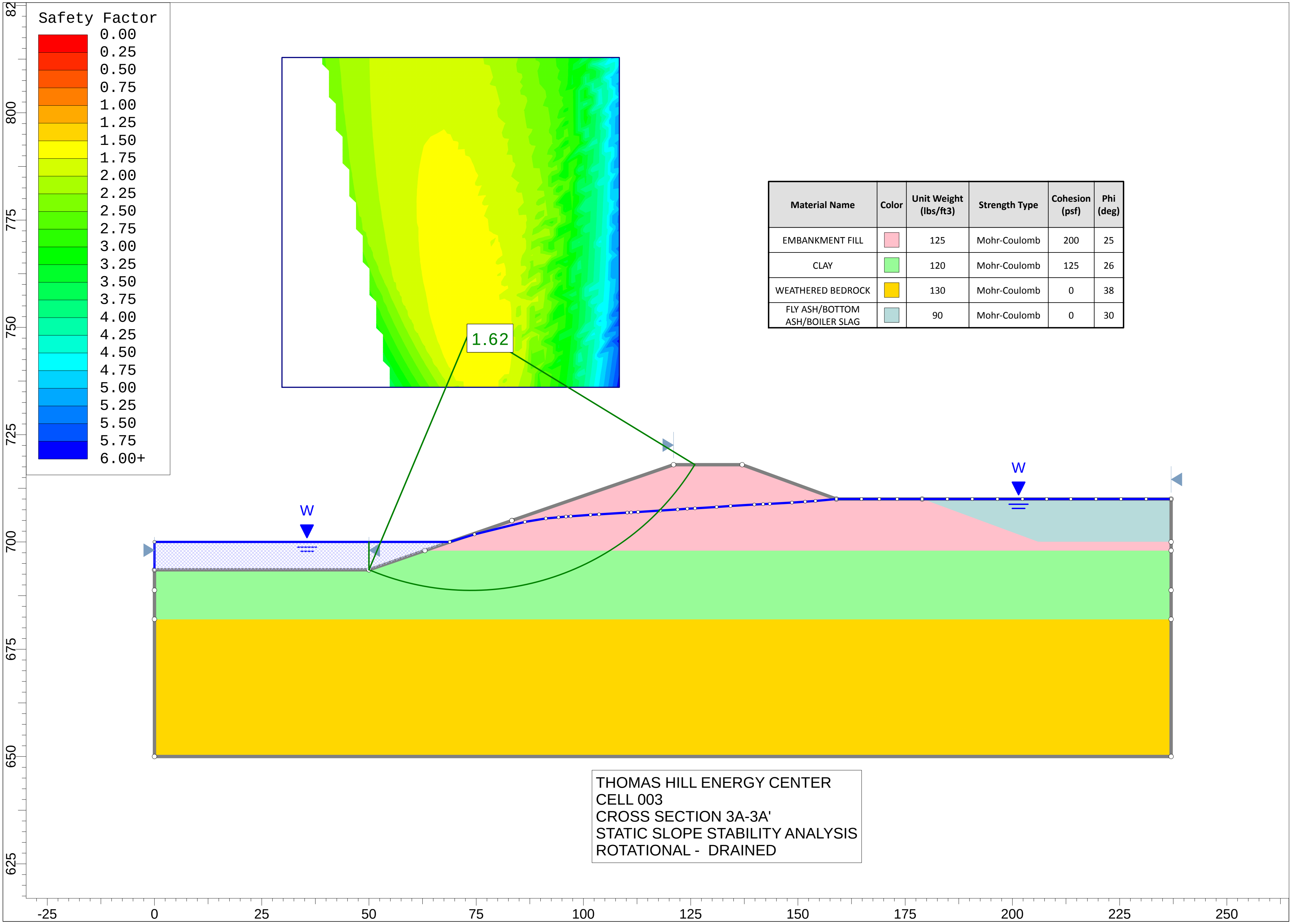
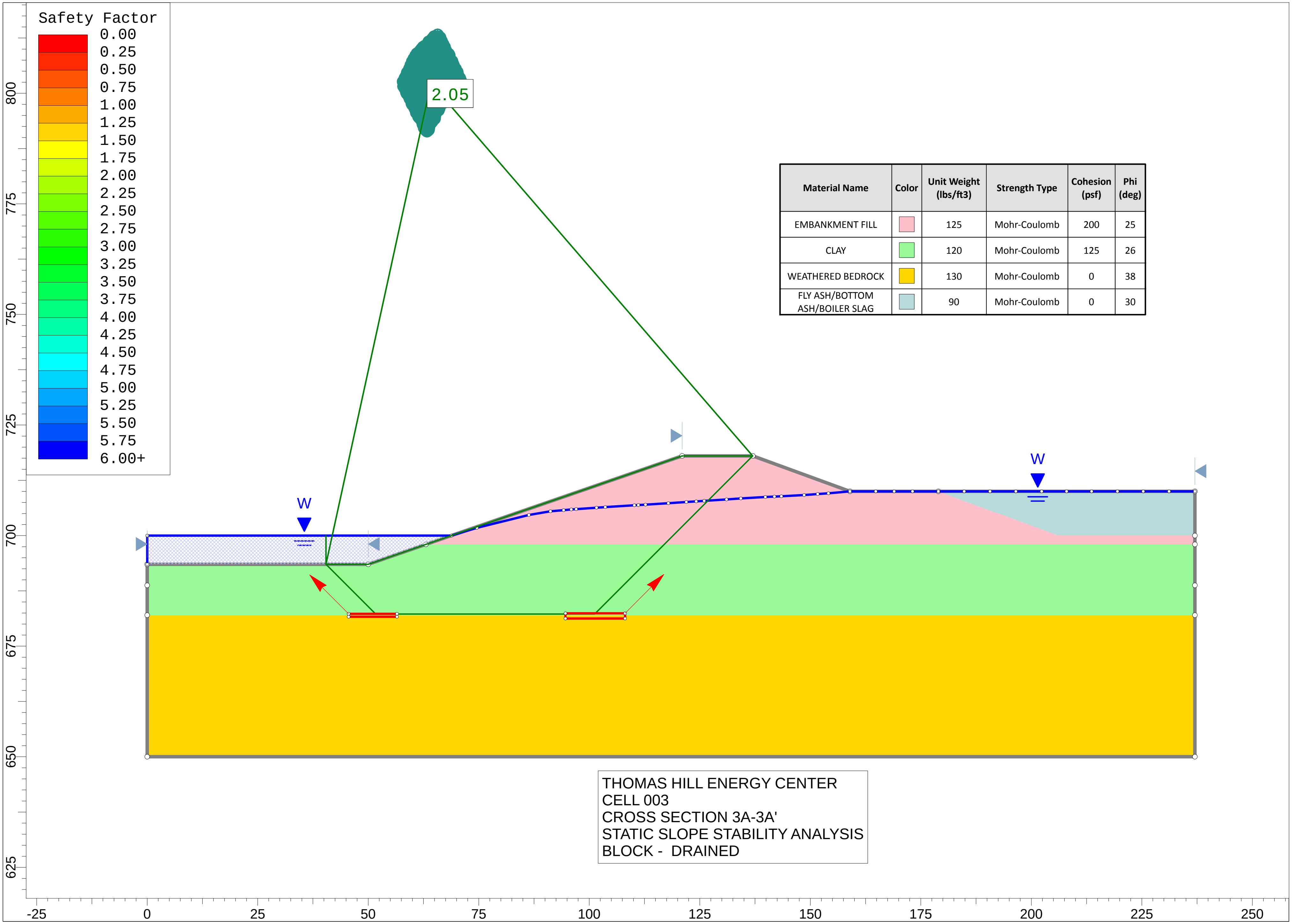
CROSS SECTION 1A-1A'
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED

