MEMORANDUM

20 November 2020
File No. 129638-006

TO: United States Environmental Protection Agency
Andrew Wheeler - Administrator

C: US EPA
Richard Huggins, Kirsten Hillyer, Frank Behan

FROM: Associated Electric Cooperative, Inc.
Kenneth S. Wilmot
Senior Vice President/Chief
Operating Officer

SUBJECT: Addendum to Report on Site Specific Alternate to Initiation of Closure Deadline for Ash Pond 1 (Cell 001, Cell 003, and Cell 004)
Thomas Hill Energy Center
Clifton Hill, Missouri

Mr. Wheeler:

Associated Electric Cooperative, Inc. (AECI) is submitting the attached addendum response to the previously submitted "Report on Site Specific Alternate to Initiation of Closure Deadline for Ash Pond 1 (Cell 001, Cell 003, and Cell 004), Thomas Hill Energy Center, Clifton Hill, Missouri" dated September 2020 (Report) in accordance with 40 CFR 257 Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; A Holistic Approach to Closure Part A: Deadline to Initiate Closure (CCR Rule Part A). Following AECI's discussion of the referenced Report with the United States Environmental Protection Agency (US EPA) on 15 October 2020, AECI submits the information in this addendum to provide further clarification of certain aspects provided in the Report for US EPA consideration in granting an approval of the closure extension for the subject CCR surface impoundments. AECI has made significant efforts in evaluating, locating, design, and constructing alternate capacity for CCR and non-CCR wastestreams which will allow for the discontinued use of Cells 001, 003, and 004 at the facility. As evidence by the Report, and the supplemental information provided in this addendum, AECI's request for a timeline extension based on the fastest technically feasible alternates is substantiated.

Furthermore, AECI reiterates that the facility has been and remains in compliance with all requirements of the of 40 CFR 257, as attested in the Report certification in the Report. AECI has completed necessary documentation for compliance requirements including but not limited to location restrictions, structural integrity and safety factor assessments, and the groundwater monitoring program. Required documentation has been placed in the facility Operating Record in accordance with 40 CFR 257.105, and required documentation has been placed on the facility's public website in accordance with 40 CFR 257.107.

We are providing the following attachments for reference for the US EPA in consideration of this closure extension request and specifically as a follow up to support comments and additional information requested by US EPA on our 15 October 2020 conference call:

> Attachment 1: Report on Site Specific Alternate to Initiation of Closure Deadline for Ash Pond 1 (Cell 001, Cell 003, and Cell 004), Thomas Hill Energy Center, Clifton Hill, Missouri" dated September 2020.
>
> Attachment 2: Updated Appendix A – No Alternate Capacity Schedule
>
> Attachment 3: CCR Groundwater Monitoring Network Description, Thomas Hill Energy Center, Clifton Hill, Missouri dated April 2019.

We appreciate US EPA's consideration of this closure extension request for the subject facility and CCR surface impoundments.

Sincerely yours,

Kenneth S. Wilmot
Senior Vice President / Chief Operating Officer
Associated Electric Cooperative, Inc.

1) Supplemental Information to Section 2.2 Development of Alternative Capacity is Technically Infeasible and Section 2.2.1 Written Narrative

The CCR and non-CCR wastestream flows are sourced from several areas within the plant, but are comprised of two main sources: 1) Unit 1 and Unit 2 boiler slag sluice water including tripper floor wash water and Unit 3 bottom ash sump water totaling on average approximately 9.2 million gallons per day (MGD) discharged into Cell 001; and 2) coal pile runoff including rotary car dumper wash water and conveyor wash water and Pond 016 stormwater runoff totaling on average approximately 0.6 MGD with significantly higher flows during significant rainfall events over this greater than 80 acre watershed which combine with discharge from Cell 001 and discharge as a total of 9.8 MGD into Cell 003 and then cell 004. AECI evaluated several on-site options for alternate capacity for both CCR and non-CCR wastestreams at the Thomas Hill Energy Center (THEC). First, there is no already existing wastewater treatment facility that exists on-site besides several small stormwater management ponds. These existing ponds are located near or around the power block, and primarily managed stormwater runoff prior to discharge into the Thomas Hill Reservoir. These ponds lack sufficient capacity to support any additional flows. Specifically, they are significantly undersized for sluice water, lack available space to expand the footprint to add additional capacity, and are not located proximate to the drainage areas for coal pile runoff.

In evaluation of alternate capacity for CCR wastestreams currently managed by Cell 001, and the downstream impoundments, AECI evaluated under boiler and remote submerged flight conveyors (SFC) to manage the Unit 1 and Unit 2 generated boiler slag. Regarding under boiler SFCs, it was determined that there is insufficient space under the current boilers to be able to install necessary equipment making this option infeasible. In considering remote SFCs, limitations on siting options with suitable space for the SFC equipment, material load-out area, and limitations on conveyor system locations showed that this system was plausible, but ultimately unpreferred due to additional timing required to procure equipment, shipment of the equipment, and outage timing to allow for installation. The selected concrete dewatering tank (CDT) reduced the amount of time required to install and commission a system to manage boiler slag by using available land adjacent to already existing sluice pipes that convey this boiler slag and associated sluice water. In addition, the CDT will provide better water chemistry for use in re-circulation back to the plant.

No other existing CCR surface impoundments exist on-site which would allow for a redirection of flows. In addition, pursuit of new CCR compliant surface impoundments would require several compliance related efforts that would extend the timeline of putting a new CCR surface impoundment online beyond that of the CDT timeline. Efforts related to siting, MDNR permitting for both construction and NPDES operating discharge, installation of a new CCR compliance groundwater monitoring program including the time required to site compliant well locations, installation of the wells, and obtaining adequate background monitoring under the detection monitoring program led to the conclusion that a new CCR surface impoundment could not be constructed to adequately manage the 9.2 MGD of CCR sluice water in less time than the CDT.

Regarding off-site alternative capacity considerations, the THEC is located in rural Randolph County. No existing public wastewater treatment works, municipal sewer system, or other publicly managed alternate capacity exists for AECI to manage CCR and/or non-CCR flows. Likewise, no other private industrial wastewater treatment works exists near the facility. Even if off-site treatment capacity existed, no existing pipelines exist to convey this volume of water. In the CCR Rule, the USEPA clearly states "while it is possible to transport dry ash off-site to alternate disposal facility that simply is not feasible for wet-generated CCR." To understand this concept, with over 9.8 MGD of wastewater needing to be managed (not accounting for peak flows which will add considerable volume), and accounting for the use of 10,000 gallon capacity tanker trucks, this would require over 980 tanker truck trips per day to haul this volume of water, increasing safety risk and concerns with over the road transport increase on local roads and highways. Likewise, temporary management (e.g. frac tanks) of 9.2 MGD of these wastewater flows was deemed infeasible based on the volume and the need for same water to be discharged either on-site or off-site.

For the non-CCR wastestreams (i.e. coal pile runoff and associated flows), AECI considered the existing on-site ponds around the power block but again determined that the ponds were undersized, not appropriately located, and there is no ability to enlarge the ponds due to space constraints. AECI then considered constructing a new pond or ponds and reconfiguring existing infrastructure (i.e. Cell 002 West and East). For a new pond or ponds, site constraints would have required revisions to pump systems and piping, revisions to existing infrastructure to manage flows at the coal piles (e.g. the size of the small pond adjacent to the Unit 1&2 coal pile would be inadequate to store significant volumes of water to allow for pumping), and the same siting and MDNR permitting constraints (both construction and operational discharge) referenced for a new CCR surface impoundment.

Instead, AECI evaluated the reconfiguration of former CCR impoundments that had been previously closed by removal (Cell 002 East was closed prior to the CCR Rule effective date, and Cell 002 West was certified closed by removal in 2019). These areas still remained as non-CCR ponds primarily managing direct rainfall and surface stormwater, but no longer received CCR wastestreams or other industrial wastestreams. Geographically, these two ponds are sited between Cell 001 and Cell 003, with an existing ditch located west of Cell 002 West that conveys flows from the coal pile runoff and Cell 001 discharges to Cell 003, thus bypassing Cell 002 West and East. AECI's plan is to reconfigure Cell 002 West with forebays and a liner system (a composite liner consisting of clay and geomembrane with protective cover materials which exceeds Missouri state law requirements) to receive these flows instead of Cell 003, discharging then into Cell 002 East (which will have a clay seal in accordance with Missouri state law requirements), which then discharges into an existing ditch along the east side of Cells 003 and 004. It was determined that these reconfigured ponds would not be adequately sized to directly receive the CCR flows and solids, and instead manage the flows from the coal pile runoff and associated flows, and any blowdown from the CDT. In addition, the chemical precipitation coagulants and flocculants at the CDT will also be used to feed the same treatment chemicals to the coal pile runoff flows to enhance settling of solids to meet NDPES permit requirements. If the chemical feed system for the coal pile runoff is constructed and available for use for the coal pile runoff, AECI will commission Cell 002 West and East to remove these flows from Cells 003 and 004 in advance of the CDT being fully functional.

2) Supplemental Information to Section 2.2.2 Detailed Schedule

Based on the supplemental information provided below, a modified visual schedule provided in Attachment 2 (Appendix A to the Report).

3) Supplemental Information to Section 2.2.3.1 Narrative Discussion of Schedule – Wastewater Treatment Facility

Supplemental clarifications and information for several subsections below have been provided to add clarity for US EPA's consideration:

<u>Engineering Design and Data Collection</u> – The visual schedule shows these activities as a combined four tasks. In particular, an initial action of preliminary engineering design with data collection took approximately eight (8) months to complete. This preliminary engineering and data collection included geotechnical investigations with borings and ground penetrating radar, topographic survey, surface water sampling and analysis, and associated data evaluation. This preliminary work was being completed in parallel with AECI's pursuit of a design engineer for the CDT structure and associated components. The actual tank engineering design is shown as three separate lines in the schedule: Bid Letter & Contractor Selection (3 months), Procurement (3 months), and Engineering Design (6 months). The engineering design by the CDT engineering included structural analysis, tank sizing, equipment design and selection for the chemical treatment, piping design, and ancillary components design. Since these four tasks were completed in parallel, the total engineering design and data collection phases took approximately 13 months to complete as shown in the schedule and described in the original Report narrative. We also note that the tense of the original Report was present and forward based, we clarify that engineering design has been completed.

<u>Air Permitting / NPDES Permit Modification</u> – We note that the air permitting has been completed. NPDES related modifications will be impacted by the recent ELG regulatory changes and AECI is still evaluating and discussing this with the MDNR regulators.

<u>Construction Activities</u> – AECI has revised the construction timing to reflect updated conditions with planned CDT and appurtenant structures being completed in 12 months (early 2021). It should be noted that this timeframe does not include the likely need for AECI to install a heat exchanger based on the results of the Initial CDT Startup and Operational Transition phase. The reference to the likely heat exchanger phase has now been added as separate tasks on the visual schedule to clarify.

<u>Startup and Operational Transition (renamed to "Initial CDT Startup and Operational Transition")</u> – AECI has revised the initial CDT startup timing to reflect the actions needed to initially turn the system on and determine if the heat exchanger will be needed prior to full commissioning. Startup will include evaluation of the electrical components, alignment of the return pump and mixers, a tuning period of the entire system, and performance tests. This entire process will take approximately five (5) months to complete. Another key component under evaluation will be water chemistry to determine effects from seasonal impacts to an exposed system. Balancing the system to meet closed loop operational requirements is the most important action being completed. During this time period, and through

installation of the heat exchanger if determined necessary, the CDT will need to discharge to Cell 001 or the west ditch instead of returning the flows back to the plant, requiring the CCR impoundment(s) to remain active.

Design and Bid Heat Exchanger (new phase added to visual schedule) – Once AECI determined that a heat exchanger would likely be necessary, they pre-emptively completed a design and completed bidding with suppliers to expedite the procurement and installation of the equipment if determined necessary. This action occurred in 2020, and took approximately four (4) months to complete.

Procure and Construct Heat Exchanger (new phase added to visual schedule) – Following initial startup of the CDT and associated evaluations of the system, AECI will determine if a heat exchanger is necessary to be added to the overall system. This decision is likely to occur in April/May 2021. If determined necessary, AECI will complete the procurement process with the vendor, construction necessary foundations, conduits, and related components, and install the equipment once delivered. It is estimated that this process will take approximately eight (8) months to manufacture, deliver, and install.

Full System Startup and Operational Transition (new phase added to visual schedule) – Following installation of the heat exchanger, AECI will start up the full system and evaluate performance to allow for the closed loop re-circulation to be completed. It is estimated that this will take approximately two (2) months to complete. Following full operational status, the combination of the CDT and the non-CCR surface impoundments will allow for Cells 001, 003, and 004 to initiate closure.

4) Supplemental Information to Section 2.2.3.2 Narrative Discussion of Schedule – Reconfiguration of Non-CCR Surface Impoundments

Procurement – We note that the procurement of the construction contractor has been completed.

Construction Activities – AECI has revised the construction timing to reflect updated conditions with planned non-CCR impoundment construction activities to be completed within seven (7) months prior to the onset of winter. We note that the updated weather rain delays have increased to over 30 days since the start of construction from that previously noted in the original Report. AECI anticipates completion of the surface impoundments in 2020 but understands that if additional weather delays require the delay of completion beyond the winter months, AECI would notify the US EPA accordingly to inform the impact to the granted closure extension.

Startup and Operational Transition – As stated above, AECI is scheduled to complete the construction activities on the non-CCR surface impoundments in 2020. However, the system will not become operational until after the chemical treatment coagulants and flocculants are installed and operational at the CDT. This is anticipated to be operational at the CDT in May 2021. Following that equipment becoming operational, AECI expects up to two (2) months of system evaluation for the non-CCR wastestreams. These wastestreams will receive the chemicals and be evaluated at the discharge point into Cell 003 to evaluate effectiveness and determine any modifications to dosing or the feeder system.

Following system evaluation, AECI will initiate flows into Cell 002 West at which point Cells 003 and 004 will no longer be receiving CCR or non-CCR wastestreams and can initiate closure.

5) Supplemental Information to Section 2.2.4 Narrative Discussion of Progress

AECI has made clear that significant efforts have been made to evaluate, design, and construct alternate capacity to replace Cells 001, 003, and 004. AECI began the planning process to identify and evaluate alternatives for capacity since Cell 003 and 004 triggered closure, and upon the release of the *USWAG* decision required unlined CCR surface impoundments to close triggering closure of Cell 001. Since that time, AECI has completed:

- Resource planning specific to this decision to determine generation fleet operational impacts.
- Feasibility studies of alternatives for CCR and non-CCR flows to determine the fastest technically feasible alternative
- Water mass balance evaluations to determine which flows needed to be or could be split to the different alternative capacity options.
- Siting and environmental evaluations to determine possible locations of alternative capacity facilities to expedite permitting and construction timeframes.
- Evaluations of current systems and internal plant configuration to determine accessibility for new equipment.
- Multiple engineering design and data collection activities including:
    - For the CDT: geotechnical field investigations, tank and appurtenant structures siting and sizing, structural engineering, chemical precipitation evaluations, evaluations of water chemistry impacts as part of the closed loop system, pipeline configurations, hydraulic capacity needs, pump system type and sizing, material staging area sizing and design, heat tracing design, and other utility and misc. design needs.
    - For the non-CCR impoundments: geotechnical field investigations for slope stability and for borrow soil/clay liner material, bottom liner system and protective cover design, stormwater and wastewater hydraulic capacity and flow rate analyses and associated design efforts, impoundments configuration and sizing, material staging area design, and other ancillary design activities in support of the new impoundments.
- NPDES construction permit development, submittal, and approvals for the non-CCR impoundments.
- Construction activities that have been completed already include:
    - For the CDT: excavate soil and pour tank foundations; erect steel reinforcements and pour concrete walls; excavate soil and pour pipeline foundations; construct conduit in western ditch to allow for pipe crossing.
    - For the non-CCR surface impoundments: Clay borrow evaluation and completion of clay liner test pad; earthworks and berm development; clay liner system installation; erection of concrete diversion walls; concrete outlet structures and drainage structures installation; partial Cell 002 West geomembrane liner installation (in progress); east ditch liner grading and preparation of liner installation.

- Procurement of major elements for the CDT including pump system, enclosures, piping, heat trace, chemical storage tanks, chemical control equipment, and other ancillary components.

AECI has made significant progress toward obtaining alternative capacity for the CCR and non-CCR flows, and intends to continue the efforts in accordance with the current planned schedule. We also note the challenges faced during the COVID-19 pandemic that has impacted staffing availability, complications in communications, supply chain impacts, and overall health and safety of AECI's staff, consultants, contractors, and the community as a whole.

6) Supplemental Information to Section 3 40 CFR §257 Subpart Compliance

Although not required to be submitted by the CCR Rule Part A regulation, AECI is providing to US EPA a copy of the documentation placed in the facility Operating Record meeting the requirements of 40 CFR §257.105(h)(2). This document was required to be placed in the facility Operating Record, but there is no reference to this document being required on the website in 40 CFR §257.107. This includes the documentation of the design, installation, development, and decommissioning of any monitoring wells, piezometers, and other measurement, sampling, and analytical devices for the multi-unit groundwater monitoring network at the CCR surface impoundment. Within that document, the hydrogeologic characteristics are described including the unsaturated materials overlying the uppermost aquifer, the uppermost aquifer, and the formation below the uppermost aquifer. For each of these strata, the associated hydraulic conductivities and lithology are also further described. This document was used as the basis for defining the groundwater monitoring network, and was also the basis for the groundwater monitoring network certification.

ATTACHMENT 1

Report on Site Specific Alternate to Initiation of Closure Deadline for Ash Pond 1 (Cell 001, Cell 003, and Cell 004), Thomas Hill Energy Center, Clifton Hill, Missouri” dated September 2020

REPORT ON

SITE SPECIFIC ALTERNATE TO INITIATION OF CLOSURE DEADLINE FOR ASH POND 1 (CELL 001, CELL 003 AND CELL 004)
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

by
Haley & Aldrich, Inc.
Cleveland, Ohio

for
Associated Electric Cooperative, Inc.
Springfield, Missouri

File No. 129638-007
September 2020

Table of Contents

KENNETH S. WILMOT
Name

Signature

SVP/COO
Title

29 SEPT 2020
Date

1. Introduction

Haley and Aldrich, Inc. was retained by Associated Electric Cooperative, Inc. (AECI) to prepare this Site Specific Alternate to Initiate Closure Report related to a closure deadline extension for the coal combustion residual (CCR) management units identified as Cells 001, 003 and 004 at the Thomas Hill Energy Center (THEC), located near Clifton Hill, Missouri. Cells 003 and 004 triggered closure in October 2018 based on the results of location restriction demonstrations for groundwater separation under the U. S. Environmental Protection Agency's (USEPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*. 80 Fed. Reg. 21302 (effective 19 October 2015) and subsequent regulatory revisions (CCR Rule). Cell 001 is also required to close since the unit is considered "unlined".

AECI has actively been pursuing alternative disposal capacity for CCR generation and non-CCR wastestreams at the THEC, but is requiring extended use of Cells 001, 003 and 004 until **30 November 2021**, when alternative capacity can be brought online. The USEPA recently issued a revised CCR Rule rulemaking entitled *Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; A Holistic Approach to Closure Part A: Deadline to Initiate Closure* (effective 28 September 2020) providing AECI the opportunity to continue use of the CCR units while alternative capacity is obtained. This Report documents the efforts AECI has made and continues to make to obtain alternative capacity including the schedule of activities to date and those planned moving forward.

1.1 REGULATORY REQUIREMENTS

The USEPA has published this referenced rulemaking to revise portions of the federal CCR regulations in Title 40 of the Code of Federal Regulations (CFR) Part 257 so that they accurately reflect the regulations as they now stand in light of the decision by the D.C. Circuit Court (D.C. Circuit) of Appeals in the case of *Utility Solid Waste Activities Group, et al. v. EPA,* 901 F.3d 414 (D.C. Circuit. 2018) (*USWAG* decision)*,* on 21 August 2018. The D.C. Circuit vacated the provisions that permitted unlined impoundments to continue receiving CCR unless they leak (see 40 CFR §257.101(a)). In addition, this rulemaking addresses the 31 October 2020 deadline in §257.101(a) and (b)(1)(i), by which CCR surface impoundments must cease receipt of waste. These regulatory provisions were remanded back to EPA by the D.C. Circuit Court of Appeals for further reconsideration in light of the *USWAG* decision. See *Waterkeeper Alliance Inc, et al. v. EPA* No. 18-1289.

Specifically, as relates to this Report, USEPA is requiring a new deadline of 11 April 2021 to replace the current deadline of 31 October 2020 for CCR units to cease receipt of waste and initiate closure because the unit either (1) is an unlined or formerly "clay-lined" CCR surface impoundment (§257.101(a)) or (2) did not demonstrate compliance with the groundwater separation location restriction (§257.101(b)(1)). USEPA also revised the alternate closure provisions, §257.103(a), (b), (e), and (f). These revisions allow facilities to receive the necessary additional time to develop alternate capacity to manage plant wastestreams (both CCR and non-CCR), to cease receipt of waste, and initiate closure of a CCR surface impoundment.

1.2 BACKGROUND

AECI owns and operates a series of CCR surface impoundments at the THEC. Ash Pond 1 consists of a series of cells (referred to as Cell 001, Cell 002 East (previously closed), Cell 002 West (previously closed), Cell 003, and Cell 004) that manage (i.e., wet handle) site CCRs and CCR sluice water (primarily boiler slag from Units 1 and 2) and non-CCR solids and process waters (e.g., coal pile runoff, plant process water) with discharge through the permitted National Pollutant Discharge Elimination System (NPDES) Outfall #001 located at the outlet structure of Cell 004.

Cells 003 and 004 have been triggered for closure based under the CCR Rule groundwater separation location restriction (40 CFR §257.60) requirements. Cell 001 is also now triggered for closure based on the vacated allowance to continue operating unlined ponds which are not leaking (40 CFR §257.101(a)). Consequently, and consistent with the updated closure requirements listed in 40 CFR §257.102, AECI is required to cease placing CCR and non-CCR wastestreams into Cells 001, 003 and 004 no later than 11 April 2021 and begin closure of the impoundments unless an alternative deadline of **30 November 2021** is approved.

1.3 CURRENT IMPOUNDMENT OPERATION

Currently, CCR (primarily boiler slag) is sluiced to Cell 001 along with intermittent non-CCR flows. The majority of flows conveyed to Cells 003 and 004 consist of non-CCR wastestreams from Generating Units 1 & 2 coal pile runoff, Generating Unit 3 coal pile runoff, site stormwater runoff, coal handling equipment washdown, various wash waters, and miscellaneous low volume wastewater flows. CCRs are settled within Cell 001, removed by AECI operational staff, and hauled and placed in the existing Prairie Hill Mine for mine reclamation purposes or taken off-site for beneficial use. Discharge from Cell 001 enters a conveyance channel where it comingles with the non-CCR wastestreams and flows south, bypasses non-CCR Cells 002 East and 002 West, and into the northwest corner of Cell 003. Water then decants into Cell 004 and is ultimately discharged to the Middle Fork of the Little Chariton River from the Cell 004 outlet structure through the plant NPDES Permit Outfall 001. Cells 001, 003, and 004 are regulated as individual active CCR impoundments under the CCR Rule.

2. Development of Alternative Capacity

AECI cannot immediately cease the placement of CCR and non-CCR wastestreams into Ash Pond 1 without causing potentially significant disruptions to plant operations and overall electric grid reliability and thus the provision of electricity to their customers, as they currently lack additional capacity to manage these CCRs and non-CCR wastestreams elsewhere. This Report provides the demonstration requested by USEPA under 40 CFR §257.103(f) to explain the reasons that CCR and non-CCR wastestreams cannot at this time be managed through alternative capacity through a technically feasible scenario by 11 April 2021, the actions being taken on an ongoing basis to pursue alternative capacity, and the justification of an operational deadline extension for these CCR units. The following sections directly address the regulatory requirements of 40 CFR §257.103(f) and are formatted in a manner to allow USEPA to complete the Agency's review process of this required submittal conveniently and efficiently.

2.2 DEVELOPMENT OF ALTERNATIVE CAPACITY IS TECHNICALLY INFEASIBLE[1]

> ***40 CFR §257.103(f)(1) Development of Alternative Capacity is Technically Infeasible. Notwithstanding the provisions of §257.101(a) and (b)(1), a CCR surface impoundment may continue to receive the waste specified in paragraph (f)(1)(ii)(A) or (B) of this section, provided the owner or operator demonstrates the wastestream(s) must continue to be managed in that CCR surface impoundment because it was technically infeasible to complete the measures necessary to obtain alternative disposal capacity on or off-site of the facility by April 11, 2021.***
>
> ***40 CFR §257.103(f)(1)(i) No alternative disposal capacity is available on or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification under this section;***
>
> ***40 CFR §257.103(f)(1)(ii)(A) For units closing pursuant to §257.101(a) and (b)(1), CCR and non-CCR wastestreams must continue to be managed in that CCR surface impoundment because it was technically infeasible to complete the measures necessary to obtain alternative disposal capacity either on or off-site of the facility by April 11, 2021.***
>
> ***40 CFR §257.103(f)(1)(iii) The facility is in compliance with all of the requirements of this subpart.***

As mentioned previously, Cell 001 is required to close based on the revised §257.101(a) related to the Unit not meeting the liner requirements of the revised rulemaking, and Cells 003 and 004 are required to close pursuant to §257.101(b)(1). AECI maintains compliance with all other requirements of the 40 CFR §257 subpart including the maintained CCR compliance website located at https://www.aeci.org/clean/ccr**.** There is no technically feasible on or off-site alternative disposal capacity currently available at the THEC to manage the CCR and non-CCR flows that are discharged into Cells 001, 003, and 004. Boiler slag is generated within the plant and stored in a wet slag tank, where sluice water and other process waters are used to discharge the boiler slag into Cell 001. There is

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[1] *Technically Infeasible* means "not possible to do in a way that would likely be successful" as defined in the 40 CFR 257 Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; A Holistic Approach to Closure Part A: Deadline to Initiate Closure.

currently no dry method of handling available for the boiler slag, and no other compliant CCR surface impoundment exists on-site that would provide an alternative wet handling option. Furthermore, the USEPA clearly states in the CCR Rule that "while it is possible to transport dry ash off-site to alternate disposal facility that simply is not feasible for wet-generated CCR." Therefore, AECI has no current alternative wet handling alternatives available for boiler slag or its associated sluice water prior to 11 April 2021. To state clearly in this submittal, AECI has in good faith been developing plans and has already begun the process of pursuing alternative capacity for Cell 001 including alternative handling of CCRs that are currently conveyed to the subject CCR impoundments.

For other non-CCR wastestreams (e.g., coal pile runoff, boiler wash water, plant surface water, stormwater runoff, and other low volume waste sources), Cells 003 and 004 provide settling treatment and discharge these waters through existing NPDES Outfall #001. The THEC power block and coal yards are sited on a naturally higher ground. The CCR surface impoundments were sited downstream, to allow for primarily gravity drainage, along with a few source flows pumped to inflow points allowing for a similar gravity drainage to the CCR impoundments. No alternative discharge locations are permitted for these flows and no sufficient treatment or volumetric capacity exists on-site to currently manage these flows with the current plant water management configuration. Therefore, no alternative capacity currently exists to manage the non-CCR wastestreams that Cells 003 and 004 currently manage prior to 11 April 2021. Similar to the CCR wastestreams currently flowing to Cell 001, AECI has in good faith been developing plans and has already begun the process of pursuing alternative capacity for Cells 003 and 004 to manage non-CCR wastestreams.

Efforts include significant planning, engineering evaluations, and pre-emptive implementation steps necessary to provide alternative capacity for these referenced CCR and non-CCR wastestreams to allow for initiating closure of CCR surface impoundments Cells 001, 003 and 004. The planned alternative capacity projects will provide the capacity needed in an implementable timeframe which falls within the USEPA identified reasonable timeframes for similar projects involving multiple technologies of between 36 and 55 months including cessation of some individual wastestreams well in advance of the reasonable timeframes. If required to immediately cease placement of CCR and non-CCR wastes into the surface impoundments, AECI would have to cease power production and there would be significant risks to grid reliability associated with the shut-down, as well as other notable adverse consequences that would arise if customers were left without power for an extended period of time. The schedule provided in **Appendix A** of this submittal (i.e., for the conversion to alternative disposal capacity for Cells 001, 003, and 004 for wet CCRs and non-CCR flows) is reasonable and defensible, and allows for the streamlined management of power grid reliability and power provision to AECI's rural constituency.

2.2 ALTERNATIVE CLOSURE EXTENSION WORKPLAN

2.2.1 Written Narrative

40 CFR §257.103(f)(1)(iv)(A) To demonstrate that the criteria in paragraphs (f)(1)(i) and (ii) of this section have been met the owner or operator must submit a workplan that contains all of the following elements:

40 CFR §257.103(f)(1)(iv)(A)(1) A written narrative discussing the options considered both on and off-site to obtain alternative capacity for each CCR and/or non-CCR wastestreams, the technical infeasibility of obtaining alternative capacity prior to April 11, 2021, and the option

selected and justification for the alternative capacity selected. The narrative must also include all of the following:

(i) An in-depth analysis of the site and any site-specific conditions that led to the decision to select the alternative capacity being developed;

(ii) An analysis of the adverse impact to plant operations if the CCR surface impoundment in question were to no longer be available for use; and

(iii) A detailed explanation and justification for the amount of time being requested and how it is the fastest technically feasible time to complete the development of the alternative capacity;

Due to the significant quantity of process water sources currently flowing into Cells 001, 003, and 004, AECI – through the use of internal feasibility studies – has considered multiple technologies to develop alternative capacity for both the CCR and non-CCR wastestreams. Off-site alternatives are not feasible since the CCR and non-CCR wastestreams consist of wet wastestreams that are incapable of being managed off-site. For CCR wastestreams, AECI evaluated conversion to dry handling consisting of a remote drag chain conveyor system, a wastewater treatment facility consisting of a concrete dewatering tank, and a reconfiguration of an existing unlined CCR surface impoundment. Alternatives analyses were completed for these technologies and based on existing plant operations, use of existing infrastructure, and a shortened construction timeframe, AECI has selected a concrete dewatering tank as the alternative capacity.

Similarly, AECI completed an alternatives analysis of non-CCR surface impoundment options to manage coal pile runoff and other low-volume wastewater flows. Coal-pile runoff and related stormwater runoff includes over 80 acres of watershed drainage area needing treatment. Based on the evaluations, AECI determined that reconfiguring of existing non-CCR surface impoundments for the purpose of new capacity is the preferred option. This reconfiguration requires design of existing non-CCR wastewater conveyance systems, and earthwork construction including berm construction, grading, installation of a liner system, construction of access roads and ramps, development of sediment removal access, and NPDES permit alterations with a new permitted outfall. Additional site-specific conditions were previously discussed in Section 2.1.

To accomplish this overall system reconfiguration, the multiple technology system requires significant evaluations of water mass balance, solids loading, geotechnical investigations and analyses, water chemistry analyses, surface water sampling and analysis, and overall system operation impacts. For both technologies being considered, the phases to complete the conversion include a planning, design and engineering phase, procurement and contractor bid phase, fabrication, and delivery of new equipment phase, and lastly, a construction and start-up phase. The timeframes for each of these phases are dependent on the site-specific circumstances and the integration of individual technologies into the master reconfiguration schedule. AECI has made notable efforts and progress associated with the planning and engineering evaluation in the pursuit of a variety of potential alternative technologies using a systematic process that allows for some steps to be completed in parallel while also managing the iterative nature of multiple component design.

AECI understands the need to develop alternative capacity in the fastest reasonable time possible. If required to immediately cease placement of CCR and non-CCR wastes into the surface impoundments, AECI would have to cease power production and there would be significant risks to grid reliability associated with the shut-down, as well as other notable adverse consequences that would arise if customers were left without power for an extended period of time. The plant relies on the existing CCR impoundments to manage not only generated CCR but also the multiple non-CCR wastestreams previously discussed. Based on discussions with state regulators, no alternative NPDES discharge outfalls would be able to manage the current flows without significant development of alternate impoundments or systems and the entire NPDES permitting process associated with those. Those alternates would not be available in a shorter period of time.

AECI selected these technologies as a means of developing alternative capacity in the shortest period of time associated with the use of existing infrastructure (e.g. internal pump systems and sluice piping, existing embankments, and channels/conduits) and more available systems. Mechanical systems in place of the proposed concrete dewatering tank had longer lead times for design, procurement, manufacturing, shipping, and installation in addition to other internal plant reconfiguration needs to develop space to construct the overall slag handling system. AECI also selected an Engineering-Procurement-Construction (EPC) contractor for the concrete dewatering tank (CDT) to allow for an expedited design-construction relationship. AECI is actively constructing the multiple technologies but will need additional time beyond the April 11, 2021 date to allow for adequate start-up of the CDT related to recirculation systems and overall plant chemistry. In addition, AECI is evaluating the EPA's Steam Electric Effluent Limitations Guidelines (ELG) regulations revisions dated 31 August 2020 to further define allowable blowdown discharges from the CDT and to determine if any alterations to that system design are required. This ELG impact, along with internal plant recirculation revisions, are significant impacts to the need for an extension to fully make the system operational. To allow for additional start-up time, AECI is requesting an approval of closure extension for Cells 001, 003, and 004 until **30 November 2021** which is reasonable and technically feasible to install and operate a fully functional multi-technology system at this site.

2.2.2 Detailed Schedule

> ***40 CFR §257.103(f)(1)(iv)(A)(2) A detailed schedule of the fastest technically feasible time to complete the measures necessary for alternative capacity to be available including a visual timeline representation. The visual timeline must clearly show all of the following:***
>
> **(i) How each phase and the steps within that phase interact with or are dependent on each other and the other phases;**
> **(ii) All of the steps and phases that can be completed concurrently;**
> **(iii) The total time needed to obtain the alternative capacity and how long each phase and step within each phase will take: and**
> **(iv) At a minimum, the following phases: engineering and design, contractor selection, equipment fabrication and delivery, construction, and start up and implementation.;**

A project schedule depicting the necessary and reasonable sequence and timing of the steps required to obtain the alternate capacity is provided as **Appendix A** and discussed in the narrative description that follows in this section. Steps are shown that are being completed in parallel to expedite the overall timeframe for completion.

2.2.3 Narrative Discussion of Schedule

> ***40 CFR §257.103(f)(1)(iv)(A)(3) A narrative discussion of the schedule and visual timeline representation, which must discuss all of the following:***
>
> **(i) Why the length of time for each phase and step is needed and a discussion of the tasks that occur during each step;**
> **(ii) Why each phase and step shown on the chart must happen in the order it is occurring;**
> **(iii) The tasks that occur during each of the steps within the phase: and**
> **(iv) Anticipated worker schedules; and**

2.2.3.1 Wastewater Treatment Facility

To address the cessation of using Cell 001, as required by the federal CCR Rule, a new CDT will be constructed at the THEC to manage CCR wastestreams (specifically boiler slag). The critical tasks necessary to implement this project, along with an estimated and approximate timeframe for completing those tasks, is provided below.

Planning / Alternatives Analysis

An alternatives analysis was completed that evaluated multiple technologies for boiler slag handling. The planning and evaluation phase took approximately eight (8) months including water mass balance assessments, surface water sampling and analysis, surveying, and preliminary layout work.

Engineering Design and Data Collection

The engineering and design phase will take approximately thirteen (13) months from the decision on the preferred alternate to complete and includes engineering and design of the tank and equipment, survey/geotechnical/water chemistry data collection, structural design, process equipment improvements in the plant/piping, site grading plans, stormwater management controls, and access to the concrete dewatering tank. Flocculant/ coagulant injection is also being evaluated. To further explain, AECI began evaluations of the tank and equipment design and determined what supplemental investigations and data collection were determined necessary. The structural design of the tank was dependent on the geotechnical field investigation results and proceeded following completion of the investigation and associated data summary report. In parallel, the water chemistry analysis was being completed to determine appropriate equipment, flocculant/coagulant types and ratios for treatment, and associated resultant effluent expectations. This analysis was further used to determine in-plant alterations necessary to re-route the closed loop system back into the plant for long-term operations. In addition, expected CDT operations for material removal, dewatering pads, and staging areas were considered to manage the solids settled. In areas where design elements could proceed in parallel, efforts have been made to do so. The iterative design process was necessary to ensure that the structural, mechanical, chemical, and operational aspects of the overall performance needs were met.

Air Permitting / NPDES Permit Modification

AECI is actively pursuing air permitting alterations to support construction activities. As discussed further in the non-CCR surface impoundment work, NPDES permit alterations are also being completed.

For Missouri Department of Natural Resources (MDNR) permitting, the design must be at a level of substantial completion that the design engineer is able to provide sealed documents to MDNR, forcing these actions to move in series. These permits may take up to six (6) months to complete including operational approvals. Specific to NPDES related permit modifications, AECI is actively negotiating permit modifications that are dependent on ELG regulatory changes that are not yet finalized and will have impacts to the CDT final design and operation, including potential changes to purging and blowdown from the CDT to manage water chemistry.

Bidding and Contractor Selection

Consistent with AECI internal mandates and in the pursuit of the most cost-competitive pricing[2], AECI obtained multiple competitive bids for the design, site/civil construction, concrete work, and wastewater treatment systems and equipment (i.e., design-build contract by an EPC contractor). A contractor bidding package and procurement documents were developed, and the completed bid package was issued by AECI for bid. Following bid issuance and prior to contractor selection, substantial time was needed for activities including, but not limited to, pre-bid meetings, contractor document review, clarifications, bid submittals, and contractor interviews. This phase required approximately three (3) months to complete.

Procurement

AECI's procurement process includes contractor selection justification and submittals to the internal management, followed by the AECI Board of Directors' packaged submittals. Board of Director meetings occur, in general, on a monthly basis. Following confirmation of the selected bidder, a purchase order was issued. This phase of the project timeline required approximately three (3) months to complete.

Construction Activities

The approximate time to complete construction for the concrete dewatering tank is approximately sixteen (16) months. This timeframe includes the site excavation, dewatering, site grading, tank foundation, concrete framing, pouring, and finishing, utilities and mechanical controls, mass grading, access roads, and piping. Construction is currently underway and includes completion of parallel tasks as possible. The total time includes the potential delays due to weather, equipment lead time and freight, regulatory changes, and supplier issues. There is the potential for a completion sooner than the total timeframe if those delays do not actually occur.

Weather is another significant factor that has impacted timing considerations for this project. Of primary impact is wet weather in late summer and fall months that reduced productivity and required more substantial unwatering efforts. Seasonal changes can be planned for, though severe or off-season weather events cannot be controlled and can substantially affect project timing. AECI has already been delayed for over 20 rain delay days since construction started in May 2020. Construction work that

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[2] AECI is a rural cooperative which is a member-owned, member-governed entity that finds its strength in its mission to provide an economical, reliable power supply and support services to members. AECI has the responsibility to produce clean, affordable, and reliable electricity that as a core value and principle pursues the lowest cost energy production for their rural electrical users. More than 48 percent of those rural customers have annual incomes less than $75,000 and 60 percent of surveyed members are age 55 or older. See also section entitled "**Reliability and Outage Timing**" in this document for additional information on AECI's maintenance needs and overall outage programs of the multiple generating facilities in AECI's fleet.

involves ground excavation, soil compaction, or filling or pouring concrete will be limited or impractical to perform during winter months (i.e., between late November and April).

Reliability and Outage Timing

To manage the maintenance needs of the multiple generating facilities, AECI continually develops the schedule for maintenance outages for all three (3) units at the THEC in conjunction with the overall outage program across the generation fleet. A long-range outage plan, consisting of outages for all five (5) coal combustion generator assets at two separate locations, determines the maintenance activities years in advance. The types of maintenance activities range from normal short-term cleaning activities to periodic longer-duration component overhauls. Scheduling when these outages can take place is dependent on the ability to properly provide load to member owners and grid reliability/stability, which are essential. For that reason, AECI limits the outage sequencing so that major generation assets are not offline together for a significant length of time. Another step that is taken to ensure load capacity to member owners and maintain grid reliability is to conduct outage activities in the fall and spring, avoiding the high demand periods of the summer and winter.

The conversion to a concrete dewatering tank at THEC will require approximately one (1) month of outage for both units to switch over the sluice lines to the concrete dewatering tank. Adding separate outages for the conversion to the concrete dewatering tank would require those outages to be in peak generation periods and have a severe, negative impact to grid reliability and significantly impact AECI's ability to provide electricity to member owners.

Startup and Operational Transition

Startup will include use of the new piping and optimization of the chemical precipitate system operation, boiler slag removal operations, and return flows back to the plant. This process may take up to seven (7) months to complete. Recirculating water to the plant and achieving an overall water chemistry and temperature balance will be key to both plant and CDT operations. Also, AECI will need to implement any additional ELG regulations to meet allowable blowdown quantities and water chemistry and temperature, along with other plant activities such as boiler washes. These ELG considerations including impacts to NPDES permit allowances may further delay the ability to commission the system. Since EPA just issued the 2020 Reconsideration Rule on 31 August 2020, AECI is evaluating any associated impacts from that rulemaking as relates the CCR management and associated wastestreams. AECI anticipates that there may be potential impacts requiring alteration or redesign to certain components or system operations.

In addition, AECI maintains active beneficial use contracts with third-party vendors that allows for the off-site beneficial use of CCR materials instead of placement in the on-site mine reclamation. The concrete tank project will involve constructing infrastructure that allows for the continued beneficial use practice. Once the system is operational, AECI will need to coordinate with the beneficial use contractors to determine access to new facilities, processing of materials, and subsequent conveyance off-site.

2.2.3.2 Reconfiguration of Existing Non-CCR Surface Impoundments

AECI evaluated operational improvement options to cease the discharge of non-CCR flows into Cells 003 and 004 and still comply with the plant's NPDES permit and CCR Rule requirements. The range of options considered include upstream source improvements/ reductions (e.g., coal pile runoff) and midstream management controls (e.g., reconfigured surface impoundments) to manage total suspended solids (TSS) loading and discharge routes in support of the objective to provide AECI with various options to consider as part of their overall long-term planning effort.

Planning / Alternatives Analysis

An alternatives analysis was completed that identified and developed supporting documentation for various upstream options (i.e., coal yard improvements) and Cell 002 East and 002 West reconfiguration with new outfall locations for consideration of near-term and long-term non-CCR management flows that currently discharge through Cells 003 and 004. Upstream options are focused on areas and/or sources of discharge (e.g., coal piles) that contribute flow into the current Cells 003 and 004 impoundments. Evaluations of operational impacts to coal yard management, pump station operations, and solids management were also considered. The planning and evaluation phase took approximately nine (9) months including water mass balance, surface water sampling and analysis, survey, and preliminary layout work.

Engineering Design and Data Collection

The engineering and design phase took approximately thirteen (13) months to complete. The engineering phase included engineering and design of the impoundment reconfiguration, geotechnical/ geologic/ hydrogeologic investigations including laboratory testing, soil borrow source evaluation, impoundment liner systems, stormwater runoff modeling, process water runoff, coordination with the concrete dewatering tank design, access to settling basins for sediment removal, dewatering pad, channel linings, and conduit/piping. Supplemental flocculant/ coagulant injection was also evaluated. The basin design is critical to determine that there is proper residence time and the construction materials selected are compatible with the water chemistry of the non-CCR waste streams. The residence time is the necessary time for any reactions or settling to be completed before the wastewater discharged.

NPDES Operating Permit Modification

The existing NPDES permit requires compliance with pH, TSS, and oil and grease concentrations from Outfall #001 (located at the outlet structure of Cell 004). The primary loading of non-CCR TSS concentrations is related to coal pile runoff (i.e., coal fines that are conveyed in the sediment-laden water). To meet the TSS discharge requirements, reductions in TSS loading at the coal piles, considerations for alternate discharge locations, and options for reconfigured impoundments were evaluated to support NPDES permitting modifications. AECI is actively working with the MDNR to complete modification to the existing NPDES operating permit to allow for discharge from the reconfigured non-CCR surface impoundment. This process was estimated to require up to six (6) months to complete but has experienced numerous review interactions and resubmittals in the review and approval of these projects, even with AECI applying for the necessary modifications in parts to attempt to expedite the process.

NPDES Construction Permit

AECI was also required to obtain a NPDES related construction permit from MDNR to allow for alteration of the existing impoundments and allow for operation and discharge from the reconfigured impoundments. MDNR determined the proposed work was a major modification to the existing basis, and therefore required a submittal, review, and response period to allow for construction activities to commence. This delayed construction start by approximately one (1) month and added additional requirements beyond original design plans.

Bidding and Contractor Selection

Following the completion of the engineering and design phase, the design drawings and contract documents were released for competitive bid. Following bid issuance and prior to contractor selection, substantial time was needed for activities including, but not limited to, pre-bid meetings, contractor document review, clarifications, bid submittals, and contractor interviews. The bidding and contractor selection process required approximately three (3) months to complete.

Procurement

As stated previously, AECI's procurement process includes contractor selection justification and submittals to the internal management, followed by the AECI Board of Directors' packaged submittals. Board of Director meetings occur, in general, on a monthly basis. Assuming confirmation of the selected bidder, a purchase order will then be issued. This phase of the project timeline required approximately three (3) months to complete.

Construction Activities

The approximate time to complete construction for the reconfigured non-CCR surface impoundments (i.e., Cell 002 West and 002 East) is estimated to take approximately sixteen (16) months if not completed prior to onset of winter months. This timeframe includes the unwatering of the impoundments, soil borrow import, subgrade development, liner installations, protective cover installations, access layer (concrete/aggregate) installation, berm construction, access roads, channel lining, and conduits/piping. The total time includes the potential delays due to weather, equipment lead time and freight, regulatory changes, and supplier issues. There is the potential for a completion sooner than the total timeframe if those delays do not actually occur.

As stated previously, weather is another significant factor that has already impacted timing considerations for this project. Of primary impact are wet weather in late summer and fall months that will reduce productivity and require more substantial unwatering efforts. Seasonal changes can be planned for, though severe or off-season weather events – as those experienced – cannot be controlled and can substantially affect project timing. Construction work that involves ground excavation, soil compaction, or filling or pouring concrete will be limited or impractical to be performed during winter months (i.e., between late November and April). AECI has already been delayed for approximately twenty (20) rain delay days in the months of June, July, and August 2020.

Startup and Operational Transition

Following construction, AECI will need to introduce flows, commence operational activities, and evaluate discharges for a period of up to three (3) months to confirm that NPDES permitted limits are being met. Alterations to system operation may be required, and sediment removal activities will need to be optimized. Once proper suspended solids settling times are achieved, the reconfigured non-CCR surface impoundment will be considered fully operational.

2.2.3.3 Anticipated Worker Schedules

During construction of the CDT, the anticipated worker schedules consists of straight time 40 hour weeks. During construction of the impoundment reconfiguration, the anticipated worker schedules consists of five (5) days per week, working approximately eight to ten hours per day. If weather days are encountered, a weekend day may be worked to attempt to make up for lost construction days.

2.2.4 Narrative Discussion of Progress

> ***40 CFR §257.103(f)(1)(iv)(A)(4) A narrative discussion of the progress the owner or operator has made to obtain alternative capacity for the CCR and/or non-CCR wastestreams. The narrative must discuss all the steps taken, starting from when the owner or operator initiated the design phase up to the steps occurring when the demonstration is compiled. It must discuss where the facility currently is on the timeline and the efforts that are currently being undertaken to develop alternative capacity.***

AECI began the planning process to identify and evaluate alternatives for capacity upon the determination that location restriction demonstrations were not successful for Cells 003 and 004. Since that time, feasibility studies of alternatives for CCR and non-CCR flows have been evaluated and water mass balance evaluations, surface water sampling and analyses, geotechnical investigations, engineering design, overall system planning activities, and bidding and procurement have been completed. As referenced previously, EPA issued the 2020 Reconsideration Rule on 31 August 2020. AECI continues to evaluate any associated impacts from that rulemaking as relates the CCR management and associated wastestreams. AECI anticipates that there may be potential impacts requiring alteration or redesign to certain components or system operations, in particular to changes need to be made to the current concrete dewatering tank and operating plan.

Construction activities for the concrete dewatering tank commenced in Spring 2020. To date, construction has been completed for the CDT foundation, the forming and rebar construction of the CDT, associated concrete pours, foundation development for the conveyance piping to and from the plant. AECI has procured the chemical treatment system and pumping system that will be used to support the operation of the CDT as well.

AECI pursued and obtained MDNR construction permits for the reconfigured impoundments in June 2020 and commenced construction thereafter. Construction completed to date includes AECI confirming suitable borrow soils, development of the proposed subgrade grades in the basins, installation of clay liner material, preparation for the geomembrane installation, procurement of chemical treatment system, installation of concrete outlet structures, installation of diversion walls, and forebay berms, procurement of baffles and channel lining materials. AECI is also actively pursuing modifications to the NPDES operating permit to discharge from the new and reconfigured facilities.

3. 40 CFR §257 Subpart Compliance

The THEC surface impoundments are in, and will remain in, compliance with all other CCR Rule requirements described under 40 CFR Part §257. AECI's CCR compliance website, located at https://www.aeci.org/clean/ccr, contains all the necessary notification postings including, but not limited to, Locations Restrictions, Annual CCR Unit Inspections, Annual Groundwater Monitoring, and Corrective Action Reports. AECI has completed an internal review of the website and the CCR units' Operating Record and has confirmed that necessary postings have been made in accordance with 40 CFR §257.105, §257.106, and §257.107.

40 CFR §257.103(f)(1)(iv)(B) To demonstrate that the criteria in paragraph (f)(1)(iii) of this section have been met, the owner or operator must submit all of the following:

(1) A certification signed by the owner or operator that the facility is in compliance with all of the requirements of this subpart;

The required certification is provided in **Appendix B**.

(2) Visual representation of hydrogeologic information at and around the CCR unit(s) that supports the design, construction and installation of the groundwater monitoring system. This includes the following:

(i) Map(s) of the monitoring well locations in relation to the CCR unit(s);
(ii) Well construction diagrams and drilling logs for all groundwater monitoring wells; and
(iii) Maps that characterize the direction of groundwater flow accounting for seasonal variations;

The required map showing monitoring well locations with flow direction are provided in **Appendix C**. Well construction diagrams and drilling logs are provided in **Appendix D**.

(3) Constituent concentrations, summarized in table form, at each groundwater monitoring well monitored during each sampling event;

The required table of constituent concentrations is provided in **Appendix E**.

(4) A description of site hydrogeology including stratigraphic cross-sections;

The THEC plant site and Ash Pond System are located in the eastern portion of the Western Interior Coal Province of the Central Lowlands physiographic province. The Central Lowland is characterized by horizontal sequences of predominantly marine sedimentary rocks that span more than 400 million years of deposition from the Paleozoic and Mesozoic eras. Several of the sedimentary formations of the Central Lowland constitute regional scale hydrogeologic units with widely variable groundwater production and groundwater quality characteristics.

The land surface is mostly comprised of rolling hills with land-surface elevations ranging from 750 feet to 650 feet. Hilltops are generally flat to gently rounded as a result of Pleistocene glacial activity. A thick mantle of Pleistocene age glacial drift material is present in the hill and through the area, which ranges in thickness from approximately 50 to 100 feet thick. In isolated areas, this glacial till is capped by a veneer of Wisconsan age wind-blown loess as thick as 10 feet. Pennsylvanian age strata underlie the glacial deposits which are in turn underlain by Mississippian age formations.

Geologic units that underlie the THEC Ash Pond System are principally horizontal with a slight regional dip northwest about 2 to 3 feet per mile. In order from ground surface downward, the THEC Ash Pond System is underlain by the Lagonda, Bevier, Verdigris, Croweburg, and Fleming formations. Each of these formations is described below.