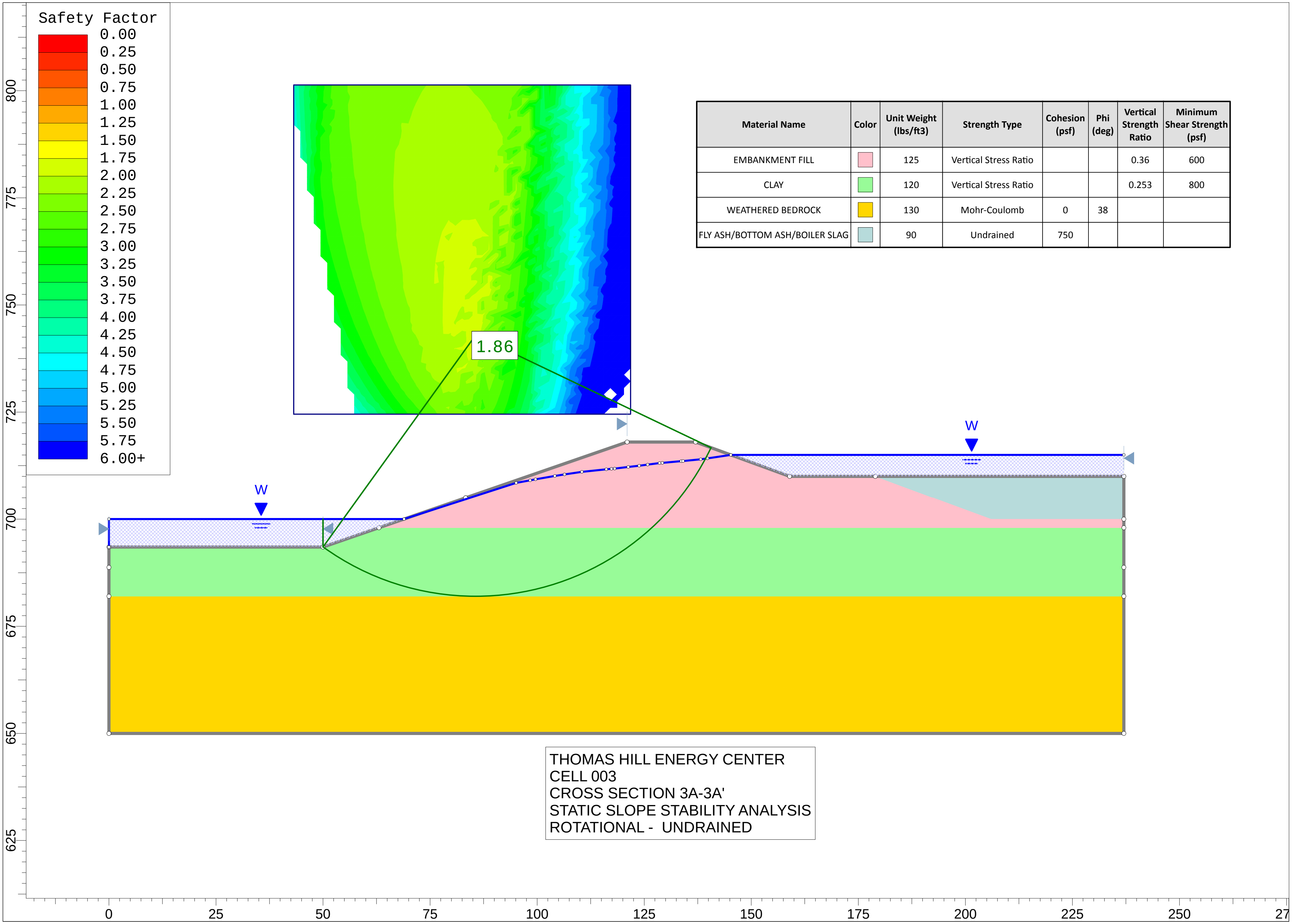


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL		125	Mohr-Coulomb	200	25
CLAY		120	Mohr-Coulomb	125	26
WEATHERED BEDROCK		130	Mohr-Coulomb	0	38
FLY ASH/BOTTOM ASH/BOILER SLAG		90	Mohr-Coulomb	0	30

THOMAS HILL ENERGY CENTER
CELL 003
CROSS SECTION 3A-3A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - DRAINED

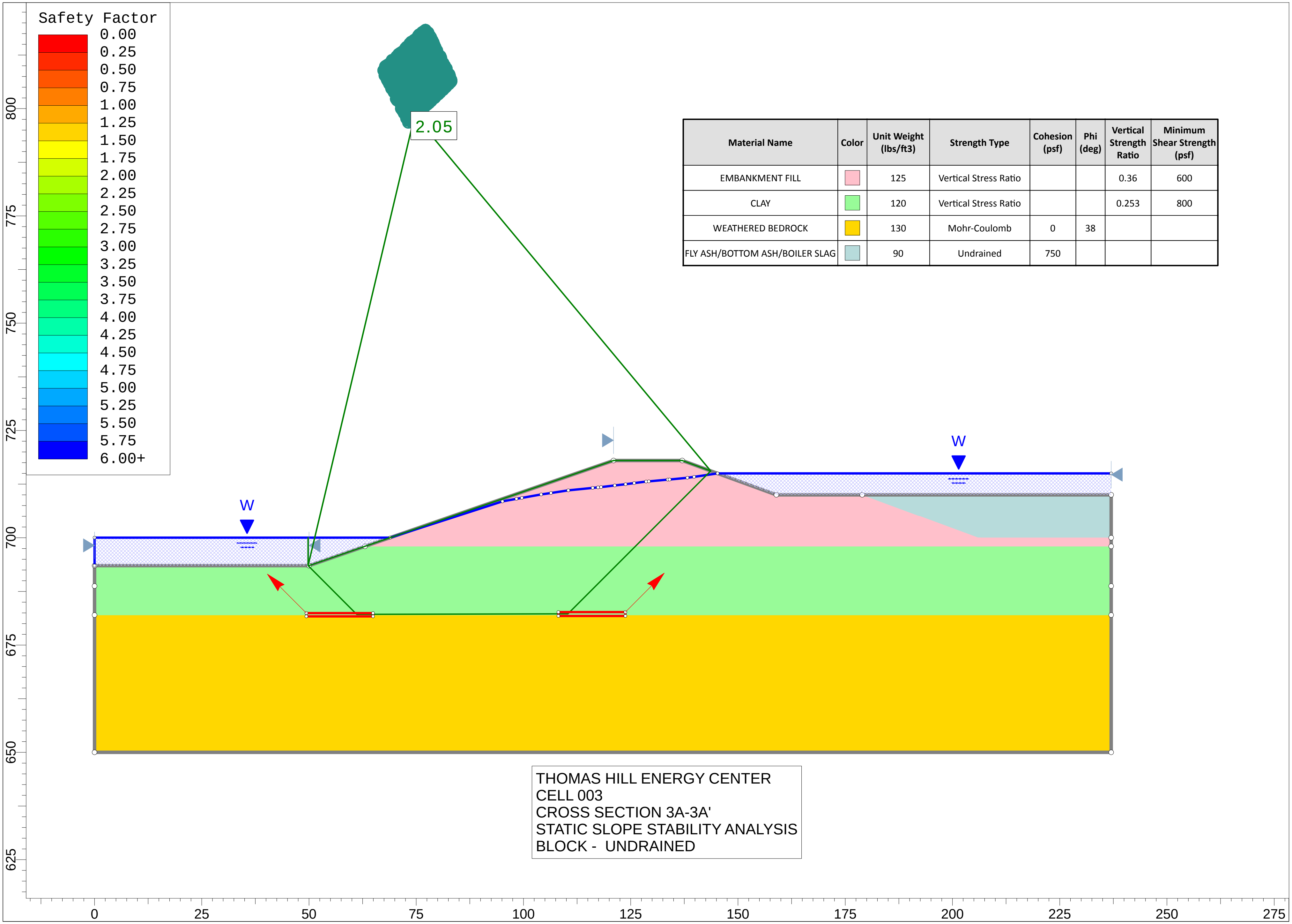


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL		125	Mohr-Coulomb	200	25
CLAY		120	Mohr-Coulomb	125	26
WEATHERED BEDROCK		130	Mohr-Coulomb	0	38
FLY ASH/BOTTOM ASH/BOILER SLAG		90	Mohr-Coulomb	0	30



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL		125	Vertical Stress Ratio			0.36	600
CLAY		120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK		130	Mohr-Coulomb	0	38		
FLY ASH/BOTTOM ASH/BOILER SLAG		90	Undrained	750			

THOMAS HILL ENERGY CENTER
CELL 003
CROSS SECTION 3A-3A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL		125	Vertical Stress Ratio			0.36	600
CLAY		120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK		130	Mohr-Coulomb	0	38		
FLY ASH/BOTTOM ASH/BOILER SLAG		90	Undrained	750			