Aquifers in Northern Missouri are typically classified in two groups: unconsolidated aquifers in glacial drift and alluvium or consolidated or bedrock aquifers. The unconsolidated aquifers are an important source of groundwater in the area, while shallow consolidated aquifers yield small supplies of moderately mineralized water and may be derived in part from underlying Pennsylvanian formations. Groundwater in the unconsolidated aquifers tend to be perched above the low permeability materials such as clay and paleosols in the glacial drift or in buried glacial drift channel deposits. Locally, there is no use of groundwater downgradient of the AECI site (i.e., between the subject CCR Units Cells 001, 003, and 004 and the Middle Fork of the Little Chariton River). Furthermore, the groundwater is unlikely to pose an exposure concern in groundwater or the Middle Fork of the Chariton River due to a lack of receptors.

The Pleistocene soils and Verdigris formation are reported to contain small quantities of groundwater and is generally incapable of producing sufficient water to support large-scale production wells. The underlying regional formations are predominately fine-grained marine shales which constitute low productivity aquifers. The overlying glacial till has a very high clay content (usually greater than 35 percent) and a very low sand content (usually less than 15 percent). Vertical groundwater movement is also impeded by the continuous underclays which lie beneath the coal seams throughout the region.

The Mississippian bedrock aquifer lies beneath the THEC site, extends throughout the region, and is a significant source of groundwater production. The United States Geological Survey (1983) reports that water yield is generally greater in carbonate rocks where fracture intensity is greatest. Wells that are completed within this aquifer will generally yield useable quantities of good quality water.

Stratigraphic cross-sections are provided in **Appendix F**.

(5) Any corrective measures assessment conducted as required at §257.96;

(6) Any progress reports on corrective action remedy selection and design and the report of final remedy selection required at §257.97(a);

The multi-unit groundwater monitoring program which includes Cells 001, 003, and 004 remains in detection monitoring and is not required to complete the corrective measures references above.

(7) The most recent structural stability assessment required at §257.73(d);

The most recent versions of the structural stability assessments are provided in **Appendix G**.

(8) The most recent safety factor assessment required at §257.73(e);

The most recent versions of the safety factor assessments are provided in **Appendix H**.

4. Summary of Actions Required During Alternative Capacity Pursuit

> ***40 CFR §257.103(f)(1)(vii) An owner or operator may seek additional time beyond the time granted in the initial approval by making the showing in paragraph (f)(1)(i) through (iv) of this section, provided that no facility may be granted time to operate the impoundment beyond the maximum allowable time frames provided in §257.103(f)(1)(vi).***
>
> ***40 CFR §257.103(f)(1)(vi)(A) Except as provided by paragraph (f)(1)(vi)(B) of this section, no later than October 15, 2023.***

AECI has demonstrated that additional time is necessary to complete the alternative capacity construction projects and obtain fully functional operational usage of the alternative capacity. AECI foresees that the projects will be completed, or key activities within the master project schedule will occur by **30 November 2021** to obtain alternative capacity and allow for AECI to cease use of Cells 001, 003, and 004.

> ***40 CFR §257.103(f)(1)(x) The owner or operator must prepare semi-annual progress reports. The semi-annual progress reports must contain all of the following elements:***
>
> > ***(A) Discussion of the progress made to date in obtaining alternative capacity, including:***
> >
> > > ***(1) Discussion of the current stage of obtaining the capacity in refence to the timeline required under paragraph (f)(1)(iv)(A) of this section;***
> > > ***(2) Discussion of whether the owner or operator is on schedule for obtaining alternative capacity;***
> > > ***(3) If the owner or operator is not on or ahead of schedule for obtaining alternative capacity, the following must be included:***
> > > ***(i) Discussion of any problems encountered, and a description of the actions taken or planned to resolve the problems and get back on schedule; and***
> > > ***(ii) Discussion of the goals for the next six months and major milestones to be achieved for obtaining alternative capacity; and***
> >
> > ***(B) Discussion of any planned operational changes at the facility.***
>
> ***(xi) The progress reports are to be completed according to the following schedule:***
>
> > ***(A) The semi-annual progress reports are to be prepared no later than April 30 and October 31 of each year for the duration of the alternate cease receipt of waste deadline.***
> > ***(B) The first semi-annual progress report must be prepared by whichever date, April 30 or October 31, is soonest after receiving approval from the Administrator or the Participating State Director; and***
> > ***(C) The owner or operator has completed the progress reports specified in paragraph (f)(1)(x) of this section when the reports are placed in the facility's operating record as required by § 257.105(i)(17).***

AECI will complete the semi-annual progress reports in accordance with the CCR Rule.

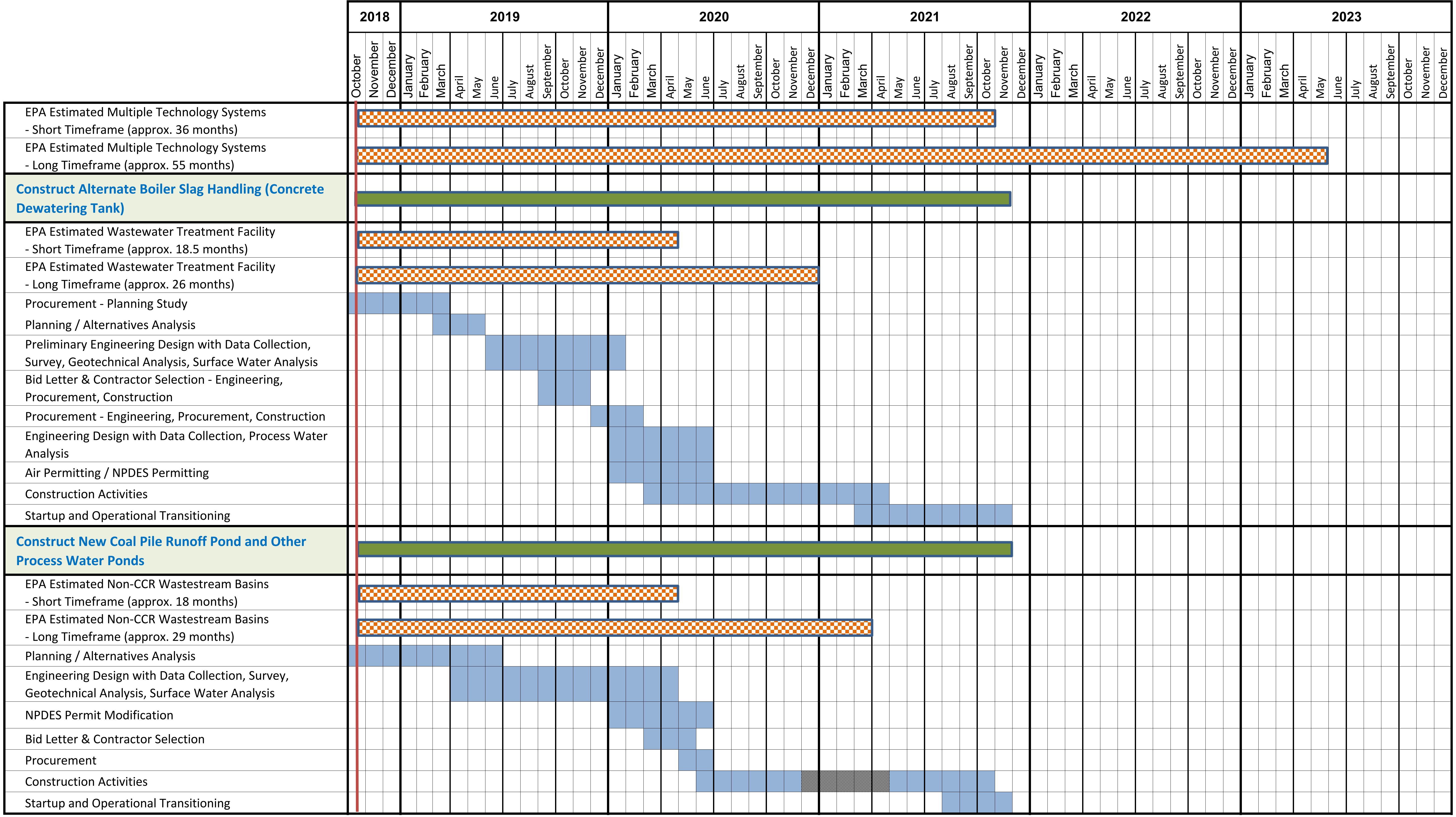
APPENDIX A

No Alternative Capacity Schedule

Associated Electric Cooperative, Inc.
Thomas Hill Energy Center
Clifton Hill, Missouri

Deadline to Initiate Closure
CCR and Non-CCR Alternative Capacity Extensions

Note: EPA Timeframes taken from Final Rule for Holistic Approach to Closure Part A



APPENDIX B

Compliance Certification

29 September 2020

SUBJECT: Site-specific Alternative Deadline to Initiate Closure of CCR Surface Impoundment
Certification of Facility Compliance with 40 CFR 257
Cell 001, Cell 003, and Cell 004
Thomas Hill Energy Center – Clifton Hill, Missouri
Associated Electric Cooperative, Inc.

Associated Electric Cooperative, Inc. (AECI) operates the existing coal-fired power plant known as the Thomas Hill Energy Center (THEC, facility) located near Clifton Hill, Missouri. AECI operates the coal combustion residuals (CCR) management units referred to as Cell 001, Cell 003, and Cell 004 at the THEC. These CCR units are required to cease receiving CCR and non-CCR wastestreams and commence closure. In support of a closure extension, this document addresses the requirements of 40 CFR §257.103(f)(1)(iv)(B)(1) of the U.S. Environmental Protection Agency (USEPA) Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities, Code of Federal Regulations Title 40 CFR (40 CFR) Part 257 (CCR Rule) effective 19 October 2015, and subsequent rulemaking revisions. AECI has actively managed and completed necessary compliance activities to meet the requirements of the CCR Rule.

I, KENNETH S. WILMOT, being a qualified representative of Associated Electric Cooperative, Inc., do hereby certify, to the best of my knowledge, information, and belief, that the Thomas Hill Energy Center facility is in compliance with all of the requirements of the 40 CFR 257 subpart applicable to the facility. This certification is being prepared to meet the requirement of 40 CFR §257.103(f)(1)(iv)(B)(1).

Signed:

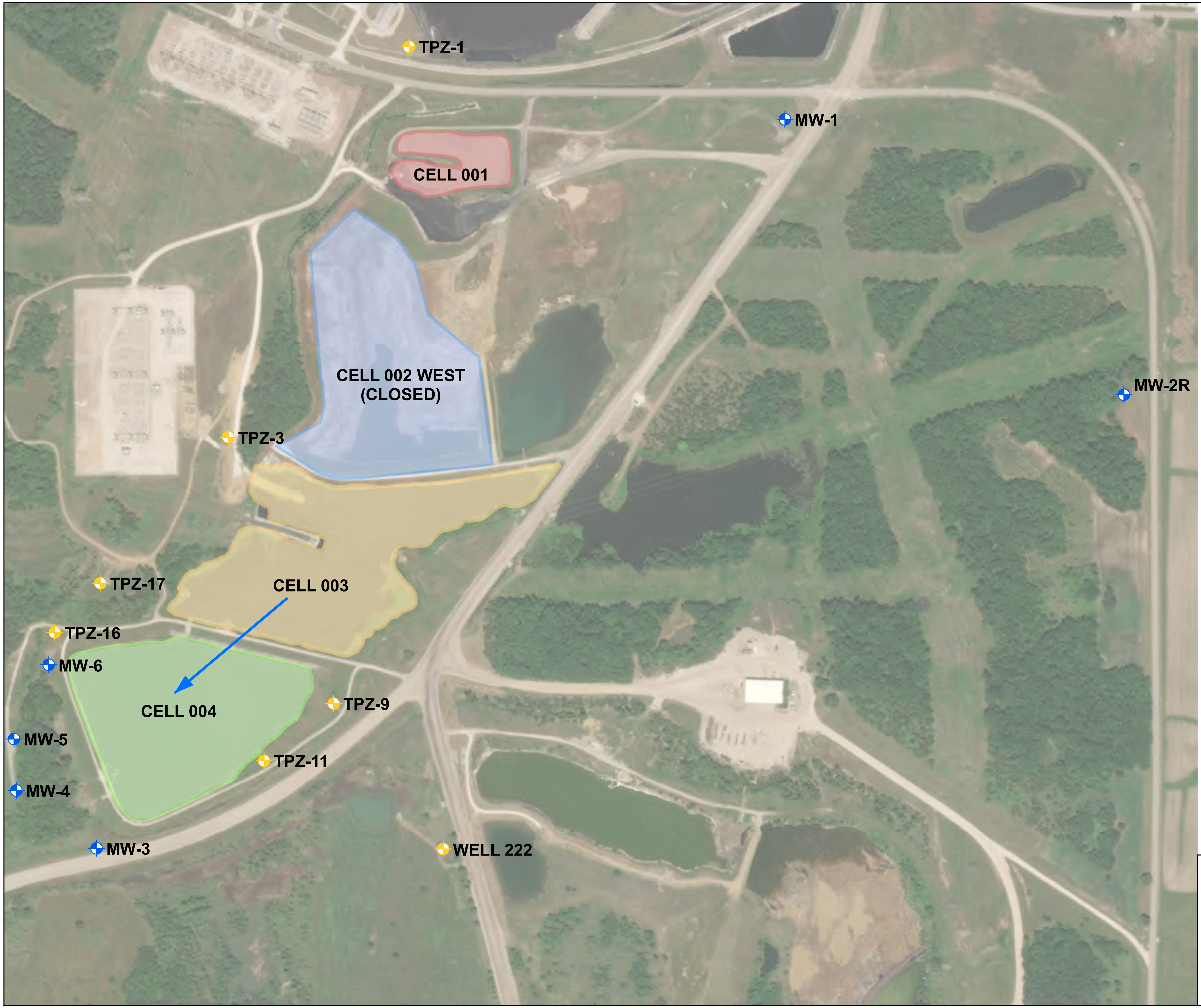
Print Name: KENNETH S. WILMOT

Title: SVP/COO

Date: 29 Sept 2020

APPENDIX C

Groundwater Wells Location Map and Flow Direction



LEGEND

⊕ THEC CCR MONITORING WELL
⊕ PIEZOMETRIC OBSERVATION ONLY
🟥 CELL 001
🟦 CELL 002 WEST (INACTIVE)
🟨 CELL 003
🟩 CELL 004
← GROUNDWATER FLOW DIRECTION

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. THEC CCR MONITORING ACCOMPLISHED VIA A MULTI-UNIT GROUNDWATER MONITORING SYSTEM, REFERRED TO AS THE ASH POND SYSTEM, THAT INCLUDES: CELL 001, CELL 003, AND CELL 004.
3. AERIAL IMAGERY SOURCE: ESRI, JUNE 9, 2018.

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

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

ASH POND SYSTEM MONITORING WELL LOCATION MAP AND FLOW DIRECTION

aeci

SEPTEMBER 2020
SCALE: AS SHOWN

FIGURE C-1

APPENDIX D

Groundwater Well Diagrams and Drilling Logs

HALEY & ALDRICH

BORING LOGS

Well No. MW-1

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

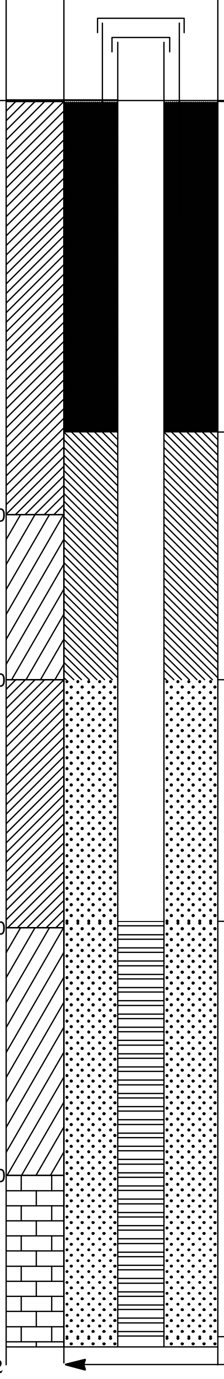
Well Diagram

▥	Riser Pipe
☰	Screen
▒	Filter Sand
▓	Cuttings
■	Grout
⁘	Concrete
▧	Bentonite Seal

File No. 128064-001
Date Installed 25 Aug 2015
H&A Rep. D. Andersen
Location See Plan

Ground El. 744.5
Datum NGVD

SOIL/ROCK CONDITIONS	DEPTH (ft.)
CH Fat clay with sand.	10.0
CL Lean clay with sand.	14.0
CH Fat clay with sand.	20.0
CL Lean clay with sand.	26.0
LIMESTONE Grey-tan colored, sandy, crystalline.	30.2



DEPTH (ft.)	ELEVATION (ft.)
0.0	744.5
0.0	744.5
8.0	736.5
14.0	730.5
19.9	724.7
29.9	714.6

WELL CONSTRUCTION DETAILS

Type of protective cover LOCKING CAP

Height of Guard Pipe above ground surface 2.9 ft

Height of top of riser above ground surface 2.4 ft

Type of protective casing Guard Pipe

Length 5.0 ft

Inside diameter 4 inches

Depth of bottom of Guard Pipe 2.1 ft

Type of riser pipe Schedule 40 PVC

Inside diameter of riser pipe 2 inch

Depth of bottom of riser pipe 19.9 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	0.0 ft	8.0 ft
Bentonite	8.0 ft	6.0 ft
	-	-

Diameter of borehole 9.5 inch

Depth to top of well screen 19.9 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 29.9 ft

Bottom of silt trap NA

Depth of bottom of borehole 30.2 ft

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. **MW-2R**

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

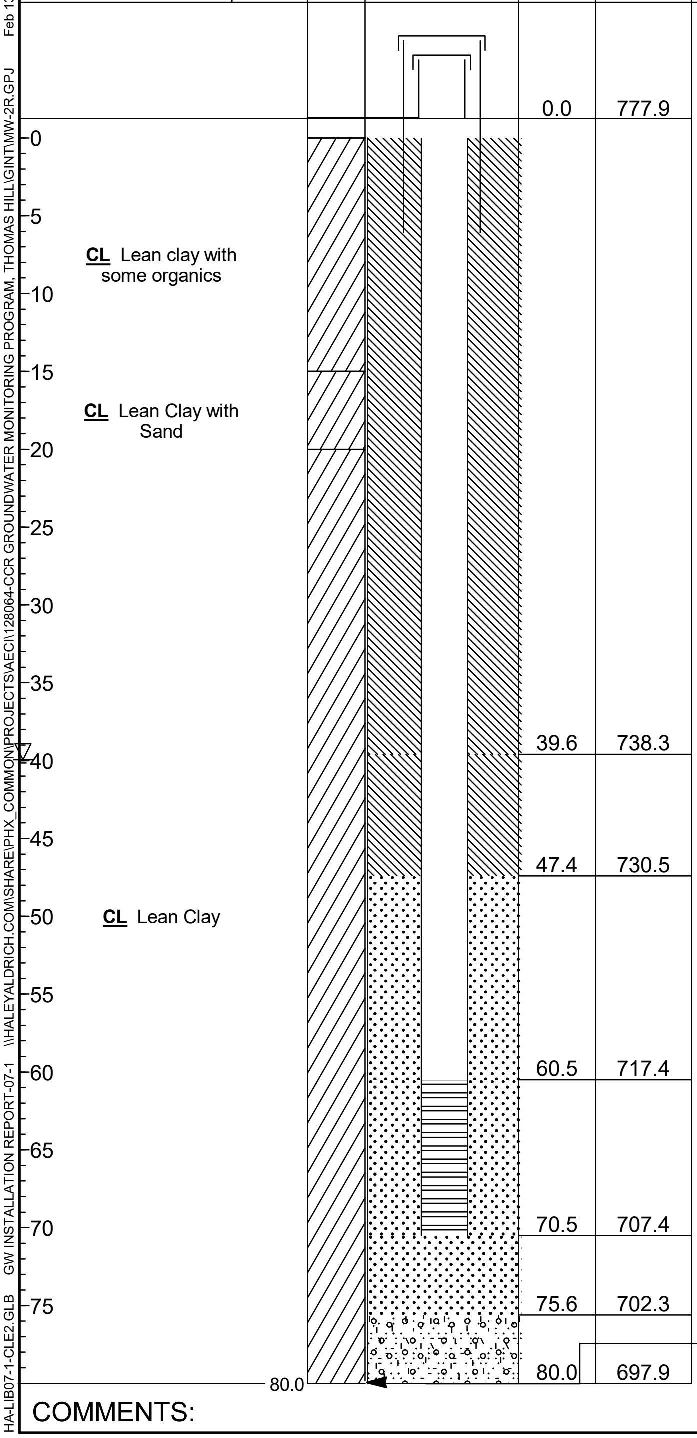
Initial Water Level (depth bgs) ft

Well Diagram

▯	Riser Pipe
▤	Screen
░	Filter Sand
▒	Cuttings
■	Grout
▨	Concrete
▧	Bentonite Seal

File No.	128064-001
Date Installed	20 Mar 2017
H&A Rep.	B. Kienenberger
Location	See Plan
Ground El.	777.9
Datum	NGVD

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)



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 2 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 60.5 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite Grout	0.0 ft	39.6 ft
Bentonite	39.6 ft	7.1 ft
	-	-

Diameter of borehole 8 inch

Depth to top of well screen 60.5 ft

Type of screen Schedule 40 PVC

Screen gauge or size of openings 0.010 in.

Diameter of screen 2 inch

Type of Backfill around Screen

Depth to bottom of well screen 70.5 ft

Bottom of silt trap NA

Depth of bottom of borehole 80.0 ft

COMMENTS:

HALEY& ALDRICH

BORING LOGS

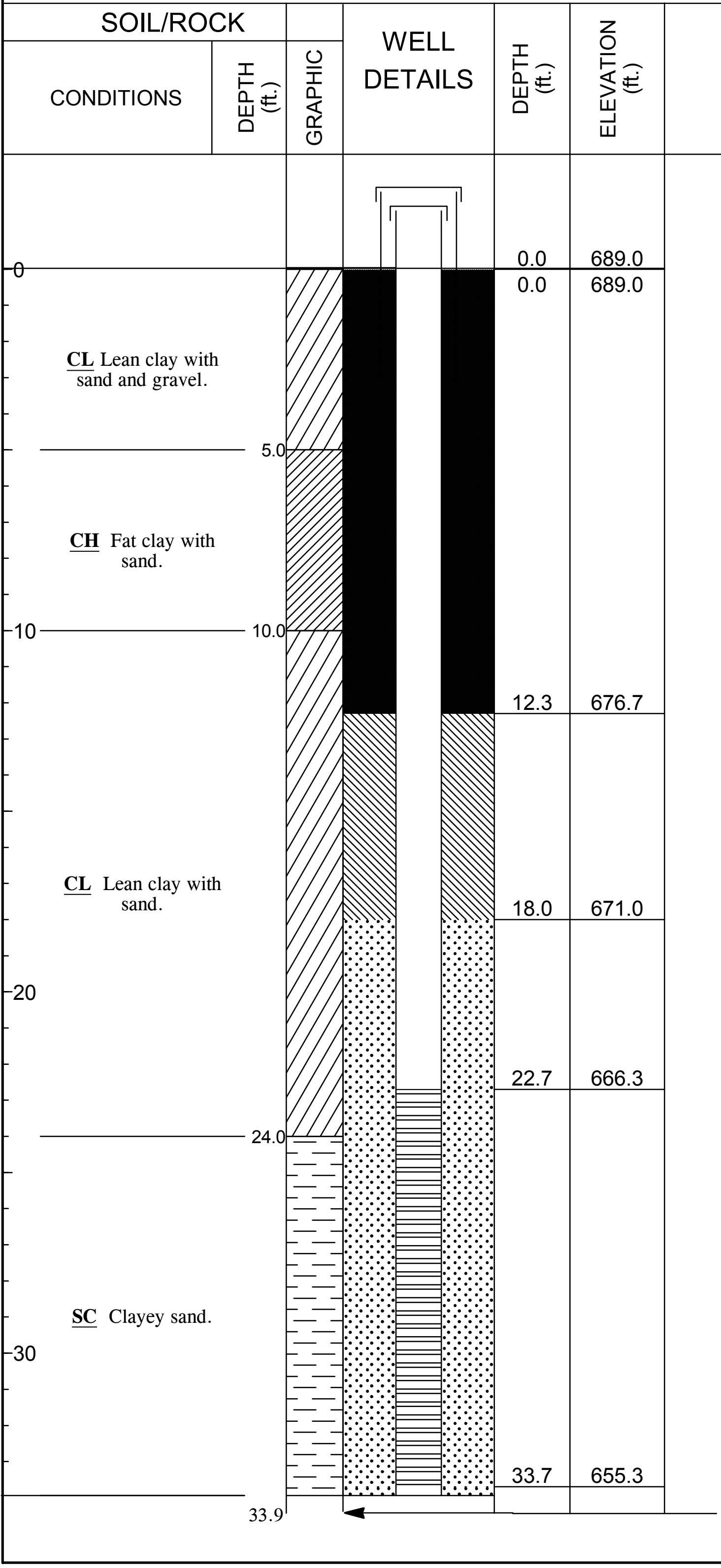
Well No. MW-3

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.	128064-001
Date Installed	19 Aug 2015
H&A Rep.	D. Andersen
Location	See Plan
Ground El.	689.0
Datum	NGVD



WELL CONSTRUCTION DETAILS

Type of protective cover LOCKING CAP

Height of Guard Pipe above ground surface 3.7 ft

Height of top of riser above ground surface 3.2 ft

Type of protective casing Guard Pipe

Length 5.0 ft

Inside diameter 4 inches

Depth of bottom of Guard Pipe 1.3 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

HALEY ALDRICH

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. **MW-4**

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

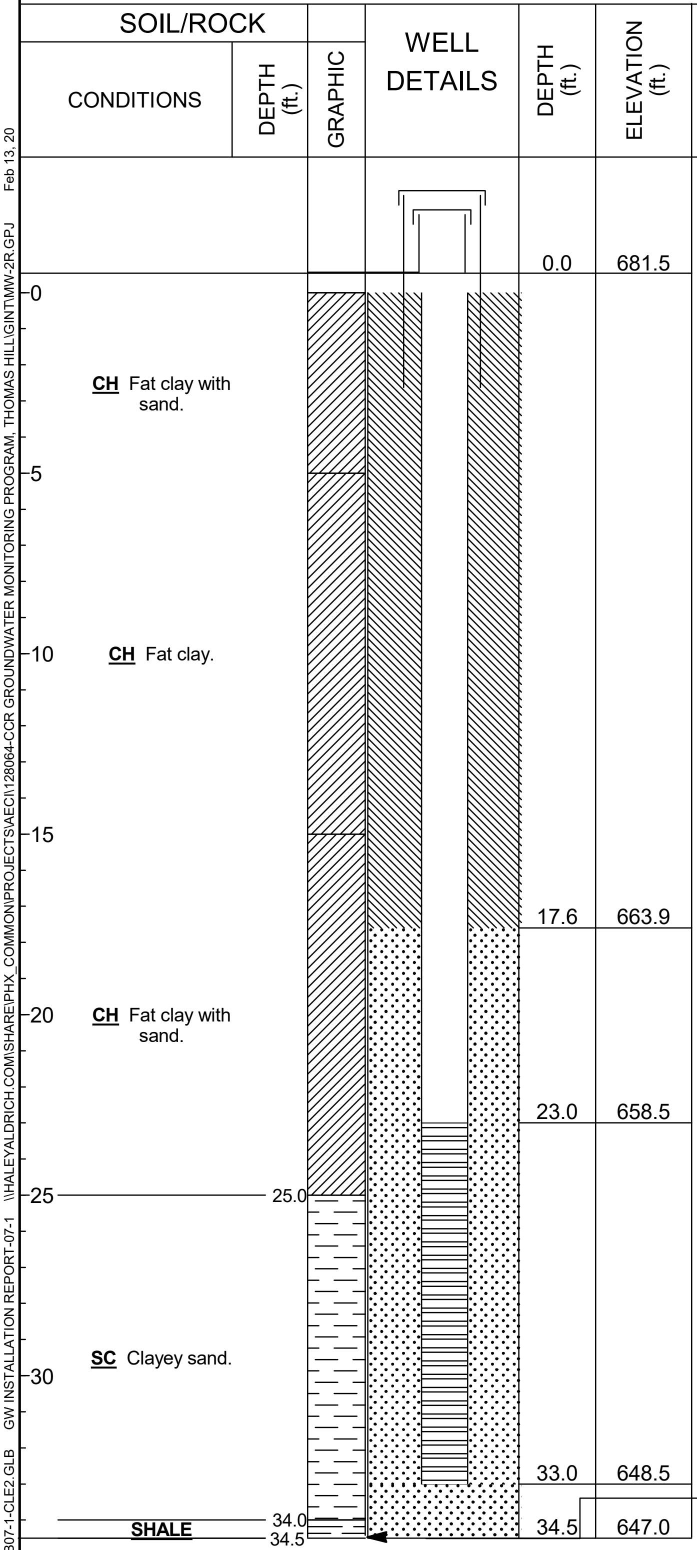
Initial Water Level (depth bgs) ft

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. 681.5
Datum NGVD



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 2.8 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
-	-	-
-	2.1 ft	-

Diameter of borehole 10 inch

Depth to top of well screen 23.0 ft

Type of screen Schedule 40 PVC

Screen gauge or size of openings 0.010 in.

Diameter of screen 2 inch

Type of Backfill around Screen

Depth to bottom of well screen 33 ft

Bottom of silt trap NA

Depth of bottom of borehole 34.5 ft

COMMENTS:

HALEY ALDRICH

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. MW-5

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

Initial Water Level (depth bgs) 20.0 ft

Well Diagram

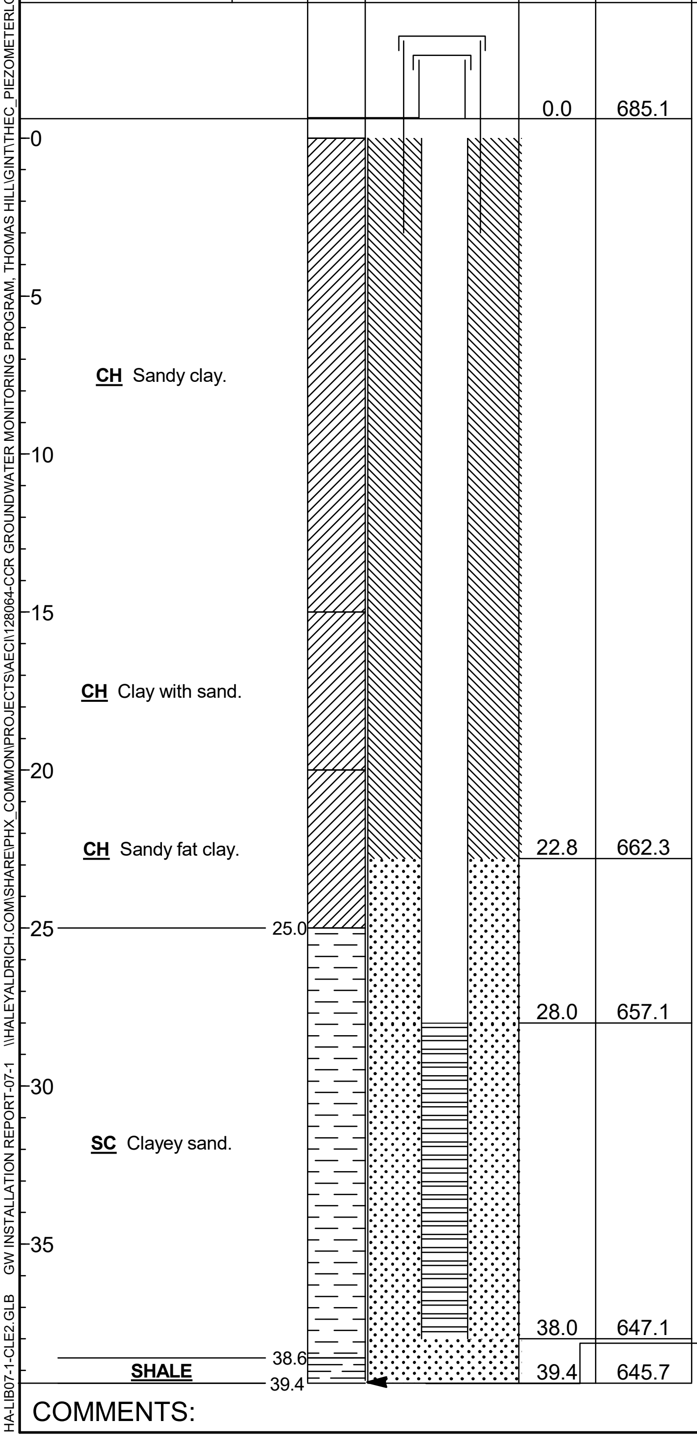
- ◫ Riser Pipe
- ☰ Screen
- ▒ Filter Sand
- ▓ Cuttings
- ■ Grout
- ⁖ Concrete
- ▨ Bentonite Seal

File No.	128064-001
Date Installed	03 Aug 2016
H&A Rep.	P. Kroger
Location	See Plan

Ground El.	685.1
Datum	NGVD

SOIL/ROCK

CONDITIONS	DEPTH (ft.)
CH Sandy clay.	
CH Clay with sand.	
CH Sandy fat clay.	25.0
SC Clayey sand.	38.6
SHALE	39.4



DEPTH (ft.)	ELEVATION (ft.)
0.0	685.1
22.8	662.3
28.0	657.1
38.0	647.1
39.4	645.7

WELL CONSTRUCTION DETAILS

Type of protective cover LOCKING CAP

Height of Guard Pipe above ground surface 2.0 ft

Height of top of riser above ground surface 1.5 ft

Type of protective casing Guard Pipe

Length 5.0 ft

Inside diameter 2 inches

Depth of bottom of Guard Pipe 3.0 ft

Type of riser pipe Schedule 40 PVC

Inside diameter of riser pipe 2 inch

Depth of bottom of riser pipe 28.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite	0.0 ft	22.8 ft
-	-	-
-	-	-

Diameter of borehole 10 inch

Depth to top of well screen 28.0 ft

Type of screen Schedule 40 PVC

Screen gauge or size of openings 0.010 in.

Diameter of screen 2 inch

Type of Backfill around Screen ____________

Depth to bottom of well screen 38 ft

Bottom of silt trap NA

Depth of bottom of borehole 39.4 ft

COMMENTS:

HALEY& ALDRICH

BORING LOGS

Well No. MW-6

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

Well Diagram

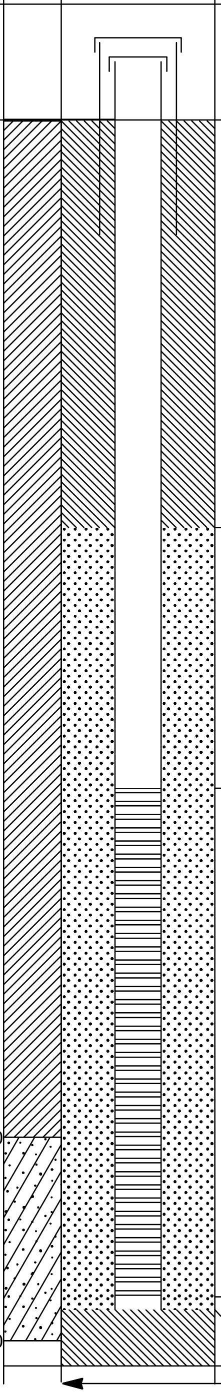
▥	Riser Pipe
▤	Screen
▨	Filter Sand
▨	Cuttings
■	Grout
▨	Concrete
▧	Bentonite Seal

File No. 128064-001
Date Installed 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
	24.5



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	2.9 ft
Height of top of riser above ground surface	2.4 ft
Type of protective casing	Guard Pipe
Length	5.0 ft
Inside diameter	4 inches
Depth of bottom of Guard Pipe	2.1 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

APPENDIX E

Table of Groundwater Constituent Concentrations

APPENDIX E
SUMMARY OF ANALYTICAL RESULTS

AECI Thomas Hill Energy Center
Ash Pond Multi-Unit Groundwater Monitoring System
Clifton Hill, Missouri

Location	Sample Date	Detection Monitoring - USEPA Appendix III Constituents (mg/L)							Assessment Monitoring - USEPA Appendix IV Constituents (mg/L)														
		Boron, Total	Calcium, Total	Chloride	Fluoride	Sulfate	pH (su)	TDS	Antimony, Total	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Chromium, Total	Cobalt, Total	Lead, Total	Lithium, Total	Molybdenum, Total	Selenium, Total	Thallium, Total	Mercury, Total	Fluoride	Radium-226 & 228 (pCi/L)
MW-1	8/22/2016	**0.067**	**541**	**27.7**	**0.3**	**2070**	**6.70**	**3389**	<0.0005	<0.001	**0.015**	<0.001	<0.0005	**0.001**	**0.001**	<0.001	**0.14**	**0.001**	**0.003**	<0.001	<0.0008	**0.3**	**1.50**
	9/17/2016	<0.125	**569**	**29.6**	**0.3**	**1970**	**6.72**	**3353**	<0.0005	<0.008	**0.027**	<0.001	<0.001	<0.008	<0.008	<0.008	**0.15**	<0.008	**0.003**	<0.001	<0.0008	**0.3**	**3.16**
	10/18/2016	**0.112**	**571**	**28**	**0.3**	**1980**	**6.76**	**3438**	<0.0005	<0.004	**0.013**	<0.004	<0.002	<0.004	<0.004	<0.004	**0.14**	<0.004	**0.002**	<0.002	<0.0008	**0.3**	**1.32**
	11/8/2016	**0.091**	**558**	**28.8**	**0.3**	**979**	**6.69**	**3461**	<0.0005	<0.005	**0.014**	<0.004	<0.002	<0.005	<0.005	<0.001	**0.140**	<0.005	**0.002**	<0.001	<0.0008	**0.3**	**1.30**
	12/15/2016	**0.111**	**632**	**27.9**	**0.3**	**2100**	**6.78**	**3482**	<0.0005	<0.005	**0.014**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.16**	<0.005	**0.002**	<0.0005	<0.0008	**0.3**	**1.0**
	1/12/2017	**0.133**	**584**	**26.1**	**0.3**	**2050**	**7.02**	**3490**	<0.0005	<0.005	**0.014**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.14**	<0.005	**0.003**	<0.0005	<0.0008	**0.3**	**1.67**
	2/2/2017	**0.122**	**595**	**26.2**	**0.3**	**2070**	**6.75**	**3577**	<0.0005	<0.005	**0.012**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.14**	<0.005	**0.003**	<0.0005	<0.0008	**0.3**	**1.27**
	3/8/2017	**0.127**	**621**	**26.8**	**0.3**	**2100**	**6.74**	**3517**	<0.0005	<0.005	**0.013**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.14**	<0.005	**0.002**	<0.0005	<0.0008	**0.3**	**0.73**
	4/10/2017	**0.094**	**601**	**28.6**	**0.3**	**2080**	**6.73**	**3350**	<0.0005	<0.005	**0.012**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.12**	<0.005	**0.003**	<0.0005	<0.0008	**0.3**	**1.07**
	5/9/2017	**0.104**	**605**	**29.5**	**0.3**	**2070**	**6.28**	**3470**	<0.0005	<0.005	**0.012**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.12**	<0.005	**0.004**	<0.0005	<0.0008	**0.3**	**1.80**
	6/13/2017	**0.071**	**572**	**29.8**	**0.3**	**2050**	**6.94**	**3490**	<0.0005	<0.005	**0.012**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.13**	<0.005	**0.004**	<0.0005	<0.0008	**0.3**	**0.58**
	7/11/2017	**0.069**	**562**	**30.8**	**0.3**	**1980**	**7.04**	**3541**	<0.0005	<0.005	**0.012**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.14**	<0.005	**0.004**	<0.0005	<0.0008	**0.3**	**1.25**
	7/11/2017	**0.079**	**589**	**30.1**	**0.3**	**2040**	**6.18**	**3545**	<0.0005	<0.005	**0.012**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.14**	<0.005	**0.004**	<0.0005	<0.0008	**0.3**	**1.13**
	2/27/2018	**0.113**	**631**	**24.5**	**0.532**	**1900**	--	**3560**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/23/2018	**0.089**	**583**	**23.8**	<0.065	**1990**	**6.65**	**3630**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9/10/2018	**0.089**	**587**	**33.8**	**1.48**	**2180**	**6.87**	**3570**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3/15/2019	**0.072**	**614**	**26.6**	< 0.100	**2070**	**7.25**	**3632**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	8/26/2019	**0.085**	**589**	**34.6**	**0.360**	**1910**	**6.56**	**3588**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/27/2020	**0.121**	**484**	**30.6**	**0.802**	**2240**	**6.68**	**3421**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/27/2020	**0.104**	**465**	**30.3**	**0.512**	**2180**	**6.71**	**3426**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-2R	5/11/2017	**0.200**	**206**	**5.4**	**0.6**	**411**	**7.34**	**1096**	<0.0005	<0.005	**0.057**	<0.004	<0.005	<0.008	<0.005	<0.005	**0.01**	**0.007**	**0.002**	<0.0005	<0.0008	**0.6**	**2.07**
	6/13/2017	**0.187**	**211**	**5.5**	**0.5**	**433**	**7.25**	**1140**	<0.0005	<0.005	**0.063**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.01**	**0.010**	**0.001**	<0.0005	<0.0008	**0.5**	**0.53**
	7/11/2017	**0.166**	**210**	**5.5**	**0.5**	**448**	**7.24**	**1277**	<0.0005	<0.005	**0.060**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	**0.011**	**0.002**	<0.0005	<0.0008	**0.5**	**1.86**
	7/31/2017	**0.202**	**240**	**5.2**	**0.5**	**474**	**7.05**	**1286**	<0.0005	<0.005	**0.056**	<0.004	<0.005	<0.008	<0.005	<0.005	**0.01**	<0.008	**0.003**	<0.0005	<0.0008	**0.5**	**2.30**
	8/14/2017	**0.203**	**241**	**5.1**	**0.5**	**473**	**7.28**	**1342**	<0.0005	<0.005	**0.066**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.01**	**0.010**	<0.001	<0.0005	<0.0008	**0.5**	**1.37**
	8/31/2017	**0.205**	**250**	**5.2**	**0.5**	**468**	**7.06**	**1327**	<0.0005	<0.005	**0.065**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.01**	**0.010**	<0.001	<0.0005	<0.0008	**0.5**	**2.70**
	9/12/2017	**0.206**	**250**	**5.1**	**0.5**	**467**	**6.98**	**1343**	<0.0005	<0.005	**0.067**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.01**	**0.010**	**0.003**	<0.0005	<0.0008	**0.5**	**1.55**
	2/27/2018	**0.200**	**266**	**5.64**	**0.634**	**457**	--	**1460**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/23/2018	**0.194**	**253**	<5.00	<0.065	**563**	**7.12**	**1540**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9/10/2018	**0.201**	**270**	**6.77**	**1.00**	**645**	**6.92**	**1500**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3/15/2019	**0.193**	**281**	**5.60**	< 0.100	**615**	**7.35**	**1615**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3/15/2019	**0.195**	**287**	**5.50**	< 0.100	**632**	**7.47**	**1601**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	8/26/2019	**0.191**	**270**	**6.00**	**0.440**	**588**	**6.95**	**1613**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	8/26/2019	**0.189**	**273**	**6.09**	**0.670**	**616**	**6.98**	**1606**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/27/2020	**0.108**	**267**	**4.64**	**0.429**	**634**	**7.05**	**1537**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

APPENDIX E
SUMMARY OF ANALYTICAL RESULTS

AECI Thomas Hill Energy Center
Ash Pond Multi-Unit Groundwater Monitoring System
Clifton Hill, Missouri

Location	Sample Date	Detection Monitoring - USEPA Appendix III Constituents (mg/L)							Assessment Monitoring - USEPA Appendix IV Constituents (mg/L)														
		Boron, Total	Calcium, Total	Chloride	Fluoride	Sulfate	pH (su)	TDS	Antimony, Total	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Chromium, Total	Cobalt, Total	Lead, Total	Lithium, Total	Molybdenum, Total	Selenium, Total	Thallium, Total	Mercury, Total	Fluoride	Radium-226 & 228 (pCi/L)
MW-3	8/22/2016	**0.281**	**410**	**12.7**	**0.1**	**1670**	**6.49**	**3482**	<0.0005	**0.026**	**0.032**	<0.001	<0.0005	<0.001	**0.007**	<0.001	**0.03**	**0.003**	**0.003**	<0.001	<0.0008	**0.1**	**1.63**
	9/18/2016	**0.472**	**470**	**13.5**	**0.1**	**2280**	**6.43**	**3911**	<0.0005	<0.008	**0.030**	<0.001	<0.001	<0.008	<0.008	<0.008	**0.03**	<0.008	**0.002**	<0.001	<0.0008	**0.1**	**2.12**
	10/17/2016	**0.475**	**455**	**13**	<0.1	**2260**	**6.48**	**4138**	<0.0005	<0.004	**0.019**	<0.004	<0.002	<0.004	**0.006**	<0.004	**0.02**	<0.004	**0.002**	<0.002	<0.0008	<0.1	**3.2**
	11/8/2016	**0.458**	**423**	**12.9**	**0.1**	**2280**	**6.48**	**3995**	<0.0005	<0.005	**0.019**	<0.004	<0.002	<0.005	**0.006**	<0.005	**0.020**	<0.005	**0.002**	<0.002	<0.0008	**0.1**	**0.46**
	12/14/2016	**0.468**	**518**	**13.6**	<0.1	**2220**	**6.60**	**3921**	<0.0005	<0.005	**0.018**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	<0.005	**0.002**	<0.0005	<0.0008	<0.1	**1.90**
	12/14/2016	**0.458**	**510**	**13.6**	<0.1	**2240**	**6.57**	**3962**	<0.0005	<0.005	**0.018**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	<0.005	**0.002**	<0.0005	<0.0008	<0.1	**1.78**
	1/11/2017	**0.453**	**481**	**13.6**	<0.1	**2340**	**6.65**	**3950**	<0.0005	<0.005	**0.017**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	<0.005	**0.003**	<0.0005	<0.0008	<0.1	**1.02**
	2/2/2017	**0.435**	**484**	**13.6**	**0.1**	**2280**	**6.55**	**3960**	<0.0005	<0.005	**0.016**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	<0.005	**0.002**	<0.0005	<0.0008	**0.1**	**0.67**
	3/7/2017	**0.449**	**512**	**13.6**	<0.1	**2360**	**6.50**	**3960**	<0.0005	<0.005	**0.017**	<0.004	<0.005	<0.005	**0.007**	<0.005	**0.02**	<0.005	**0.002**	<0.0005	<0.0008	<0.1	**ND**
	4/10/2017	**0.444**	**492**	**13.3**	**0.2**	**2290**	**6.54**	**3850**	<0.0005	<0.005	**0.017**	<0.004	<0.005	<0.005	**0.007**	<0.005	**0.01**	<0.005	**0.003**	<0.0005	<0.0008	**0.2**	**ND**
	5/9/2017	**0.393**	**498**	**13.6**	<0.1	**2280**	**6.41**	**3790**	<0.0005	<0.005	**0.017**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	<0.005	**0.003**	<0.0005	<0.0008	<0.1	**1.15**
	6/13/2017	**0.378**	**483**	**13.6**	<0.1	**2330**	**6.65**	**4000**	<0.0005	<0.005	**0.018**	<0.004	<0.005	<0.005	**0.006**	<0.005	**0.02**	<0.005	**0.003**	<0.0005	<0.0008	<0.1	**ND**
	6/13/2017	**0.373**	**482**	**13.5**	<0.1	**2310**	**6.74**	**3970**	<0.0005	<0.005	**0.019**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	<0.005	**0.003**	<0.0005	<0.0008	<0.1	**0.77**
	7/11/2017	**0.348**	**472**	**13.7**	<0.1	**2320**	**6.62**	**3985**	<0.0005	<0.005	**0.018**	<0.004	<0.005	<0.005	**0.006**	<0.005	**0.02**	<0.005	**0.004**	<0.0005	<0.0008	<0.1	**0.88**
	2/27/2018	**0.404**	**516**	**11.6**	<0.500	**1970**	--	**3790**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/27/2018	**0.407**	**495**	**24.1**	<1.0	**2040**	--	**3800**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/23/2018	**0.366**	**473**	**10.4**	<0.065	**2200**	**6.51**	**4010**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9/10/2018	**0.420**	**520**	**15.7**	<0.500	**4830**	**6.55**	**3970**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9/10/2018	**0.083**	**625**	**33.4**	**0.516**	**4420**	**6.63**	**3570**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3/15/2019	**0.353**	**469**	**13.1**	< 0.100	**2040**	**6.92**	**3677**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	8/26/2019	**0.352**	**465**	**14.2**	**0.110**	**1920**	**6.32**	**3770**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/27/2020	**0.183**	**459**	**12.9**	<0.100	**2300**	**6.43**	**3578**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	8/21/2016	**0.050**	**109**	**6.9**	**0.3**	**178**	**7.14**	**505**	<0.0005	**0.002**	**0.171**	<0.001	<0.0005	**0.001**	**0.001**	<0.001	**0.01**	**0.003**	<0.001	<0.001	<0.0008	**0.3**	**0.80**
	9/17/2016	<0.125	**99.8**	**9.1**	**0.3**	**116**	**6.97**	**378**	<0.0005	<0.008	**0.15**	<0.001	<0.001	<0.008	<0.008	<0.008	<0.01	<0.008	<0.001	<0.001	<0.0008	**0.3**	**1.68**
	10/17/2016	**0.035**	**105**	**7**	**0.3**	**112**	**6.91**	**454**	<0.0005	**0.006**	**0.141**	<0.004	<0.002	<0.004	<0.004	<0.004	<0.01	**0.005**	**0.001**	<0.002	<0.0008	**0.3**	**1.74**
	11/8/2016	**0.057**	**110**	**7.2**	**0.3**	**159**	**7.06**	**511**	<0.0005	**0.006**	**0.180**	<0.004	<0.002	<0.005	<0.005	<0.005	<0.01	**0.006**	<0.001	<0.002	<0.0008	**0.3**	**1.57**
	12/14/2016	**0.042**	**117**	**7.3**	**0.4**	**104**	**7.15**	**397**	<0.0005	<0.005	**0.142**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	**0.002**	<0.0005	<0.0008	**0.4**	**2.59**
	1/11/2017	**0.031**	**116**	**7.2**	**0.3**	**164**	**6.90**	**489**	<0.0005	<0.005	**0.150**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	**0.001**	<0.0005	<0.0008	**0.3**	**0.68**
	2/2/2017	**0.035**	**122**	**7.0**	**0.3**	**174**	**6.85**	**538**	<0.0005	**0.010**	**0.144**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.001	<0.0005	<0.0008	**0.3**	**1.26**
	3/8/2017	**0.030**	**131**	**6.9**	**0.3**	**188**	**6.92**	**565**	<0.0005	**0.015**	**0.152**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.001	<0.0005	<0.0008	**0.3**	**1.52**
	4/11/2017	**0.028**	**118**	**6.7**	**0.3**	**168**	**6.97**	**523**	<0.0005	**0.008**	**0.138**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	**0.006**	<0.001	<0.0005	<0.0008	**0.3**	**0.86**
	5/9/2017	<0.025	**120**	**6.9**	**0.3**	**176**	**6.93**	**387**	<0.0005	**0.005**	**0.137**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	**0.006**	**0.001**	<0.0005	<0.0008	**0.3**	**2.31**
	5/9/2017	<0.025	**122**	**6.9**	**0.3**	**176**	**7.01**	**460**	<0.0005	**0.005**	**0.138**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	**0.006**	**0.001**	<0.0005	<0.0008	**0.3**	**1.11**
	6/13/2017	<0.025	**116**	**7.0**	**0.4**	**169**	**6.85**	**558**	<0.0005	**0.007**	**0.137**	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	**0.006**	<0.001	<0.0005	<0.0008	**0.4**	**3.13**
	7/11/2017	**0.026**	**113**	**6.9**	**0.3**	**164**	**6.94**	**514**	<0.0005	**0.008**	**0.136**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	**0.006**	**0.001**	<0.0005	<0.0008	**0.3**	**0.94**
	2/27/2018	<0.050	**130**	**6.67**	**0.820**	**179**	--	**573**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/23/2018	**0.034**	**116**	<5.00	<0.065	**157**	**6.83**	**558**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9/10/2018	**0.052**	**107**	**7.49**	<0.500	**101**	**6.96**	**380**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3/15/2019	**0.016**	**121**	**6.30**	**0.279**	**158**	**7.49**	**540**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	8/26/2019	**0.043**	**110**	**7.78**	**0.730**	**173**	**6.82**	**573**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/27/2020	**0.030**	**121**	**8.01**	**0.274**	**213**	**6.88**	**444**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