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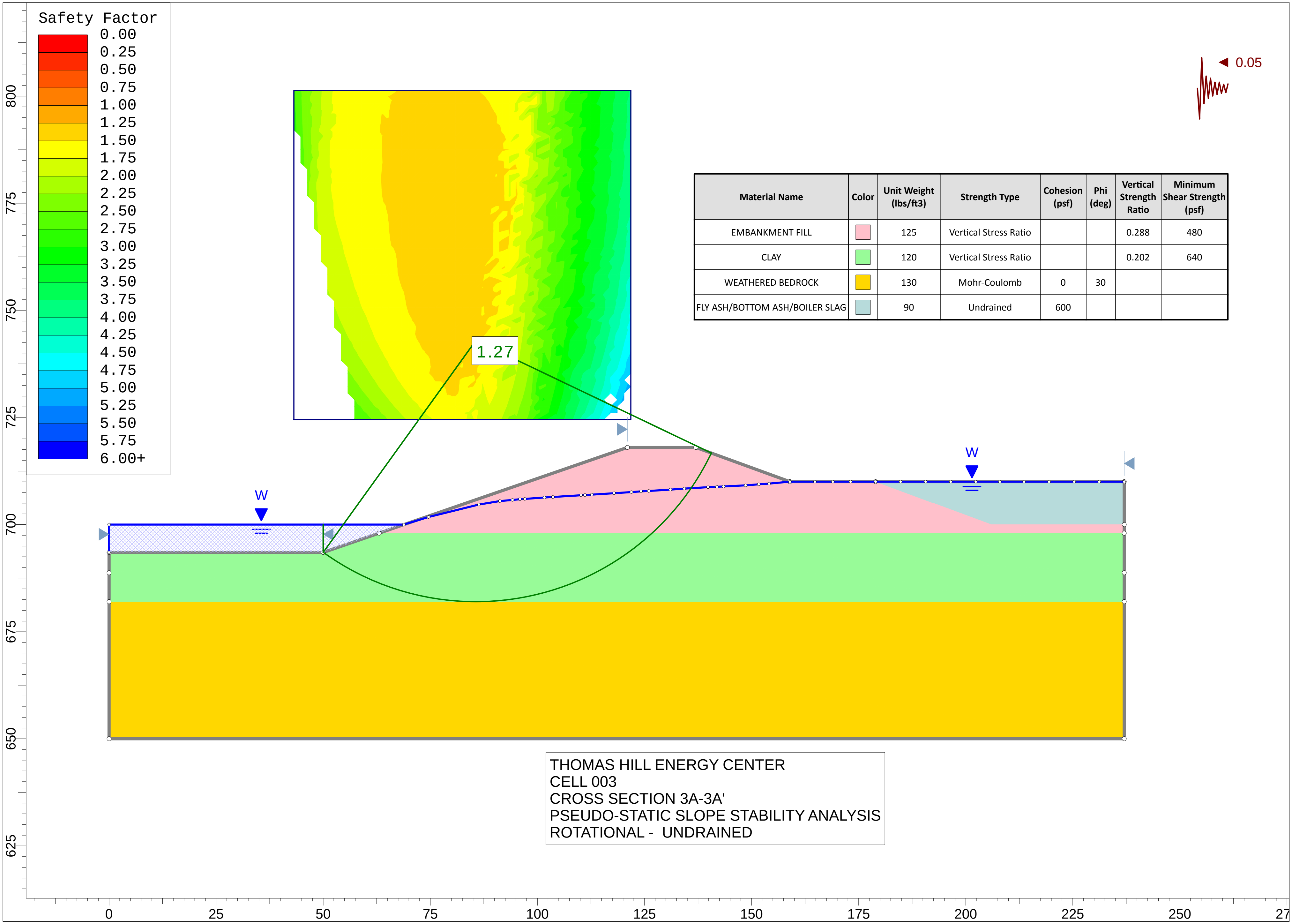
CELL 003
CROSS SECTION 3A-3A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL		125	Vertical Stress Ratio			0.288	480
CLAY		120	Vertical Stress Ratio			0.202	640
WEATHERED BEDROCK		130	Mohr-Coulomb	0	30		
FLY ASH/BOTTOM ASH/BOILER SLAG		90	Undrained	600			

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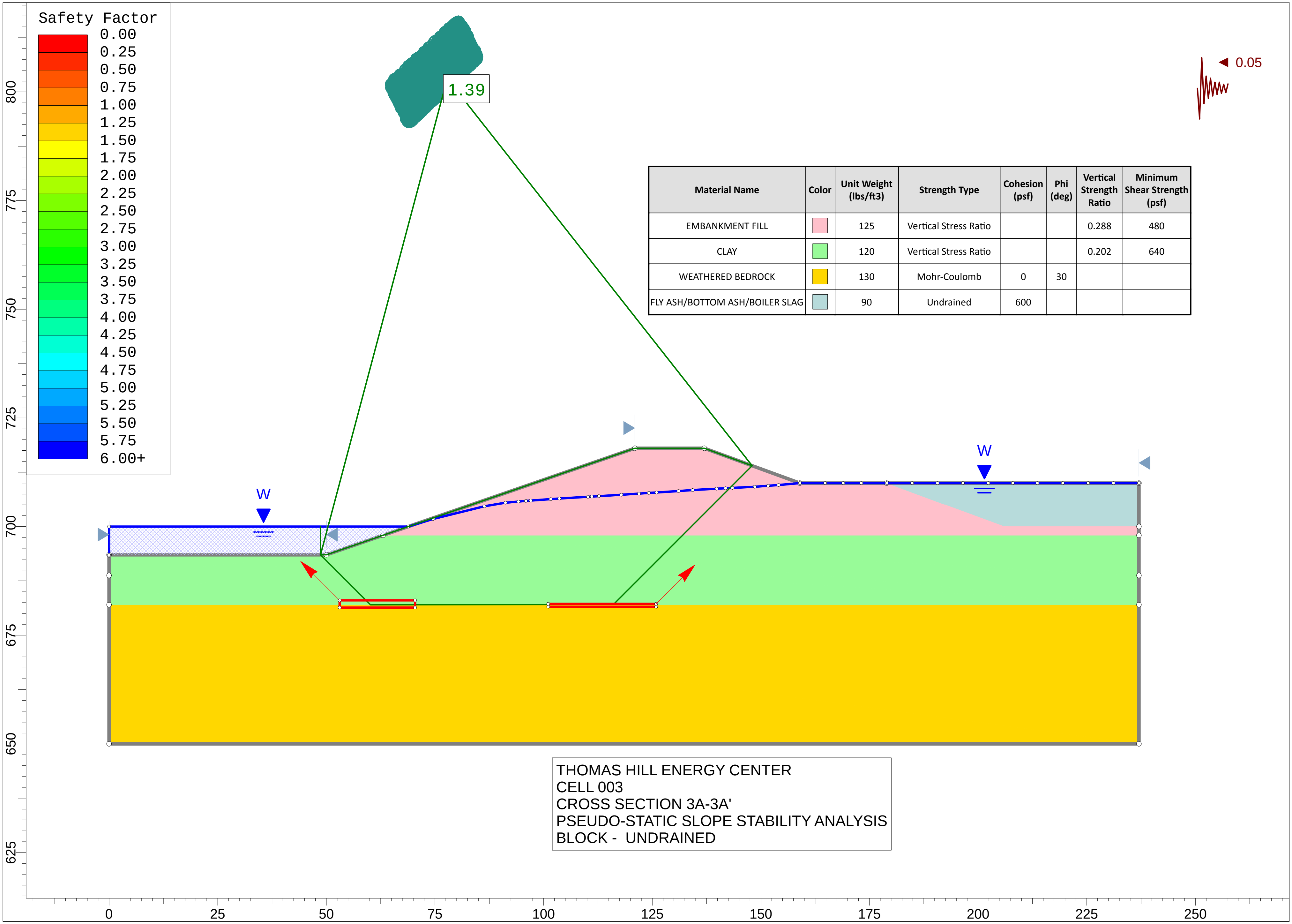
CROSS SECTION 3A-3A'
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