APPENDIX E
SUMMARY OF ANALYTICAL RESULTS
AECI Thomas Hill Energy Center
Ash Pond Multi-Unit Groundwater Monitoring System
Clifton Hill, Missouri

Location	Sample Date	Detection Monitoring - USEPA Appendix III Constituents (mg/L)							Assessment Monitoring - USEPA Appendix IV Constituents (mg/L)														
		Boron, Total	Calcium, Total	Chloride	Fluoride	Sulfate	pH (su)	TDS	Antimony, Total	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Chromium, Total	Cobalt, Total	Lead, Total	Lithium, Total	Molybdenum, Total	Selenium, Total	Thallium, Total	Mercury, Total	Fluoride	Radium-226 & 228 (pCi/L)
MW-5	8/21/2016	**0.371**	**128**	**6.1**	**0.2**	**329**	**7.21**	**620**	<0.0005	**0.006**	**0.039**	<0.001	<0.0005	<0.001	<0.001	<0.001	**0.01**	**0.003**	<0.001	<0.001	<0.0008	**0.2**	**3.71**
	8/21/2016	**0.378**	**129**	**6.1**	**0.2**	**329**	**7.21**	**601**	<0.0005	**0.006**	**0.035**	<0.001	<0.0005	<0.001	<0.001	<0.001	**0.01**	**0.002**	<0.001	<0.001	<0.0008	**0.2**	**1.94**
	9/17/2016	**0.437**	**125**	**6.1**	**0.3**	**323**	**7.10**	**566**	<0.0005	<0.008	**0.04**	<0.001	<0.001	<0.008	<0.008	<0.008	**0.02**	<0.008	<0.001	<0.001	<0.0008	**0.3**	**1.66**
	10/18/2016	**0.418**	**136**	**6**	**0.2**	**306**	**7.05**	**632**	<0.0005	**0.008**	**0.038**	<0.004	<0.002	<0.004	<0.004	<0.004	<0.01	<0.004	<0.001	<0.002	<0.0008	**0.2**	**1.83**
	11/8/2016	**0.438**	**133**	**6.5**	<0.1	**323**	**7.32**	**667**	<0.0005	**0.010**	**0.038**	<0.004	<0.002	<0.005	<0.005	<0.005	<0.01	<0.005	<0.001	<0.002	<0.0008	<0.1	**0.99**
	11/8/2016	**0.436**	**136**	**6.2**	**0.3**	**323**	**7.18**	**683**	<0.0005	**0.010**	**0.039**	<0.004	<0.002	<0.005	<0.005	<0.005	<0.01	<0.005	<0.001	<0.002	<0.0008	**0.3**	**1.51**
	1/11/2017	**0.482**	**152**	**6.4**	**0.3**	**328**	**7.41**	**667**	<0.0005	**0.009**	**0.038**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.001	<0.0005	<0.0008	**0.3**	**1.43**
	2/2/2017	**0.452**	**153**	**6.2**	**0.2**	**322**	**6.95**	**726**	<0.0005	**0.010**	**0.036**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.001	<0.0005	<0.0008	**0.2**	**1.33**
	2/2/2017	**0.459**	**154**	**6.2**	**0.2**	**323**	**6.95**	**705**	<0.0005	**0.01**	**0.036**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.001	<0.0005	<0.0008	**0.2**	**0.96**
	3/9/2017	**0.513**	**196**	**6.2**	**0.2**	**326**	**7.04**	**715**	<0.0005	<0.005	**0.055**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	**0.021**	<0.001	<0.0005	<0.0008	**0.2**	**1.42**
	4/11/2017	**0.475**	**148.0**	**6**	**0.2**	**329**	**7.06**	**721**	<0.0005	**0.010**	**0.038**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.001	<0.0005	<0.0008	**0.2**	**1.14**
	4/11/2017	**0.476**	**147**	**6**	**0.2**	**328**	**7.08**	**724**	<0.0005	**0.009**	**0.037**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.001	<0.0005	<0.0008	**0.2**	**1.65**
	5/9/2017	**0.434**	**156**	**6.2**	**0.2**	**324**	**7.20**	**591**	<0.0005	<0.005	**0.038**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	**0.001**	<0.0005	<0.0008	**0.2**	**2.35**
	6/13/2017	**0.445**	**146**	**6.1**	**0.2**	**328**	**6.99**	**696**	<0.0005	**0.010**	**0.038**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	**0.001**	<0.0005	<0.0008	**0.2**	**0.33**
	7/11/2017	**0.397**	**142**	**6.2**	**0.2**	**315**	**7.02**	**722**	<0.0005	**0.008**	**0.035**	<0.004	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	**0.001**	<0.0005	<0.0008	**0.2**	**1.32**
	2/27/2018	**0.533**	**159**	**5.39**	<0.500	<5.00	--	**965**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/23/2018	**0.478**	**147**	<5.00	<0.065	**293**	**6.93**	**758**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/23/2018	**0.487**	**147**	<5.00	<0.065	**300**	**6.94**	**733**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9/10/2018	**0.476**	**145**	**6.66**	<0.500	**329**	**6.92**	**311**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3/15/2019	**0.564**	**151**	**5.21**	< 0.100	**259**	**7.43**	**710**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	8/26/2019	**0.459**	**133**	**5.95**	**0.460**	**271**	**6.96**	**700**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/27/2020	**0.340**	**143**	**5.66**	**0.225**	**245**	**6.94**	**588**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-6	8/22/2016	**0.440**	**152**	**11.5**	**0.4**	**353**	**6.86**	**782**	<0.0005	<0.001	**0.044**	<0.001	<0.0005	<0.001	<0.001	<0.001	**0.02**	**0.019**	**0.001**	<0.001	<0.0008	**0.4**	**0.72**
	9/17/2016	**0.545**	**151**	**11.3**	**0.4**	**359**	**7.04**	**680**	<0.0005	<0.008	**0.045**	<0.001	<0.001	<0.008	<0.008	<0.008	**0.03**	**0.020**	<0.001	<0.001	<0.0008	**0.4**	**2.32**
	10/17/2016	**0.473**	**162**	**11**	**0.4**	**346**	**6.89**	**780**	<0.0005	<0.004	**0.047**	<0.004	<0.002	<0.004	<0.004	<0.004	**0.02**	**0.023**	**0.002**	<0.002	<0.0008	**0.4**	**1.77**
	10/17/2016	**0.479**	**162**	**11**	**0.4**	**344**	**6.99**	**775**	<0.0005	<0.004	**0.047**	<0.004	<0.002	<0.004	<0.004	<0.004	**0.02**	**0.022**	**0.001**	<0.002	<0.0008	**0.4**	**1.37**
	11/8/2016	**0.479**	**158**	**11.6**	**0.4**	**361**	**6.90**	**752**	<0.0005	<0.005	**0.049**	<0.004	<0.002	<0.005	<0.005	<0.005	**0.02**	**0.023**	**0.001**	<0.002	<0.0008	**0.4**	**0.99**
	12/14/2016	**0.499**	**193**	**11.7**	**0.4**	**375**	**7.05**	**777**	<0.0005	<0.005	**0.052**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	**0.024**	<0.001	<0.0005	<0.0008	**0.4**	**2.82**
	1/12/2017	**0.5**	**179**	**11.8**	**0.4**	**385**	**7.30**	**791**	<0.0005	<0.005	**0.053**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	**0.022**	**0.001**	<0.0005	<0.0008	**0.4**	<0.59
	2/2/2017	**0.475**	**185**	**11.9**	**0.4**	**385**	**6.99**	**855**	<0.0005	<0.005	**0.1**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.020**	**0.022**	**0.001**	<0.0005	<0.0008	**0.4**	**0.92**
	3/8/2017	**0.504**	**193**	**11.9**	**0.4**	**390**	**6.95**	**849**	<0.0005	<0.005	**0.055**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	**0.021**	<0.001	<0.0005	<0.0008	**0.4**	**0.73**
	3/8/2017	**0.030**	**131**	**11.9**	**0.4**	**388**	**6.93**	**838**	<0.0005	**0.015**	**0.152**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	<0.005	<0.001	<0.0005	<0.0008	**0.4**	**0.84**
	4/10/2017	**0.487**	**182**	**11.7**	**0.3**	**382**	**6.84**	**813**	<0.0005	<0.005	**0.050**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	**0.021**	**0.002**	<0.0005	<0.0008	**0.3**	**0.73**
	5/9/2017	**0.402**	**177**	**11.7**	**0.3**	**372**	**6.89**	**704**	<0.0005	<0.005	**0.050**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	**0.020**	**0.002**	<0.0005	<0.0008	**0.3**	<0.66
	6/13/2017	**0.446**	**167**	**11.7**	**0.3**	**371**	**6.96**	**833**	<0.0005	<0.005	**0.050**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	**0.019**	**0.001**	<0.0005	<0.0008	**0.3**	**0.78**
	7/11/2017	**0.397**	**164**	**11.6**	**0.4**	**356**	**7.20**	**790**	<0.0005	<0.005	**0.048**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.02**	**0.021**	**0.002**	<0.0005	<0.0008	**0.4**	**1.08**
	2/27/2018	**0.498**	**190**	**10.0**	**0.530**	**426**	--	**847**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5/23/2018	**0.409**	**153**	**7.70**	<0.065	**317**	**6.88**	**794**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9/10/2018	**0.460**	**154**	**10.9**	<0.500	**313**	**6.93**	**627**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3/15/2019	**0.509**	**181**	**11.1**	**0.338**	**366**	**7.42**	**848**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	8/26/2019	**0.453**	**151**	**11.8**	**0.510**	**297**	**6.89**	**775**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2/27/2020	**0.233**	**155**	**10.6**	**0.314**	**315**	**6.91**	**758**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TPZ-9	12/15/2016	**2.15**	**387**	**15.0**	**0.4**	**2590**	**6.88**	**4347**	<0.0005	<0.005	**0.021**	<0.004	<0.005	<0.005	<0.005	<0.005	**0.16**	<0.005	**0.006**	<0.0005	<0.0008	**0.4**	**1.22**

Notes:

ND: "Non Detect," the report does not provide reporting limit and instead states "ND."

Bold Value: indicates a detection by the laboratory

mg/L : milligrams per liter

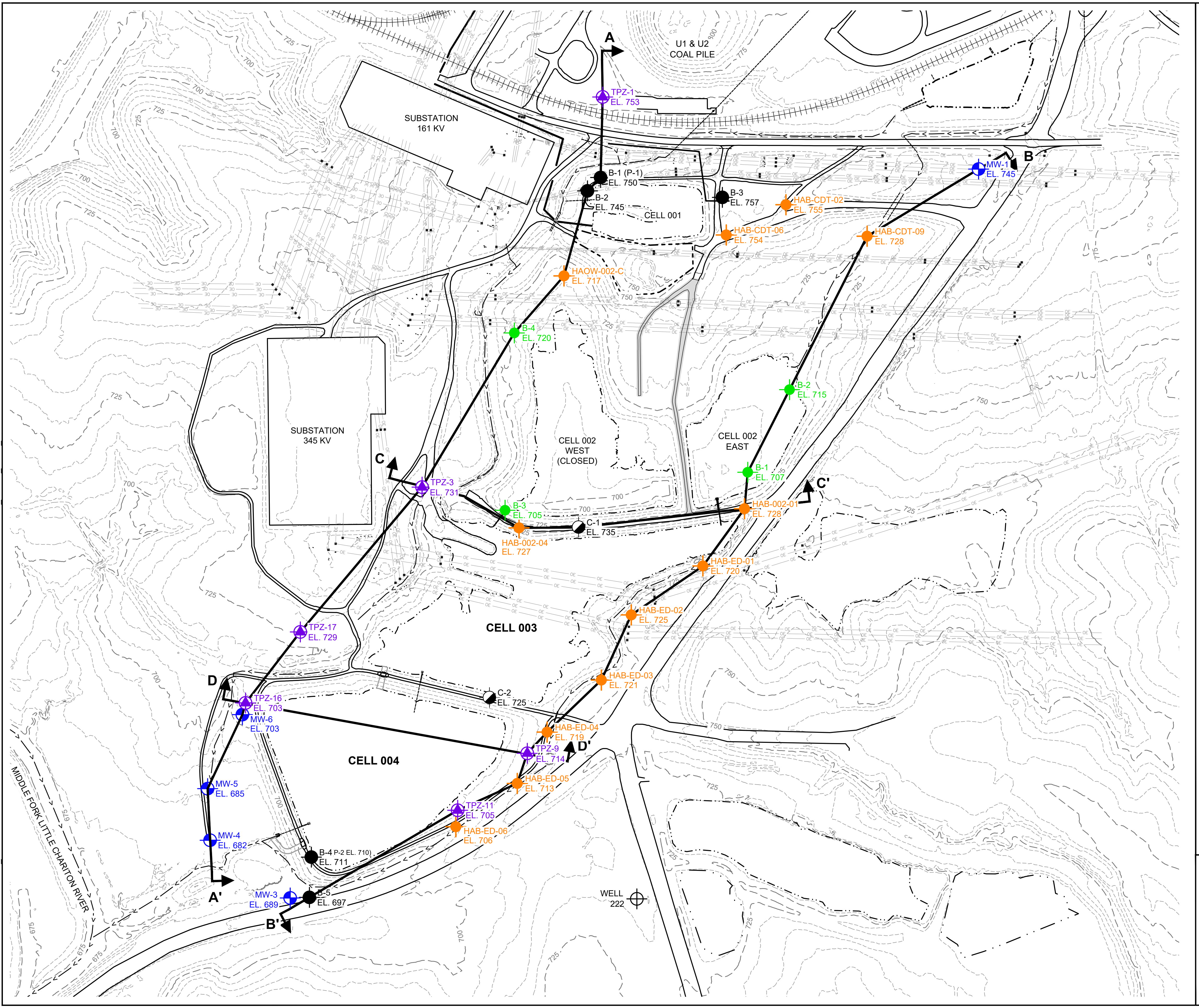
pCi/L : picocuries per liter

su : standard unit

USEPA : United States Environmental Protection Agency

APPENDIX F

Stratigraphic Cross-Sections



LEGEND

C-1 EL. 735	APPROXIMATE LOCATION OF TEST BORING PERFORMED BY GEOTECHNOLOGY, INC. JANUARY 2010.
B-1 (P-1) EL. 750	TEST BORINGS PERFORMED BY GEOTECHNOLOGY, INC. NOVEMBER 2011. "P" INDICATES TEMPORARY PIEZOMETER WAS INSTALLED
B-2 EL. 715	APPROXIMATE EXPLORATORY BORING LOCATION PERFORMED BY GREDELL ENGINEERING RESOURCES, INC. SEPTEMBER 2014
TPZ-1 EL. 753	PIEZOMETERS INSTALLED BY BULLDOG DRILLING AUGUST 2015 TO MARCH 2018
MW-1 EL. 745	CCR MONITORING WELL LOCATION INSTALLED BY BULLDOG DRILLING AUGUST 2015 TO MARCH 2017
HAB-ED-01 EL. 720	TEST BORING PERFORMED BY BULLDOG DRILLING OCTOBER 2019
EL. 745	APPROXIMATE GROUND SURFACE ELEVATION AT TIME OF DRILLING
A A'	CROSS SECTION LOCATION

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, COMBINED WITH DRONE SURVEY PERFORMED BY HLR IN MAY 2019 FOR THE CELLS AND COAL PILES AREA.
   - HORIZONTAL CONTROL IS MISSOURI STATE PLANE CENTRAL ZONE COORDINATE SYSTEM (NAD 83).
   - ELEVATIONS IN THIS DRAWING ARE SHOWN IN FEET. THE VERTICAL DATUM FOR GROUND SURFACE ELEVATION CONTOUR LINES IS NAVD 88.

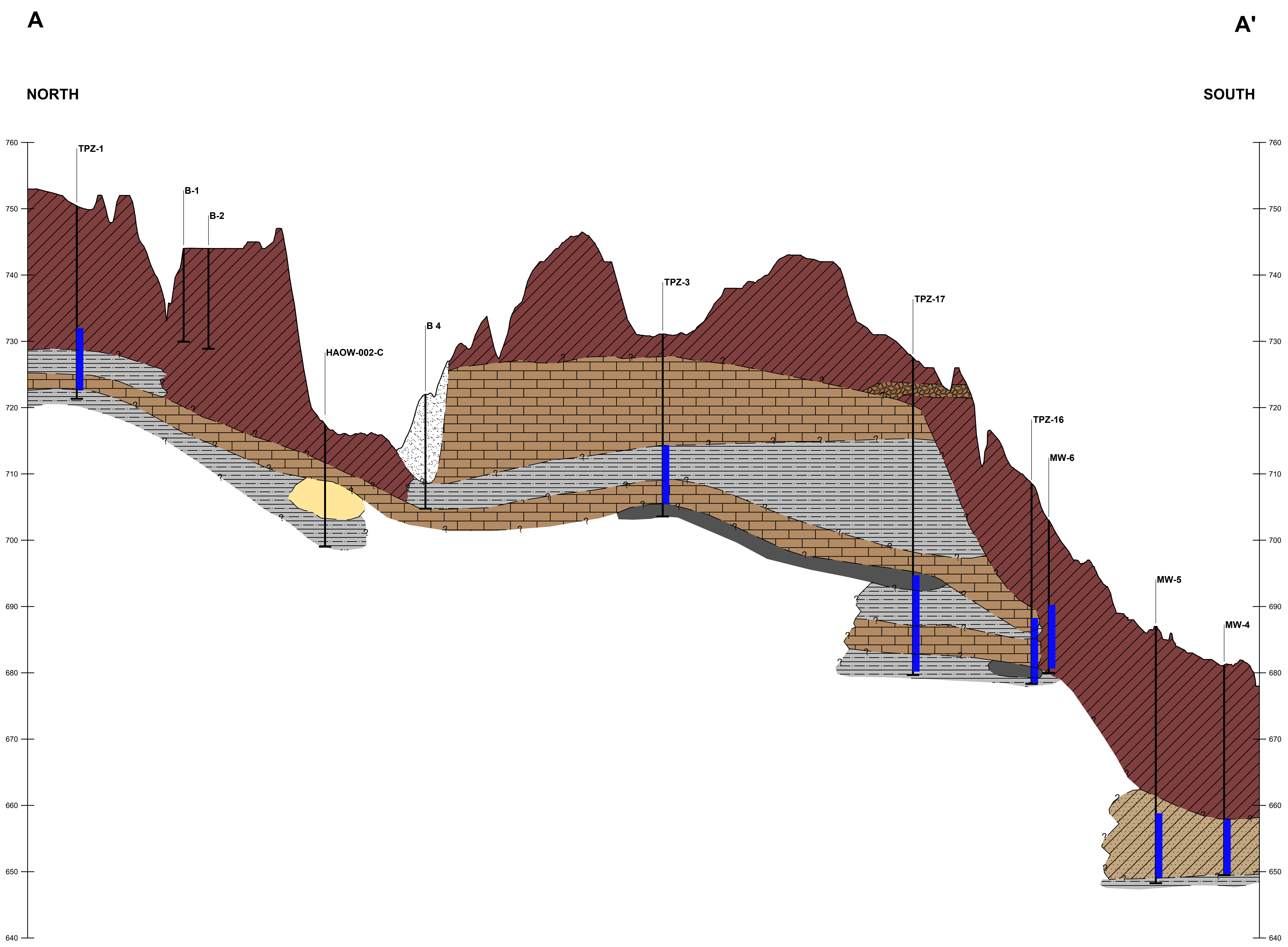
HALEY ALDRICH

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

GEOLOGIC CROSS SECTION LOCATION MAP

SCALE: AS SHOWN
SEPTEMBER 2020

FIGURE F-1



LEGEND

- ▨ LEAN CLAY, CLAY WITH SAND
- ▨ GRAVEL
- ▨ SANDY CLAY
- ▨ BOTTOM ASH
- ▨ LIMESTONE
- ▨ SHALE
- ▨ SANDSTONE
- ▨ COAL

BORING / MONITORING WELL / PIEZOMETER

SCREEN INTERVAL

NOTES:

1. VERTICAL SCALE EXAGGERATED 20 TIMES.
2. STRATIGRAPHIC CONDITIONS INTERPOLATED BETWEEN DATA POINTS. ACTUAL CONDITIONS MAY VARY FROM WHAT IS SHOWN.

HORIZ. 0 200 400 600 800
VERT. 0 10 20 30 40
SCALE IN FEET

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GEOLOGIC CROSS-SECTION A-A'

SCALE: AS SHOWN
SEPTEMBER 2020

FIGURE F-2

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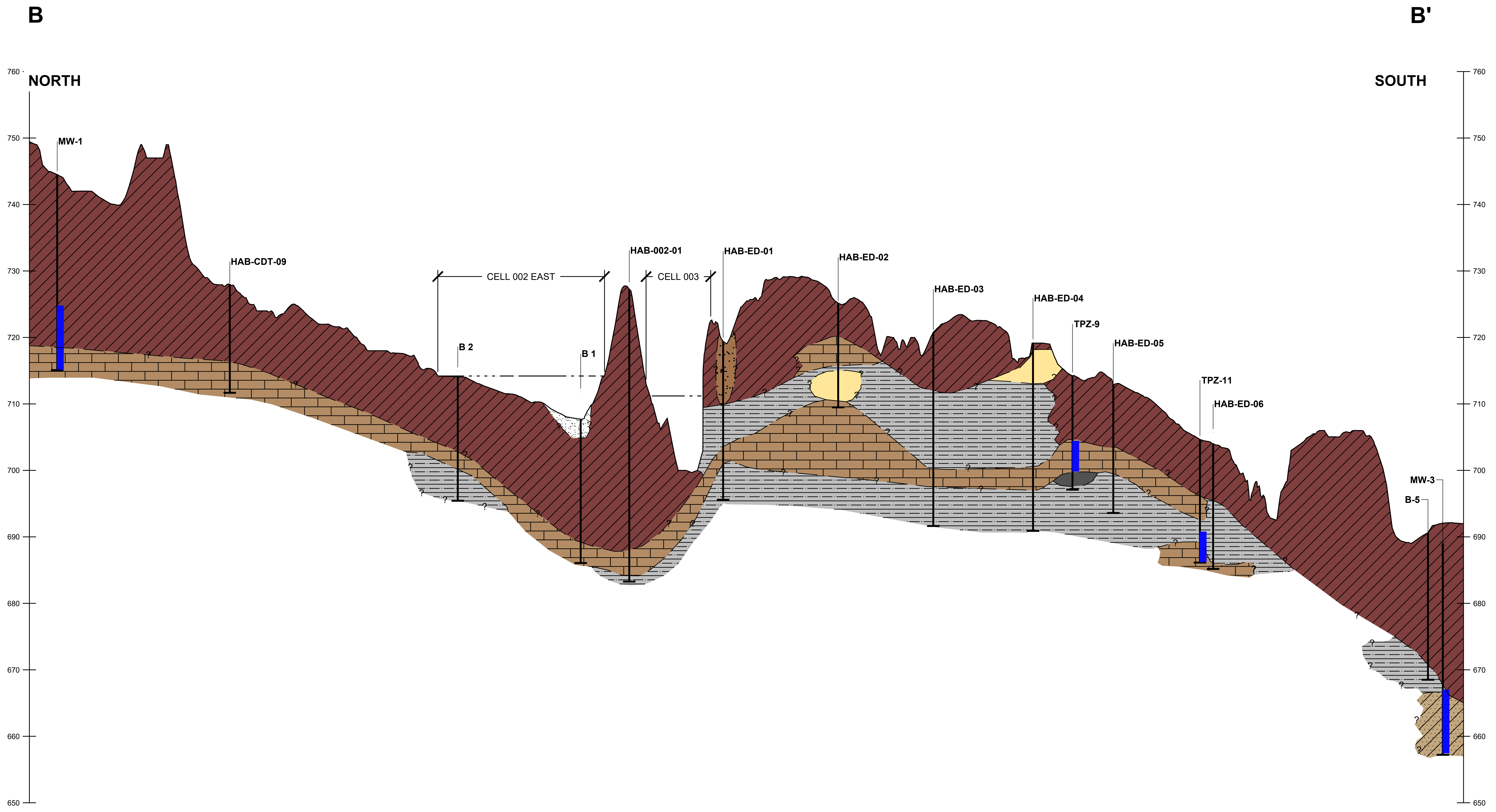
\\HALEYALDRICH.COM\SHARE\CLE_COMMON\PROJECTS\128064-AECI THEC CCR SUPPORT\CAD\FIGURES\SCR\128064-013_FIGF-2-5_XS.DWG



LEGEND

▨ LEAN CLAY, CLAY WITH SAND

▨ SANDY CLAY

▨ SAND

▨ FLY ASH/BOTTOM ASH

▨ LIMESTONE

▨ SHALE

▨ SANDSTONE

▨ COAL

| BORING / MONITORING WELL / PIEZOMETER

▮ SCREEN INTERVAL

NOTES:

1. VERTICAL SCALE EXAGGERATED 20 TIMES.
2. STRATIGRAPHIC CONDITIONS INTERPOLATED BETWEEN DATA POINTS. ACTUAL CONDITIONS MAY VARY FROM WHAT IS SHOWN.

HORIZ. 0 200 400 600 800
VERT. 0 10 20 30 40
SCALE IN FEET

HALEY ALDRICH

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

GEOLOGIC CROSS-SECTION B-B'

SCALE: AS SHOWN
SEPTEMBER 2020

FIGURE F-3

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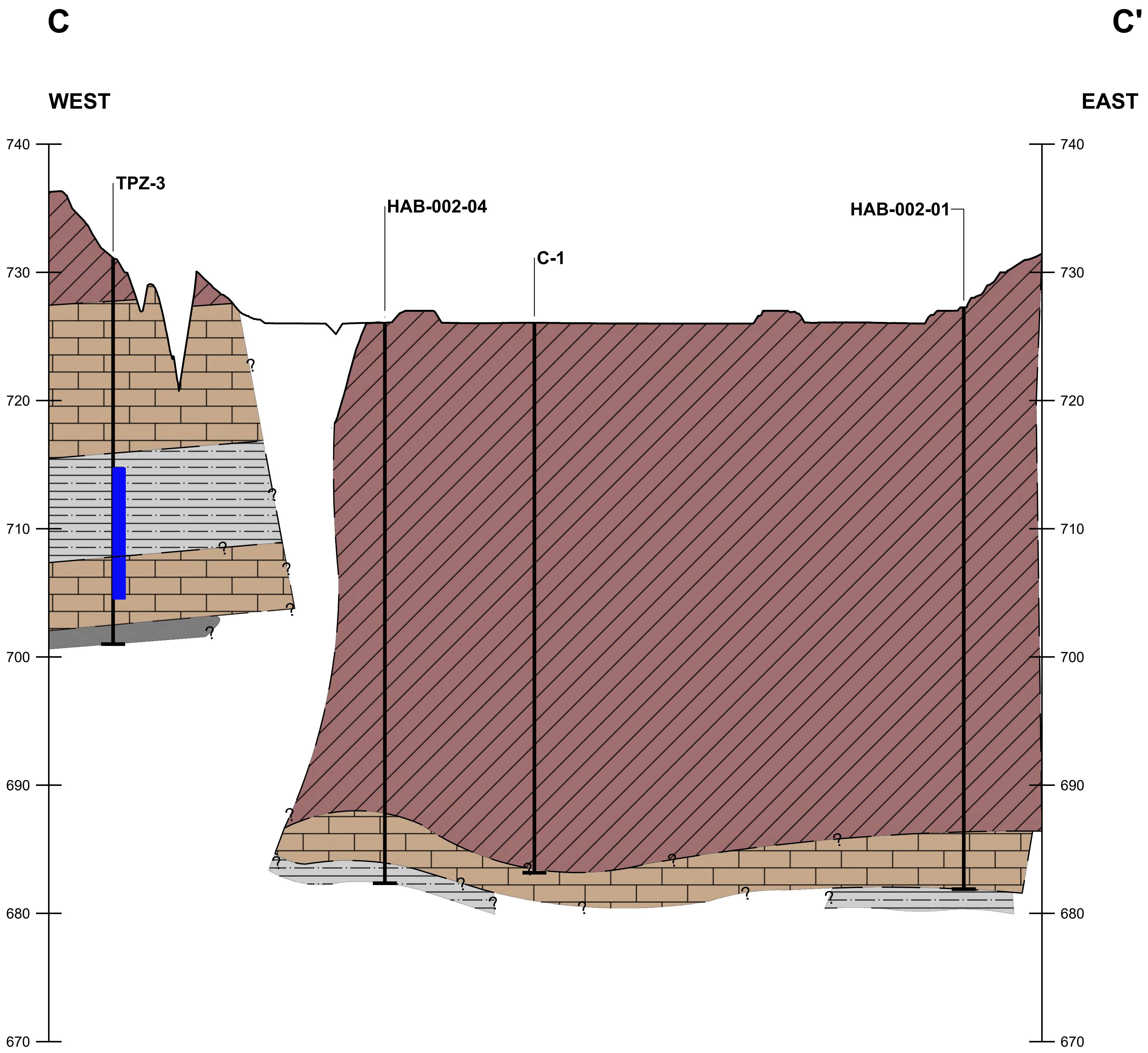
\\HALEYALDRICH.COM\SHARE\CLE_COMMON\PROJECTS\128064-AECI THEC CCR SUPPORT\CAD\FIGURES\SCR\128064-013_FIGF-2-5_XS.DWG



LEGEND

▨ LEAN CLAY, SANDY CLAY, CLAY WITH SAND

▦ LIMESTONE

▤ SHALE

■ COAL

PIEZOMETER

SCREEN INTERVAL

NOTES:

1. VERTICAL SCALE EXAGGERATED 20 TIMES.
2. STRATIGRAPHIC CONDITIONS INTERPOLATED BETWEEN DATA POINTS. ACTUAL CONDITIONS MAY VARY FROM WHAT IS SHOWN.
3. AN INTERPRETATION OF THE GEOLOGY WAS NOT MADE BETWEEN TPZ-3 AND HAB-002-04 DUE TO INSUFFICIENT DATA.

HORIZ. 0 200 400
VERT. 0 10 20
SCALE IN FEET

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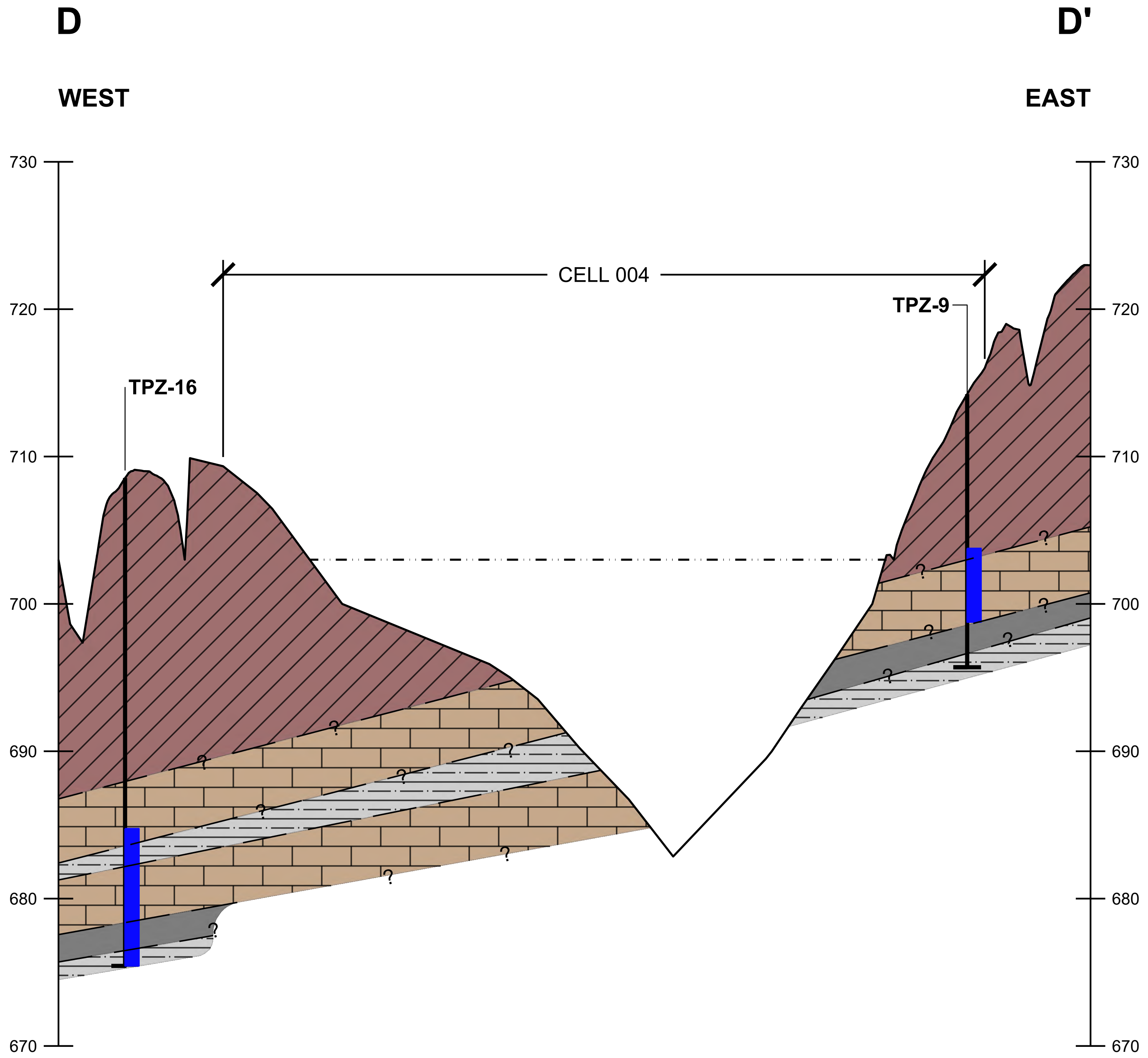
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

CROSS-SECTION C-C'

SCALE: AS SHOWN
SEPTEMBER 2020

FIGURE F-4



LEGEND

▨ LEAN CLAY, SANDY CLAY, CLAY WITH SAND

▨ LIMESTONE

▨ SHALE

■ COAL

PIEZOMETER

SCREEN INTERVAL

NOTES:

1. VERTICAL SCALE EXAGGERATED 20 TIMES.
2. STRATIGRAPHIC CONDITIONS INTERPOLATED BETWEEN DATA POINTS. ACTUAL CONDITIONS MAY VARY FROM WHAT IS SHOWN.

HORIZ. 0 200 400

VERT. 0 10 20

SCALE IN FEET

HALEY ALDRICH

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

GEOLOGIC CROSS-SECTION D-D'

SCALE: AS SHOWN
SEPTEMBER 2020

FIGURE F-5

Saved by: LSAUNDERS Printed:9/2/2020 1:49 PM Layout: F5-XSEC-DD
\\HALEYALDRICH.COM\SHARE\CLE_COMMON\PROJECTS\128064-AECI THEC CCR SUPPORT\CAD\FIGURES\SCR\128064-013_FIGF-2-5_XS.DWG

APPENDIX G

Structural Stability Assessments

REPORT ON

INITIAL PERIODIC STRUCTURAL STABILITY ASSESSMENT
POND 001 – CELL 001
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Clifton Hill, Missouri

File No. 128064-003
October 2016

HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.739.0555

17 October 2016
File No. 128064-003

Associated Electric Cooperative, Inc.
Thomas Hill Energy Center
5693 Highway F
Clifton Hill, Missouri 65244

Attention: Ms. Kim Dickerson
Senior Environmental Analyst

Subject: Initial Periodic Structural Stability Assessment
Pond 001 - Cell 001
Thomas Hill Energy Center
Clifton Hill, Missouri

Ms. Dickerson:

Enclosed please find our report on the Initial Periodic Structural Stability Assessment for the Associated Electric Cooperative, Inc. (AECI) Pond 001 - Cell 001 (Cell 001) coal combustion residuals (CCR) Surface Impoundment located at the Thomas Hill Energy Center (THEC) in Clifton Hill, Missouri.

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

The scope of our work consisted of the following: 1) obtain and review readily available reports, investigations, plans and data pertaining to the Cell 001 surface impoundment; 2) visit the site to observe Cell 001; 3) evaluate whether the design, construction, operation, and maintenance of Cell 001 are consistent with recognized and generally accepted good engineering practices; and 4) prepare and submit this report presenting the results of our assessment including recommendations.

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.

Steven F. Putrich, P.E.
Project Principal

Enclosures

Cc: Mark Brownstein-Haley & Aldrich

REPORT ON
INITIAL PERIODIC STRUCTURAL STABILITY ASSESSMENT
POND 001 – CELL 001
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Clifton Hill, Missouri

File No. 128064-003
October 2016

List of Figures

1. General

1.1 AUTHORITY

Haley & Aldrich, Inc. (Haley & Aldrich) has been contracted by Associated Electric Cooperative, Inc. (AECI) to perform the Initial Periodic Structural Stability Assessment (Assessment) for the AECI Pond 001 – Cell 001 (Cell 001) coal combustion residuals (CCR) surface impoundment located at Thomas Hill Energy Center (THEC) in Clifton Hill, Missouri. This work was completed in accordance with the US Environmental Protection Agency's (EPA's) Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities, 40 CFR Part 257, specifically §257.73(d).

1.2 PURPOSE OF STRUCTURAL STABILITY ASSESSMENT

The purpose of this Initial Structural Stability Assessment was to document whether the design, construction, operation, and maintenance of Cell 001 are consistent with recognized and generally accepted good engineering practices.

The scope of our work consisted of the following: 1) obtain and review readily available reports, investigations, plans and data pertaining to the Cell 001 surface impoundment; 2) visit the site to observe Cell 001; 3) evaluate whether the design, construction, operation, and maintenance of Cell 001 are consistent with recognized and generally accepted good engineering practices; and 4) prepare and submit this report presenting the results of our evaluation, including recommendations.

2. Description and Operation of Cell 001

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 Burns & McDonnell in 1978-1979 and constructed shortly thereafter. The embankments were constructed from clayey fill obtained from an on-site borrow source. Underlying the embankment fill is naturally deposited stiff clay, which in turn is underlain by stiff shaley clay.

Historically, CCR that settled in Cell 001 were excavated from the impoundment and placed in the high and dry northern portion of Cell 002. The ash was then loaded onto trucks by a contractor who sold it for beneficial re-use. Excess CCR has been placed as mine reclamation.

In 2015, AECI constructed a CCR Processing and Containment Pad to allow continued removal and dewatering of CCR from Cell 001 in compliance with Federal CCR Regulation 40 CFR Part 257 Subpart D. 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.

The Cell 001 impoundment has an area of approximately 2.3 acres. The 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 OPERATION, MAINTENANCE AND INSPECTION

Cell 001 and the other cells within Pond 001 system are operated and managed by AECI personnel in accordance with AECI's "Operating and Management Plan" dated December 14, 2012 (Reference 1).

AECI personnel are conducting 7-day and annual inspections of the Cell 001 impoundment in accordance with EPA's Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities, 40 CFR Part 257.83. In addition, the impoundment is inspected following heavy rain events. No instrumentation exists in the dike for the 30-day inspection.

Maintenance of the impoundment includes regular mowing of grass, seeding of thinly vegetated areas, control of woody growth, repair of erosion as needed, and inspection of the drain mechanisms.

Operation includes regular removal and processing of accumulated bottom ash and boiler slag from the impoundment, regulating and monitoring wastewater discharge from the plant to Cell 001, regulating water levels in the cell, and monitoring flow in the drainage channel from Cell 001 to Cell 003.

3. Structural Stability Assessment

3.1 REVIEW OF EXISTING INFORMATION

For this assessment, Haley & Aldrich reviewed multiple sources of information including:

- Report on the Initial Annual Inspection performed by AECI in accordance with 40 CFR §257.83, dated January 19, 2016
- Previous impoundment inspection reports by GEI (on behalf of EPA) and Geotechnology, Inc.
- Operating and Management Plan
- Topographic plans and aerial photos
- Construction drawings
- Subsurface information
- Geotechnical laboratory test results
- Slope stability evaluations
- Correspondence
- Variety of other information in addition to verbal information provided by AECI during our assessment.

Our review included, but was not limited to the references listed in Appendix A.

3.2 SITE VISIT AND FIELD OBSERVATIONS

On 29 August 2016, Haley & Aldrich visited Thomas Hill Energy Center to observe conditions at Cell 001, and to meet with AECI personnel to discuss operations and maintenance of the impoundment. Prior to the site visit, we reviewed previous inspection reports including the above-referenced Initial Annual Inspection Report by AECI, and previous inspection reports referenced above and listed in Appendix A. At the time of our site visit, Cell 001 was in operation with water levels at the normal operating level.

3.3 STRUCTURAL STABILITY ASSESSMENT

In accordance with 40 CFR §257.73(d), the owner or operator of a CCR surface impoundment must conduct initial and periodic structural stability assessments to determine whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices.

Haley & Aldrich reviewed the information provided to us and visited the site to observe Cell 001. Based on our review of available information and observations during our 29 August 2016 site visit, we have concluded the following in accordance with 40 CFR §257.73(d):

1. *§257.73(d)(1)(i): Stable foundations and abutments.*

   Based on our review of available subsurface information, design/construction records, investigation reports, impoundment inspection reports, geotechnical laboratory test results, slope stability analyses, and observations during our 29 August 2016 site visit, Cell 001 was judged to have stable foundations. The Cell 001 embankments have not exhibited signs of excessive settlement, instability or other signs of inadequate foundation support.

2. *§257.73(d)(1)(ii): Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown.*

   The Cell 001 interior slopes are covered with vegetation for the full height of the slopes. Based on observations during our 29 August 2016 site visit, the slope protection on the interior slopes was in good condition and was judged to provide adequate slope protection against surface erosion, wave action and adverse effects from sudden drawdown.

   The exterior slopes are well vegetated with grass and were judged to have adequate slope protection.

3. *§257.73(d)(1)(iii): Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit.*

   Records of the original construction of Cell 001 are not available. However, in 2001, Geotechnology, Inc. drilled three test borings through the Cell 001 embankments and into the underlying natural soils. The test borings indicate that the embankments consist of medium stiff clay fill with varying amounts of sand, gravel and slag.

   During our 29 August 2016 site visit, we observed no evidence of slope instability or other signs of inadequate compaction of the embankment fill. In addition, based on the information reviewed for this Structural Stability Assessment, there has been no historic evidence of slope instability or other signs of inadequate embankment compaction.

   Based on our review of the test boring logs and other available information on the Cell 001 embankments, as well as our observations during the 29 August 2016 site visit, we have concluded the fill soils used to construct the Cell 001 embankments were likely mechanically compacted during construction.

4. *§257.73(d)(1)(iv): Vegetated slopes of dikes and surrounding areas not to exceed a height of six inches above the slope of the dike, except for slopes which have an alternate form or forms of slope protection.*

   At the time of our 29 August 2016 site visit, the grass on the Cell 001 exterior slopes was typically 6 to 12 inches in height. During our site visit, AECI was mowing the interior slopes of Cell 001 using a recently purchased specialized mower that attaches to the boom of a Cat 330 long-reach excavator. The excavator has a 60-ft reach, enabling the equipment to mow areas that were previously inaccessible. After mowing, vegetation on the interior slopes was approximately 6 inches in length.

5. *<u>§257.73(d)(1)(v)(A):</u> Spillway Erosion Protection – All spillways must be either: (1) Of non-erodible construction and designed to carry sustained flows; or (2) Earth- of grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected.*

   The spillway in Cell 001 consists of the concrete decant structure located in the northwest corner of the impoundment. The concrete construction is non-erodible and designed to carry sustained flows.

6. *<u>§257.73(d)(1)(v)(B):</u> Spillway Capacity – The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a: (1) Probable maximum flood (PMF) for a high hazard potential CCR surface impoundment; or (2) 1000-year flood for a significant hazard potential CCR surface impoundment; or (3) 100-year flood for a low hazard potential CCR surface impoundment.*

   The spillway capacity for the impoundment is required to be modeled and analyzed in accordance with §257.82 Hydrologic and Hydraulic Capacity Requirements for CCR Surface Impoundments. AECI will complete that capacity analysis requirement under separate cover, consistent with the CCR Rule Preamble reference to the same section.

7. *<u>§257.73(d)(1)(vi):</u> Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure.*

   Cell 001 hydraulic structures include the decant structure and outlet pipe. The rectangular concrete decant structure is located in the northwest corner of the impoundment. Flow entering the decant structure is conveyed through the Cell 001 west embankment via a 30-in. diameter reinforced concrete pipe which discharges to a drainage ditch that flows to Cell 003.

   The decant structure has some surface pitting on the concrete and surface rust on some of the metal components but was judged to be in good condition overall.

   The 30-inch discharge pipe is buried and is only visible for a few feet at each end of the pipe. There are no signs of ground settlement above or around the pipe. No sediment or debris were observed at either end of the outlet pipe.

8. *<u>§257.73(d)(1)(vii):</u> For CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.*

   There are no natural water bodies in the vicinity of Cell 001. Cell 002 exists immediately to the south of Cell 001 with normal operating levels below the elevation of the Cell 001 slope. The drainage channel west and southwest of Cell 001 that conveys flow from Cell 001 to Cell 003 also conveys other plant process water and coal pile runoff. Flow to this channel is controlled by the power plant, and their elevations and flow capacities prevent them from inundating the downstream slopes of Cell 001. As a result, inundation of the Cell 001 downstream slopes is not likely and no rapid drawdown potential exists.

9. *<u>§257.73(d)(2):</u> Identify any structural stability deficiencies associated with the CCR unit in addition to recommending corrective measures.*

   Our Structural Stability Assessment identified no structural stability deficiencies at Cell 001. However, we recommend the following maintenance actions:

   a. Maintain height of vegetation in accordance with §257.73(d)(1)(iv).

   b. Update Operating and Management Plan to reflect recent modifications to Cell 001 including the new processing and containment pad.

4. Conclusions/Certification

Based on our review of the information provided to us and observations during our 29 August 2016 site visit, it is our opinion that the design, construction, operation, and maintenance of Pond 001 – Cell 001 at Thomas Hill Energy Center is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded in Cell 001.

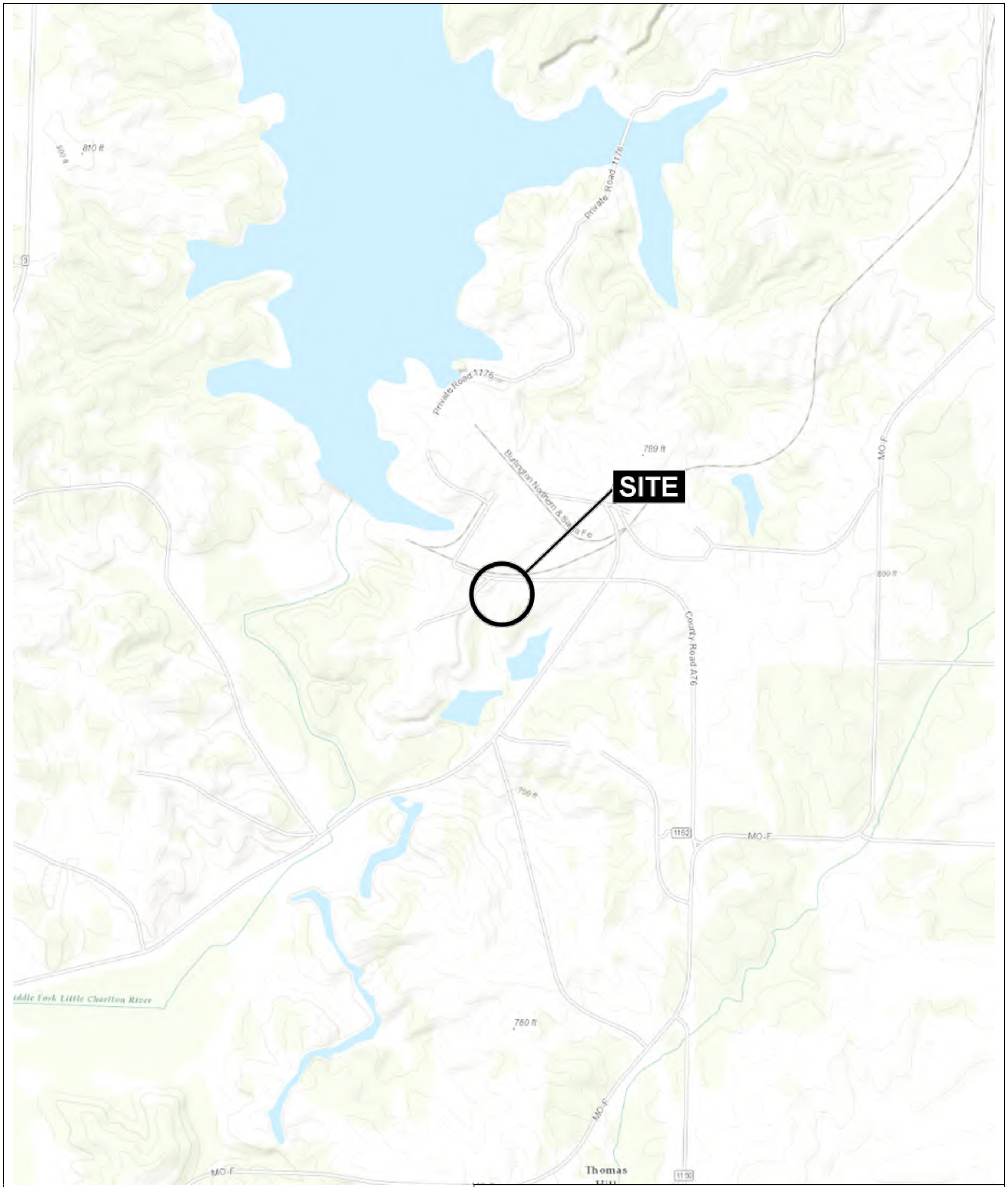
I certify that the Periodic Structural Stability Assessment for AECI's Pond 001 – Cell 001 at the Thomas Hill Energy Center was conducted in accordance with the requirements of §257.73(d) of the USEPA's CCR Rule.

Signed:________________________________
Certifying Engineer

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

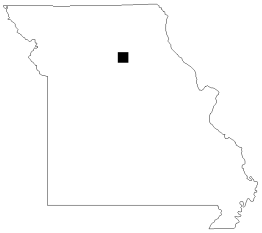
Professional Engineer's Seal:

STEVEN F.
PUTRICH
NUMBER
PE-2014035813
10-17-16



MAP SOURCE: ESRI

SITE COORDINATES: 39°32'51"N, 92°38'10"W



HALEY ALDRICH

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

POND 001 - CELL 001
PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
OCTOBER 2016

FIGURE 1

LEGEND

– – – APPROXIMATE IMPOUNDMENT BOUNDARY

— · · · — WATER

——— PIPE

——— DITCH

——— ROAD

NOTES

1. AERIAL IMAGERY PROVIDED BY GOOGLE EARTH PRO. PHOTO TAKEN ON 11 MAY 2015.

N

0 50 100
SCALE IN FEET

HALEY ALDRICH

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

POND 001 - CELL 001
SITE PLAN

SCALE: AS SHOWN
OCTOBER 2016

FIGURE 2

LUCAS, ANDY Printed: 10/3/2016 7:45 AM Layout: HA-FIG-B-L-H
G:\40616_AECI-CCR ELG MANAGEMENT SUPPORT\CAD-TH\FIGURES\STRUCTURAL STABILITY ASSESSMENT\40616_FIG-2_THEC_POND 001_CELL 001 SITE PLAN.DWG

APPENDIX A

References

References

1. AECI, “Pond #001, the Ash Pond Series Operating and Management Plan,” revised December 14, 2012.

2. AECI, “Report: Initial Annual CCR Surface Impoundment PE Inspection, Ash Pond 001 – Cell 001, Cell 002, Cell 003, Cell 004,” dated January 19, 2016.

3. Burns & McDonnell, Various Construction Drawings, dated 1979 and 1984.

4. GEI Consultants, “Specific Site Assessment for Coal Combustion Waste Impoundments at Thomas Hill Energy Center,” dated June 2011.

5. Gredell Engineering Resources, Inc., “Project #3 – CCR Processing Pad & Containerization, Pond 001 Cell 1 – 2015, Project Description and Specifications,” dated September 9, 2015.

6. Gredell Engineering Resources, Inc., “Pond 001 Cell 1 CCR Processing Pad” Design and Construction Summary Report, dated December 2015.

7. Geotechnology, Inc., “Slope Stability and Seepage Analysis, Slag Dewatering Basin, Thomas Hill Energy Center,” dated February 3, 2012.

www.haleyaldrich.com

REPORT ON

INITIAL PERIODIC STRUCTURAL STABILITY ASSESSMENT
POND 001 – CELL 003
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Clifton Hill, Missouri

File No. 128064-003
October 2016

HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.739.0555

17 October 2016
File No. 128064-003

Associated Electric Cooperative, Inc.
Thomas Hill Energy Center
5693 Highway F
Clifton Hill, Missouri 65244

Attention: Ms. Kim Dickerson
Senior Environmental Analyst

Subject: Initial Periodic Structural Stability Assessment
Pond 001 - Cell 003
Thomas Hill Energy Center
Clifton Hill, Missouri

Ms. Dickerson:

Enclosed please find our report on the Initial Periodic Structural Stability Assessment for the Associated Electric Cooperative, Inc. (AECI) Pond 001 - Cell 003 (Cell 003) coal combustion residuals (CCR) surface impoundment located at the Thomas Hill Energy Center (THEC) in Clifton Hill, Missouri.

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

The scope of our work consisted of the following: 1) obtain and review readily available reports, investigations, plans and data pertaining to the Pond 001 – Cell 003 surface impoundment; 2) visit the site to observe Cell 003; 3) evaluate whether the design, construction, operation, and maintenance of Cell 003 are consistent with recognized and generally accepted good engineering practices; and 4) prepare and submit this report presenting the results of our assessment including recommendations.

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.

Steven F. Putrich, P.E.
Project Principal

Enclosures

Cc: Mark Brownstein-Haley & Aldrich

REPORT ON
INITIAL PERIODIC STRUCTURAL STABILITY ASSESSMENT
POND 001 – CELL 003
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Clifton Hill, Missouri

File No. 128064-003
October 2016

List of Figures

1. General

1.1 AUTHORITY

Haley & Aldrich, Inc. (Haley & Aldrich) has been contracted by Associated Electric Cooperative, Inc. (AECI) to perform the Initial Periodic Structural Stability Assessment (Assessment) for the AECI Pond 001 – Cell 003 (Cell 003) coal combustion residuals (CCR) surface impoundment located at Thomas Hill Energy Center (THEC) in Clifton Hill, Missouri. This work was completed in accordance with the US Environmental Protection Agency's (EPA's) Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities, 40 CFR Part 257, specifically §257.73(d).

1.2 PURPOSE OF STRUCTURAL STABILITY ASSESSMENT

The purpose of this Initial Structural Stability Assessment was to document whether the design, construction, operation, and maintenance of Cell 003 are consistent with recognized and generally accepted good engineering practices.

The scope of our work consisted of the following: 1) obtain and review readily available reports, investigations, plans and data pertaining to the Cell 003 surface impoundment; 2) visit the site to observe Cell 003; 3) evaluate whether the design, construction, operation, and maintenance of Cell 003 are consistent with recognized and generally accepted good engineering practices; and 4) prepare and submit this report presenting the results of our evaluation, including recommendations.

2. Description and Operation of Cell 003

2.1 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 Burns & McDonnell in 1978-1979 and constructed shortly thereafter. It is understood that Cell 003 was modified in 1984.

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. The embankment is constructed from clay fill obtained from an on-site borrow source. The embankment is underlain by naturally deposited medium stiff to very stiff clay and silty clay. The north interior slope of Cell 003 varies from about 3H:1V to 2H:1V, while the north exterior slope is typically 3H:1V.

On the south side, an embankment with 16-ft crest width separates Cell 003 and Cell 004. The embankment is constructed from clay fill obtained from an on-site borrow source. The embankment is underlain by naturally deposited stiff clay with trace sand, which is in turn underlain by weathered limestone. 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 has a surface area of approximately 13 acres and total storage capacity of approximately 160 acre-feet as stated in the Initial Annual Inspection.

Cell 003 receives decant water and suspended 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 Cell 002/003 embankment 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 Cell 003/004 embankment 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.

Accumulated CCR is periodically dredged from Cell 003, generally in odd years, one half of the cell at a time at an approximate 4-year cycle for the full unit.

2.2 OPERATION, MAINTENANCE AND INSPECTION

Cell 003 and the other cells within the Pond 001 system are operated and managed by AECI personnel in accordance with AECI's "Operating and Management Plan" dated December 14, 2012 (Reference 1).

AECI personnel are conducting 7-day and annual inspections of the Cell 003 impoundment in accordance with EPA's Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities, 40 CFR Part 257.83. In addition, the impoundment is inspected following heavy rain events. No instrumentation exists in the dike for the 30-day inspection.

Maintenance of the impoundment includes regular mowing of grass, seeding of thinly vegetated areas, control of woody growth, repair of erosion as needed, and inspection of the drain mechanisms.

Operation includes regulating water levels in the impoundment, regulating and monitoring process water discharge from Cell 001 and Cell 002, and periodic dredging of accumulated CCR from the impoundment.

3. Structural Stability Assessment

3.1 REVIEW OF EXISTING INFORMATION

For this assessment, Haley & Aldrich reviewed multiple sources of information including:

- Report on the Initial Annual Inspection performed by AECI in accordance with 40 CFR §257.83, dated January 19, 2016
- Previous impoundment inspection reports by GEI (on behalf of EPA) and Geotechnology, Inc.
- Operating and Management Plan
- Topographic plans and aerial photos
- Construction drawings
- Subsurface information
- Geotechnical laboratory test results
- Slope stability evaluations
- Correspondence
- Variety of other information in addition to verbal information provided by AECI during our assessment.

Our review included, but was not limited to the references listed in Appendix A.

3.2 SITE VISIT AND FIELD OBSERVATIONS

On 29 August 2016, Haley & Aldrich visited Thomas Hill Energy Center to observe conditions at Cell 003, and to meet with AECI personnel to discuss operations and maintenance of the impoundment. Prior to the site visit, we reviewed previous inspection reports including the above-referenced Initial Annual Inspection Report by AECI, and previous inspection reports referenced above and listed in Appendix A. At the time of our site visit, Cell 003 was in operation with water levels at the normal operating level.

3.3 STRUCTURAL STABILITY ASSESSMENT

In accordance with 40 CFR §257.73(d), the owner or operator of a CCR surface impoundment must conduct initial and periodic structural stability assessments to determine whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices.

Haley & Aldrich reviewed the information provided to us and visited the site to observe Cell 003. Based on our review of available information and observations during our 29 August 2016 site visit, we have concluded the following in accordance with 40 CFR §257.73(d):

1. *§257.73(d)(1)(i):* *Stable foundations and abutments.*

   Based on our review of available subsurface information, impoundment inspection reports, geotechnical laboratory test results, slope stability analyses, and observations during our 29 August

2016 site visit, Cell 003 was judged to have stable foundations. The Cell 003 embankments have not exhibited signs of excessive settlement, instability or other signs of inadequate foundation support.

2. *§257.73(d)(1)(ii): Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown.*

   The Cell 003 interior slopes are covered with vegetation for the full height of the slopes. Based on observations during our 29 August 2016 site visit, the slope protection on the interior slopes was judged to provide adequate slope protection against surface erosion, wave action and adverse effects from sudden drawdown. The exterior slopes of Cell 003 are vegetated for the full height of the slopes and were judged to have adequate slope protection.

3. *§257.73(d)(1)(iii): Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit.*

   Cell 003 is incised on the east and west sides. Constructed dikes around Cell 003 include the north and south embankments. The north embankment separates Cell 003 and Cell 002, while the south embankment separates Cell 003 and Cell 004.

   Construction records are not available for the north and south embankments. However, in 2010, Geotechnology, Inc. performed one test boring and one cone penetrometer sounding through the north embankment, and one test boring and one cone penetrometer sounding through the south embankment. The borings and cone penetrometers were drilled through the embankment fill and into the underlying natural soils. The subsurface explorations indicate the embankment fill in the north embankment consists of stiff clay with trace silt and sand, while the fill in the south embankment consists of medium stiff to stiff clay with varying amounts of silt, sand and gravel.

   During our 29 August 2016 site visit, we observed no evidence of slope instability or other signs of inadequate compaction of the embankment fill. In addition, based on the information reviewed for this Assessment, there has been no historic evidence of slope instability or other signs of inadequate embankment compaction.

   Based on our review of subsurface exploration logs, and other available information on the Cell 003 embankments, as well as our observations during the 29 August 2016 site visit, we have concluded the fill used to construct the Cell 003 embankments was mechanically compacted.

4. *§257.73(d)(1)(iv): Vegetated slopes of dikes and surrounding areas not to exceed a height of six inches above the slope of the dike, except for slopes which have an alternate form or forms of slope protection.*

   The vegetation on the interior and exterior slopes of Cell 003 was generally 6 to 12 inches in height at the time of our 29 August 2016 site visit. AECI has recently purchased a specialized mower that attaches to the boom of a Cat 330 long-reach excavator. The excavator has a 60-ft reach, enabling the equipment to mow areas that were previously inaccessible. During our site visit, AECI was in the process of mowing such areas. After mowing, vegetation was approximately 6 inches in height.

5. *<u>§257.73(d)(1)(v)(A):</u>   Spillway Erosion Protection – All spillways must be either: (1) Of non-erodible construction and designed to carry sustained flows; or (2) Earth- of grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected.*

   The primary spillway in Cell 003 consists of the concrete decant structure located in the southwest corner of the impoundment. The concrete construction is non-erodible and designed to carry sustained flows.

   The emergency spillway in Cell 003 consists of an 18-ft wide riprap-lined channel which is approximately 2 ft in depth located across the crest of the south dike. The emergency spillway channel was judged to have adequate erosion protection to withstand short-term, infrequent flows.

6. *<u>§257.73(d)(1)(v)(B):</u> Spillway Capacity – The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a: (1) Probable maximum flood (PMF) for a high hazard potential CCR surface impoundment; or (2) 1000-year flood for a significant hazard potential CCR surface impoundment; or (3) 100-year flood for a low hazard potential CCR surface impoundment.*

   The spillway capacity for the impoundment is required to be modeled and analyzed in accordance with §257.82 Hydrologic and Hydraulic Capacity Requirements for CCR surface impoundments. AECI will complete that capacity analysis requirement under separate cover, consistent with the CCR Rule Preamble reference to the same section.

7. *<u>§257.73(d)(1)(vi):</u> Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure.*

   Cell 003 hydraulic structures include the rectangular concrete decant structure and outlet pipe. Flow entering the decant structure is conveyed through the Cell 003 south embankment and discharges underwater into Cell 004. The decant structure was judged to be in good condition.

   The discharge pipe is buried within the south embankment and is not visible. There are no signs of ground settlement above or around the pipe. No sediment or debris was observed at either end of the outlet pipe.

8. *<u>§257.73(d)(1)(vii):</u> For CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.*

   There are no natural water bodies in the vicinity of Cell 003. Cell 002 exists immediately to the north (upstream) of Cell 003 and shares the northern edge of Cell 003, while Cell 004 exists immediately to the south (downstream) of Cell 003 and shares the south dike of Cell 003.

   The water level in Cell 004 is controlled by AECI using stop logs in the impoundment’s outlet structure, thus a rapid drawdown condition is not a realistic possibility without a failure of its own berm. In addition, in 2010, Geotechnology, Inc. performed slope stability analyses on both the north and south embankments of Cell 003 (Reference 5) and confirmed the stability of these embankments. Additional analyses for a Cell 004 sudden drawdown are recommended to confirm the stability of the Cell 003 berm under that unlikely scenario.

9. *<u>§257.73(d)(2):</u> Identify any structural stability deficiencies associated with the CCR unit in addition to recommending corrective measures.*

   Our Structural Stability Assessment identified no structural stability deficiencies at Cell 003. However, we recommend the following maintenance actions:

   a. Repair ruts on crest of the north embankment.

   b. Maintain height of vegetation in accordance with §257.73(d)(1)(iv).

   c. Confirmation of Cell 003 structural stability following a sudden drawdown of Cell 004.

4. Conclusions/Certification

Based on our review of the information provided to us and observations during our 29 August 2016 site visit, it is our opinion that the design, construction, operation, and maintenance of Pond 001 – Cell 003 at Thomas Hill Energy Center is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded in Cell 003.

I certify that the Periodic Structural Stability Assessment for AECI's Pond 001 – Cell 003 at the Thomas Hill Energy Center was conducted in accordance with the requirements of §257.73(d) of the USEPA's Final CCR Rule.

Signed:________________________________
Certifying Engineer

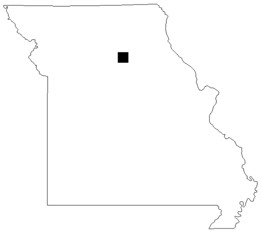
Print Name: Steven F. Putrich
Missouri License No.: 2014035813
Title: Project Principal
Company: Haley & Aldrich, Inc.

Professional Engineer's Seal:

STEVEN F.
PUTRICH
NUMBER
PE-2014035813
10-17-16

MAP SOURCE: ESRI

SITE COORDINATES: 39°32'34"N, 92°38'17"W



HALEY ALDRICH

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

POND 001 - CELL 003
PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
OCTOBER 2016

FIGURE 1

128064_1_LOCUS.PDF

LEGEND

- - - APPROXIMATE IMPOUNDMENT BOUNDARY
— PIPE
— DITCH
— ROAD
- · · · - WATER

NOTES

1. AERIAL IMAGERY PROVIDED BY GOOGLE EARTH PRO. PHOTO TAKEN ON 11 MAY 2015.

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SCALE IN FEET

HALEY ALDRICH

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

POND 001 - CELL 003
SITE PLAN

SCALE: AS SHOWN
OCTOBER 2016

FIGURE 2

LUCAS, ANDY Printed: 10/15/2016 12:21 PM Layout: HA-FIG-B-L-H
G:\40616_AECI-CCR ELG MANAGEMENT SUPPORT\CAD-THI\FIGURES\STRUCTURAL STABILITY ASSESSMENT\40616_FIG-2_THEC_POND 001_CELL 003 SITE PLAN.DWG

APPENDIX A

References

References

1. AECI, “Pond #001, the Ash Pond Series Operating and Management Plan,” revised December 14, 2012.

2. AECI, “Report: Initial Annual CCR Surface Impoundment PE Inspection, Ash Pond 001 – Cell 001, Cell 002, Cell 003, Cell 004,” dated January 19, 2016.

3. Burns & McDonnell, Various Construction Drawings, dated 1979 and 1984.

4. GEI Consultants, “Specific Site Assessment for Coal Combustion Waste Impoundments at Thomas Hill Energy Center,” dated June 2011.

5. Geotechnology, Inc., “Global Stability Evaluation, Mine Waste and Ash Pond Embankments, AECI Facilities, Bee Veer and Thomas Hill, Missouri,” dated April 22, 2010.

6. Gredell Engineering Resources, Inc., “CCR Separation Berm - Pond 001 Cell 2 – 2015, Project Description and Specifications,” dated October 1, 2015.

7. Gredell Engineering Resources, Inc., “Pond 001 Cell 2 Separation Berm” Design and Construction Summary Report, dated November 2015.

8. Gredell Engineering Resources, Inc., “Ash Pond 001 Cell 2 Separation Berm” Construction Drawings, dated October 2015.

www.haleyaldrich.com

REPORT ON

INITIAL PERIODIC STRUCTURAL STABILITY ASSESSMENT
POND 001 – CELL 004
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Clifton Hill, Missouri

File No. 128064-003
October 2016

HALEY ALDRICH

HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.739.0555

17 October 2016
File No. 128064-003

Associated Electric Cooperative, Inc.
Thomas Hill Energy Center
5693 Highway F
Clifton Hill, Missouri 65244

Attention: Ms. Kim Dickerson
Senior Environmental Analyst

Subject: Initial Periodic Structural Stability Assessment
Pond 001 - Cell 004
Thomas Hill Energy Center
Clifton Hill, Missouri

Ms. Dickerson:

Enclosed please find our report on the Initial Periodic Structural Stability Assessment (Assessment) for the Associated Electric Cooperative, Inc. (AECI) Pond 001 - Cell 004 coal combustion residuals (CCR) surface impoundment located at the Thomas Hill Energy Center (THEC) in Clifton Hill, Missouri.

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

The scope of our work consisted of the following: 1) obtain and review readily available reports, investigations, plans and data pertaining to the Pond 001 – Cell 004 surface impoundment; 2) visit the site to observe Cell 004; 3) evaluate whether the design, construction, operation, and maintenance of Cell 004 are consistent with recognized and generally accepted good engineering practices; and 4) prepare and submit this report presenting the results of our assessment including recommendations.

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.

Steven F. Putrich, P.E.
Project Principal

Enclosures

www.haleyaldrich.com

REPORT ON
INITIAL PERIODIC STRUCTURAL STABILITY ASSESSMENT
POND 001 – CELL 004
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Clifton Hill, Missouri

File No. 128064-003
October 2016

List of Figures

1. General

1.1 AUTHORITY

Haley & Aldrich, Inc. (Haley & Aldrich) has been contracted by Associated Electric Cooperative, Inc. (AECI) to perform the Initial Periodic Structural Stability Assessment (Assessment) for the AECI Pond 001 – Cell 004 (Cell 004) coal combustion residuals (CCR) surface impoundment located at Thomas Hill Energy Center (THEC) in Clifton Hill, Missouri. This work was completed in accordance with the US Environmental Protection Agency's (EPA's) Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities, 40 CFR Part 257, specifically §257.73(d).

1.2 PURPOSE OF STRUCTURAL STABILITY ASSESSMENT

The purpose of this Initial Structural Stability Assessment was to document whether the design, construction, operation, and maintenance of Cell 004 are consistent with recognized and generally accepted good engineering practices.

The scope of our work consisted of the following: 1) obtain and review readily available reports, investigations, plans and data pertaining to the Cell 004 surface impoundment; 2) visit the site to observe Cell 004; 3) evaluate whether the design, construction, operation, and maintenance of Cell 004 are consistent with recognized and generally accepted good engineering practices; and 4) prepare and submit this report presenting the results of our evaluation, including recommendations.

2. Description and Operation of Cell 004

2.1 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 Burns & 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 mostly by earthen berms on all sides except for some portion that is natural ground in the northwest corner and other dike abutment areas. Maximum embankment height is approximately 15 ft. 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.

The embankments are constructed from clay fill obtained from an on-site borrow source. The embankments are underlain by naturally deposited soft to stiff clay with trace sand and/or gravel, which is in turn underlain by weathered limestone, siltstone or shale.

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 flowing to 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.

2.2 OPERATION, MAINTENANCE AND INSPECTION

Cell 004 and the other cells within the Pond 001 system are operated and managed by AECI personnel in accordance with AECI's "Operating and Management Plan" dated December 14, 2012 (Reference 1).

AECI personnel are conducting 7-day and annual inspections of the Cell 004 impoundment in accordance with EPA's Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities, 40 CFR Part 257.83. In addition, the impoundment is inspected following heavy rain events. No instrumentation exists in the dike for the 30-day inspection.

Maintenance of Cell 004 includes regular mowing of grass, seeding of thinly vegetated areas, control of woody growth, repair of erosion as needed, repair of riprap as needed, maintenance of the outfall to the Middle Fork of the Little Chariton River, and inspection of the drain mechanisms.

Operation includes regulating water levels in the impoundment, regulating and monitoring wastewater discharge from Cell 003 into Cell 004, and regulating and monitoring flow from Cell 004 to the outfall to the Middle Fork of the Little Chariton Rover.

3. Structural Stability Assessment

3.1 REVIEW OF EXISTING INFORMATION

For this assessment, Haley & Aldrich reviewed multiple sources of information including:

- Report on the Initial Annual Inspection performed by AECI in accordance with 40 CFR §257.83, dated January 19, 2016
- Previous impoundment inspection reports by GEI (on behalf of EPA) and Geotechnology, Inc.
- Operating and Management Plan
- Topographic plans and aerial photos
- Construction drawings
- Subsurface information
- Geotechnical laboratory test results
- Slope stability evaluations
- Correspondence
- Variety of other information in addition to verbal information provided by AECI during our Assessment.

Our review included, but was not limited to the references listed in Appendix A.

3.2 SITE VISIT AND FIELD OBSERVATIONS

On 29 August 2016, Haley & Aldrich visited Thomas Hill Energy Center to observe conditions at Cell 004, and to meet with AECI personnel to discuss operations and maintenance of the impoundment. Prior to the site visit, we reviewed previous inspection reports including the above-referenced Initial Annual Inspection Report by AECI, and previous inspection reports referenced above and listed in Appendix A. At the time of our site visit, Cell 004 was in operation with water levels at the normal operating level.

3.3 STRUCTURAL STABILITY ASSESSMENT

In accordance with 40 CFR §257.73(d), the owner or operator of a CCR surface impoundment must conduct initial and periodic structural stability assessments to determine whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices.

Haley & Aldrich reviewed the information provided to us and visited the site to observe Cell 004. Based on our review of available information and observations during our 29 August 2016 site visit, we have concluded the following in accordance with 40 CFR §257.73(d):

1. *<u>§257.73(d)(1)(i):</u> Stable foundations and abutments.*

   Based on our review of available subsurface information, impoundment inspection reports, geotechnical laboratory test results, slope stability analyses, and observations during our 29 August 2016 site visit, Cell 004 was judged to have stable foundations. The Cell 004 embankments have not exhibited signs of excessive settlement, instability or other signs of inadequate foundation support.

2. *<u>§257.73(d)(1)(ii):</u> Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown.*

   Along the west embankment and northern half of the east embankment, the Cell 004 interior slopes are covered with vegetation for the full height of the slope. On all other interior slopes, riprap protection is provided on the lower 8 to 15 ft of the slope.

   Based on observations during our 29 August 2016 site visit, the slope protection on the interior slopes was judged to provide adequate slope protection against surface erosion, wave action and adverse effects from sudden drawdown. The exterior slopes of Cell 004 are vegetated for the full height of the slopes and were judged to have adequate slope protection.

3. *<u>§257.73(d)(1)(iii):</u> Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit.*

   Construction records are not available for the Cell 004 embankments.

   However, in 2010, Geotechnology, Inc. performed one test boring and one cone penetrometer sounding through the north embankment. In 2011, Geotechnology drilled one test boring through the south embankment and one boring at the exterior toe of the embankment. The borings and cone penetrometer were drilled through the embankment fill and into the underlying natural soils.

   The subsurface explorations indicate the embankment fill in the north embankment consists of medium stiff to stiff clay with varying amounts of silt, sand and gravel. In the south embankment, the borings encountered embankment fill generally consisting of medium stiff clay with varying amounts of gravel.

   During our 29 August 2016 site visit, we observed no evidence of slope instability or other signs of inadequate compaction of the embankment fill. In addition, based on the information reviewed for this Structural Stability Assessment, there has been no historic evidence of slope instability or other signs of inadequate embankment compaction.

   Based on our review of subsurface exploration logs and other available information on the Cell 004 embankments, as well as our observations during the 29 August 2016 site visit, we have concluded the fill used to construct the Cell 004 embankments was mechanically compacted.

4. *<u>§257.73(d)(1)(iv):</u> Vegetated slopes of dikes and surrounding areas not to exceed a height of six inches above the slope of the dike, except for slopes which have an alternate form or forms of slope protection.*

   The vegetation on the interior and exterior slopes of Cell 004 was generally 6 to 12 inches in height at the time of our 29 August 2016 site visit. AECI has recently purchased a specialized mower that attaches to the boom of a Cat 330 long-reach excavator. The excavator has a 60-ft reach, enabling the equipment to mow areas that were previously inaccessible to conventional mowing equipment.

5. *<u>§257.73(d)(1)(v)(A):</u> Spillway Erosion Protection – All spillways must be either: (1) Of non-erodible construction and designed to carry sustained flows; or (2) Earth- of grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected.*

   The primary spillway in Cell 004 consists of the concrete decant structure located in the southwest corner of the impoundment. The concrete construction is non-erodible and designed to carry sustained flows.

   The emergency spillway in Cell 004 consists of an 18-ft wide riprap-lined channel which is approximately 2 ft in depth located across the crest of the west dike. The emergency spillway channel was judged to have adequate erosion protection to withstand short-term, infrequent flows.

6. *<u>§257.73(d)(1)(v)(B):</u> Spillway Capacity – The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a: (1) Probable maximum flood (PMF) for a high hazard potential CCR surface impoundment; or (2) 1000-year flood for a significant hazard potential CCR surface impoundment; or (3) 100-year flood for a low hazard potential CCR surface impoundment.*

   The spillway capacity for the impoundment is required to be modeled and analyzed in accordance with §257.82 Hydrologic and Hydraulic Capacity Requirements for CCR surface impoundments. AECI will complete that capacity analysis requirement under separate cover, consistent with the CCR Rule Preamble reference to the same section.

7. *<u>§257.73(d)(1)(vi):</u> Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure.*

   Cell 004 hydraulic structures include the rectangular concrete decant structure and outlet pipe. The decant structure was judged to be in good condition.

   Flow entering the decant structure is conveyed through the Cell 004 embankment and discharges from the NPDES-permitted Outfall #001 into a concrete open channel before flowing to the Middle Fork of the Little Chariton River. The discharge pipe is buried within the embankment and is not visible. There are no signs of ground settlement above or around the pipe. No sediment or debris was observed at either end of the outlet pipe.

8. *<u>§257.73(d)(1)(vii):</u> For CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural*

stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.

The only natural water body in the vicinity of Cell 004 is the Middle Fork of the Little Chariton River. Due to the limited size of the channel and the local topography, inundation of the Cell 004 downstream slopes by the Middle Fork of the Little Chariton River is not possible nor is a sudden drawdown condition.

9. *§257.73(d)(2): Identify any structural stability deficiencies associated with the CCR unit in addition to recommending corrective measures.*

   Our Structural Stability Assessment identified no structural stability deficiencies at Cell 004. However, we recommend the following maintenance actions:

   a. Maintain height of vegetation in accordance with §257.73(d)(1)(iv).

4. Conclusions/Certification

Based on our review of the information provided to us and observations during our 29 August 2016 site visit, it is our opinion that the design, construction, operation, and maintenance of Pond 001 – Cell 004 at Thomas Hill Energy Center is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded in Cell 004.

I certify that the Periodic Structural Stability Assessment for AECI's Pond 001 – Cell 004 at the Thomas Hill Energy Center was conducted in accordance with the requirements of §257.73(d) of the USEPA's Final CCR Rule.

Signed:________________________________
Certifying Engineer

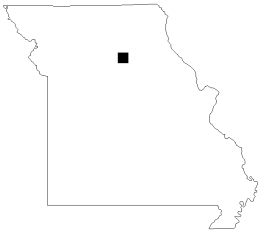
Print Name: Steven F. Putrich
Missouri License No.: 2014035813
Title: Project Principal
Company: Haley & Aldrich, Inc.

Professional Engineer's Seal:

STEVEN F.
PUTRICH
NUMBER
PE-2014035813
10-17-16

MAP SOURCE: ESRI

SITE COORDINATES: 39°32'28"N, 92°38'26"W



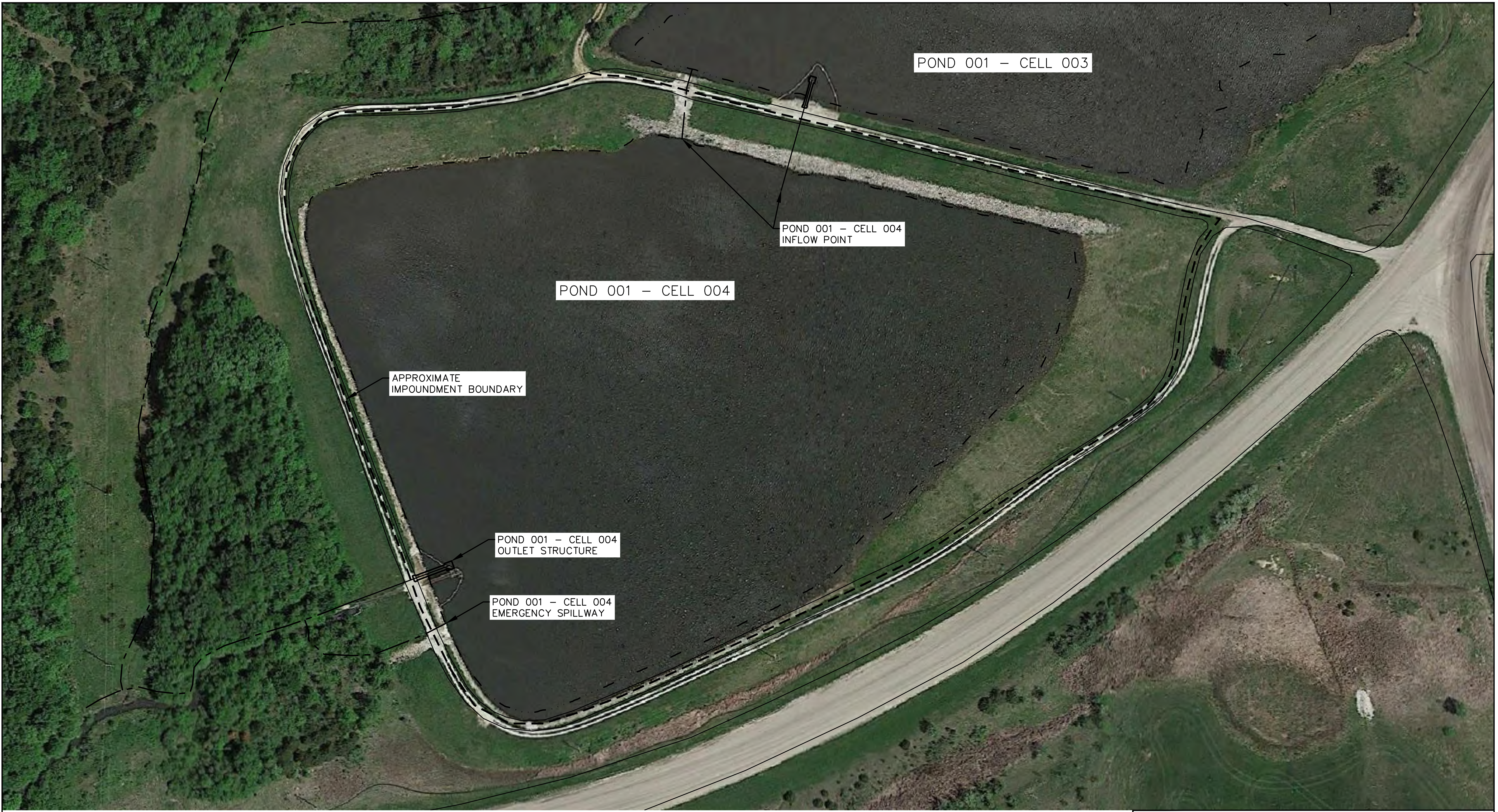
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

POND 001 - CELL 004
PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
OCTOBER 2016

FIGURE 1

128064_1_LOCUS.PDF



LEGEND

- – – APPROXIMATE IMPOUNDMENT BOUNDARY
- – · · · – WATER
- PIPE
- DITCH
- ROAD

NOTES

1. AERIAL IMAGERY PROVIDED BY GOOGLE EARTH PRO. PHOTO TAKEN ON 11 MAY 2015.

0 120 240
SCALE IN FEET

HALEY ALDRICH

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

POND 001 - CELL 004
SITE PLAN

SCALE: AS SHOWN
OCTOBER 2016

FIGURE 2

LUCAS, ANDY Printed: 10/3/2016 8:11 AM Layout: HA-FIG-B-L-H
G:\40616_AECI-CCR ELG MANAGEMENT SUPPORT\CAD-TH\FIGURES\STRUCTURAL STABILITY ASSESSMENT\40616_FIG-2_THEC_POND 001_CELL 004 SITE PLAN.DWG

APPENDIX A

References

References

1. AECI, “Pond #001, the Ash Pond Series Operating and Management Plan,” revised December 14, 2012.

2. AECI, “Report: Initial Annual CCR Surface Impoundment PE Inspection, Ash Pond 001 – Cell 001, Cell 002, Cell 003, Cell 004,” dated January 19, 2016.

3. Burns & McDonnell, Various Construction Drawings, dated 1979 and 1984.

4. GEI Consultants, “Specific Site Assessment for Coal Combustion Waste Impoundments at Thomas Hill Energy Center,” dated June 2011.

5. Geotechnology, Inc., “Global Stability Evaluation, Mine Waste and Ash Pond Embankments, AECI Facilities, Bee Veer and Thomas Hill, Missouri,” dated April 22, 2010.

6. Geotechnology, Inc., “Slope Stability and Seepage Analysis, Ash Pond No. 3, Thomas Hill Energy Center,” dated February 3, 2012.

APPENDIX H

Safety Factor Assessments

www.haleyaldrich.com

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

HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.739.0555

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

www.haleyaldrich.com

REPORT ON
INITIAL SAFETY FACTOR ASSESSMENT
CELLS 001, 003, AND 004
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Springfield, Missouri

File No. 128064-003
October 2016

Table of Contents

Table of Contents

List of Tables

List of Figures

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.

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[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 ($FS \geq 1.0$) 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:

STEVEN F.
PUTRICH
NUMBER
PE-2014035813
10-17-16

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:

STEVEN F.
PUTRICH
NUMBER
PE-2014035813
10-17-16

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:

STEVEN F. PUTRICH
NUMBER
PE-2014035813
10-17-16

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			600	23
B-1	1	ST2	3.0-5.0	CL	EMBANKMENT FILL					17	127.7				
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			500	27
B-2	1	ST4	7.0-9.0	CH	CLAY		65	20	45	24	122.8				
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

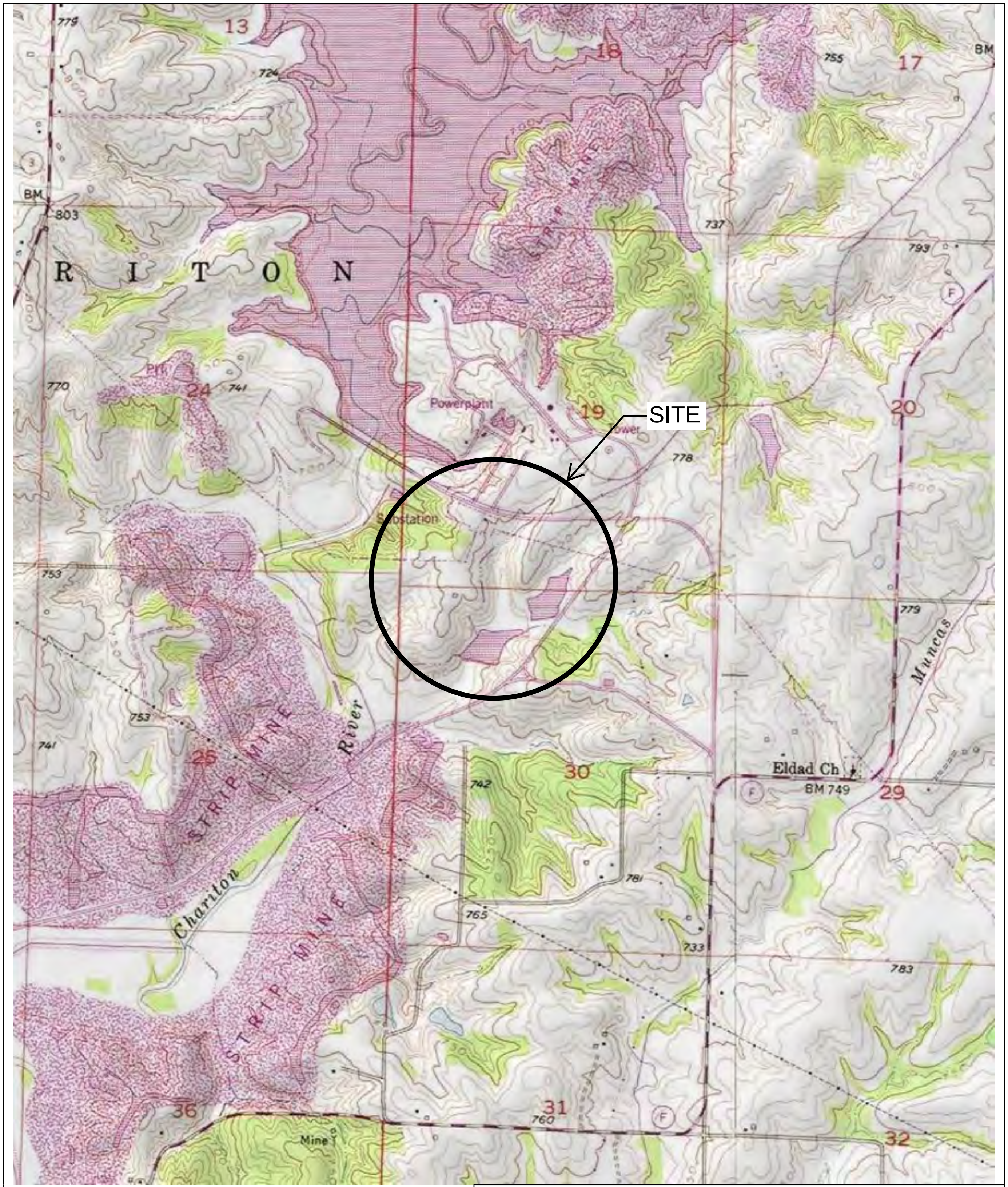
Observation Well Designation	Top of Casing Elevation (ft)[1]	Well Depth (ft)	Measurement Date	Depth to Water[2] (ft)	Groundwater Elevation (ft)	Well Installation Notes
TPZ-3	733.2	28.5	8/28/2015	7.1	726.1	Well installed 8/26/15 by Bulldog Drilling.
			9/16/2015	8.6	724.6	
			9/30/2015	9.3	723.9	
			8/2 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.

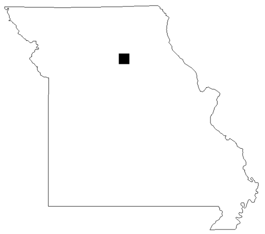
2) Groundwater level readings have been made in the wells at times and under conditions discussed herein. However it must be noted that fluctuations in the level of the groundwater may occur due to variations in season, rainfall, plant sluicing activities, temperature, and other factors not evident at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

FIGURES



MAP SOURCE: ESRI

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



HALEY ALDRICH

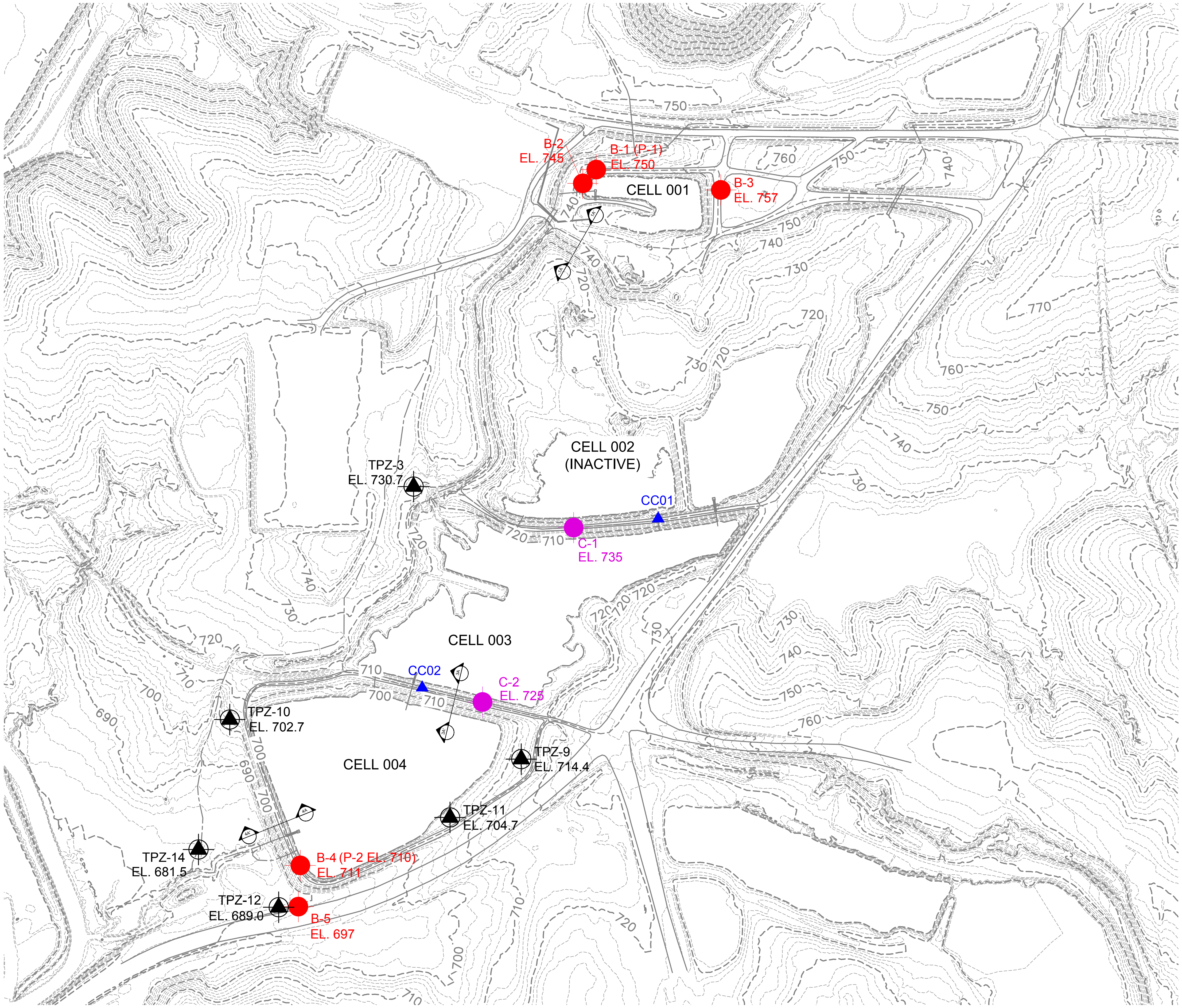
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
OCTOBER 2016

FIGURE 1

40616_000_1_LOCUS.PDF

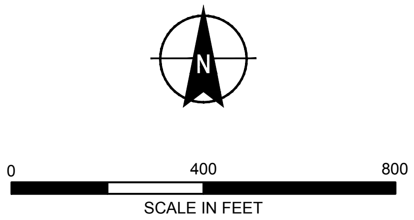


LEGEND

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.
1A' — 1A'	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.



HALEY ALDRICH

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

SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
OCTOBER 2016

FIGURE 2

LUCIDO, SAM
G:\40616_AECI-CCR ELG MANAGEMENT SUPPORT\CAD-TH\FIGURES\SUBSURFACE EXPLORATION LOCATION PLAN.DWG
Printed: 10/17/2016 11:45 AM   Layout: FIG 2

APPENDIX A

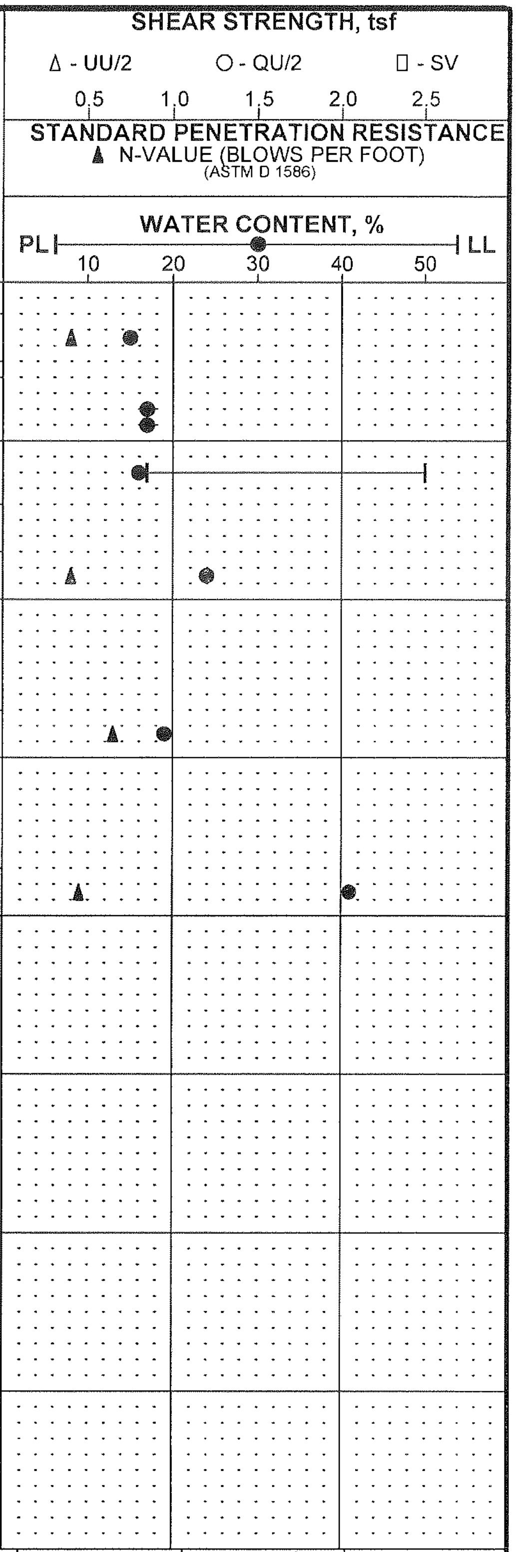
Historic Test Boring Logs and Laboratory Test Results

Surface Elevation: 750

Datum msl

Completion Date: 11/7/11

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
5		▩	110 111	ST2
		▩	115	ST3
10	black slag layer	▩ ▽	1-3-5	SS4
	Stiff, brown and gray CLAY, trace sand and gravel - CH (TILL)	▨		
15		▨	1-6-7	SS5
	Stiff, orange to green, shaley CLAY - CH	▤	3-4-5	SS6
20	Boring terminated at 20 feet.			
25				
30				
35				



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: JFB	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

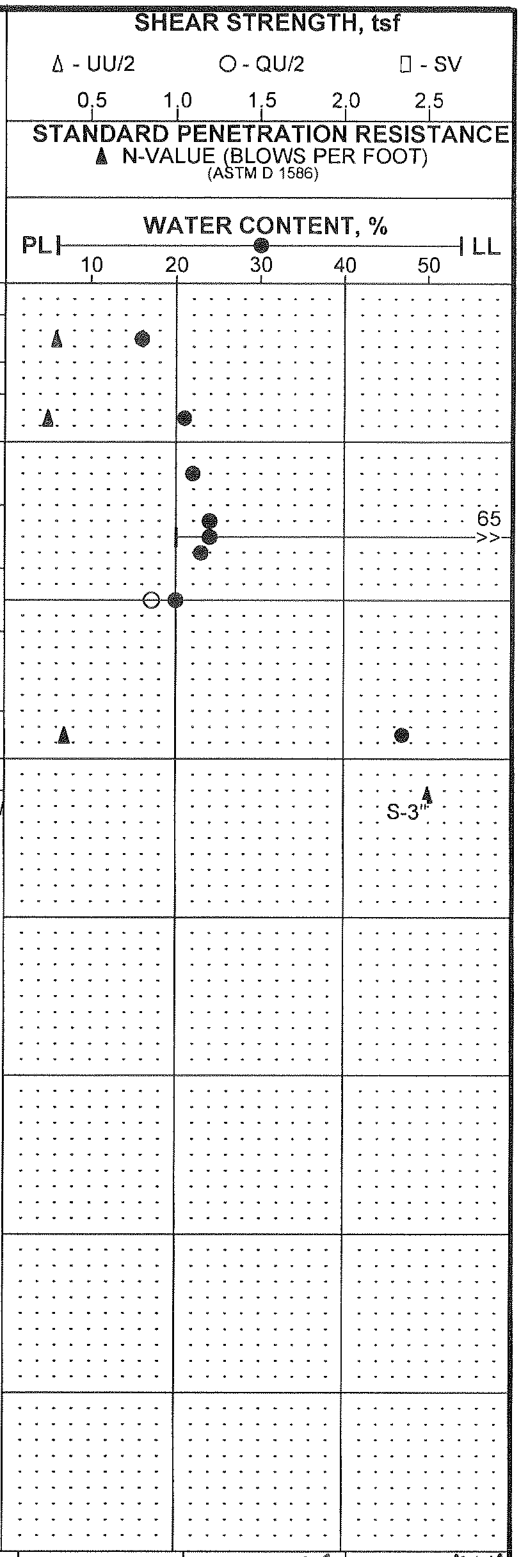
LOG OF BORING 2002 WL J011309.02 - AECI B1-3.GPJ 00 CLONE ME.GPJ 12/15/11

Surface Elevation: 745

Datum msl

Completion Date: 11/8/11

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	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
10			108	ST5
	Medium stiff, orange and green, shaley CLAY - CH	▤		
			1-2-5	SS6
15				
	Auger refusal at 16 feet.		50/3"	SS7
20				
25				
30				
35				



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: DB	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

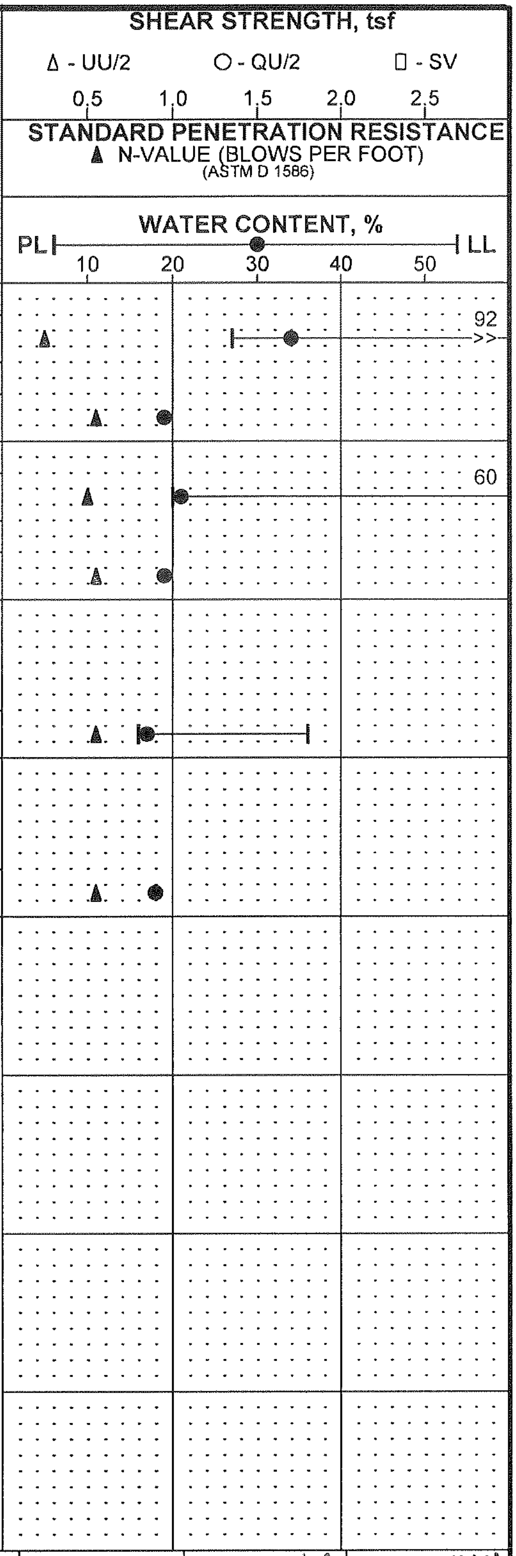
Project No. J011309.02

Surface Elevation: 757

Datum msl

Completion Date: 11/8/11

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL: blackish-brown clay with sand, gravel, and slag	▩		
			1-2-3	SS1
	Stiff, orange-brown to brown and gray CLAY, trace sand and gravel - (CH) (TILL)	▨		
			1-5-6	SS2
5				
			1-3-7	SS3
			3-4-7	SS4
10				
	Stiff, brown and gray to tan, silty CLAY, trace sand and gravel - (CL) (TILL)	▧		
			1-5-6	SS5
15				
	tan		4-5-6	SS6
20	Boring terminated at 20 feet.			
25				
30				
35				