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EMBANKMENT FILL		125	Vertical Stress Ratio			0.288	480
CLAY		120	Vertical Stress Ratio			0.202	640
WEATHERED BEDROCK		130	Mohr-Coulomb	0	30		
FLY ASH/BOTTOM ASH/BOILER SLAG		90	Undrained	600			

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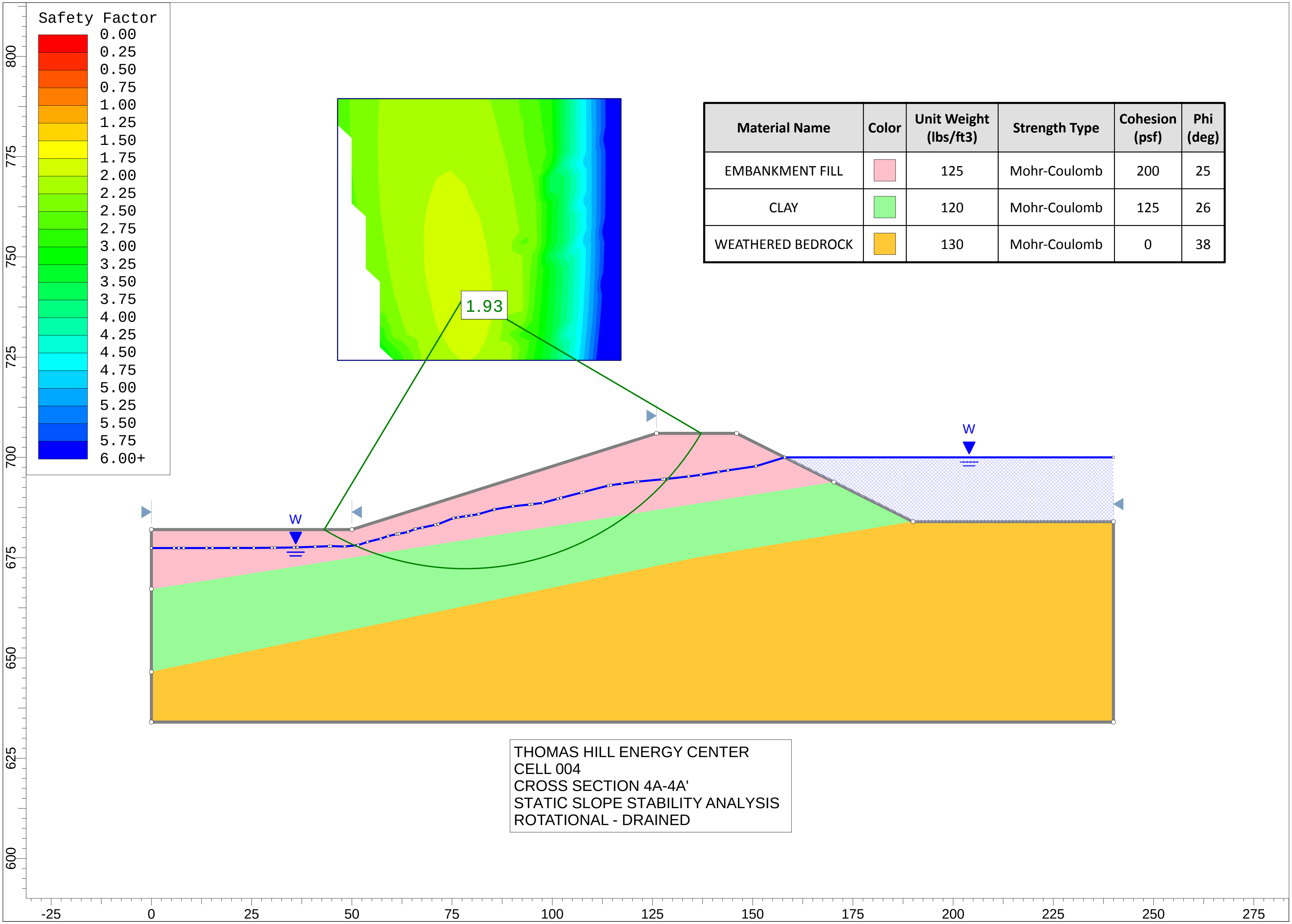
CELL 003
CROSS SECTION 3A-3A'
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL		125	Mohr-Coulomb	200	25
CLAY		120	Mohr-Coulomb	125	26
WEATHERED BEDROCK		130	Mohr-Coulomb	0	38