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:	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

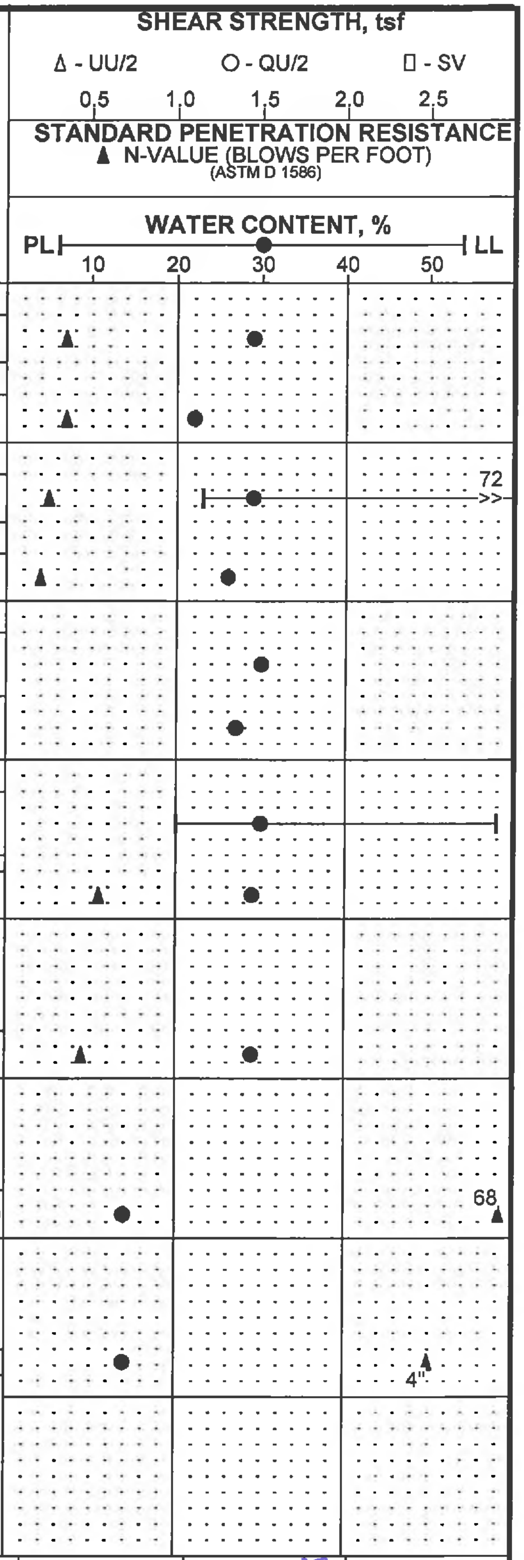
Project No. J011309.02

Surface Elevation: 711

Datum msl

Completion Date: 11/8/11

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



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

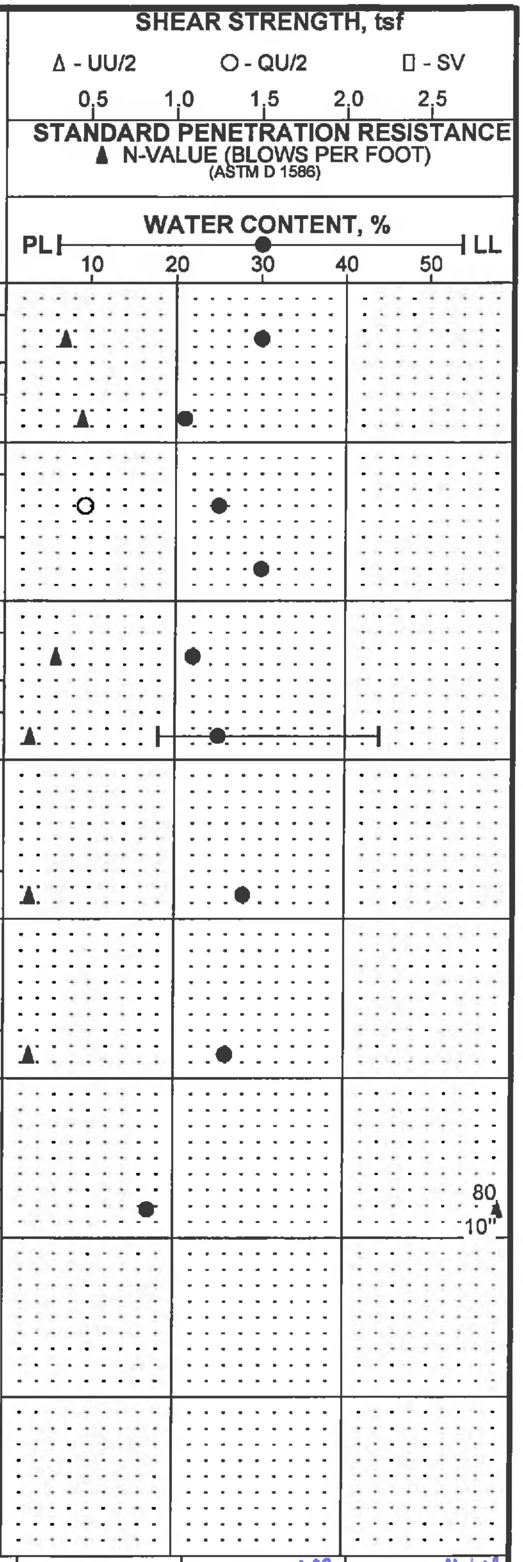
Project No. J011309.02

Surface Elevation: 697

Datum msl

Completion Date: 11/8/11

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	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				



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: DFB	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

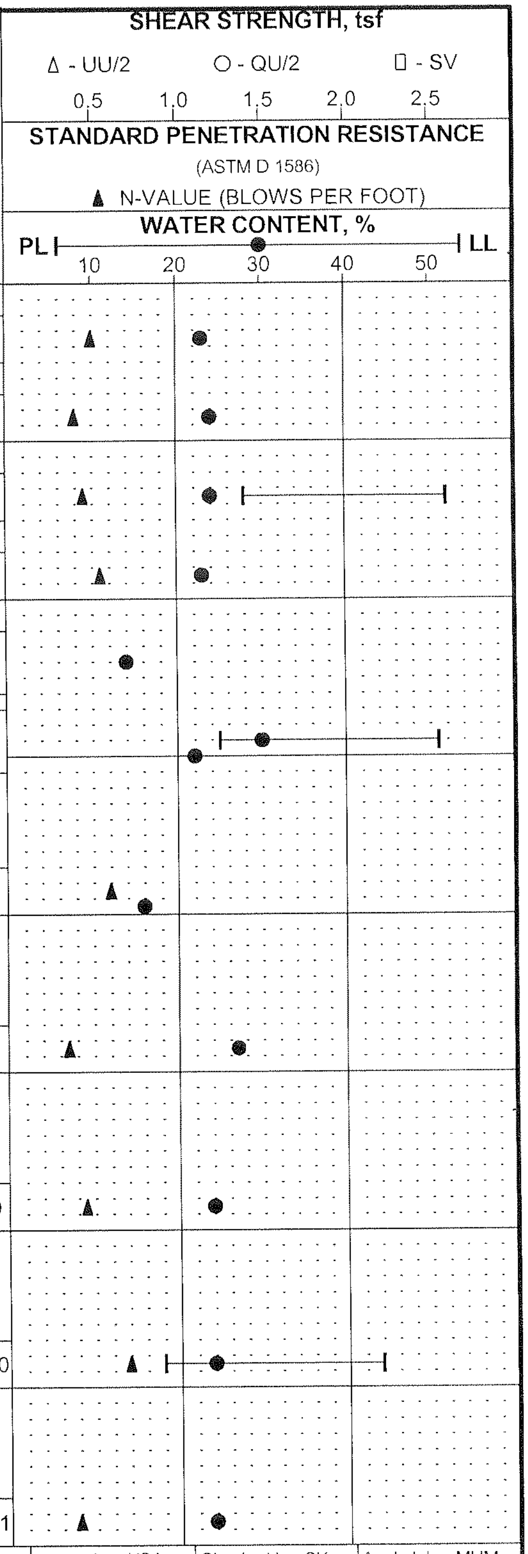
Project No. J011309.02

Surface Elevation: 735

Completion Date: 1/13/10

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Crushed rock, slag and fly ash	4-4-6	SS1
	FILL: brown and gray clay, trace silt and sand	3-4-4	SS2
5		3-4-5	SS3
		4-5-6	SS4
10			
	Very stiff, yellow, brown and gray CLAY - (CH)		ST5
		97 99	ST6
15			
	Medium stiff to stiff, brown and gray CLAY with sand and gravel - CH	3-5-7	SS7
20			
		3-3-4	SS8
25			
		3-4-5	SS9
30			
	Stiff to medium stiff, gray, silty CLAY - (CL)	5-7-7	SS10
35			
		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

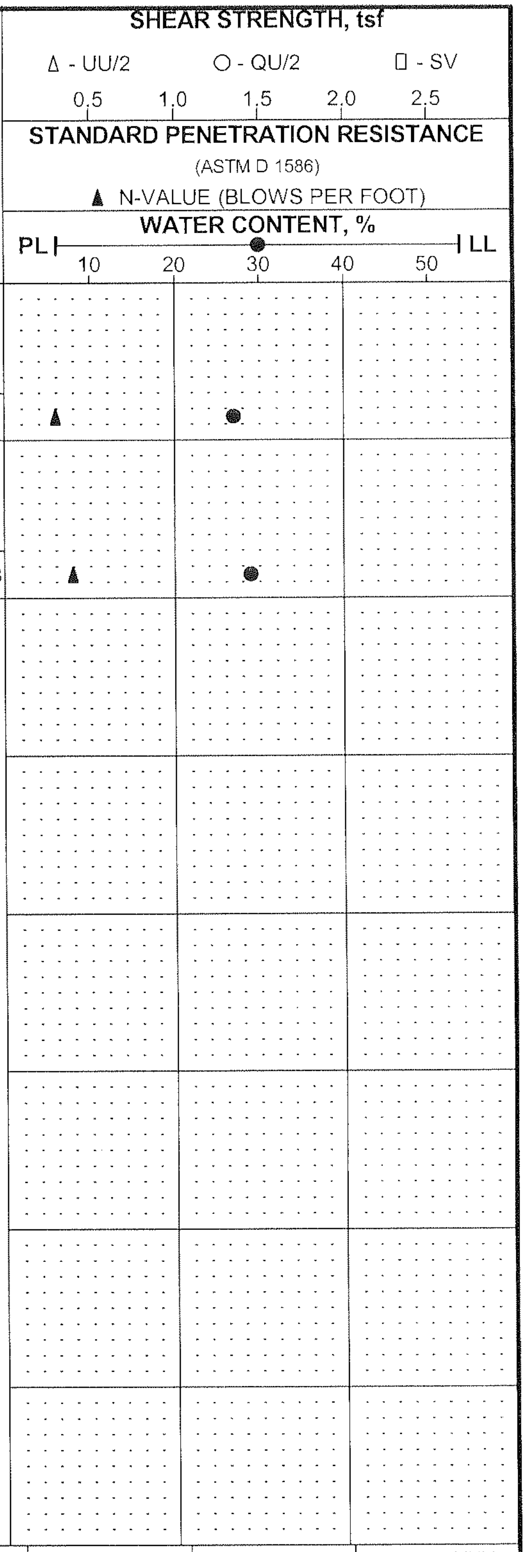
Project No. J011309.01

Surface Elevation: 735

Datum msl

Completion Date: 1/13/10

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	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				



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

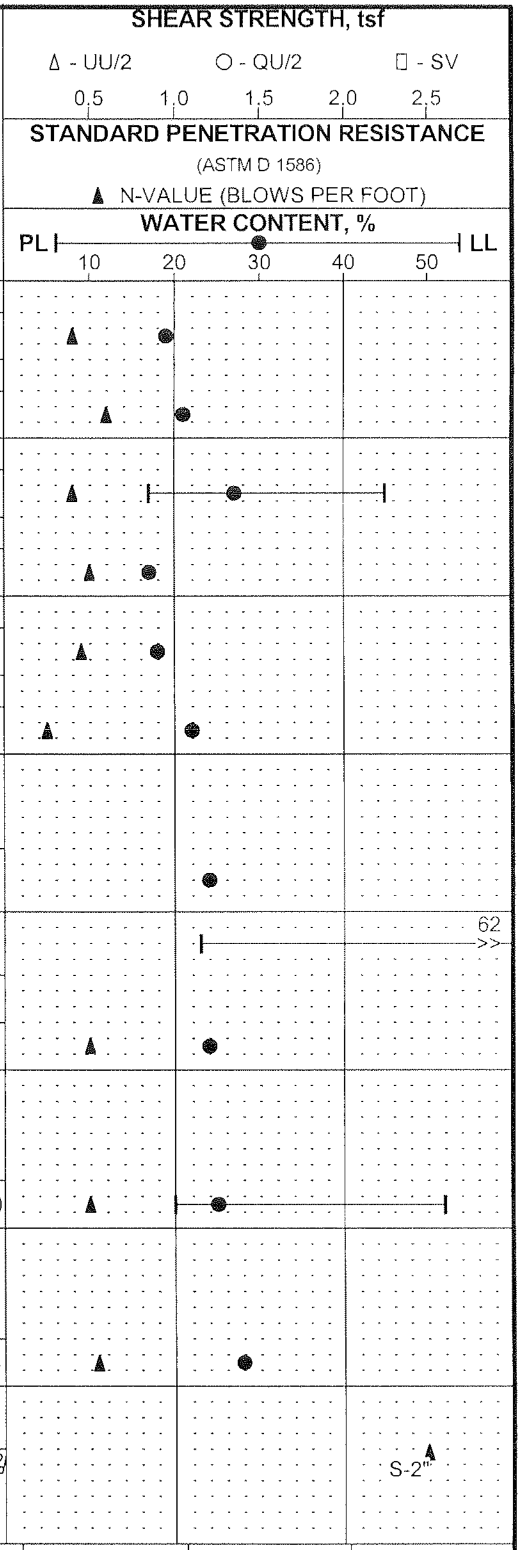
LOG OF BORING 2002 WL 1130901 - ASH POND.GPJ GTINC 0638301.GPJ 4/20/10

Surface Elevation: 725

Datum msl

Completion Date: 1/14/10

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

PROJECT: AECI Thomas Hill Energy Center
Slag Dewatering Basin

NUMBER: J011309.02

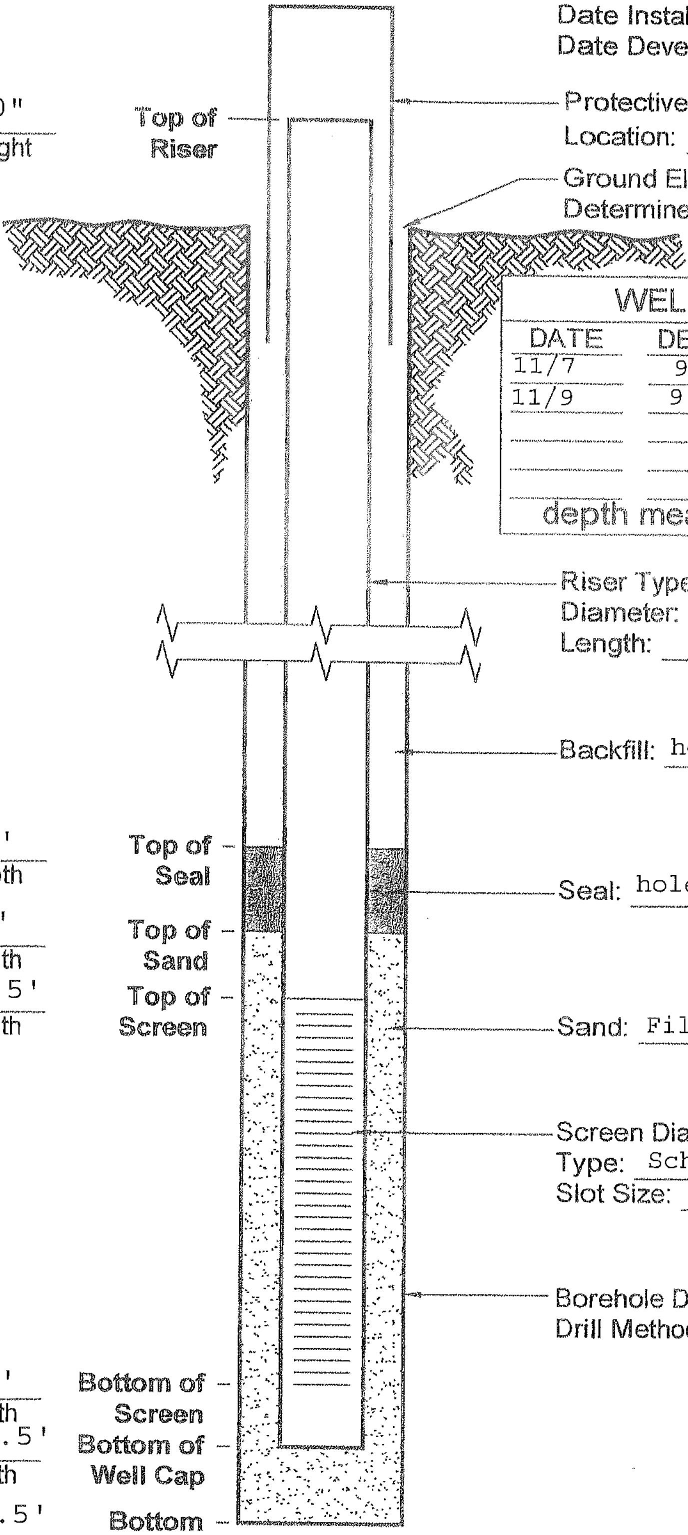
P-1

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

750 Elev.
0" Height
Top of Riser

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

749 Elev.
1' Depth
Top of Seal

Seal: holeplug bentonite

746 Elev.
4' Depth
Top of Sand

744.5 Elev.
5.5' Depth
Top of Screen

Sand: Filtersil

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

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

740 Elev.
10' Depth
Bottom of Screen

739.5 Elev.
10.5' Depth
Bottom of Well Cap

739.5 Elev.
10.5' Depth
Bottom of Hole

REMARKS: Offset 5' west of Boring B-1

PIEZOMETER SCHEMATIC DIAGRAM

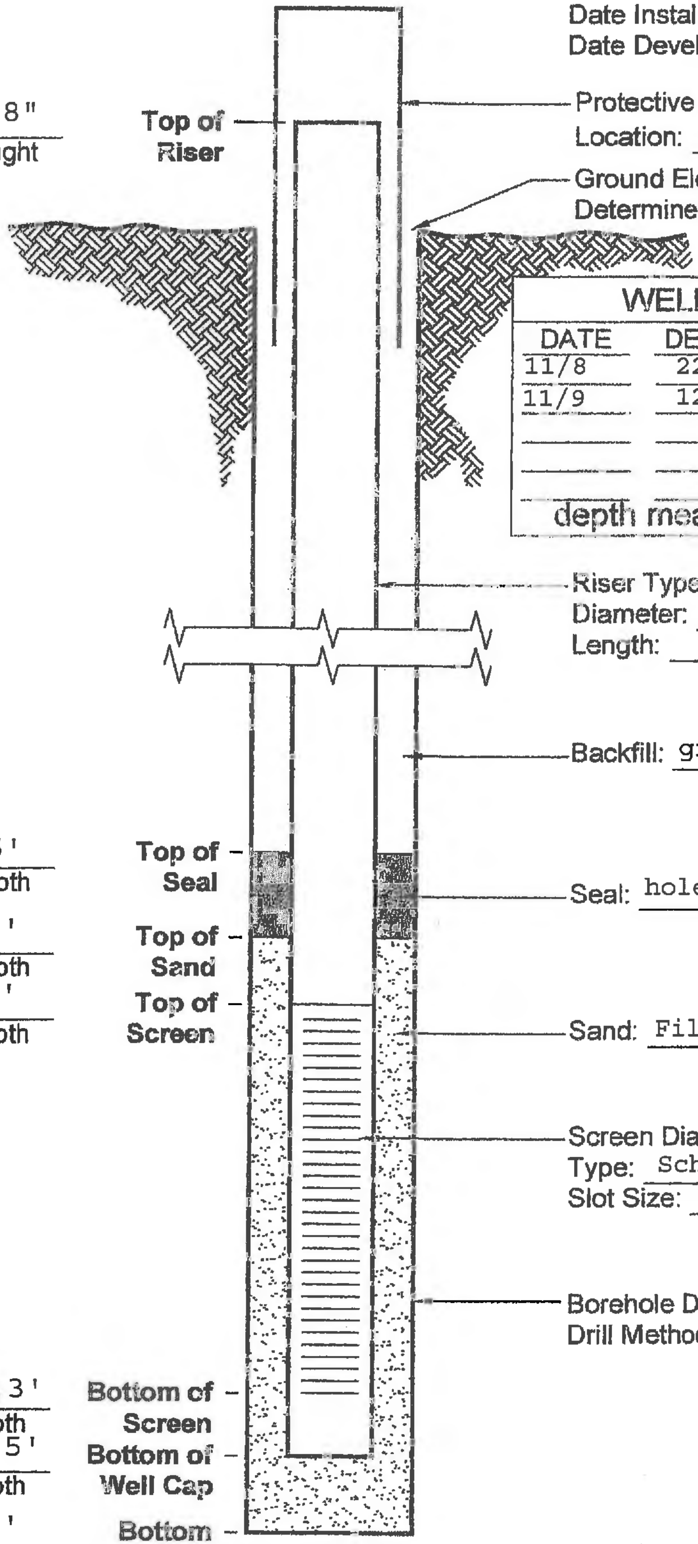
GEOTECHNOLOGY INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
ST. LOUIS • COLLINSVILLE

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



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

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

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

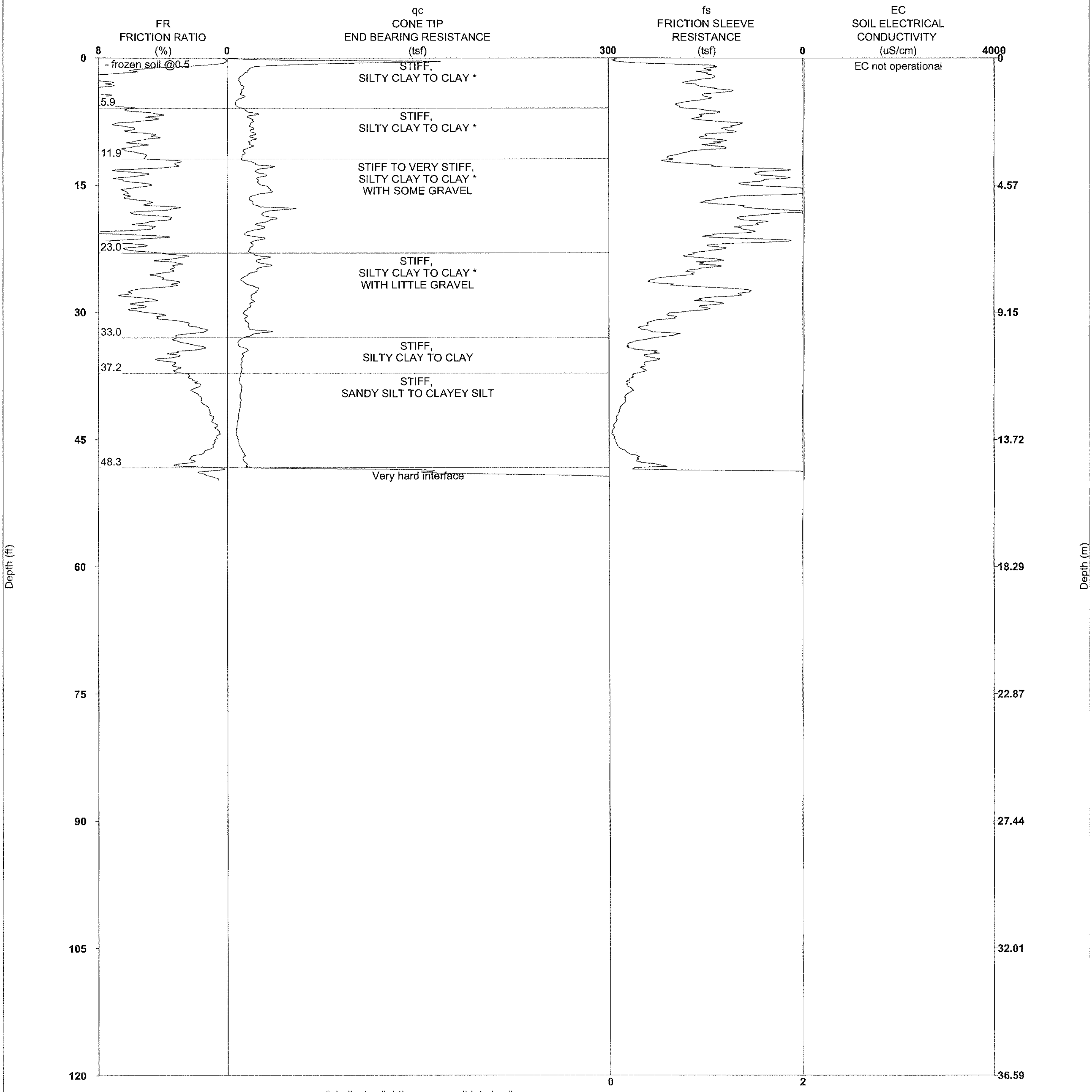
Borehole Diameter: 8"
Drill Method: hollow-stem auger

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

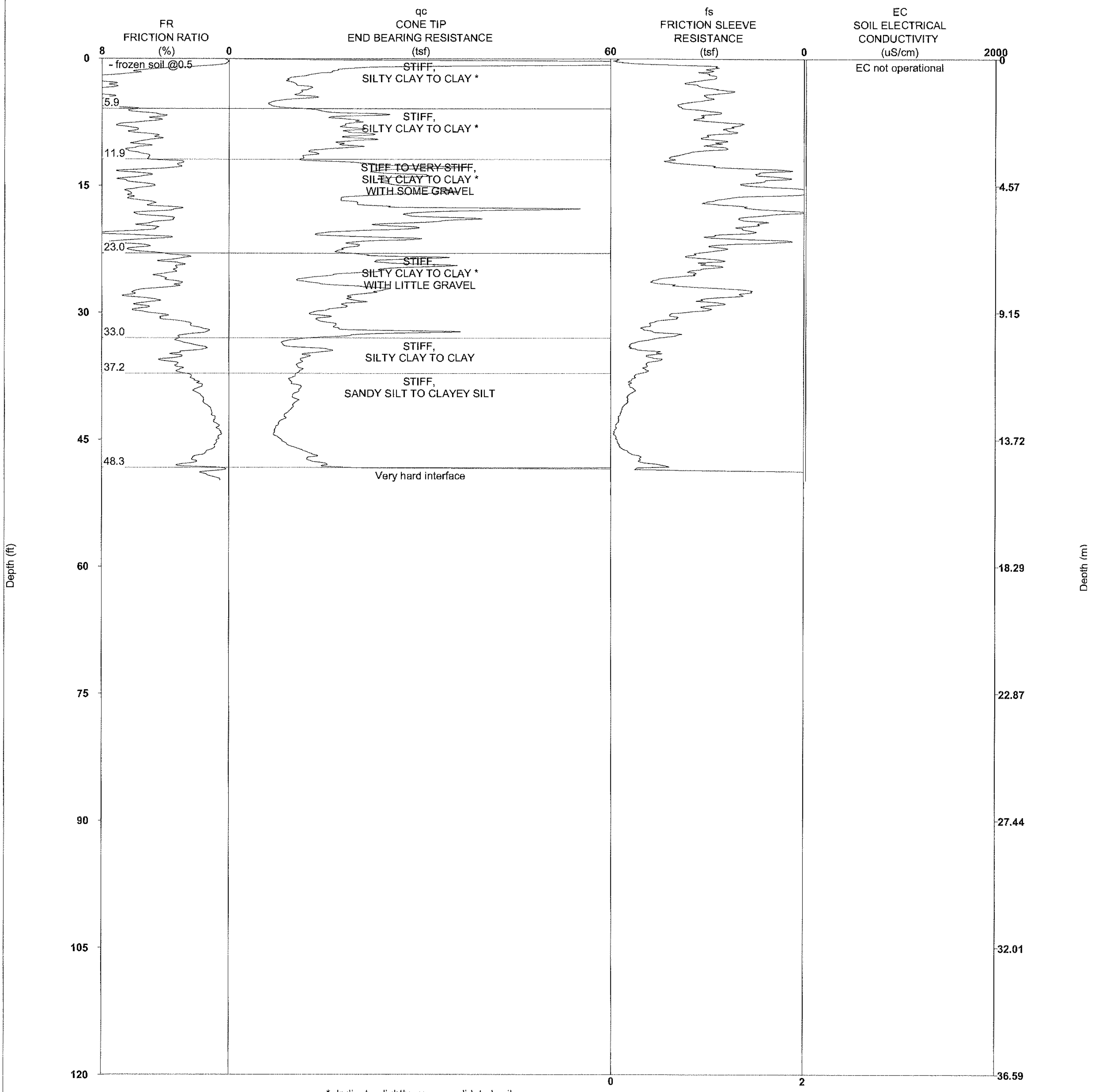
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

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

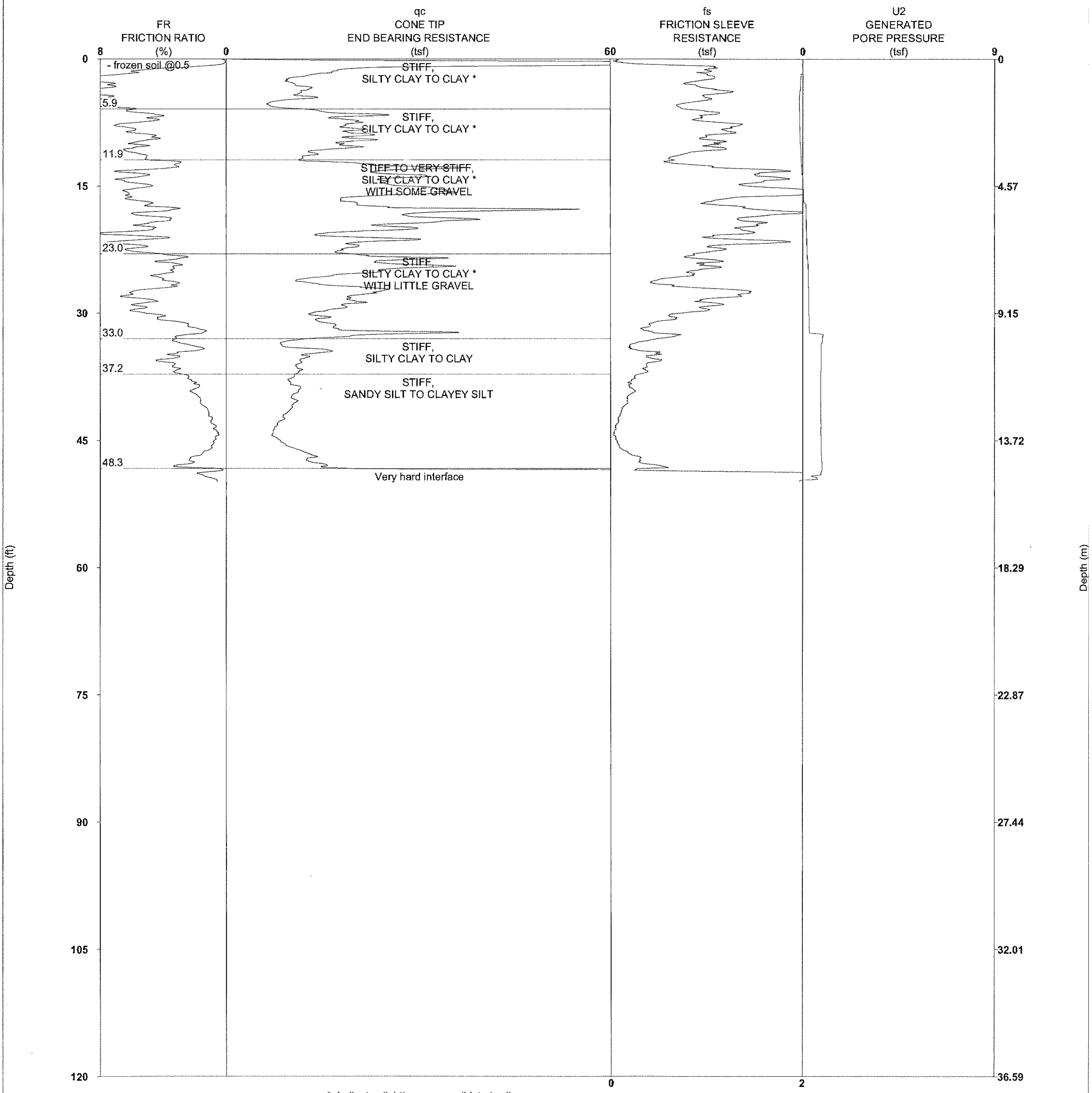
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

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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Latitude: 39.54378 Longitude: -92.63682

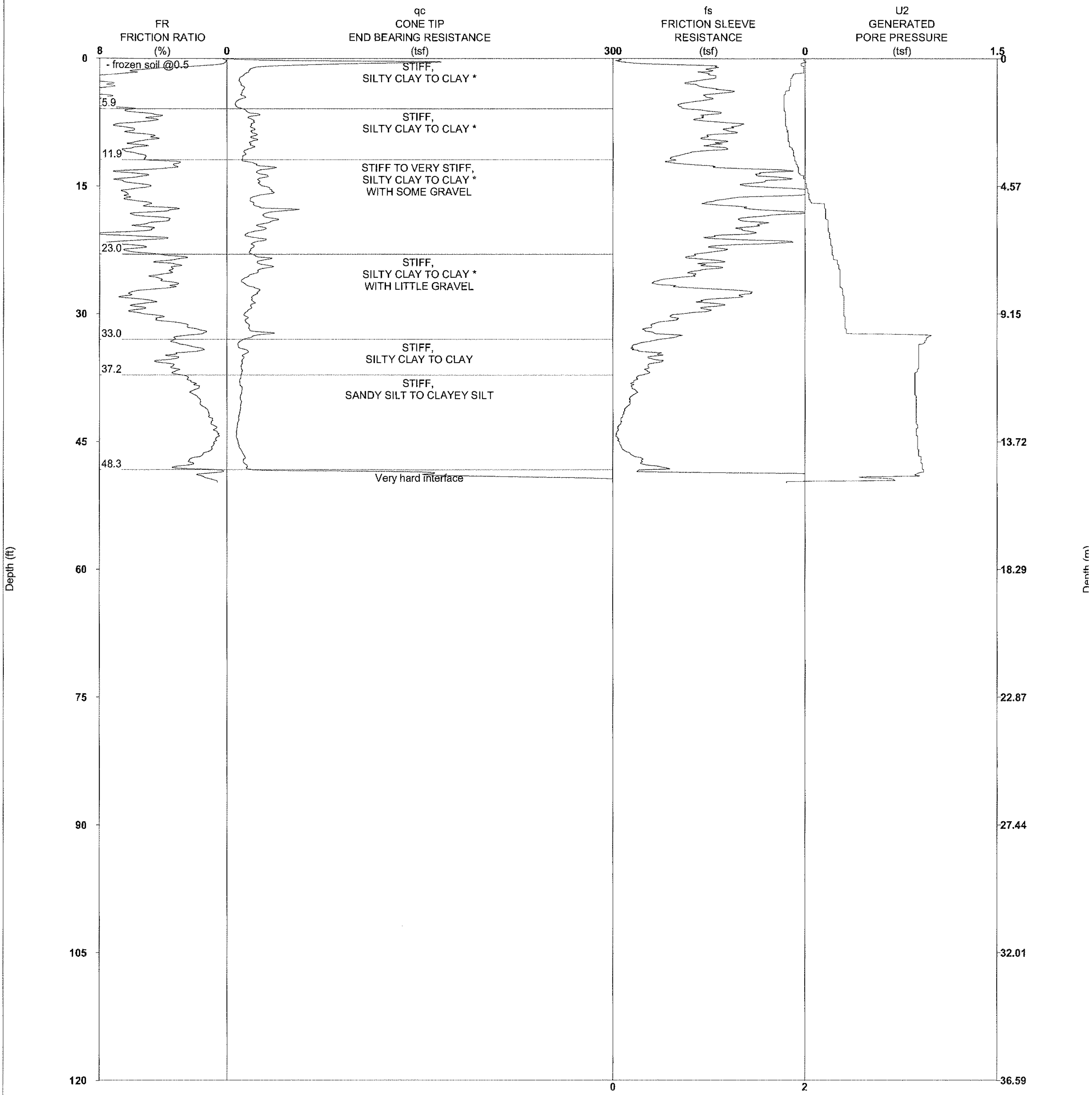
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

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

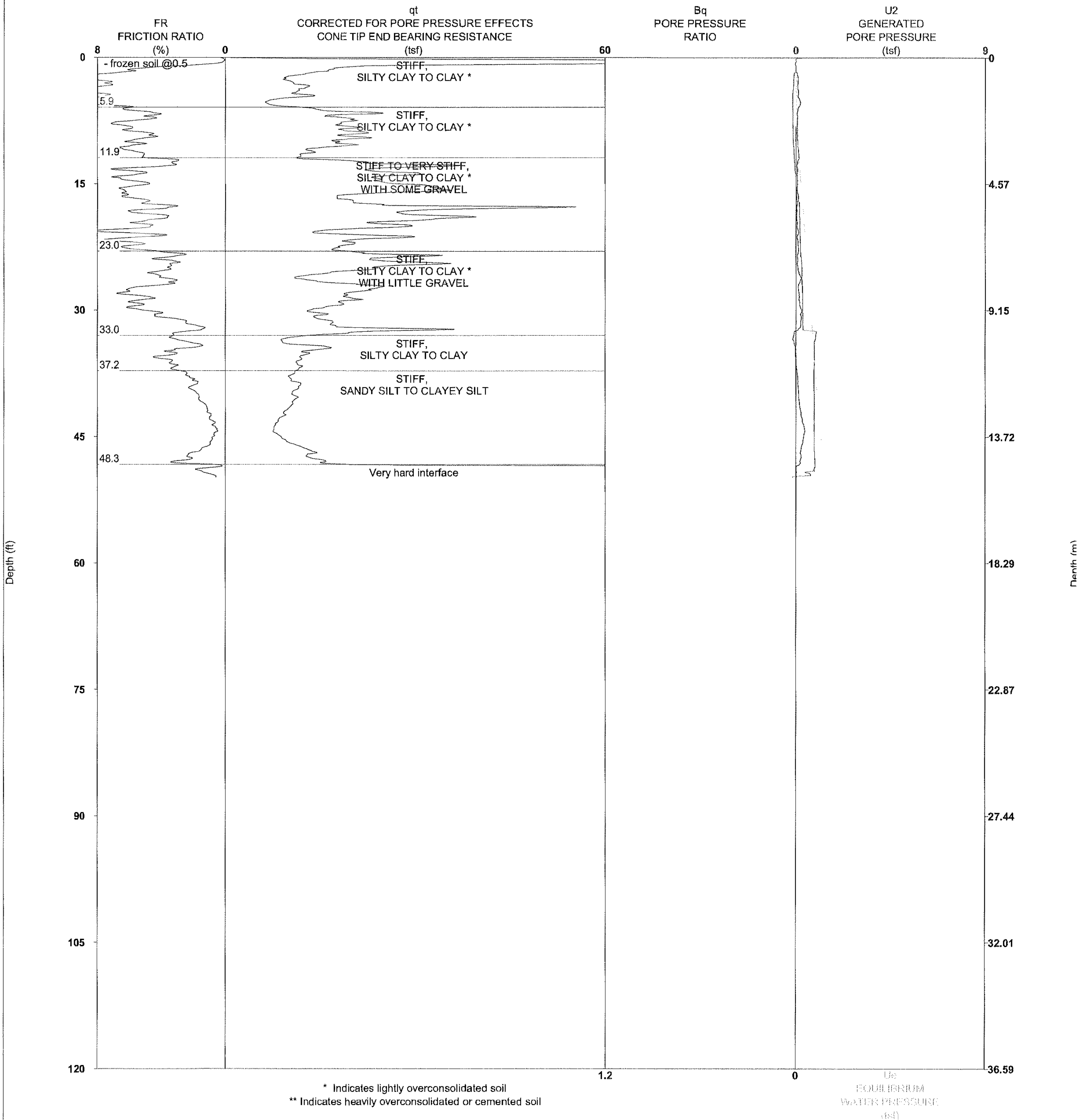
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

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

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



* Indicates lightly overconsolidated soil

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Latitude: 39.54378 Longitude: -92.63682

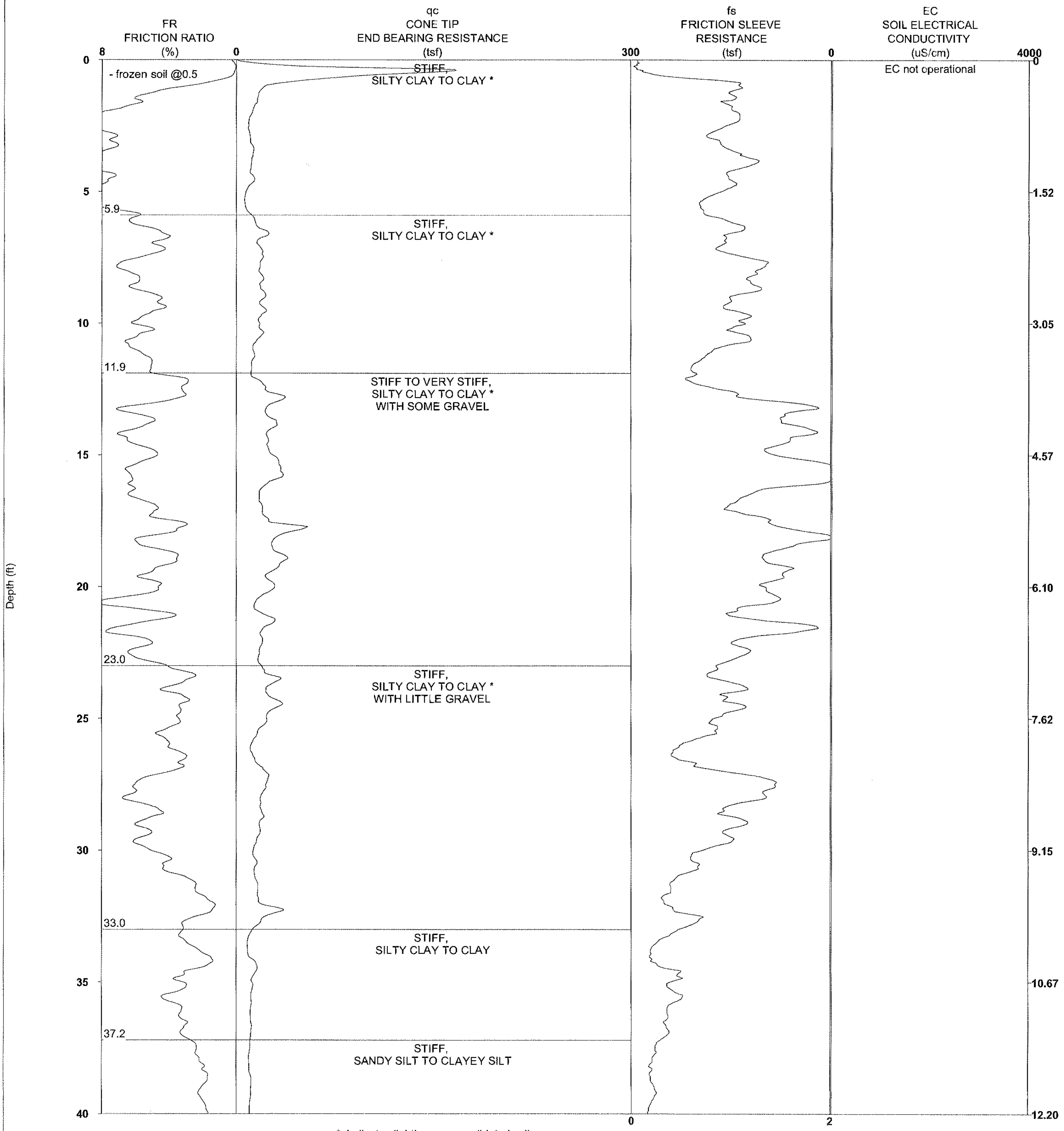
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

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

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



* Indicates lightly overconsolidated soil

** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54378 Longitude: -92.63682

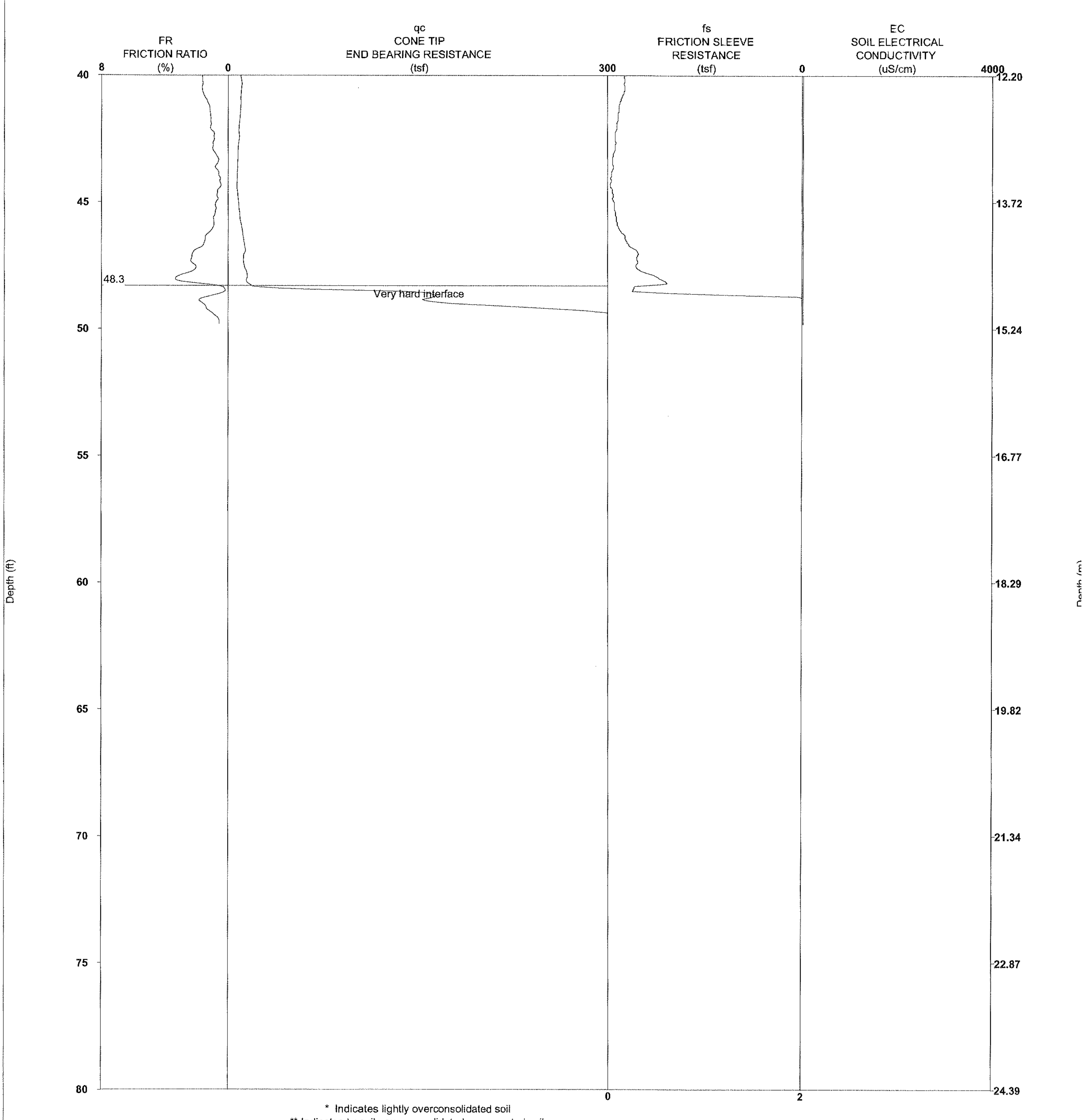
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

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

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



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

Latitude: 39.54378 Longitude: -92.63682

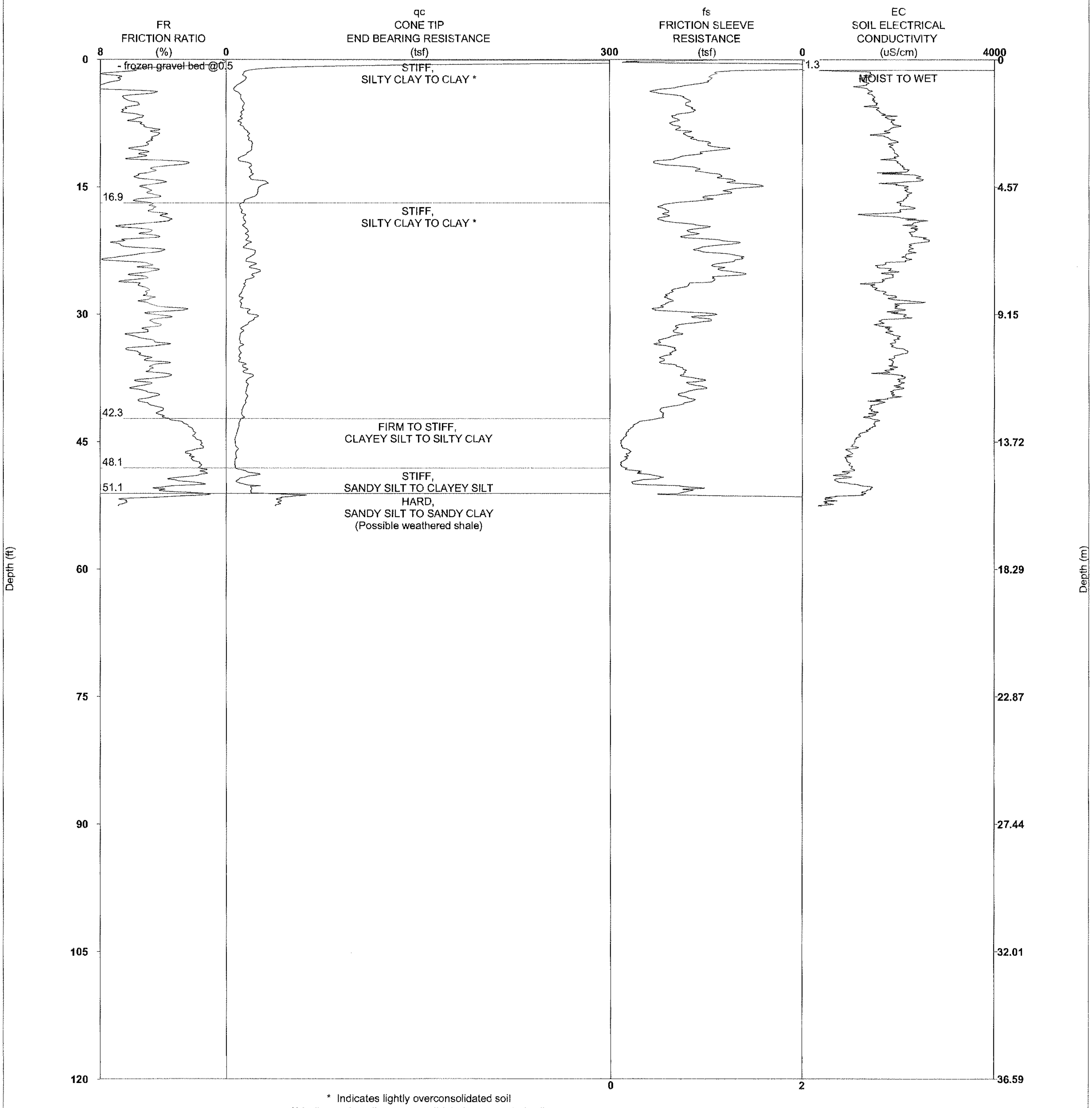
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

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

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



* Indicates lightly overconsolidated soil

** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54198 Longitude: -92.63939

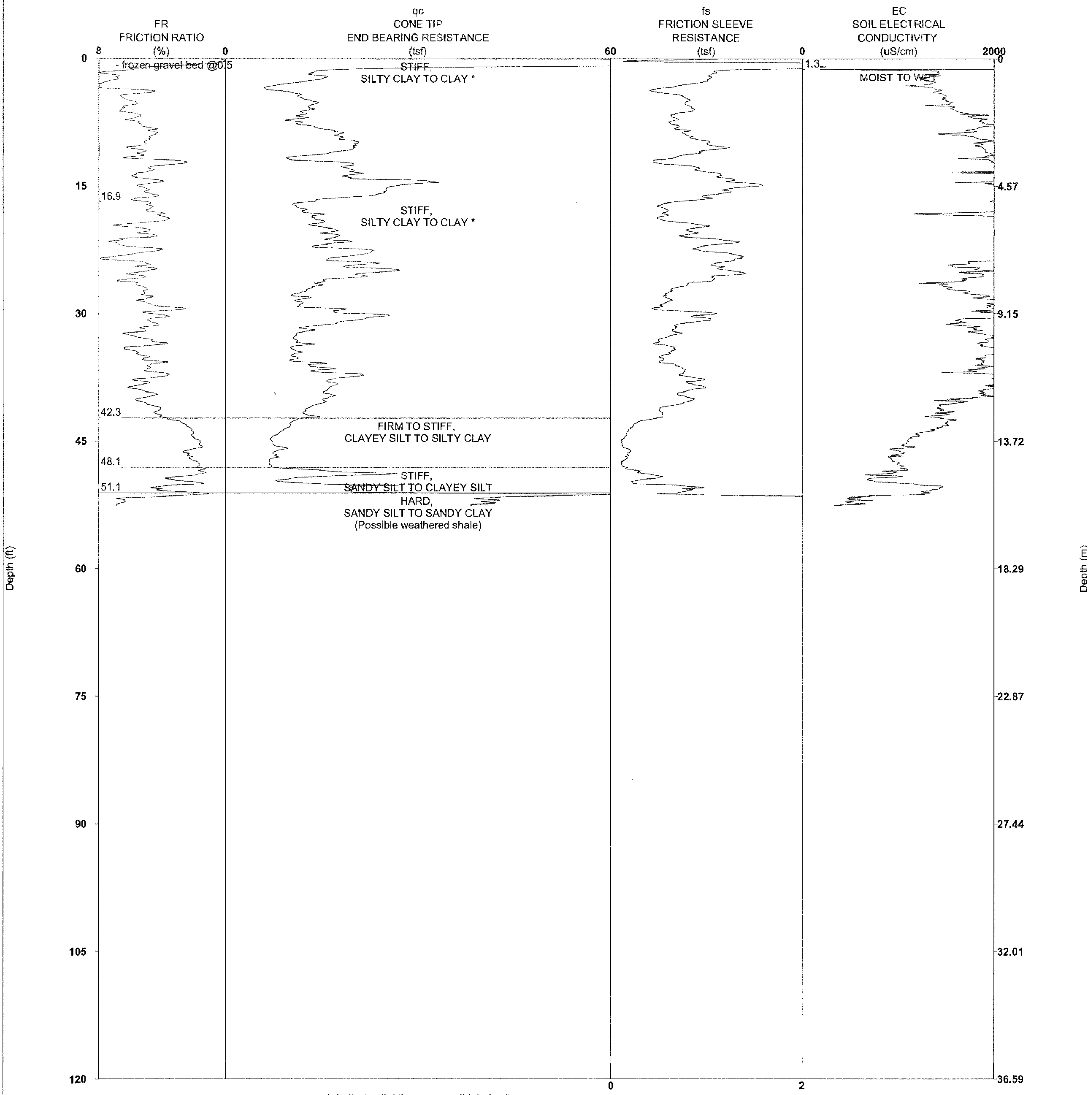
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

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

** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54198 Longitude: -92.63939

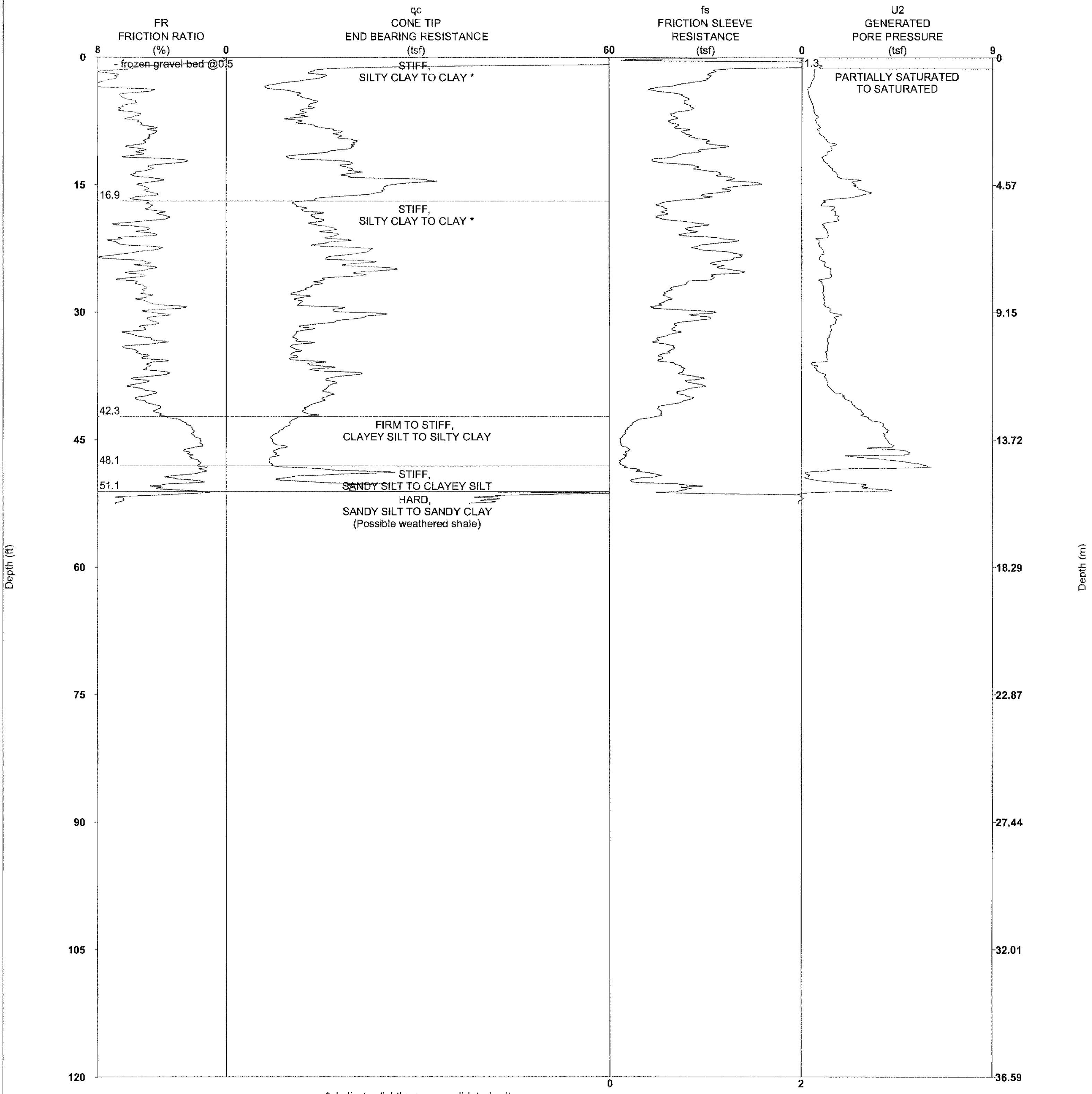
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

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

** Indicates heavily overconsolidated or cemented soil

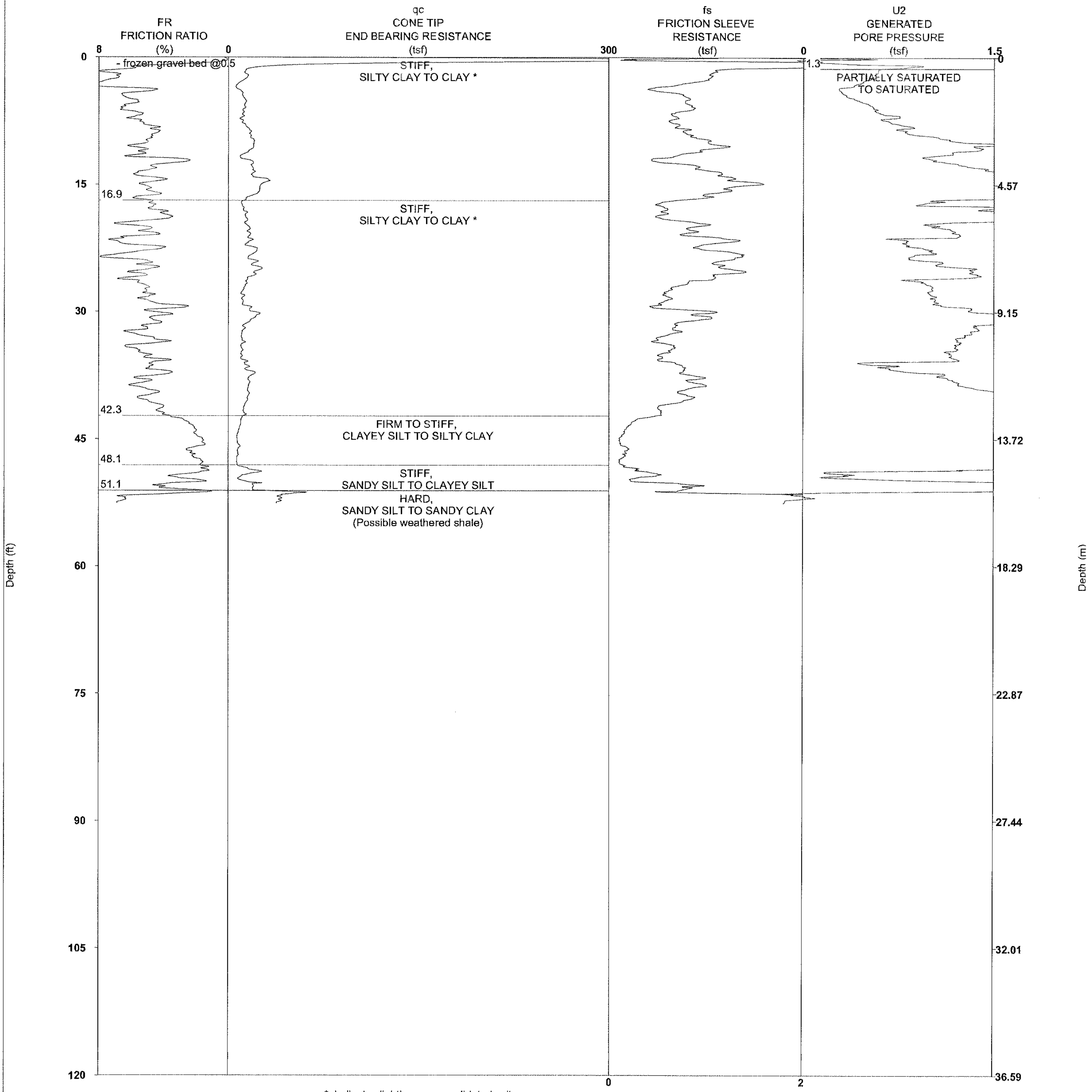
Latitude: 39.54198 Longitude: -92.63939

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

STRATIGRAPHICS

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

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



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

Latitude: 39.54198 Longitude: -92.63939

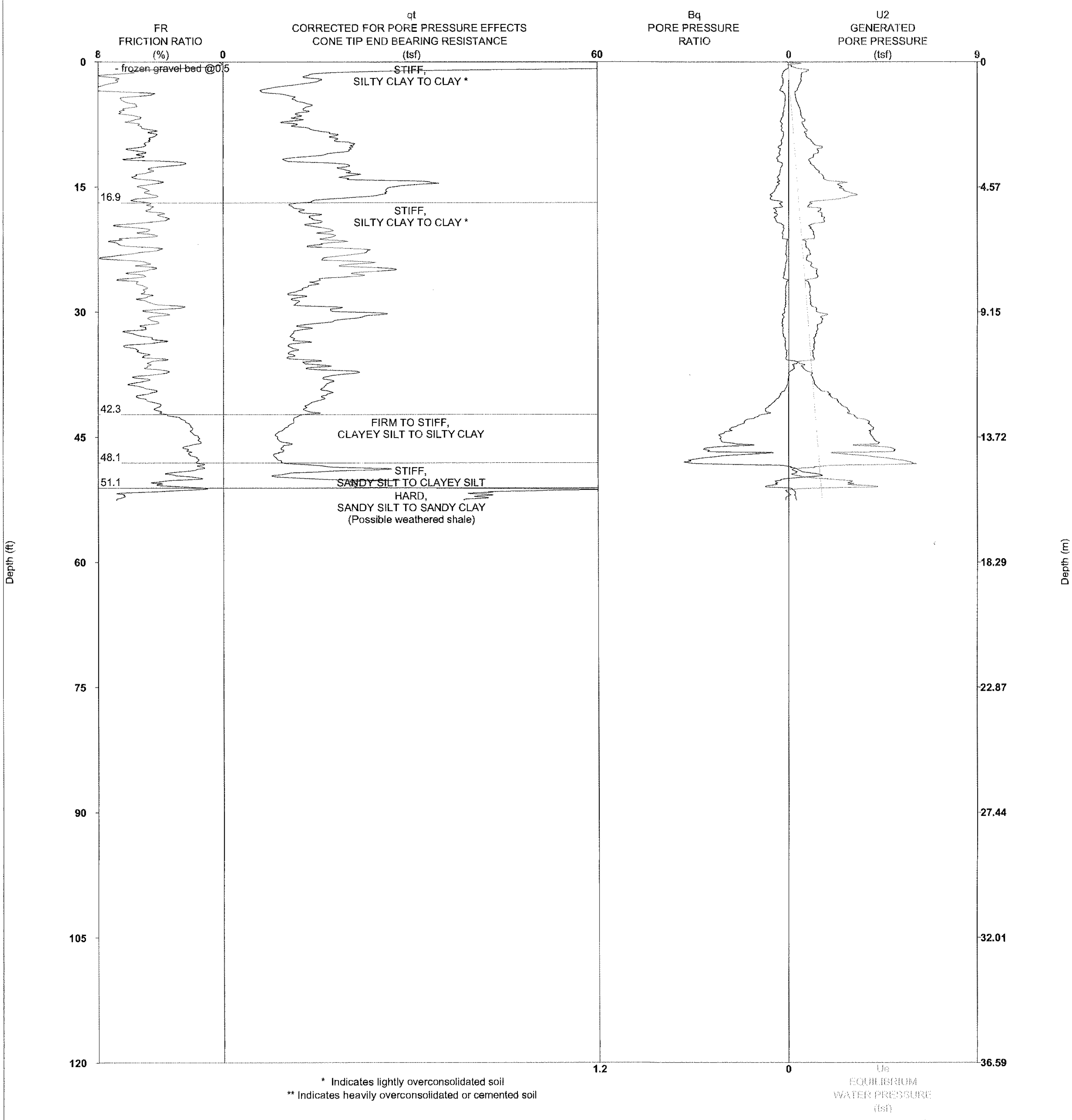
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

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

** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54198 Longitude: -92.63939

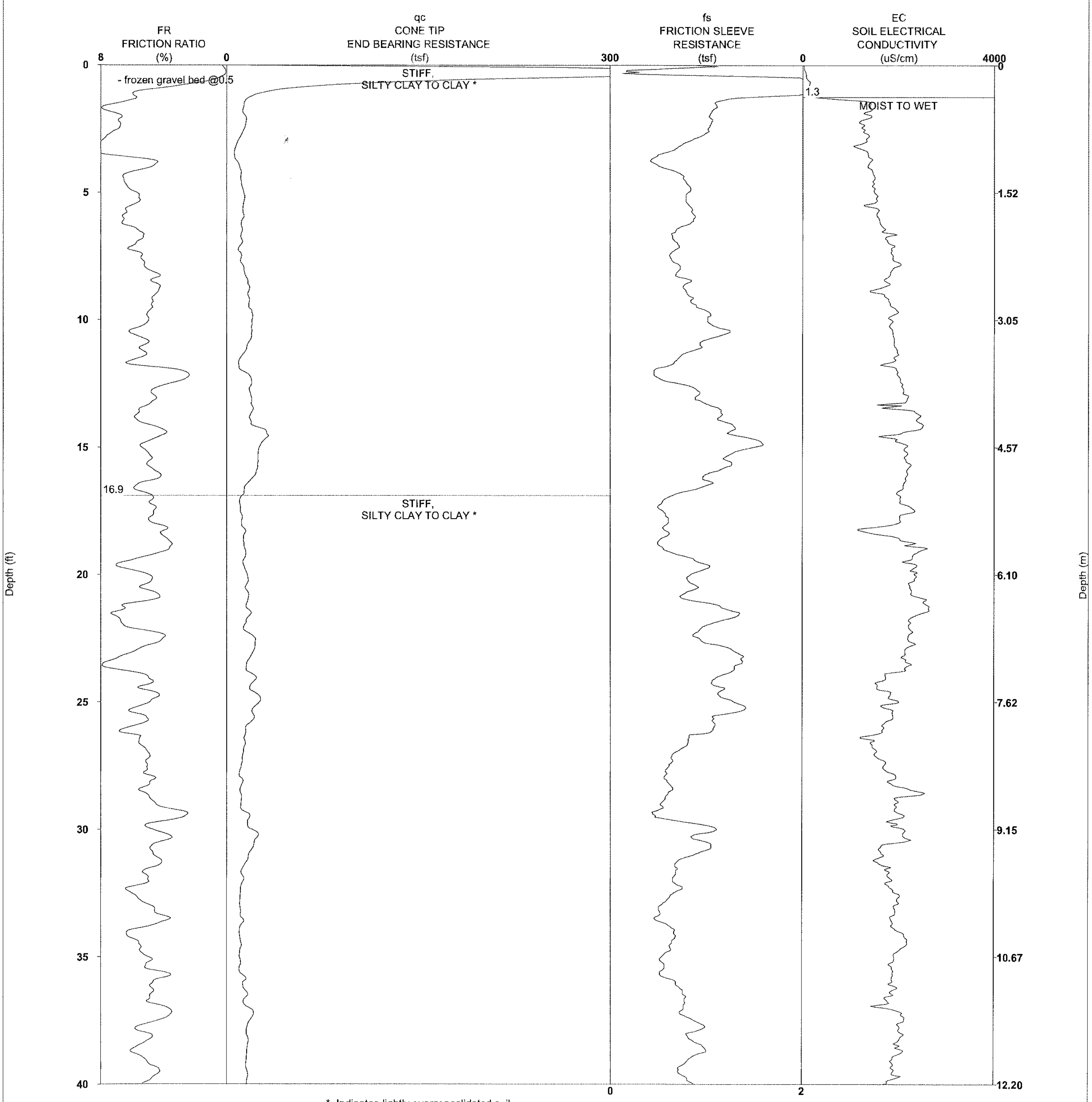
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

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
** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54198 Longitude: -92.63939

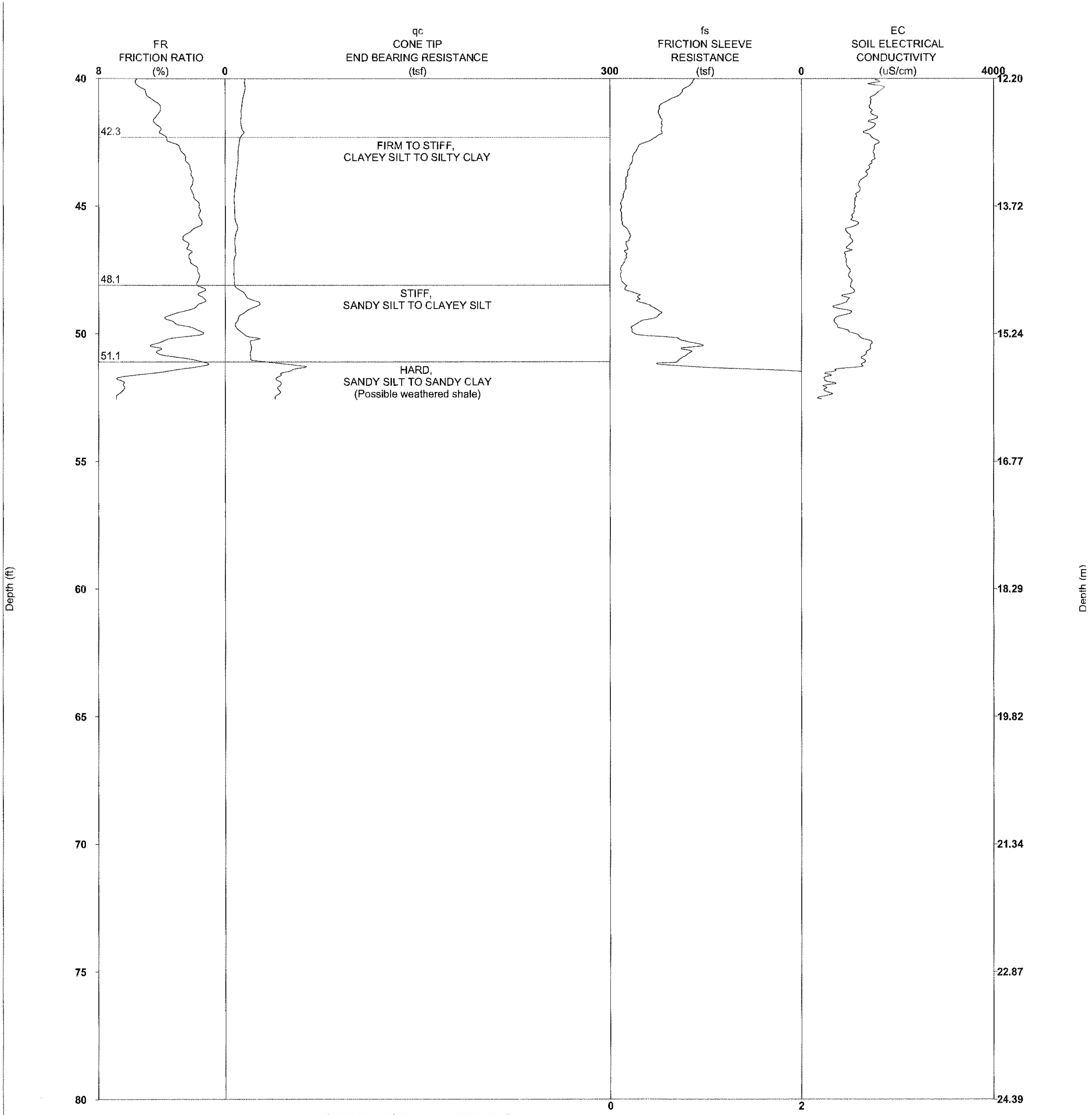
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

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
** Indicates heavily overconsolidated or cemented soil

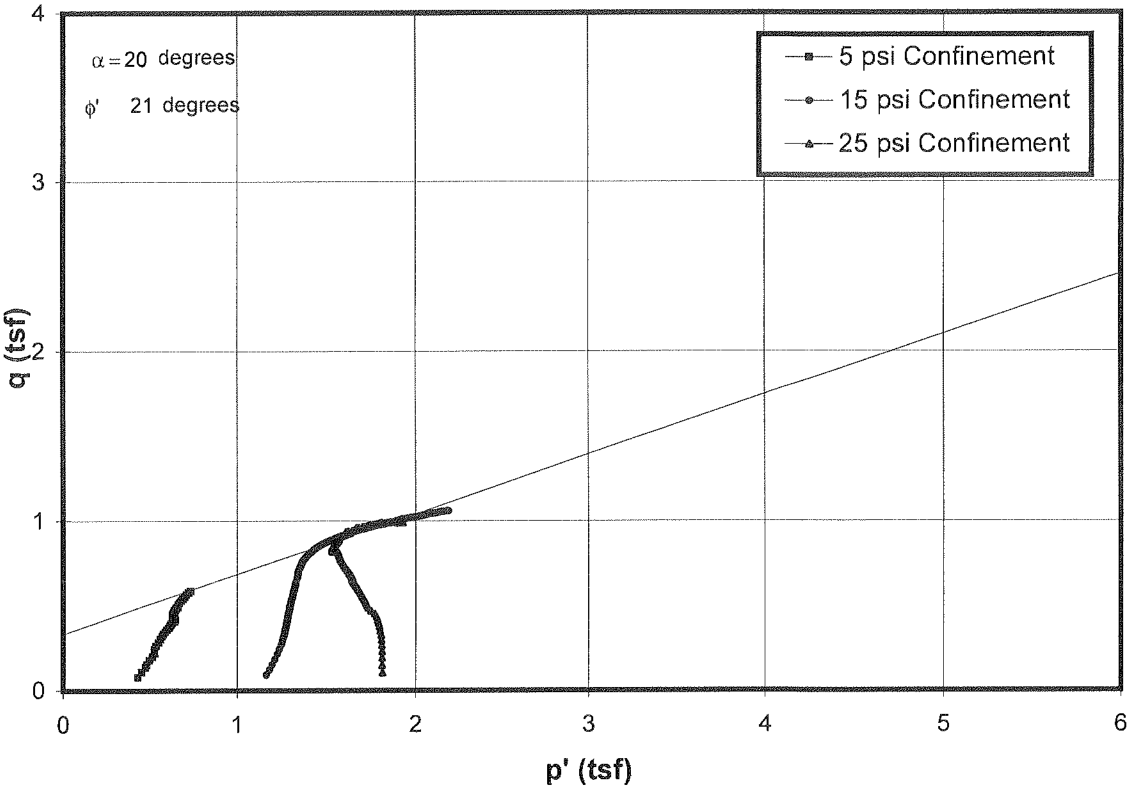
Latitude: 39.54198 Longitude: -92.63939

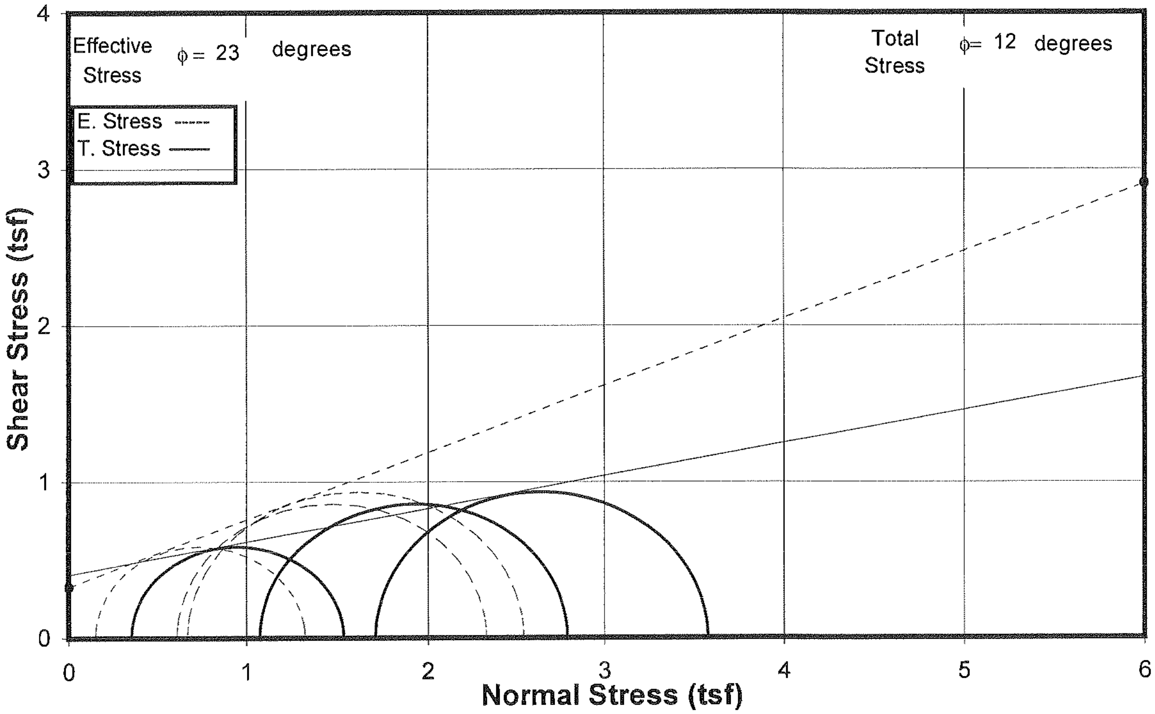
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

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

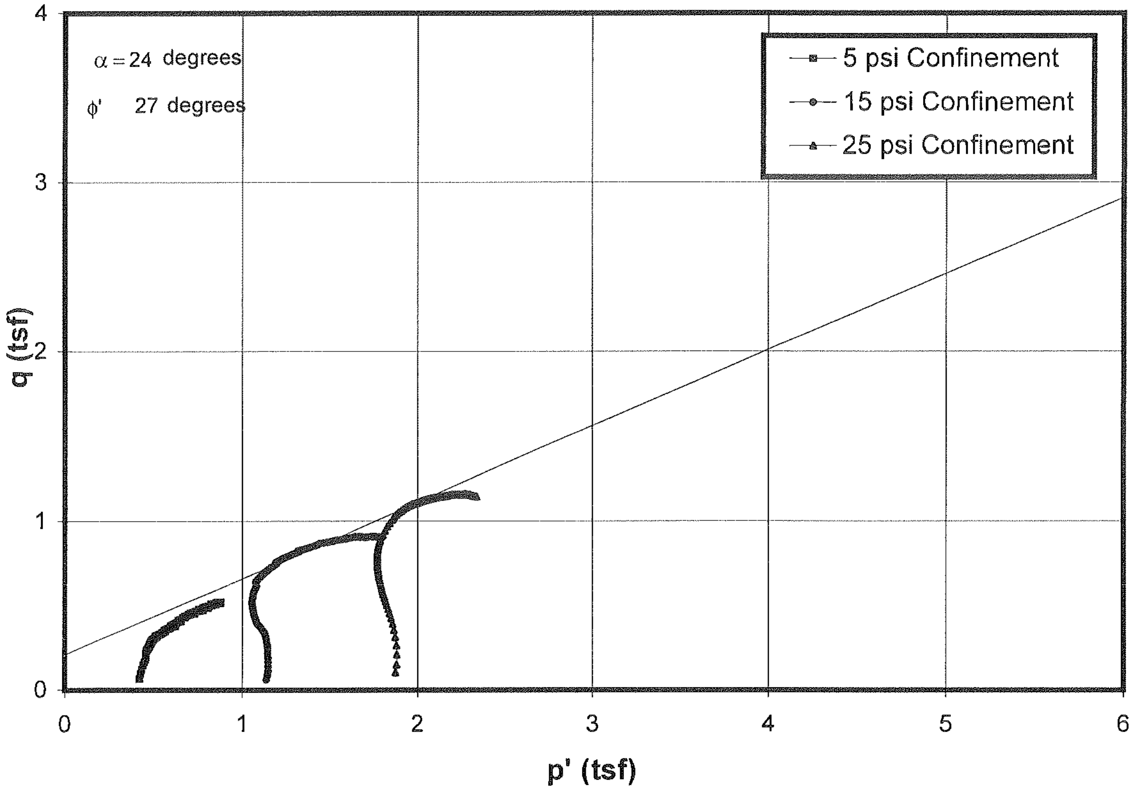
CPCC02

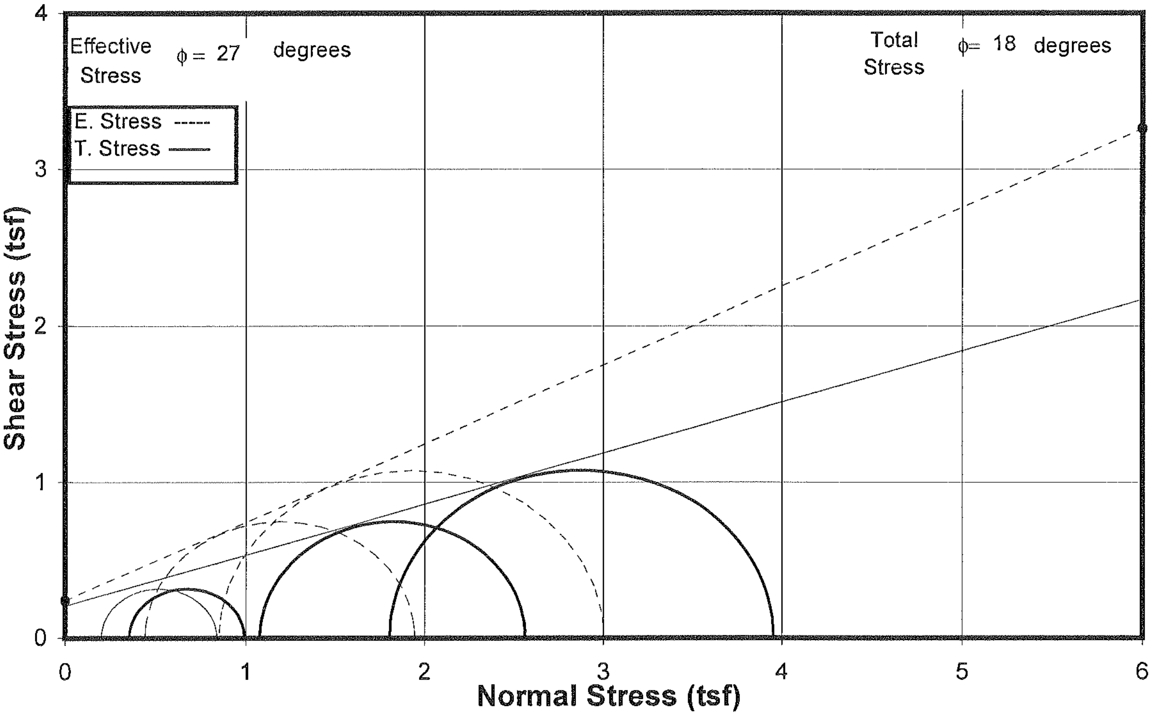




CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

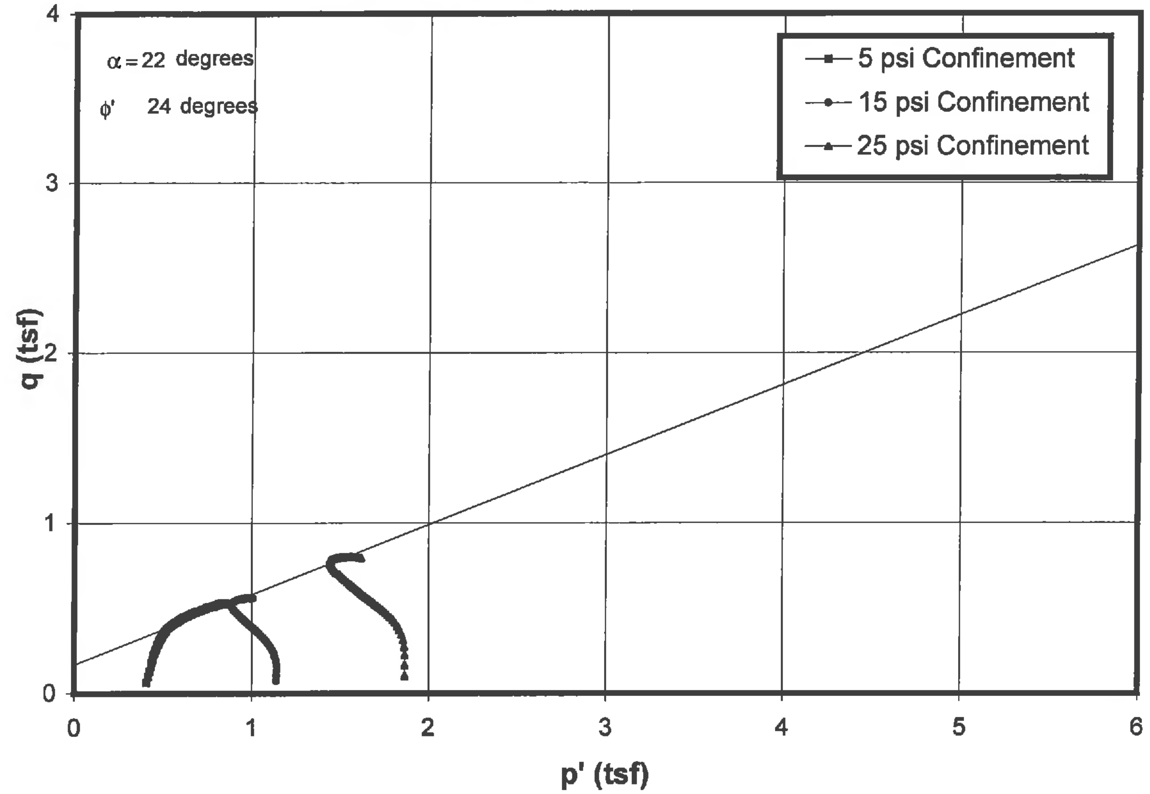
ASTM D 4767
Project No.: J011309.02
Boring: B-1
Sample: ST2, ST2, ST3 - Depth: 3, 3, 5

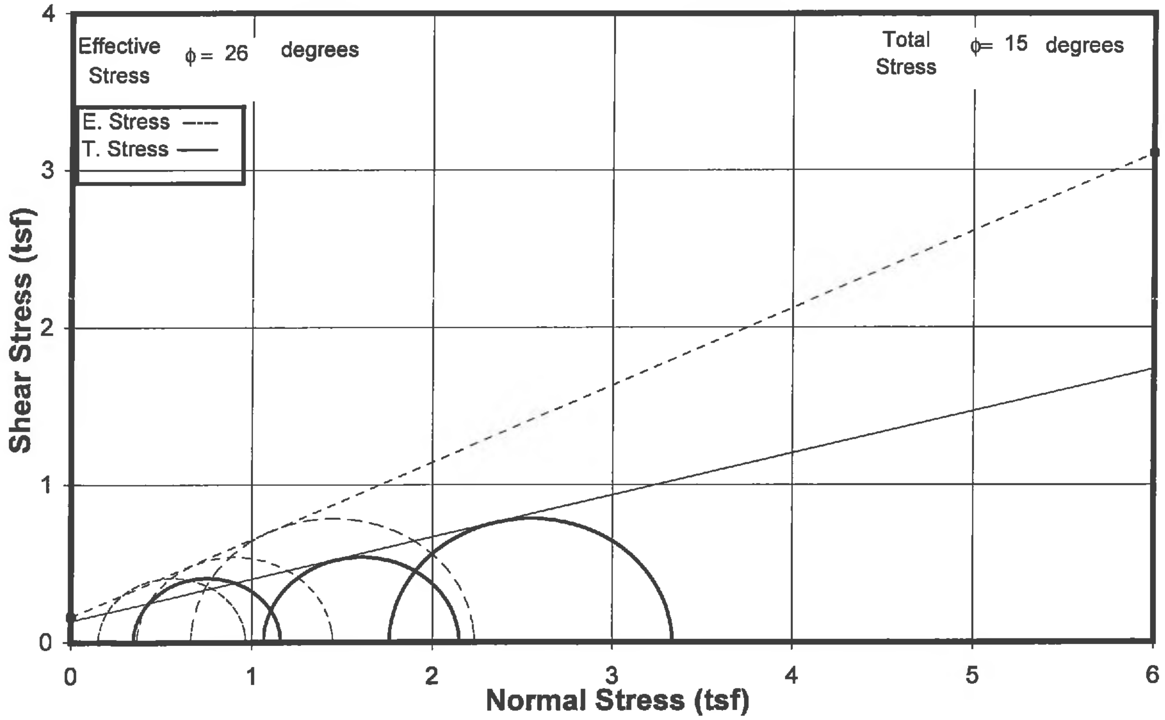




CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

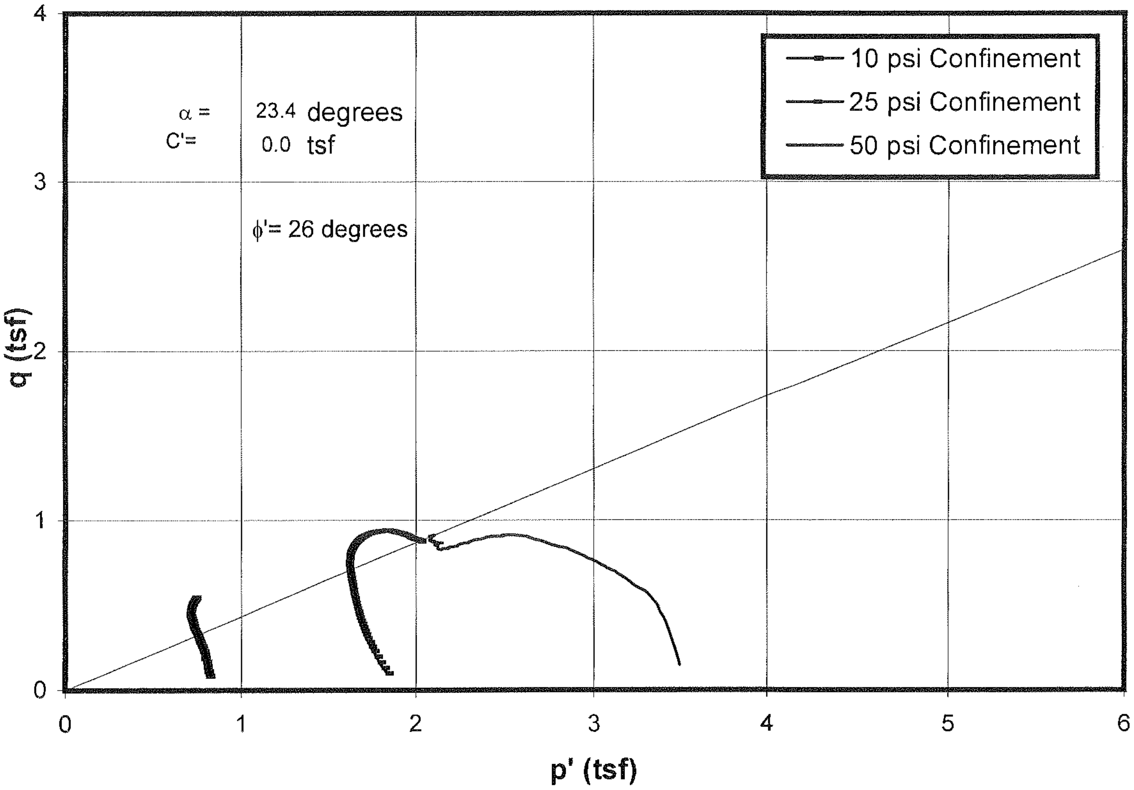
ASTM D 4767
Project No.: J011309.02
Boring: B-2
Sample: ST4 - Depth: 7

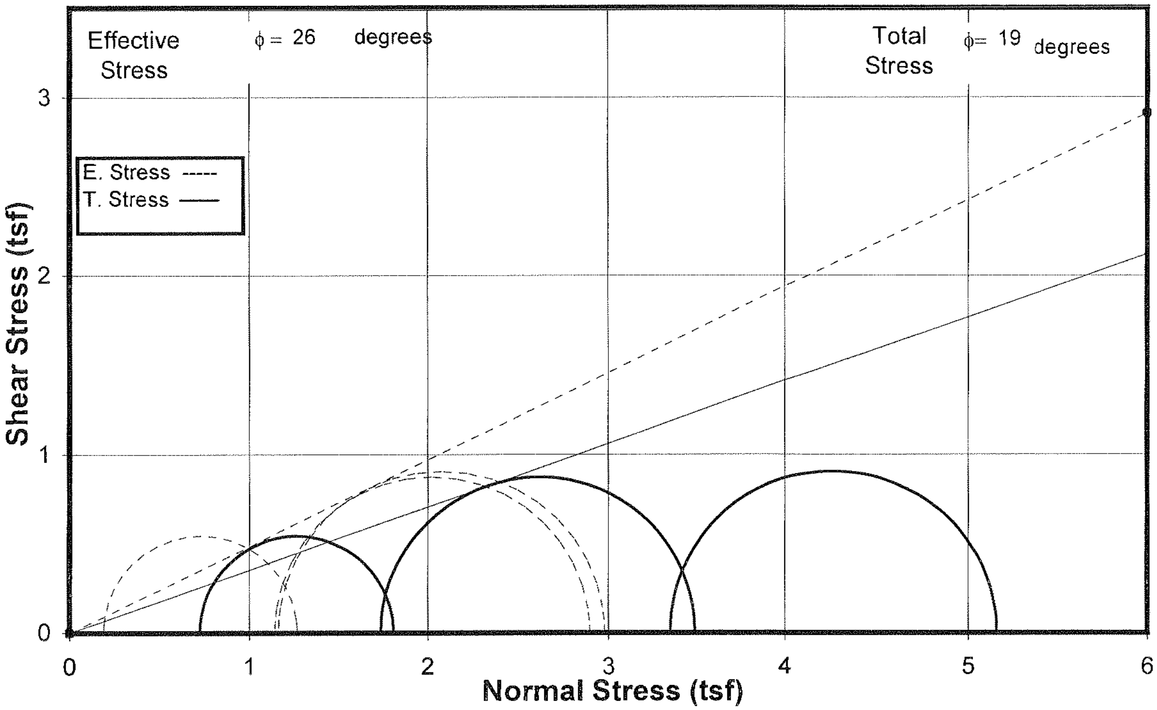




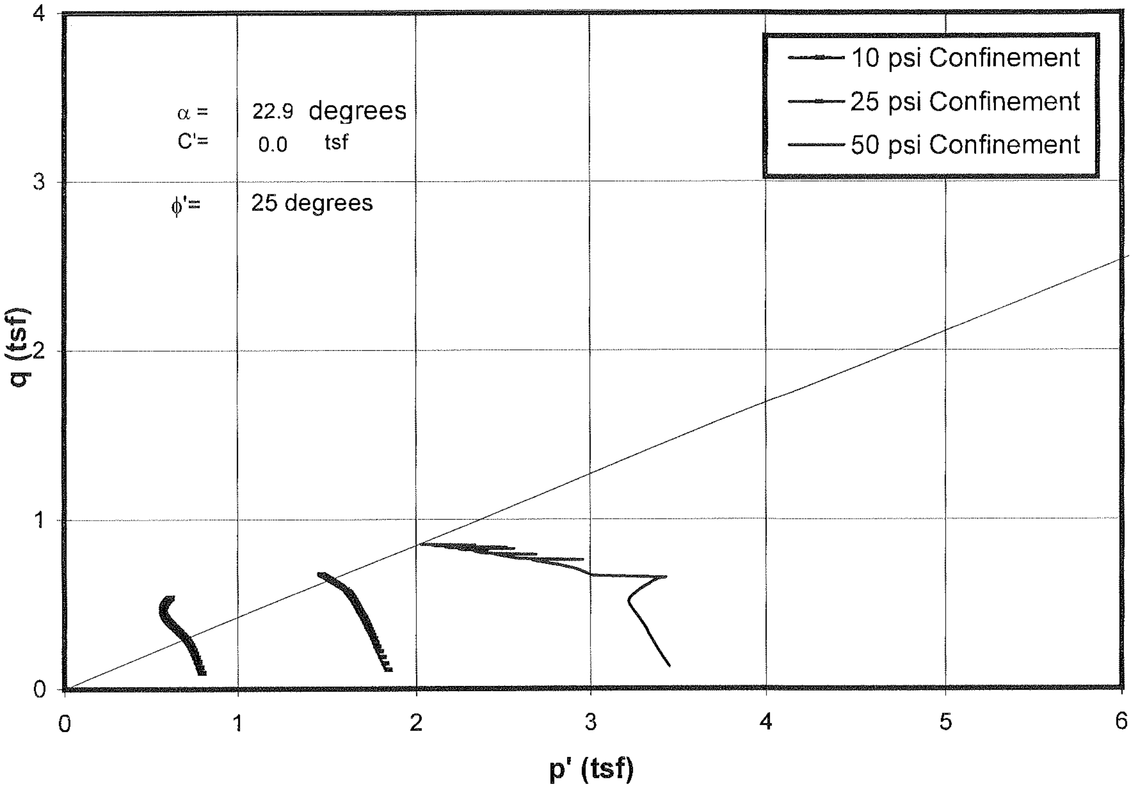
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

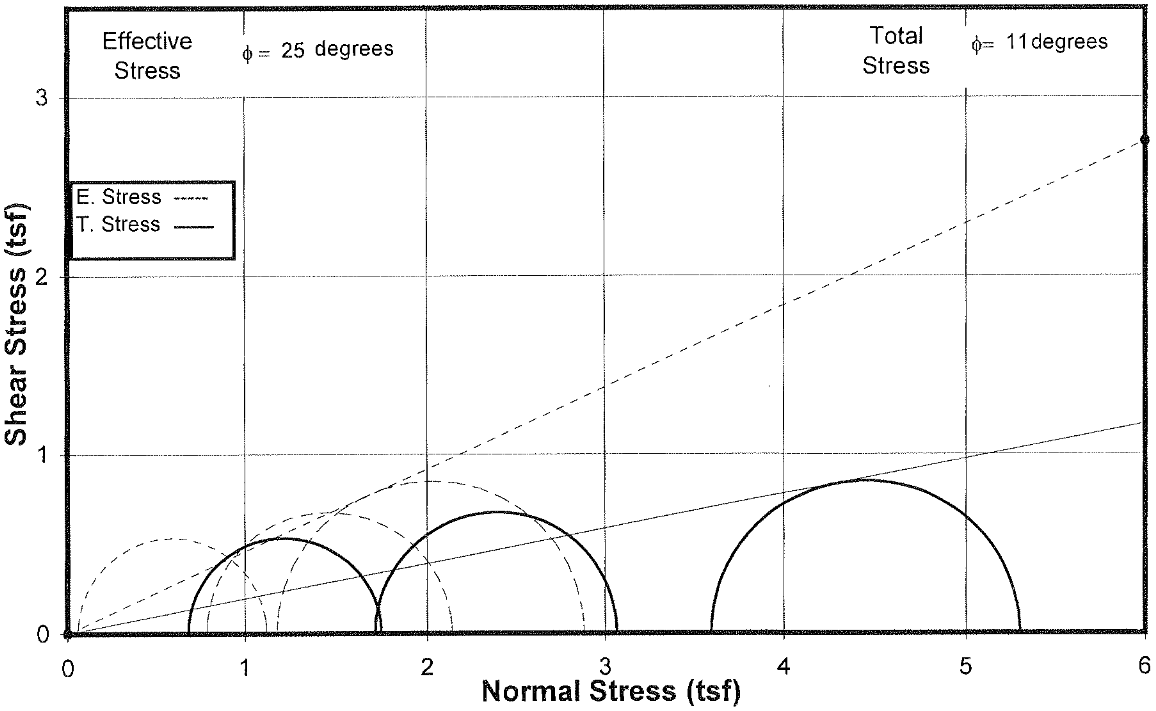
ASTM D 4767
Project No.: J011309.02
Boring: B-5, B-4, B-4
Sample: ST4,ST6,ST7 - Depth: 8, 13,16





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

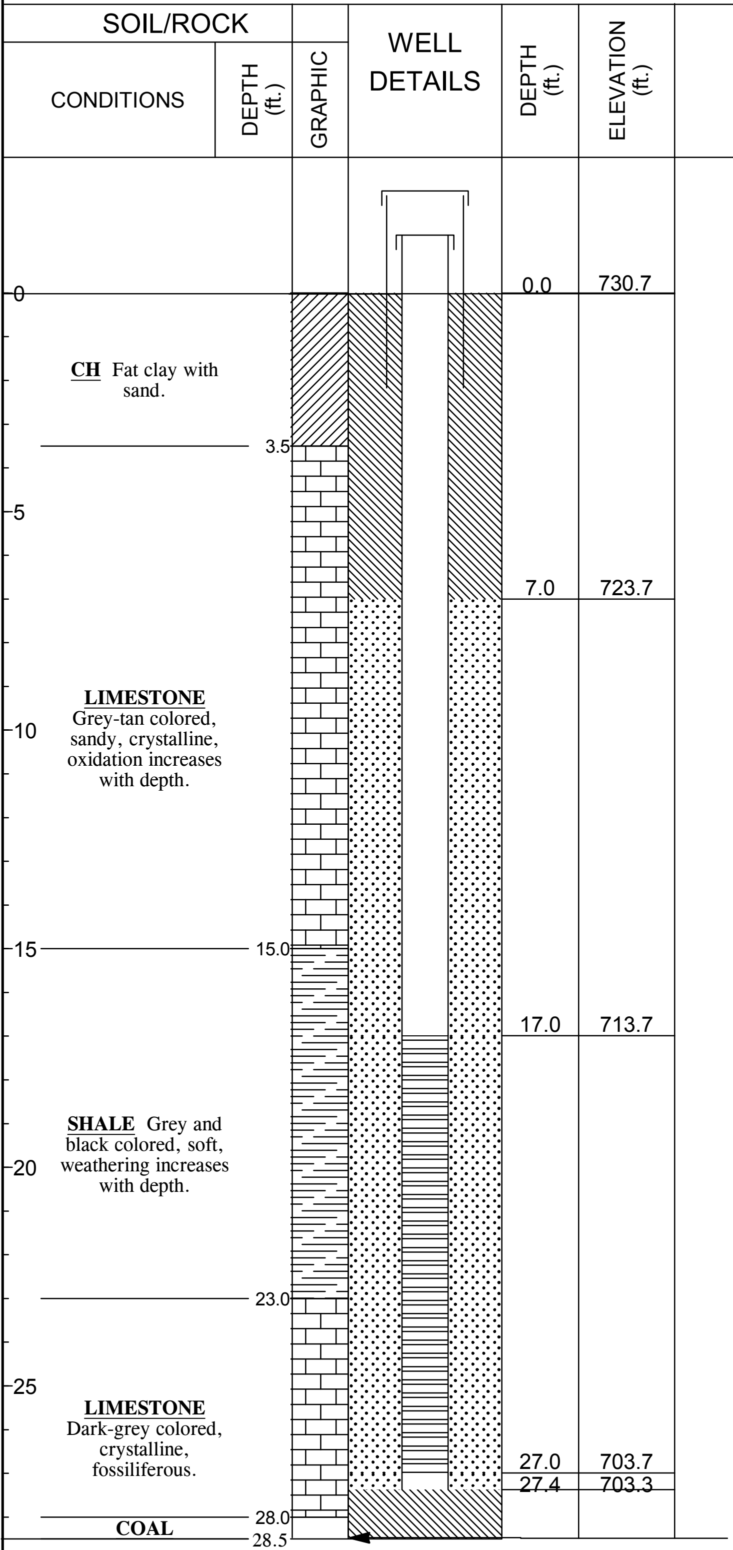
Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

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



CH Fat clay with sand.