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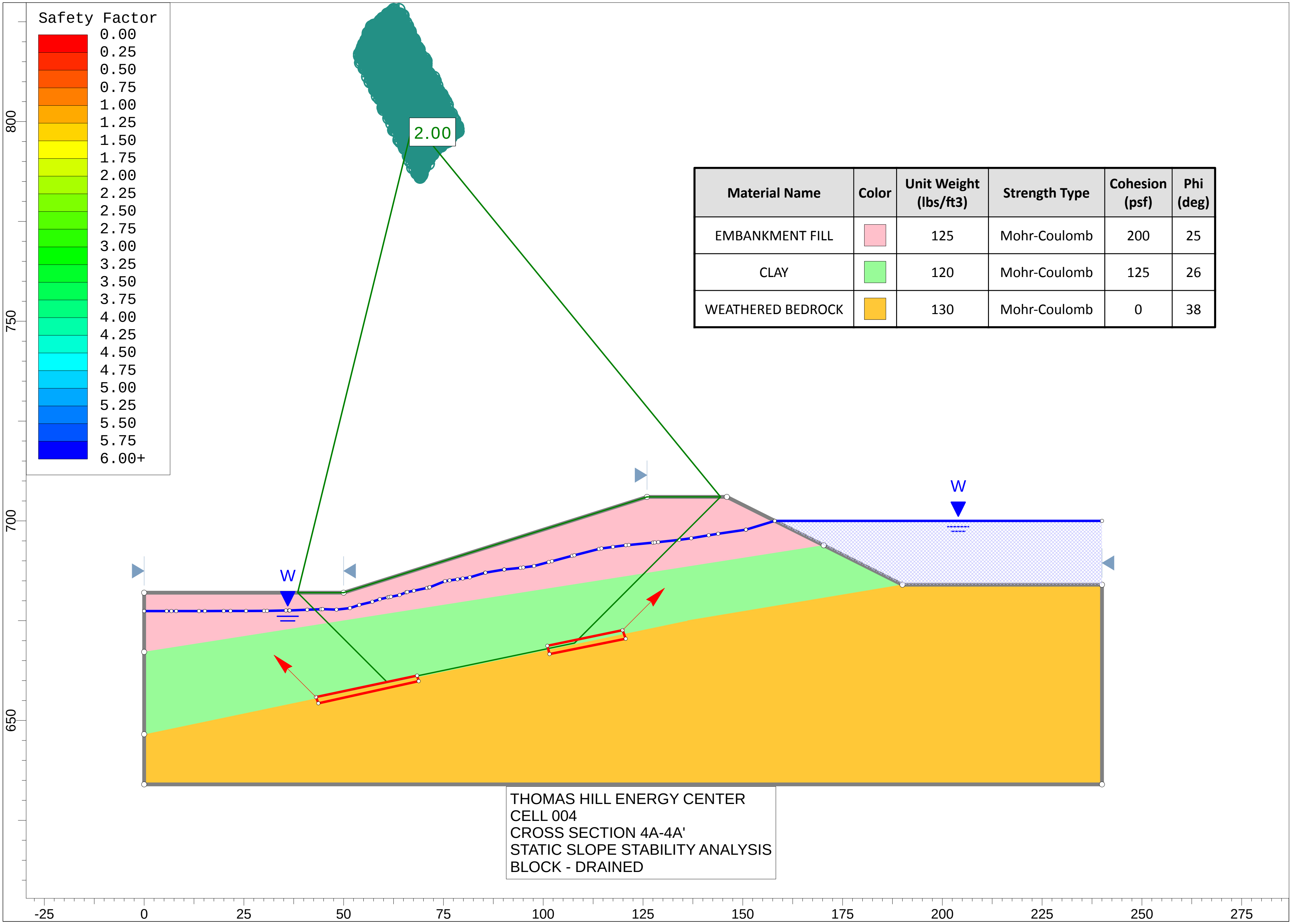
CROSS SECTION 4A-4A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - DRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL		125	Mohr-Coulomb	200	25
CLAY		120	Mohr-Coulomb	125	26
WEATHERED BEDROCK		130	Mohr-Coulomb	0	38

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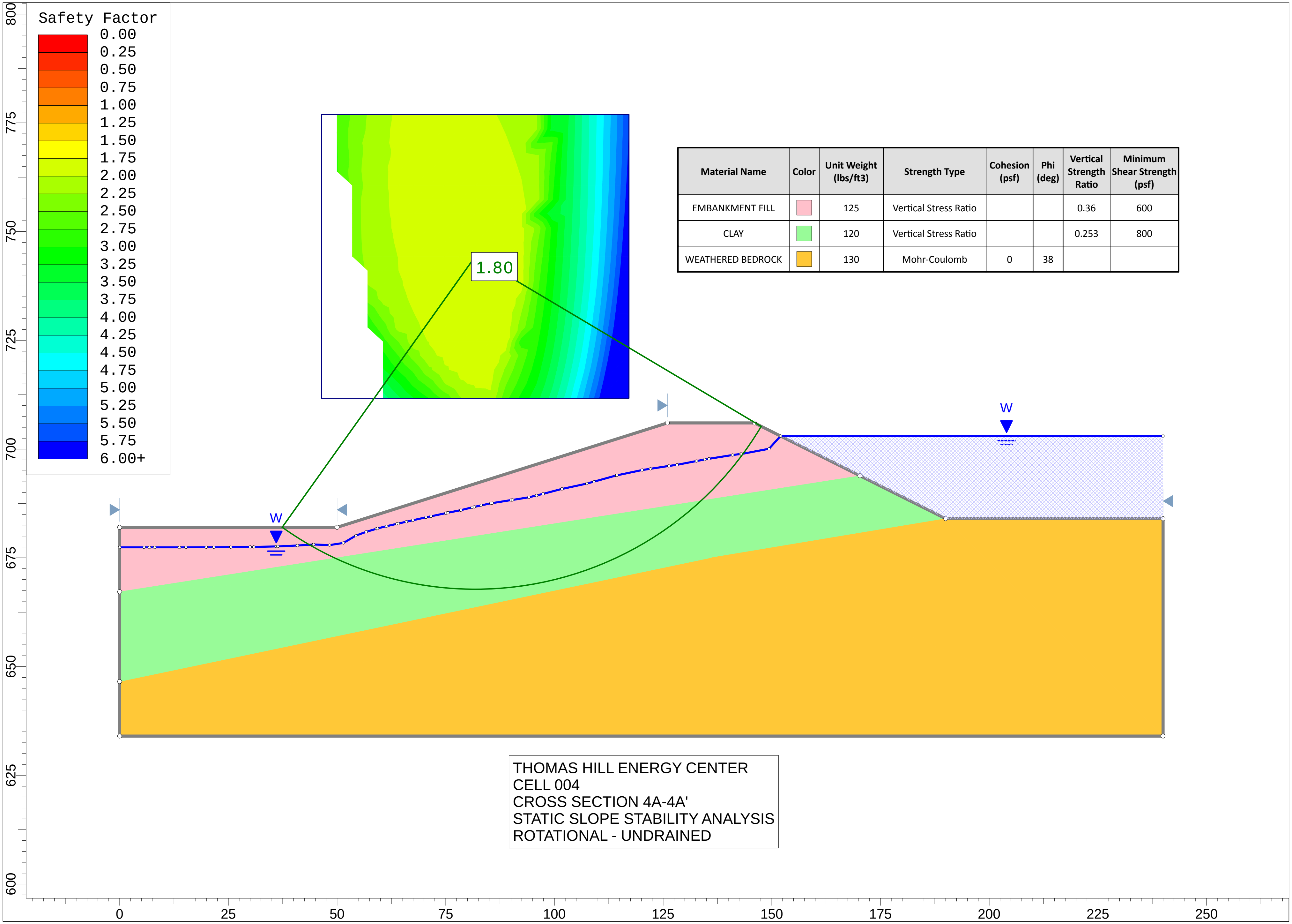
CROSS SECTION 4A-4A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - DRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL		125	Vertical Stress Ratio			0.36	600
CLAY		120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK		130	Mohr-Coulomb	0	38		

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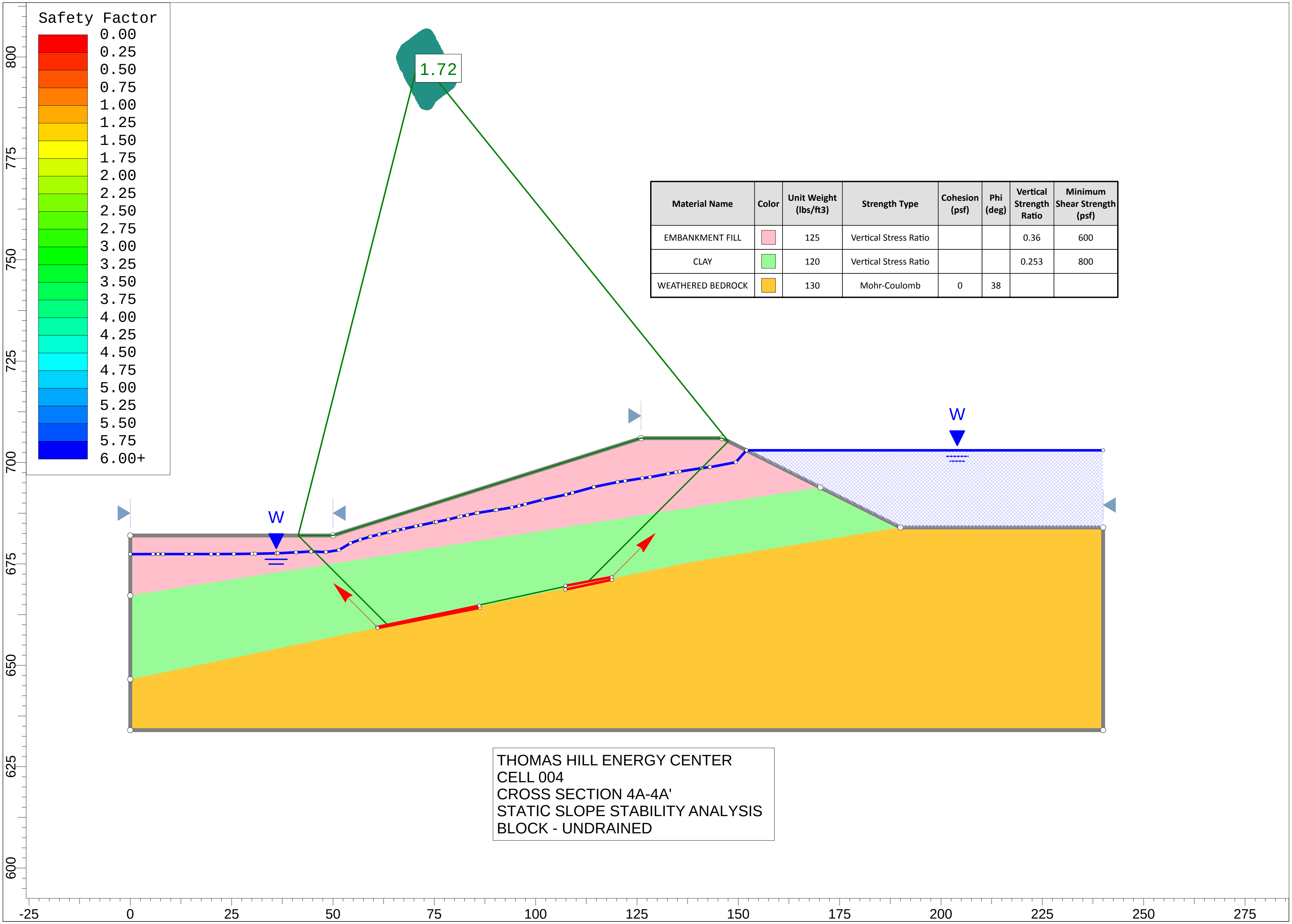
CROSS SECTION 4A-4A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL		125	Vertical Stress Ratio			0.36	600
CLAY		120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK		130	Mohr-Coulomb	0	38		