LIMESTONE Grey-tan colored, sandy, crystalline, oxidation increases with depth.

SHALE Grey and black colored, soft, weathering increases with depth.

LIMESTONE Dark-grey colored, crystalline, fossiliferous.

COAL

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

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

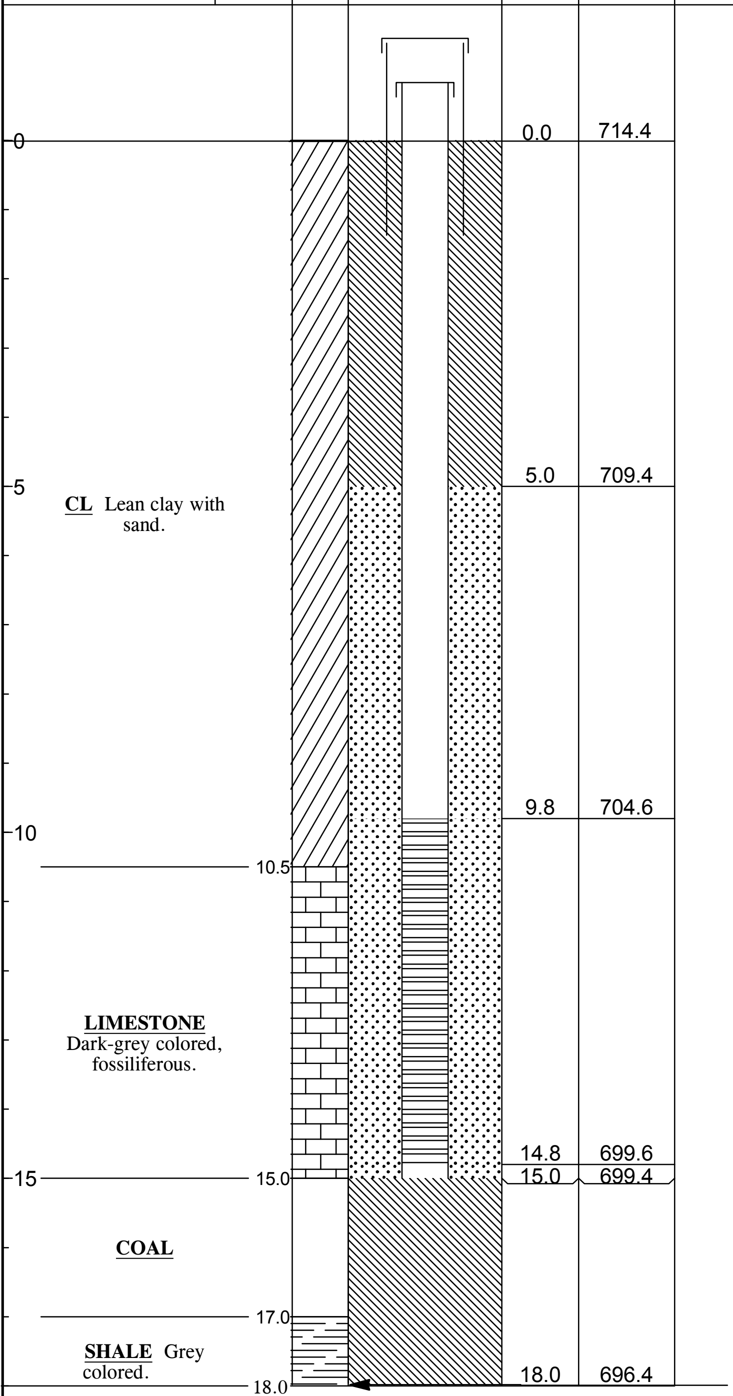
File No.: 40616-400
Date Installed: 24 Aug 2015
H&A Rep.: D. Andersen
Location: See Plan

Ground El.: 714.4
Datum: NGVD

Well Diagram

- ▥ Riser Pipe
- ▤ Screen
- ░ Filter Sand
- ▒ Cuttings
- ■ Grout
- ⁘ Concrete
- ▨ Bentonite Seal

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



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

HALEY ALDRICH

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. TPZ-10

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

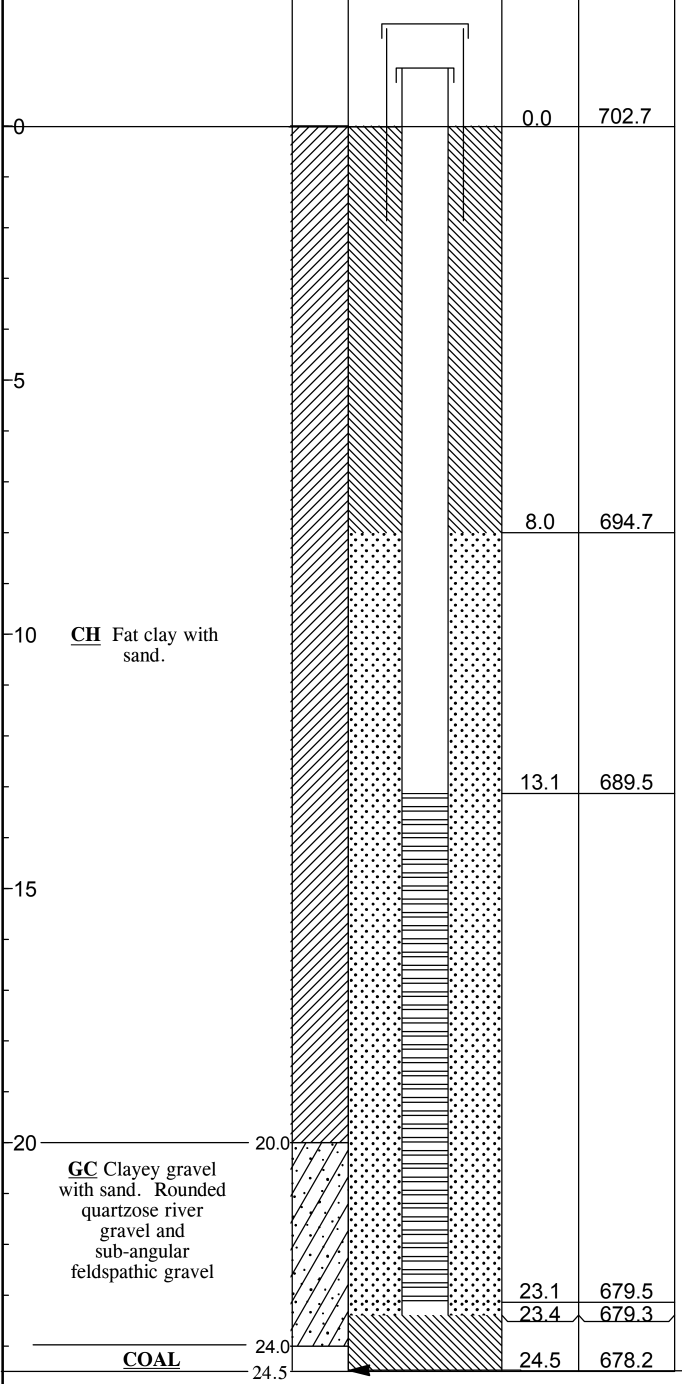
File No. 40616-400
Date Installed 25 Aug 2015
H&A Rep. D. Andersen
Location See Plan

Ground El. 702.7
Datum NGVD

Well Diagram

▥	Riser Pipe
☰	Screen
░	Filter Sand
▒	Cuttings
■	Grout
⁘	Concrete
▧	Bentonite Seal

SOIL/ROCK CONDITIONS	DEPTH (ft.)	DEPTH (ft.)	ELEVATION (ft.)
		0.0	702.7
		8.0	694.7
CH Fat clay with sand.		13.1	689.5
GC Clayey gravel with sand. Rounded quartzose river gravel and sub-angular feldspathic gravel	20.0	23.1	679.5
		23.4	679.3
COAL	24.0 24.5	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

HALEY ALDRICH

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. TPZ-11

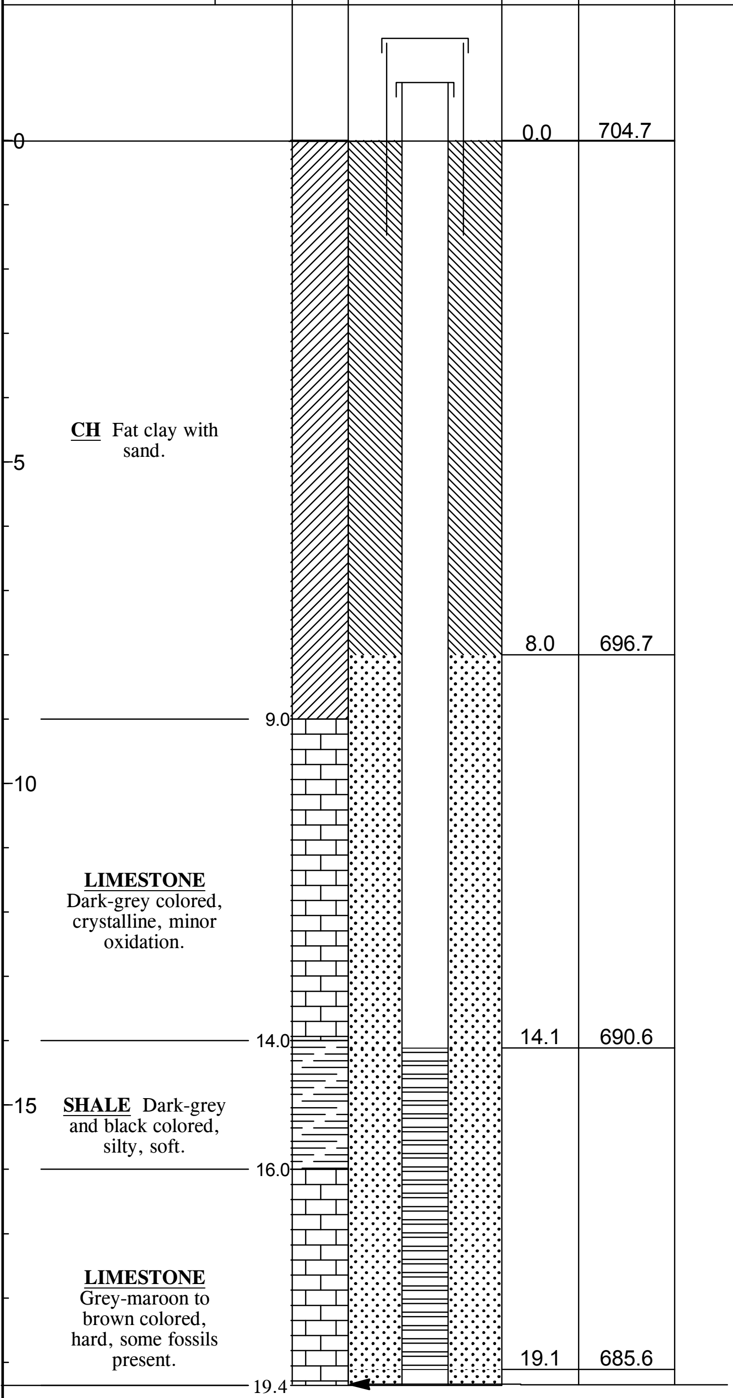
Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

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



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 (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

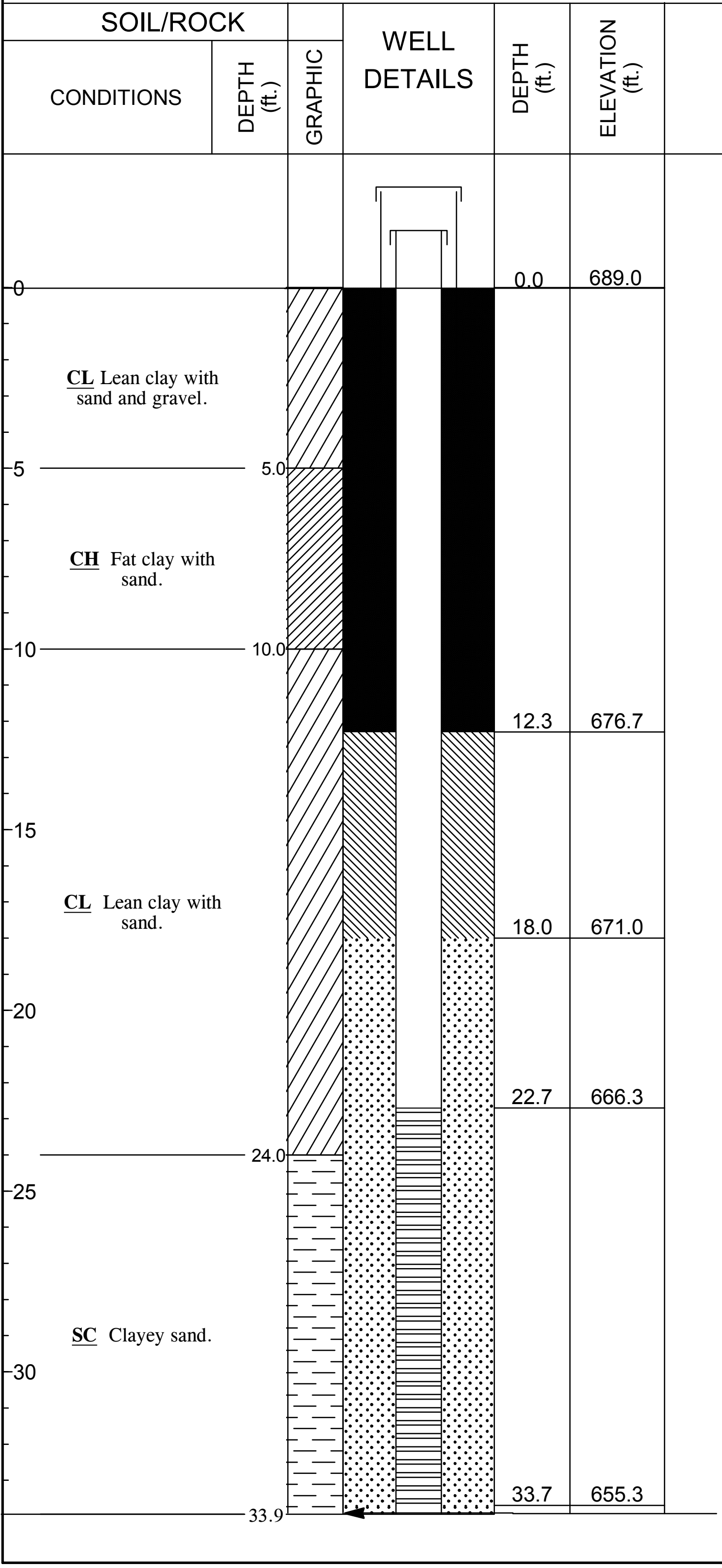
GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

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



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

Well No. TPZ-14

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

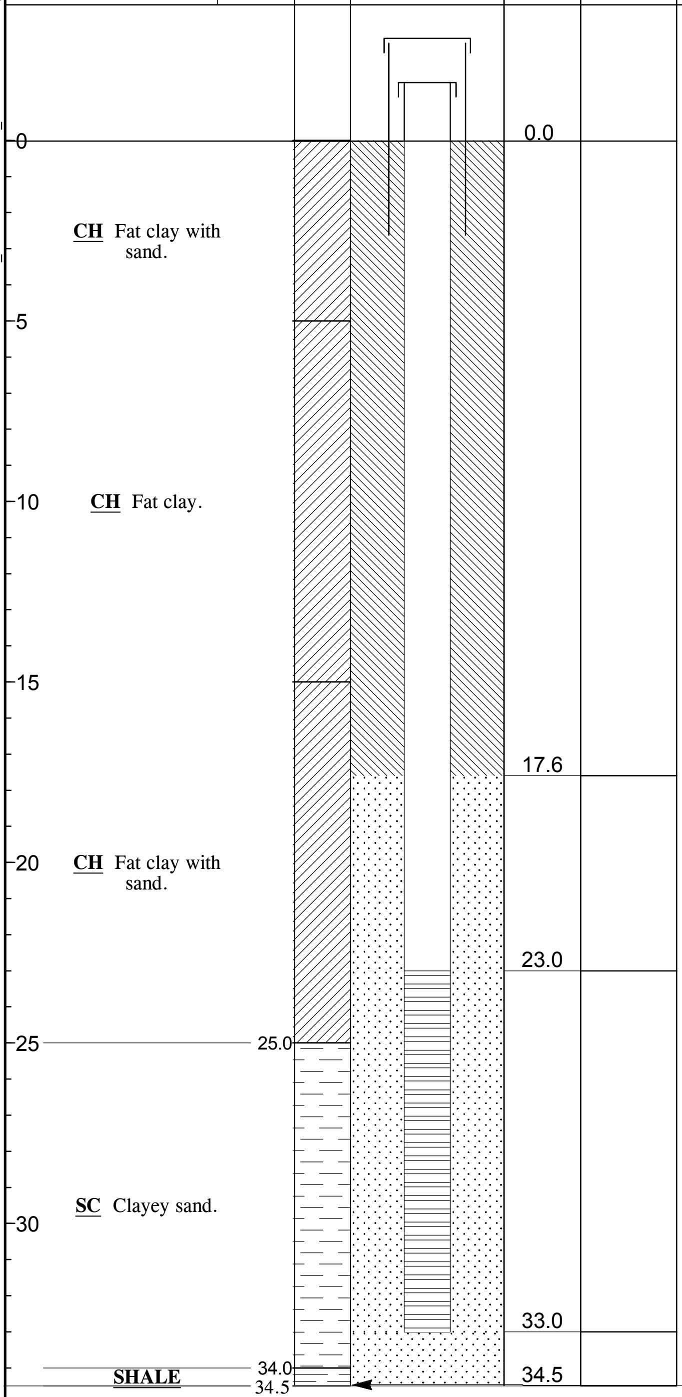
Well Diagram

▥	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



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

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 $S_u/\sigma_v' = 0.360$	600 psf	--	**--**	**--**	**$S_{u,min} = 600$ psf** **$S_u/\sigma_v' = 0.360$**	--	--	--	--	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 $S_u/\sigma_v' = 0.253$	700 to 1000 psf	--	**--**	**--**	**$S_{u,min} = 800$ psf** **$S_u/\sigma_v' = 0.253$**	--	--	--	--	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 Design[1]	Current Design	SPT		CPT		UU and CIU Trx	Historic Design[1]		Current Design			SPT		CPT		Laboratory CIU Trx (Site-Wide)				Historic Design[1]		Current Design	
	avg	Site-Wide Average			avg	avg - 1σ	avg	avg - 1σ	avg						avg	avg - 1σ	avg	avg - 1σ	avg		min.					
	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:

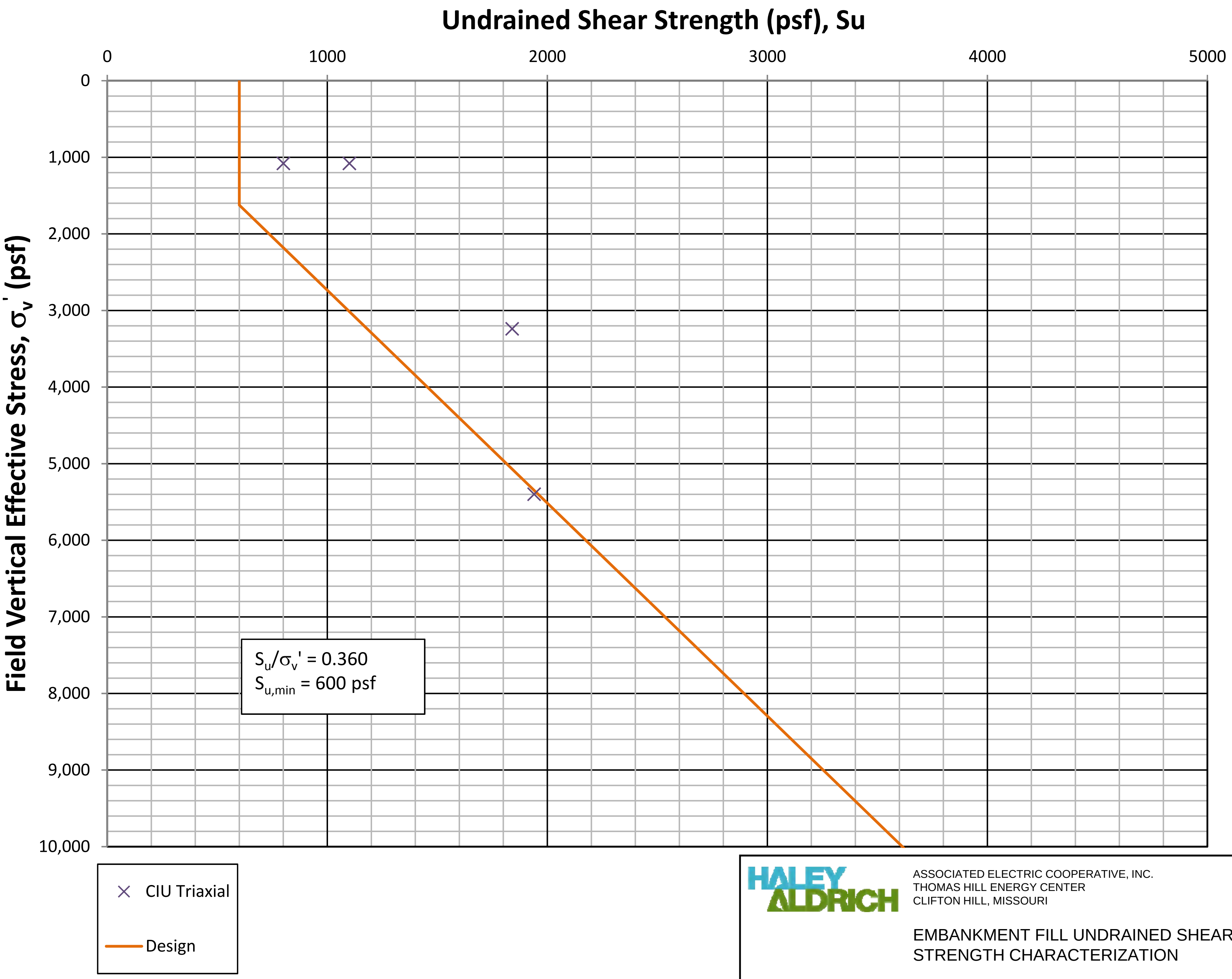
1. Based on historic analyses performed by Geotechnology, Inc.
2. In cases where historic design properties, SPT/CPT correlations, and laboratory test data do not exist, the current design properties for these materials have been conservatively estimated using typical published values and Haley & Aldrich's 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 Design[1]	Current Design	SPT		CPT		UU and CIU Trx	Historic Design[1]		Current Design			SPT		CPT		Laboratory CIU Trx (Site-Wide)				Historic Design[1]		Current Design	
	avg	Site-Wide Average			avg	avg - 1σ	avg	avg - 1σ	avg						avg	avg - 1σ	avg	avg - 1σ	avg		min.					
	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.

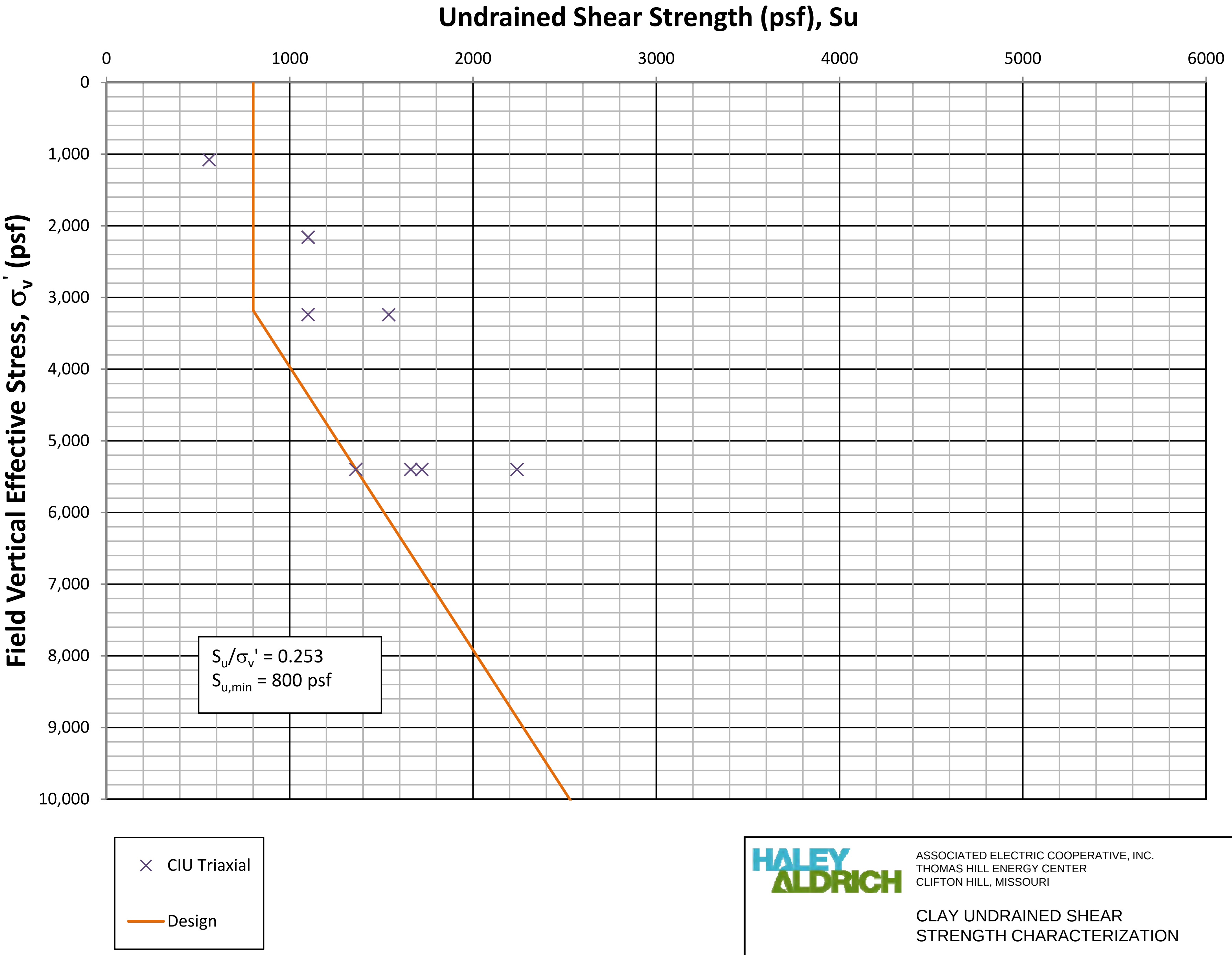


ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

EMBANKMENT FILL UNDRAINED SHEAR STRENGTH CHARACTERIZATION

SCALE : AS SHOWN
OCTOBER 2016

FIGURE C1



HALEY ALDRICH

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

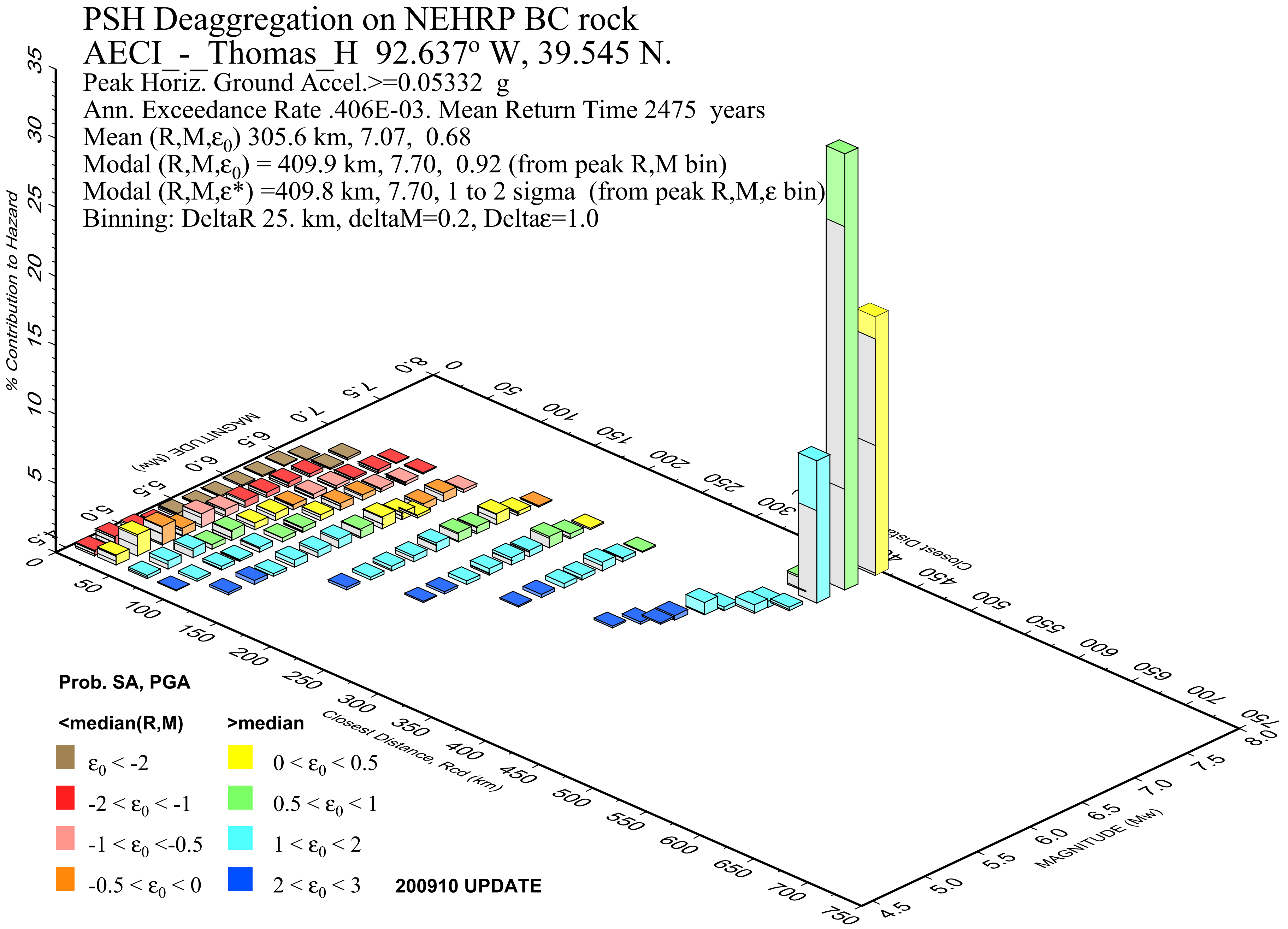
CLAY UNDRAINED SHEAR STRENGTH CHARACTERIZATION

SCALE : AS SHOWN
OCTOBER 2016

FIGURE C2

128064-003_FIG C2.PPT

Seismic Documents



PSH Deaggregation on NEHRP BC rock

AECI_-_Thomas_H 92.637° W, 39.545 N.

Peak Horiz. Ground Accel.>=0.05332 g

Ann. Exceedance Rate .406E-03. Mean Return Time 2475 years

Mean (R,M,ε_0) 305.6 km, 7.07, 0.68

Modal (R,M,ε_0) = 409.9 km, 7.70, 0.92 (from peak R,M bin)

Modal (R,M,ε^*) =409.8 km, 7.70, 1 to 2 sigma (from peak R,M,ε bin)

Binning: DeltaR 25. km, deltaM=0.2, Deltaε=1.0

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

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

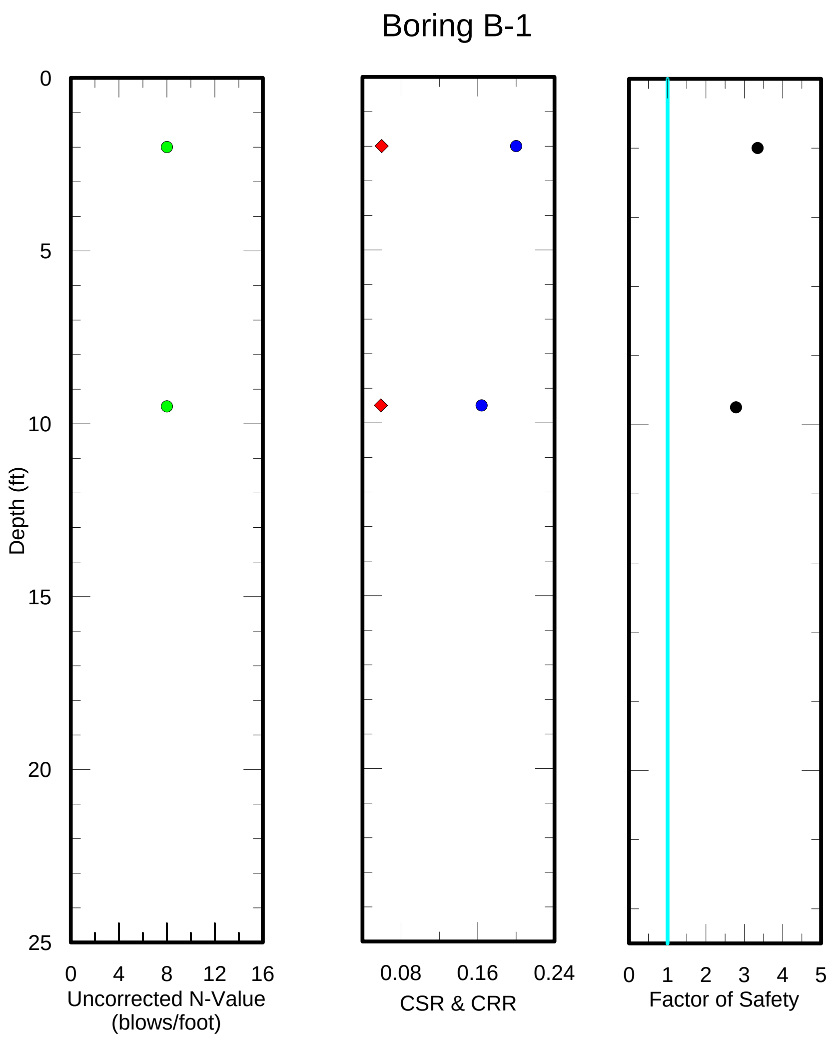
For Site Class = D and PGA = 0.057 g, F_{PGA} = 1.600

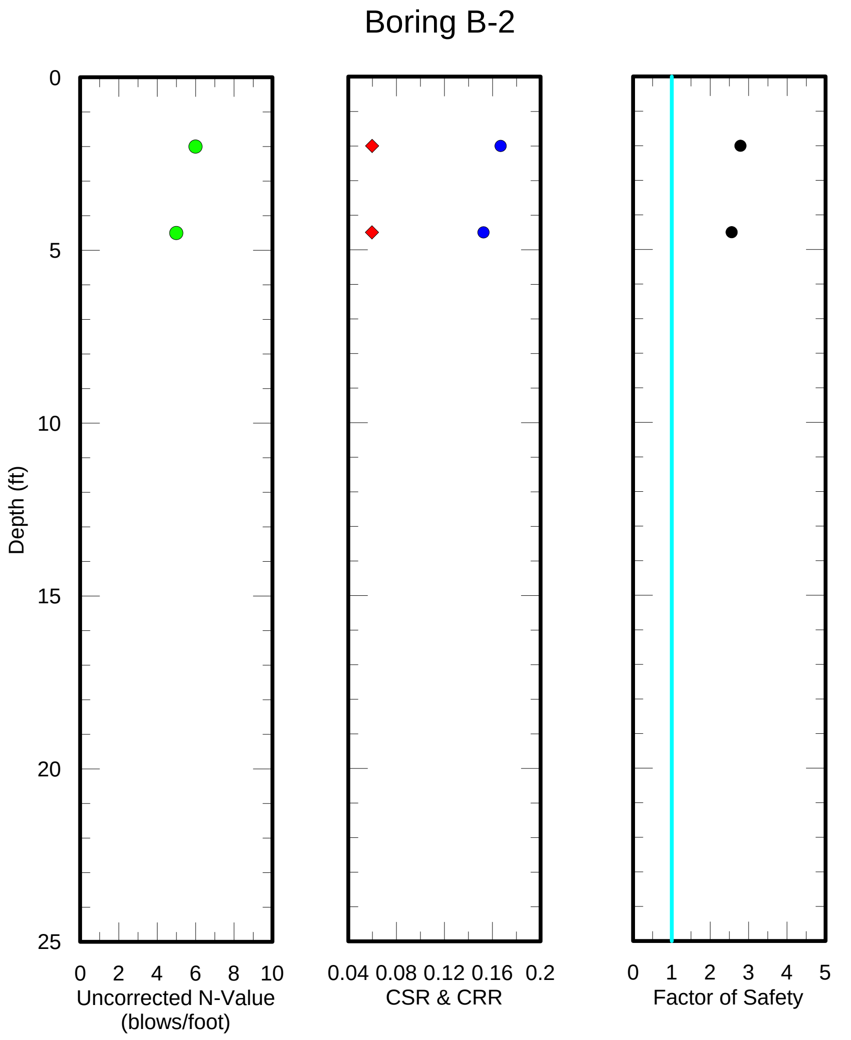
Section 21.2.1.1 — Method 1 (from Chapter 21 – Site-Specific Ground Motion Procedures for Seismic Design)

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

Liquefaction Analysis

\\was\Common\Projects\40616\-XXX TH SF Assessment\Analyses\Liquefaction\SPT_Liquefaction Triggering_2500 B-1, B-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

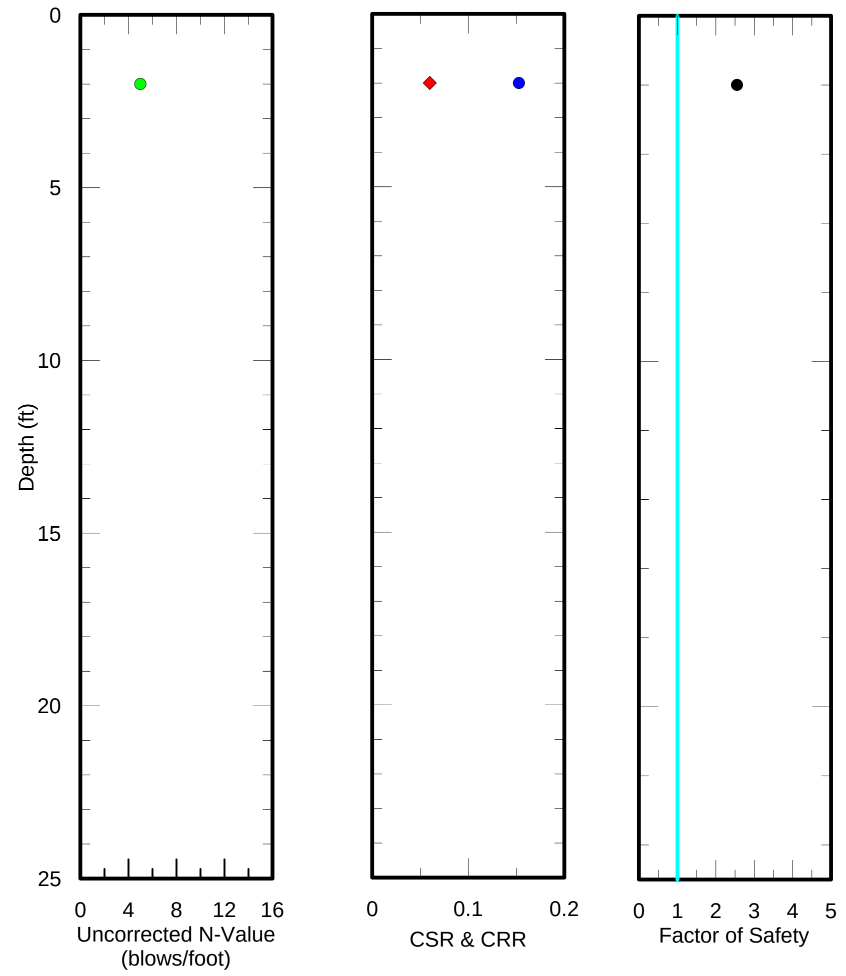
Liquefaction Triggering Evaluation
B-1 & B-2
2,500-Year Return Period

October 2016

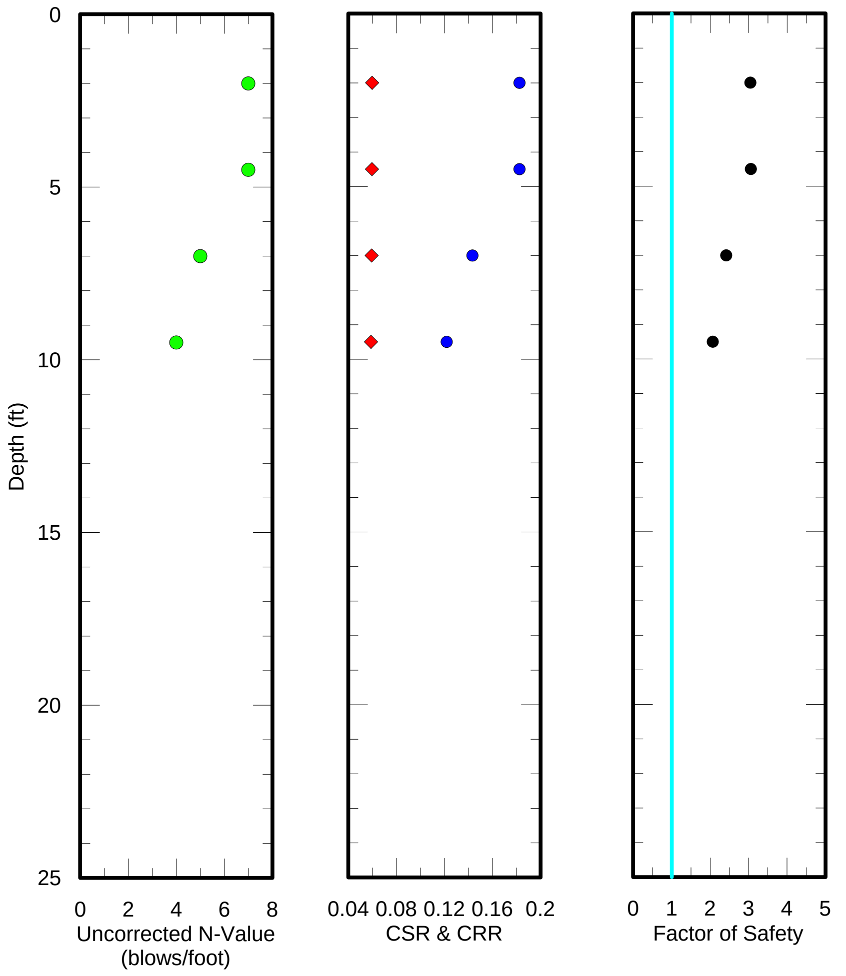
FIGURE NO.