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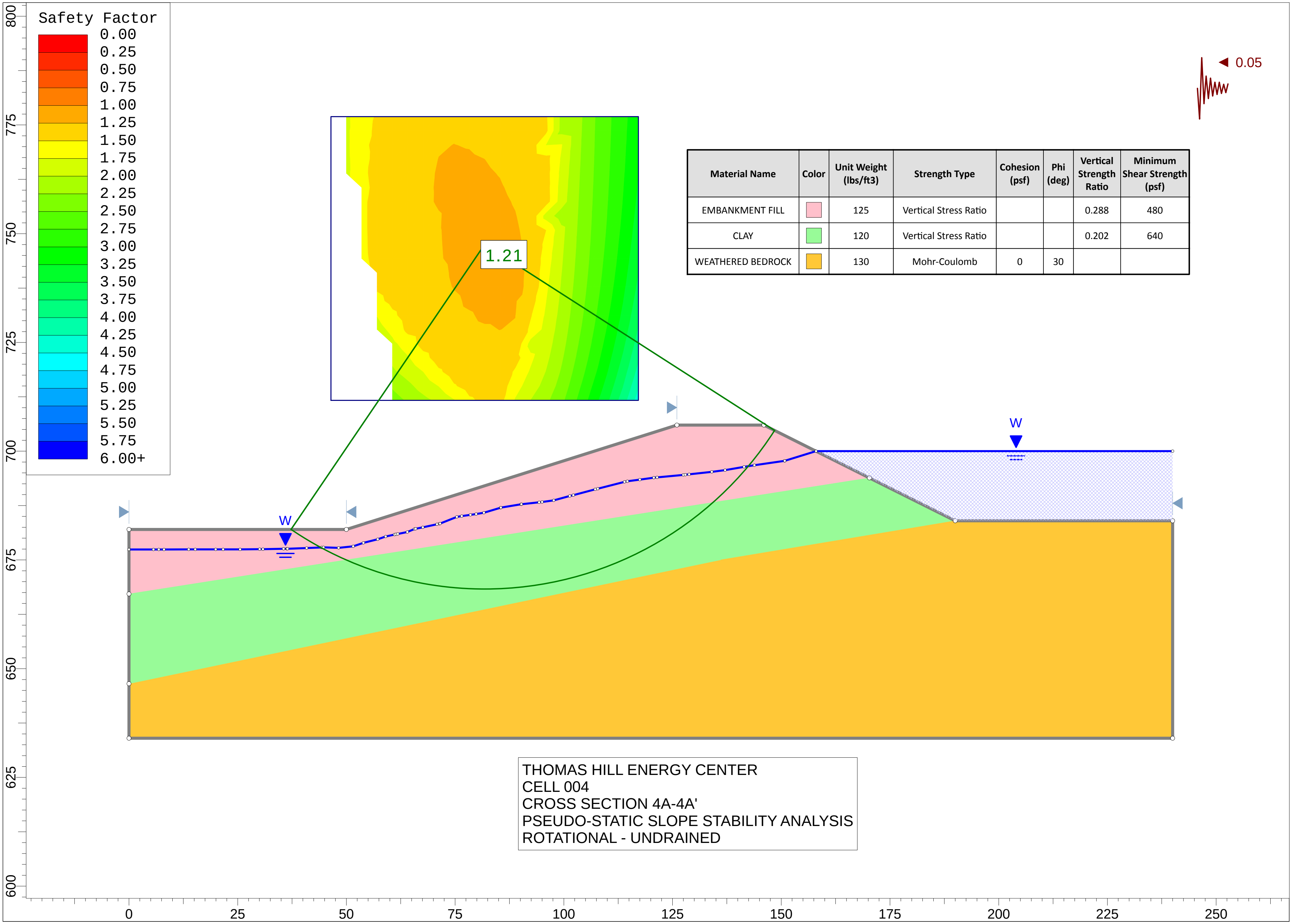
CROSS SECTION 4A-4A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL		125	Vertical Stress Ratio			0.288	480
CLAY		120	Vertical Stress Ratio			0.202	640
WEATHERED BEDROCK		130	Mohr-Coulomb	0	30		

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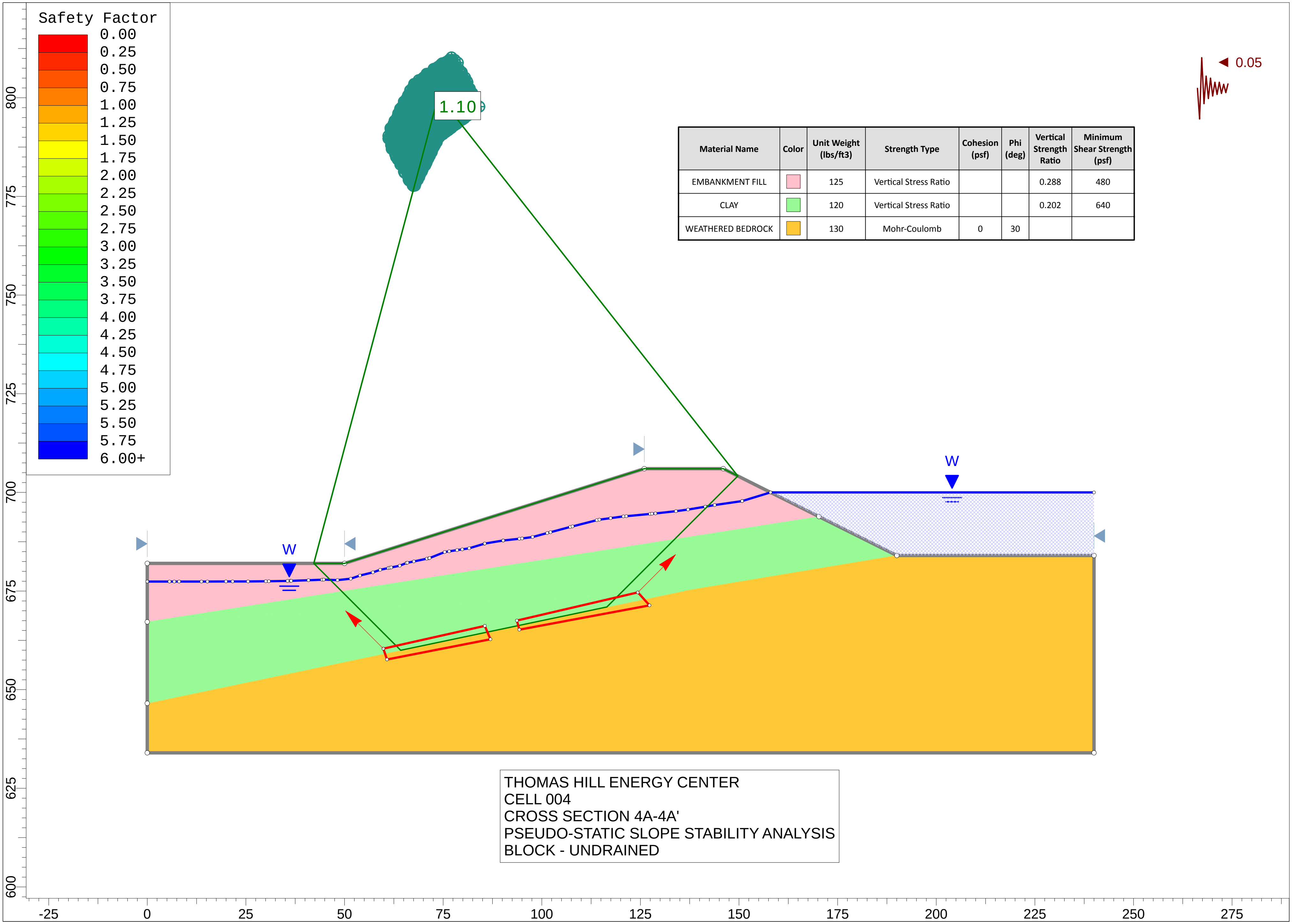
CELL 004
CROSS SECTION 4A-4A'
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL		125	Vertical Stress Ratio			0.288	480
CLAY		120	Vertical Stress Ratio			0.202	640
WEATHERED BEDROCK		130	Mohr-Coulomb	0	30		