\\was\Common\Projects\40616\-XXX TH SF Assessment\Analyses\Liquefaction\SPT_Liquefaction Triggering_2500 B-3, B-4.grf

Boring B-3



Boring B-4



LEGEND

♦ Cyclic Stress Ratio$_{M,\sigma'_{vc}}$

● Cyclic Resistance Ratio$_{M,\sigma'_{vc}}$

● Factor of Safety

NOTES:
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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.
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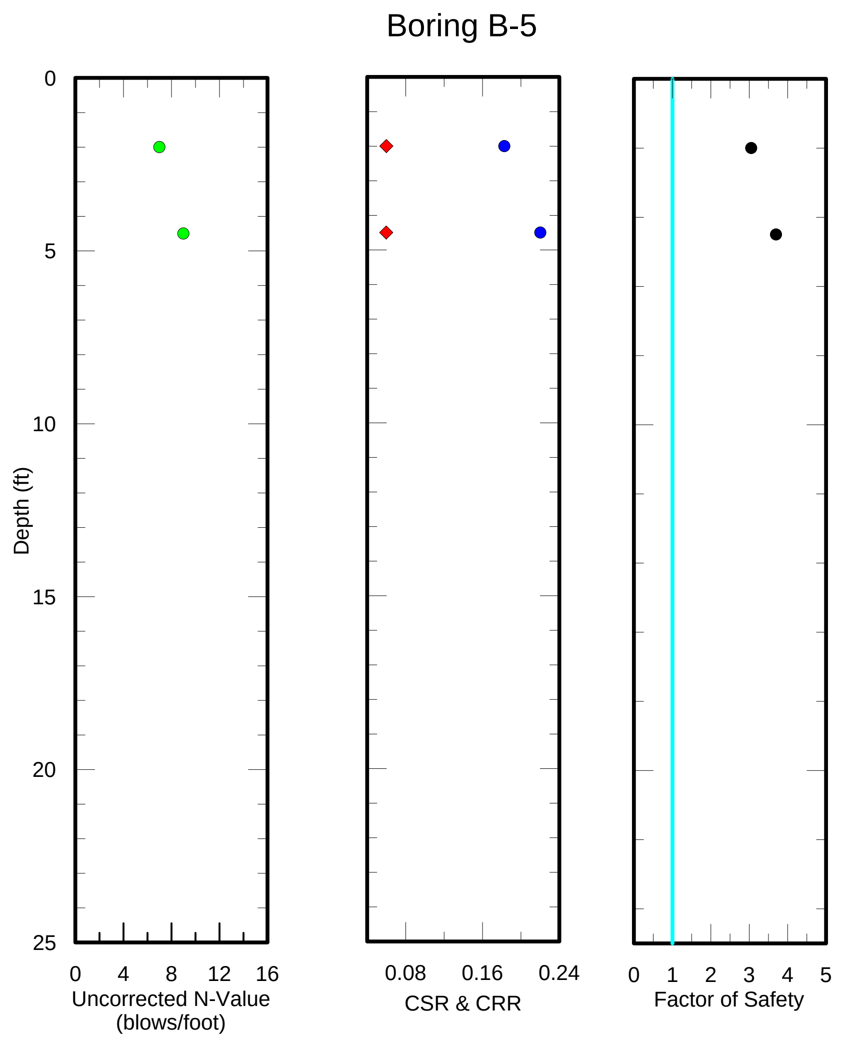
Thomas Hill Energy Center Liquefaction Analysis

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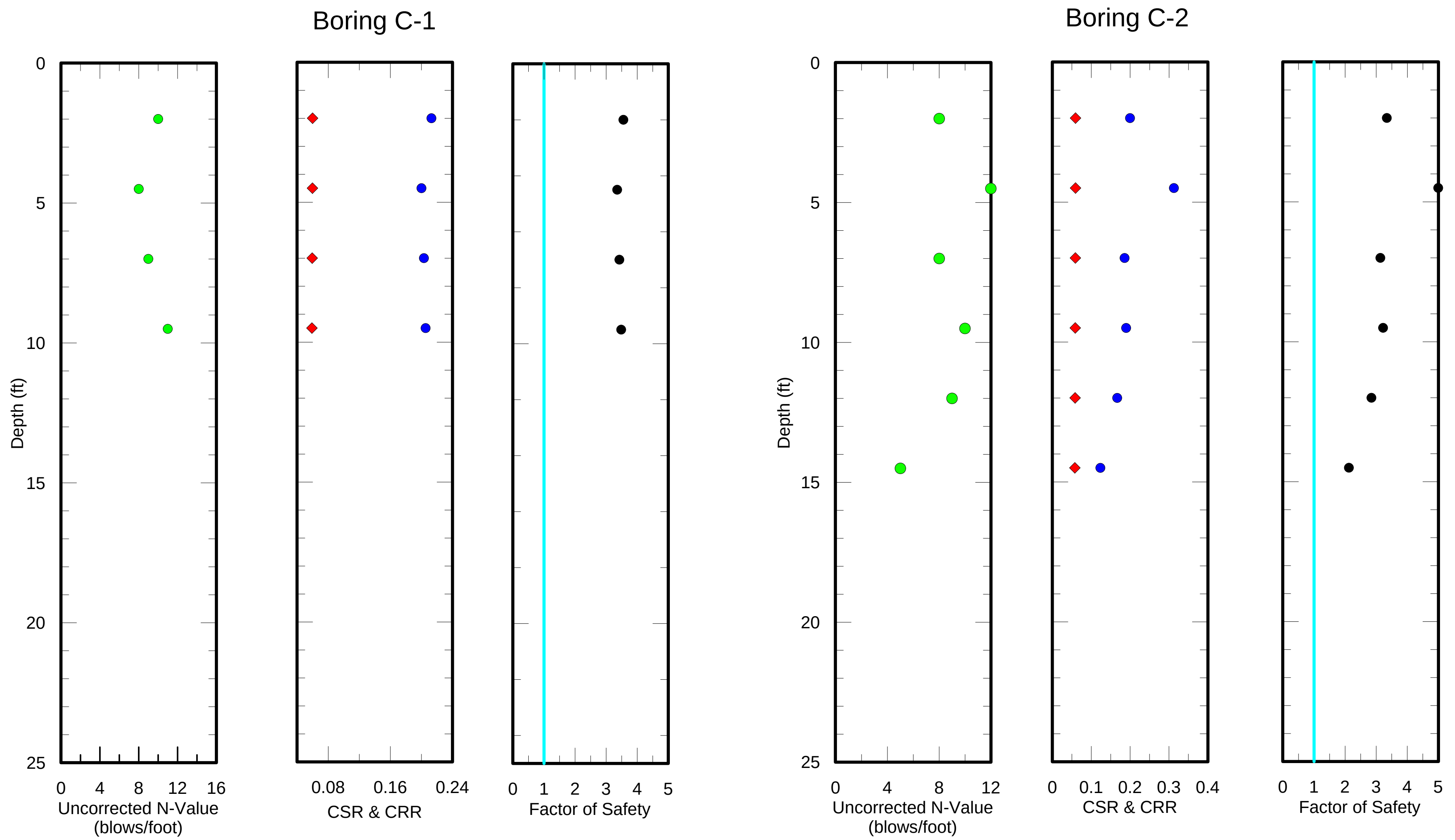
Liquefaction Triggering Evaluation
B-5
2,500-Year Return Period

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.
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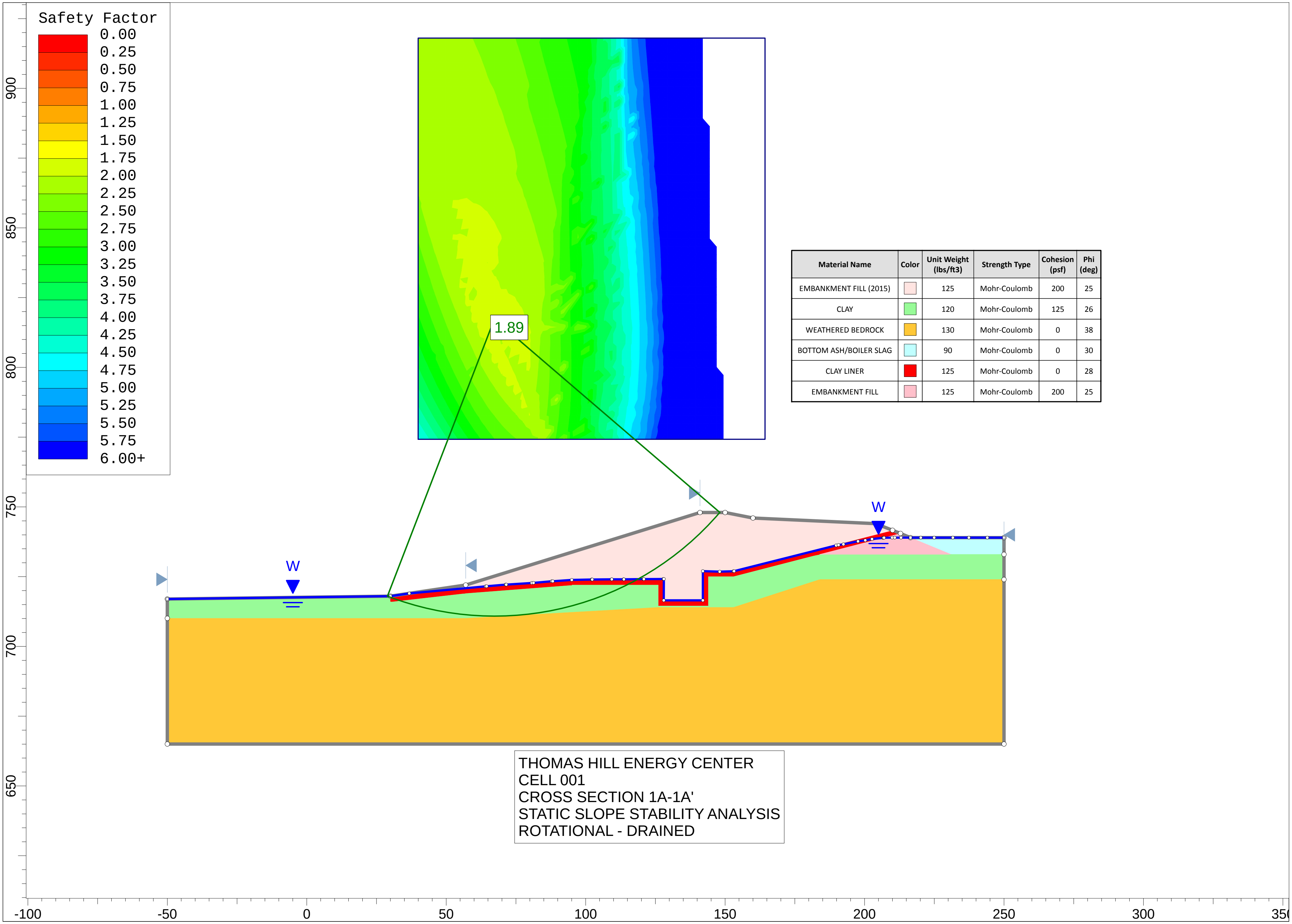
Thomas Hill Energy Center Liquefaction Analysis

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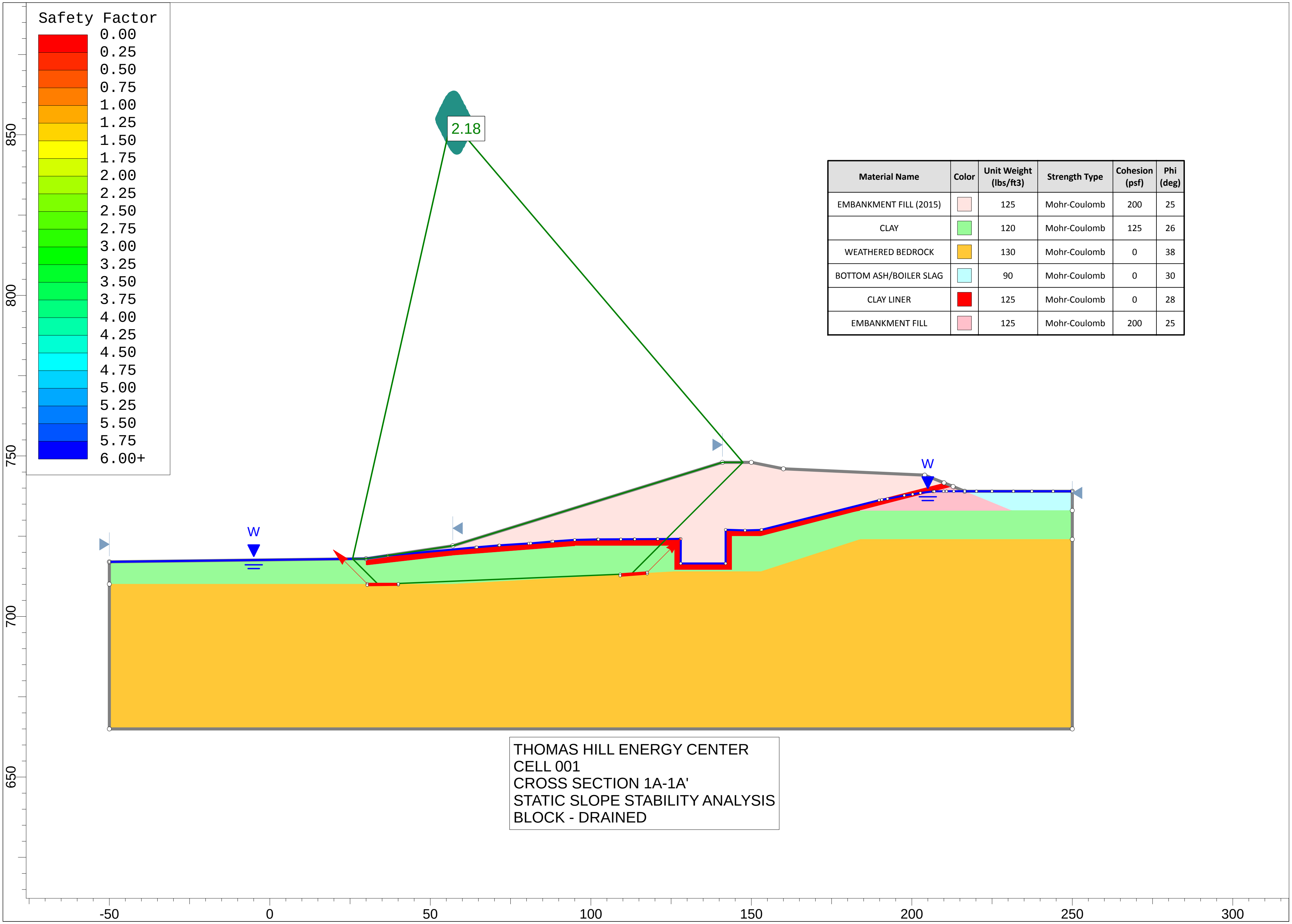
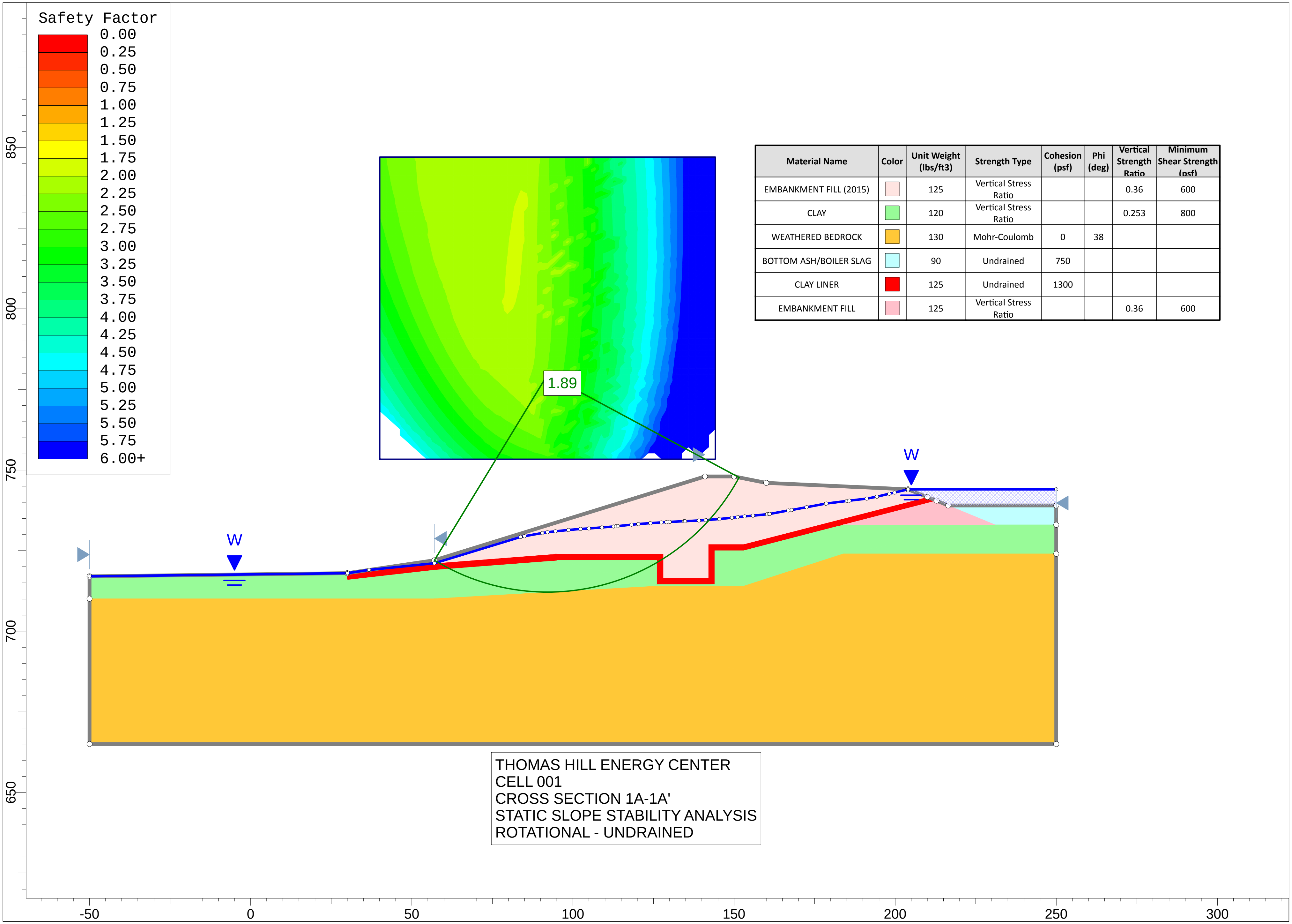
CELL 001
CROSS SECTION 1A-1A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - DRAINED



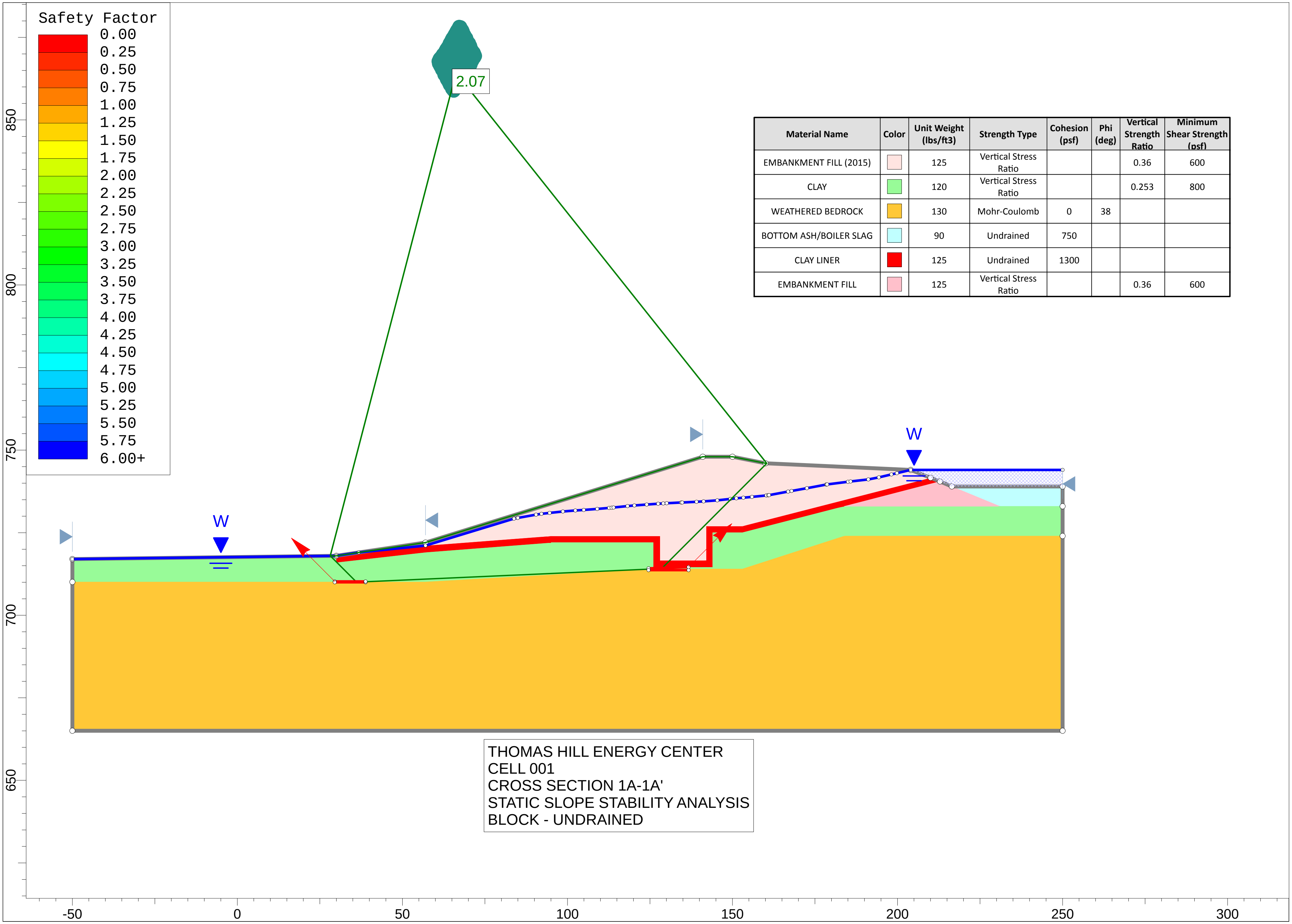
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL (2015)	▨	125	Mohr-Coulomb	200	25
CLAY	🟩	120	Mohr-Coulomb	125	26
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	38
BOTTOM ASH/BOILER SLAG	🟦	90	Mohr-Coulomb	0	30
CLAY LINER	🟥	125	Mohr-Coulomb	0	28
EMBANKMENT FILL	▨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

THOMAS HILL ENERGY CENTER
CELL 001
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

THOMAS HILL ENERGY CENTER
CELL 001
CROSS SECTION 1A-1A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



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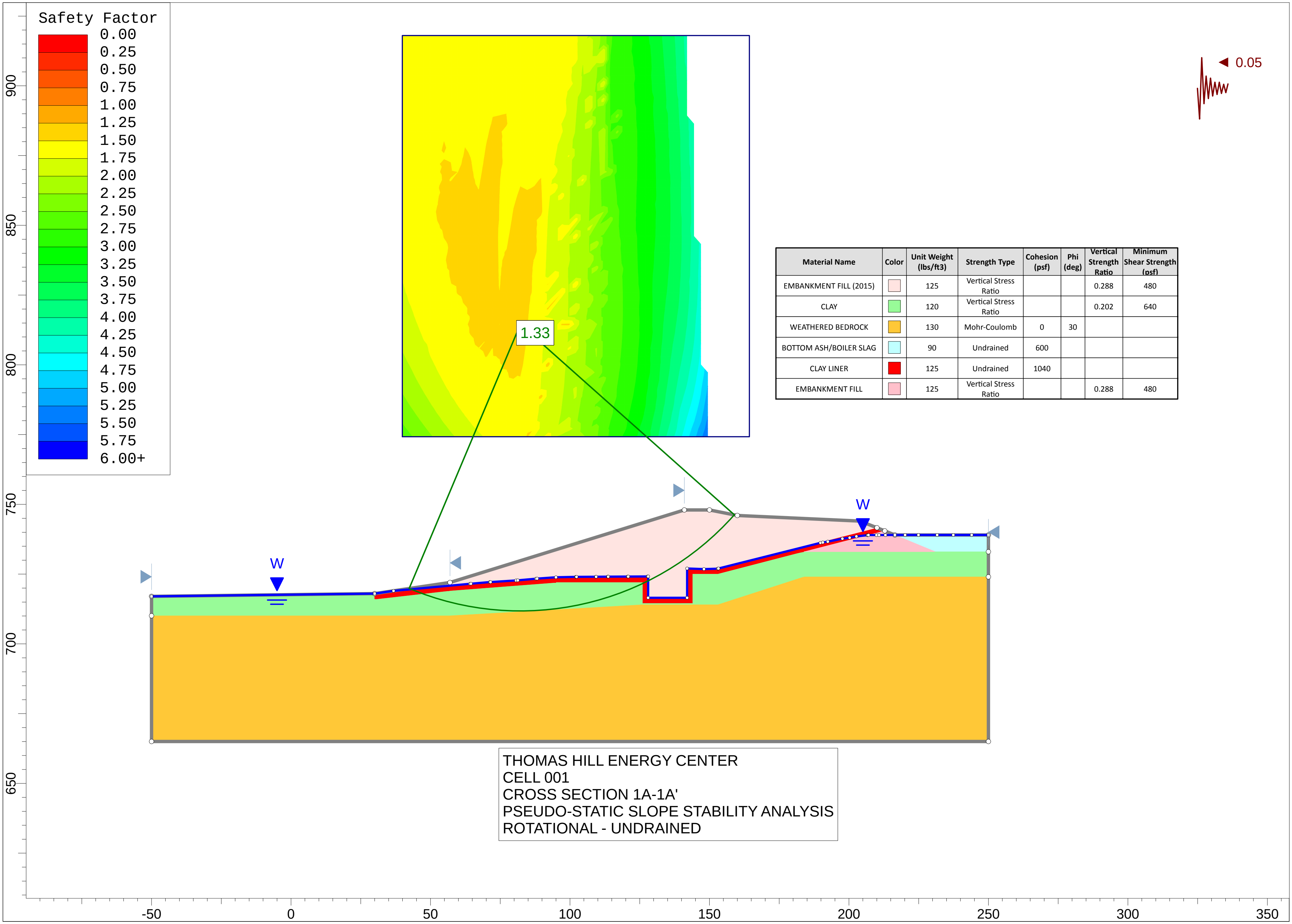
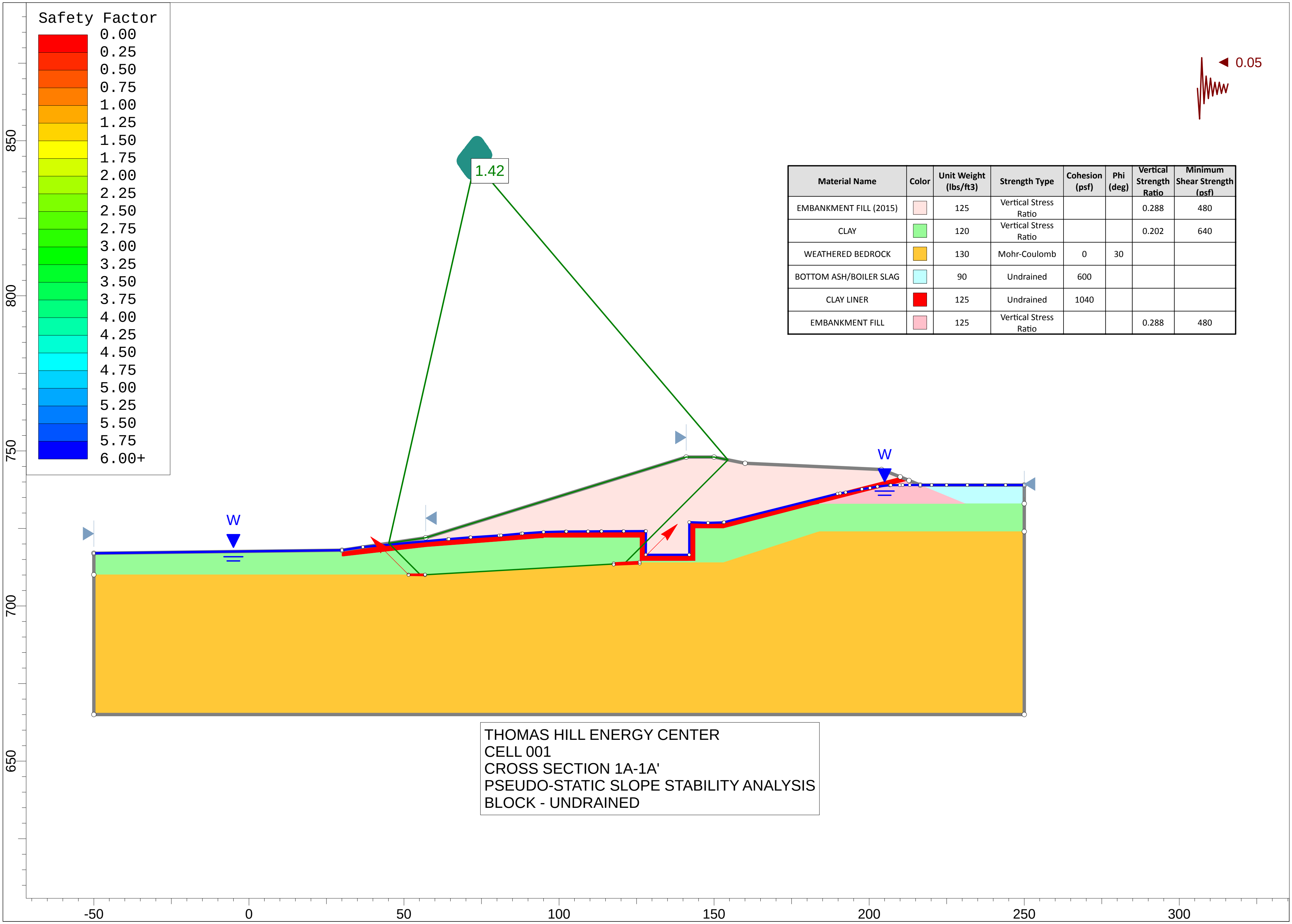
EMBANKMENT FILL	⬜	125	Vertical Stress Ratio			0.36	600

THOMAS HILL ENERGY CENTER
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

THOMAS HILL ENERGY CENTER
CELL 001
CROSS SECTION 1A-1A'
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



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CLAY LINER	🟥	125	Undrained	1040			
EMBANKMENT FILL	🟪	125	Vertical Stress Ratio			0.288	480

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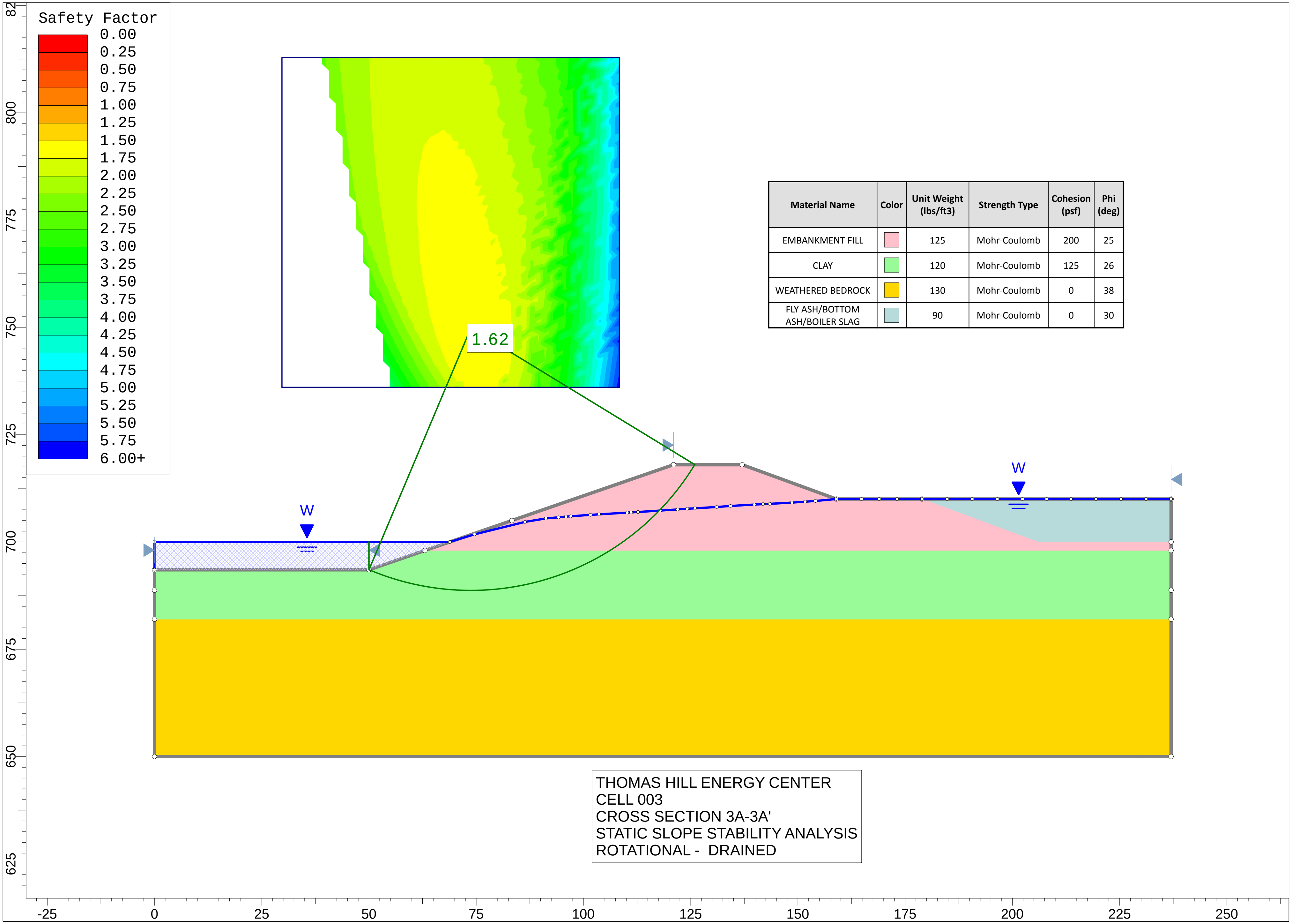
CROSS SECTION 1A-1A'
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED



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

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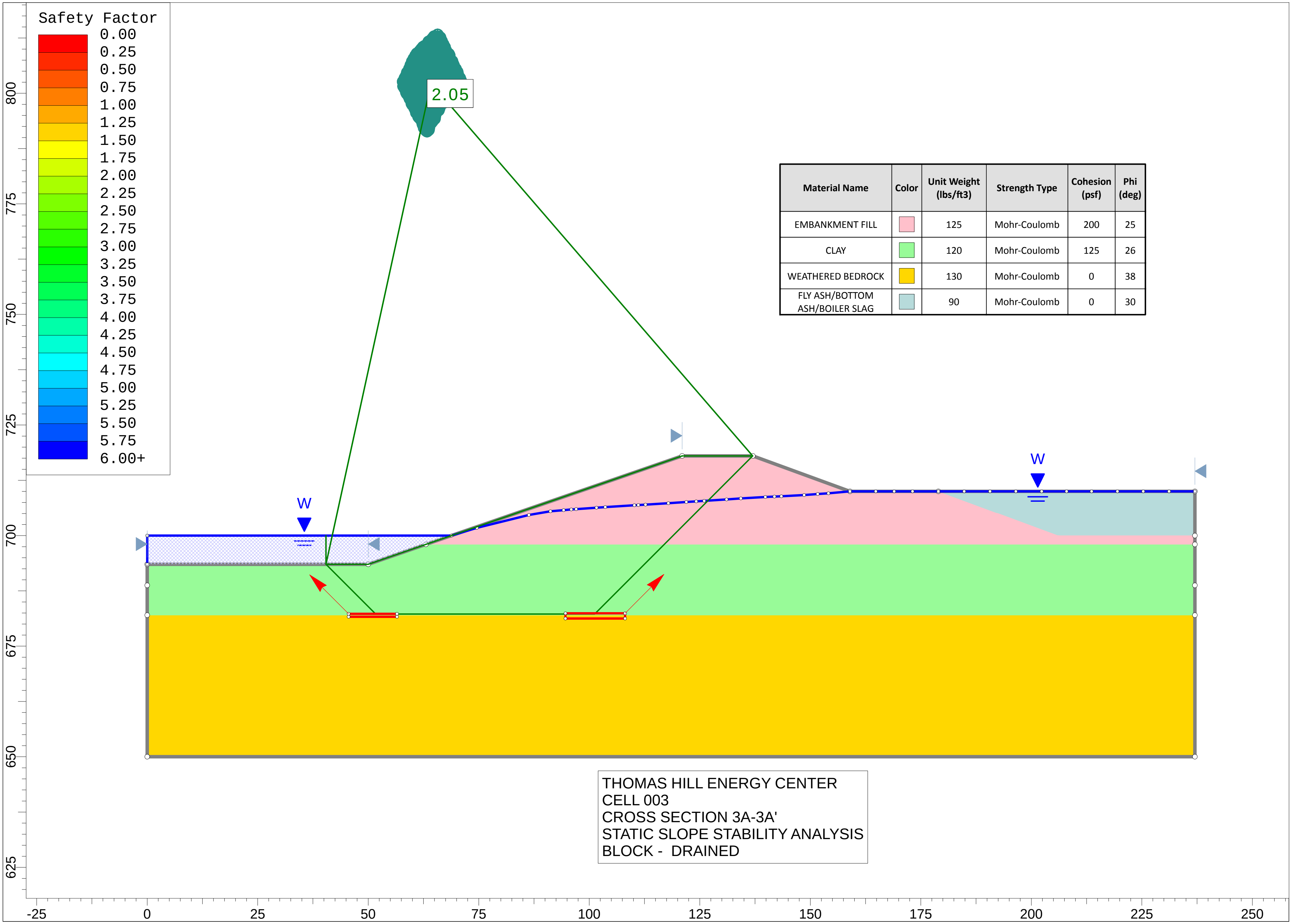
CELL 003
CROSS SECTION 3A-3A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - DRAINED



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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
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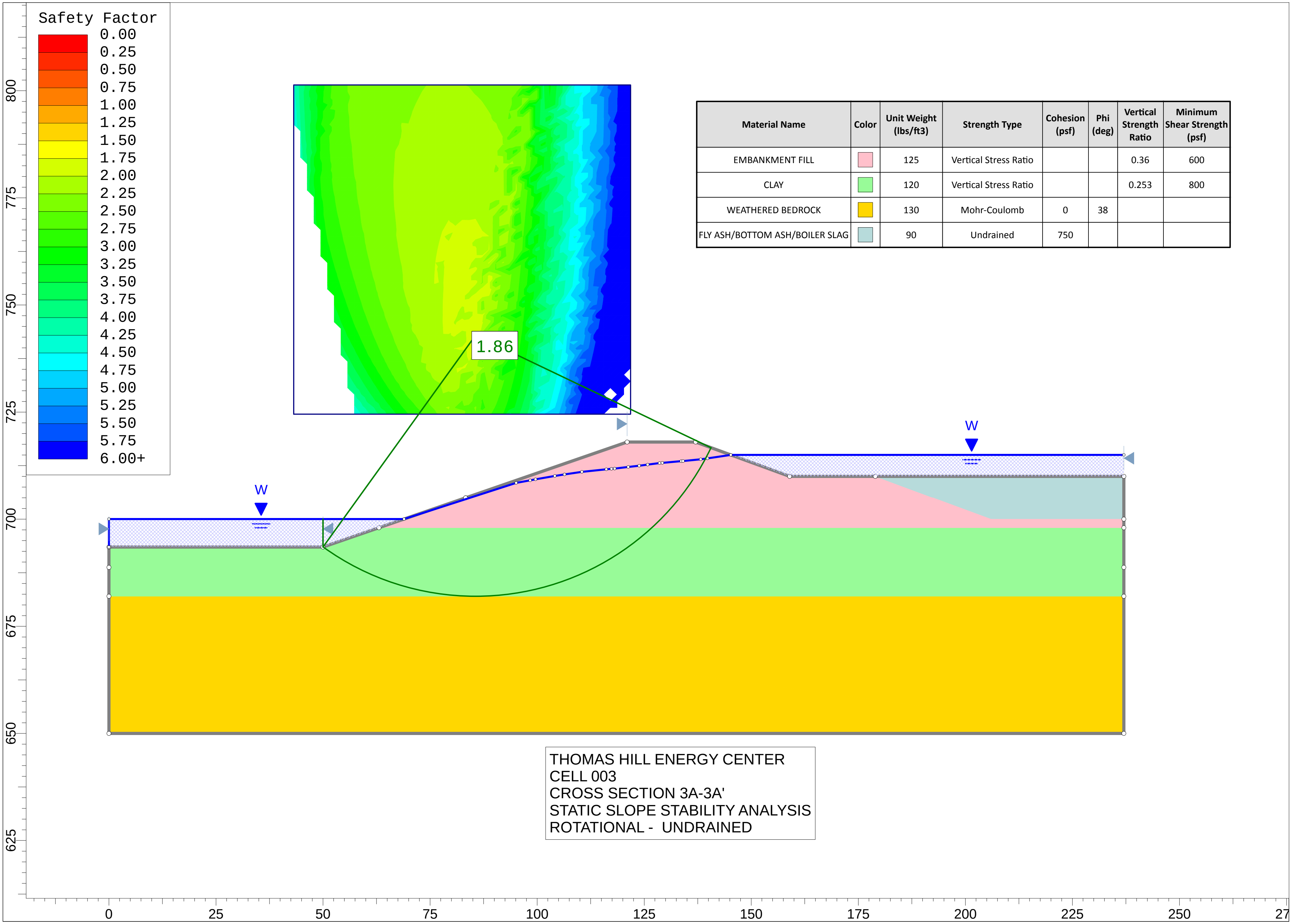
CROSS SECTION 3A-3A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - DRAINED



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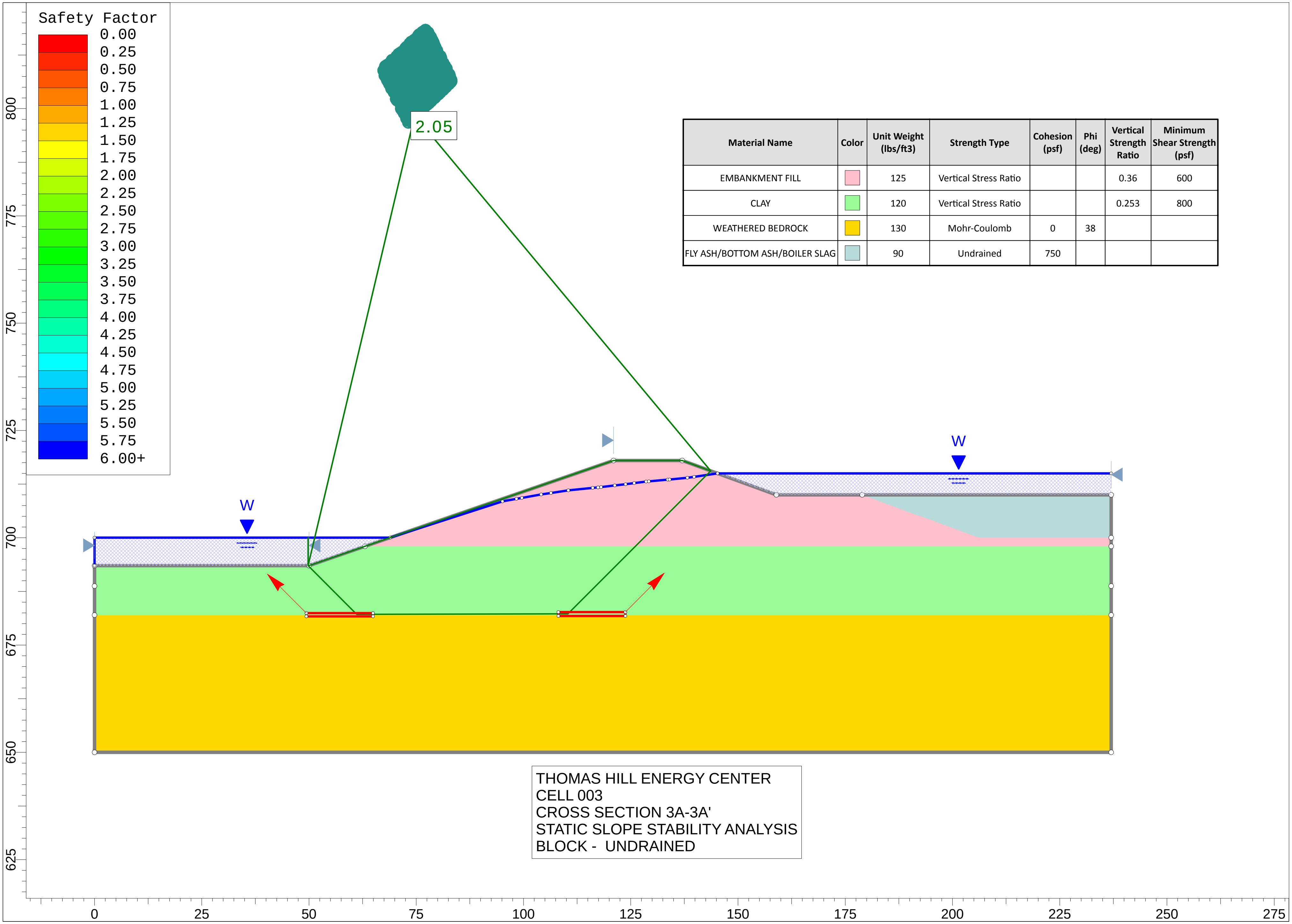
CROSS SECTION 3A-3A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



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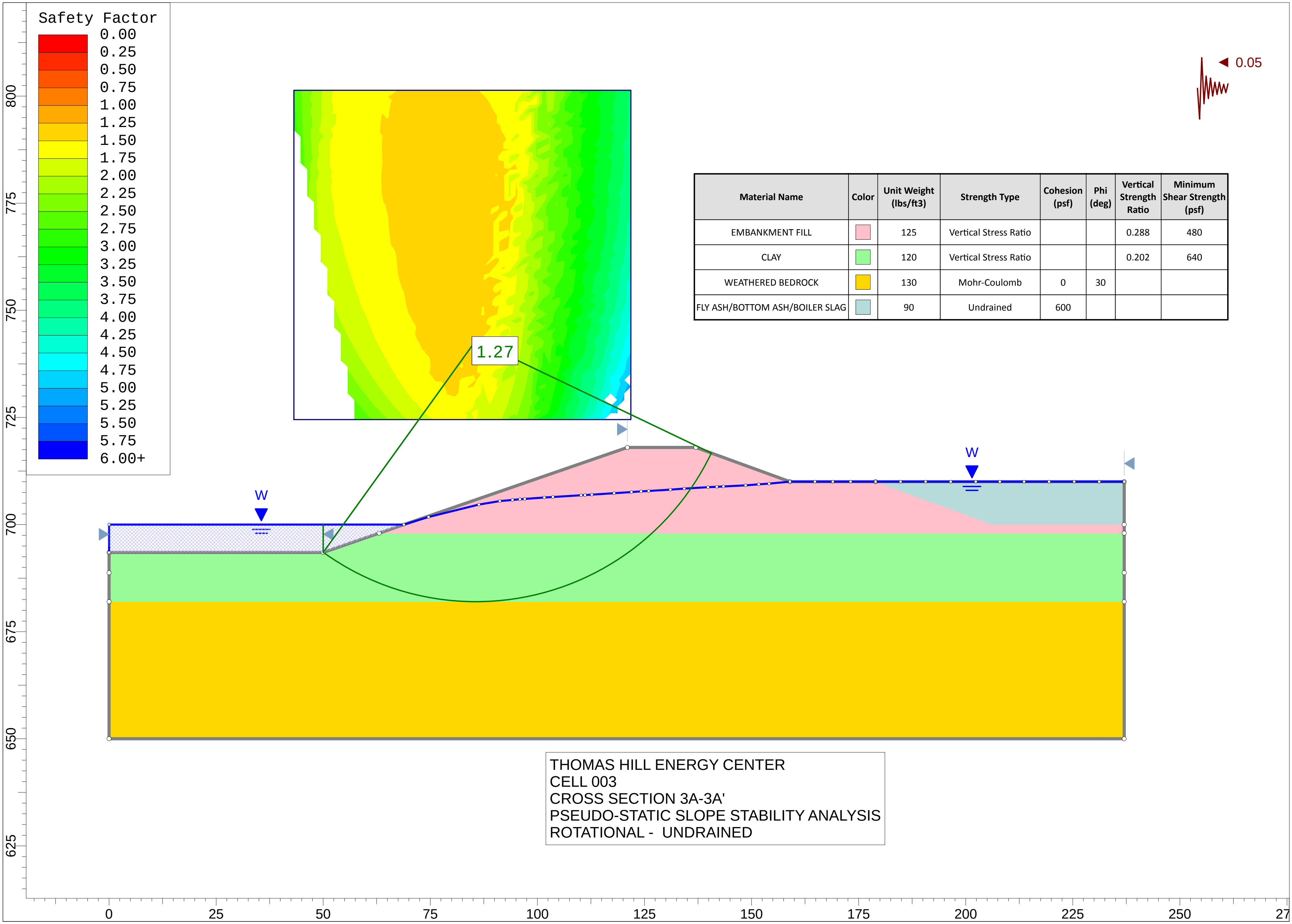
CLAY	🟩	120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	38		
FLY ASH/BOTTOM ASH/BOILER SLAG	🟦	90	Undrained	750			

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



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
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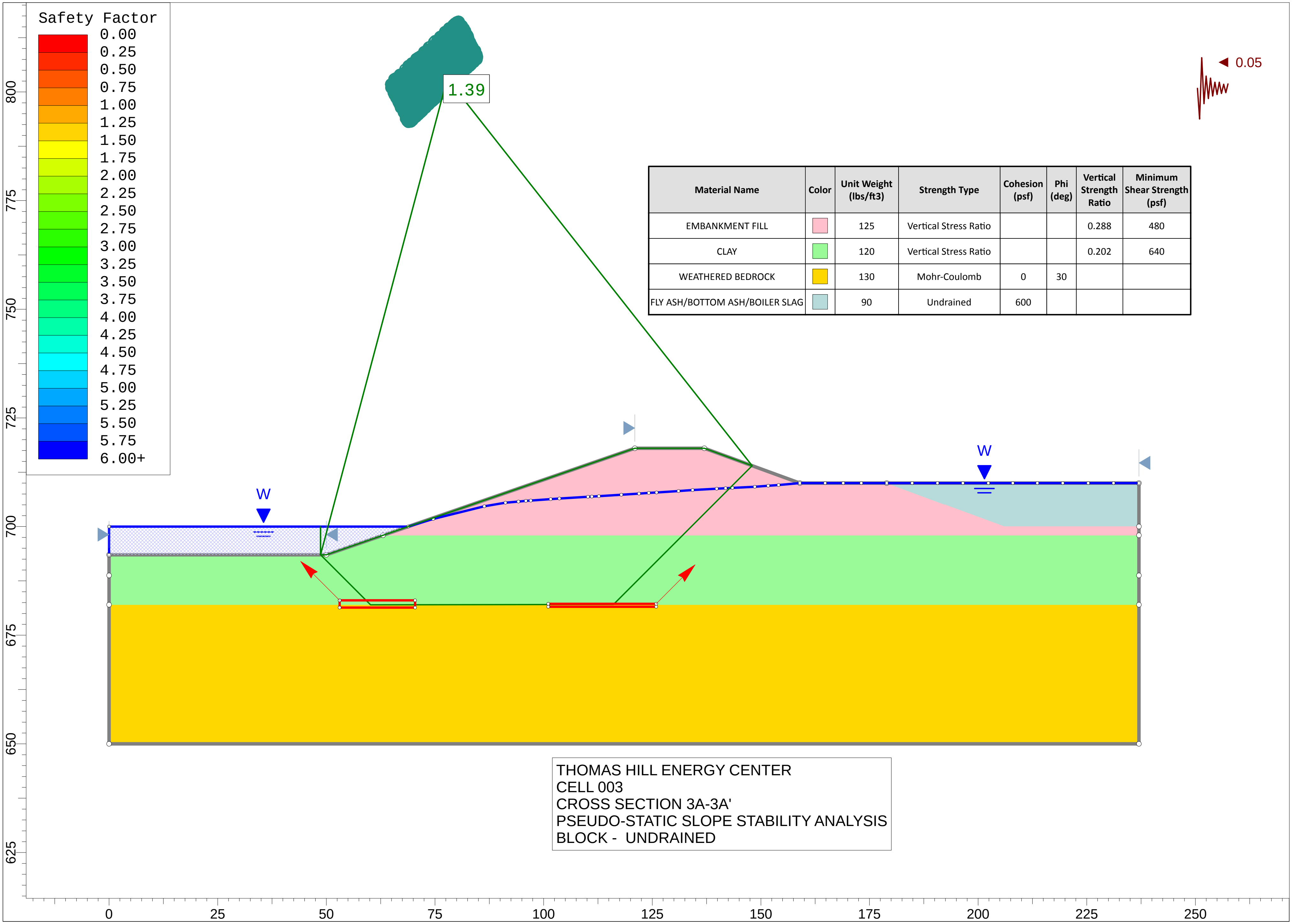
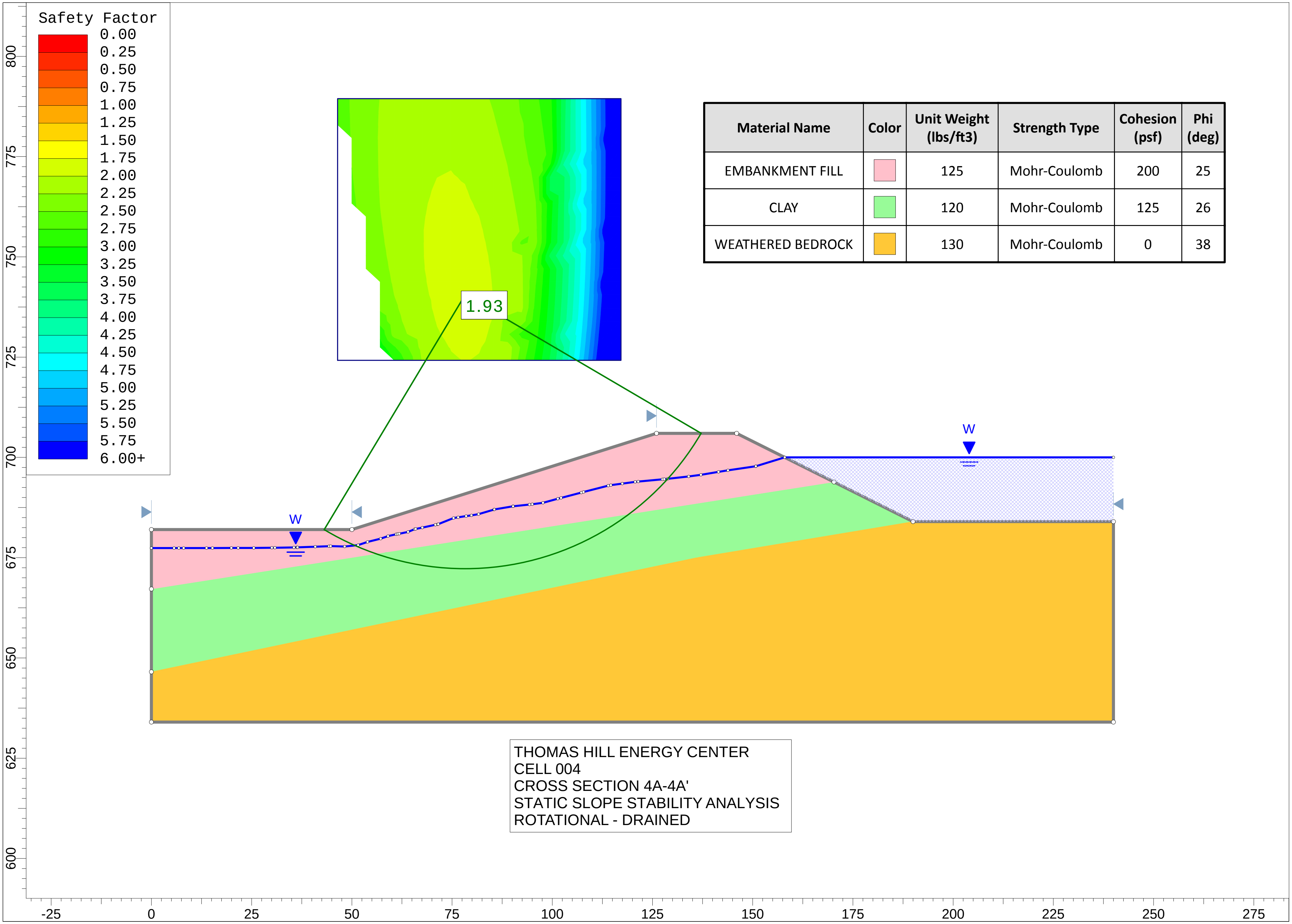
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	30		
FLY ASH/BOTTOM ASH/BOILER SLAG	🟦	90	Undrained	600			

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



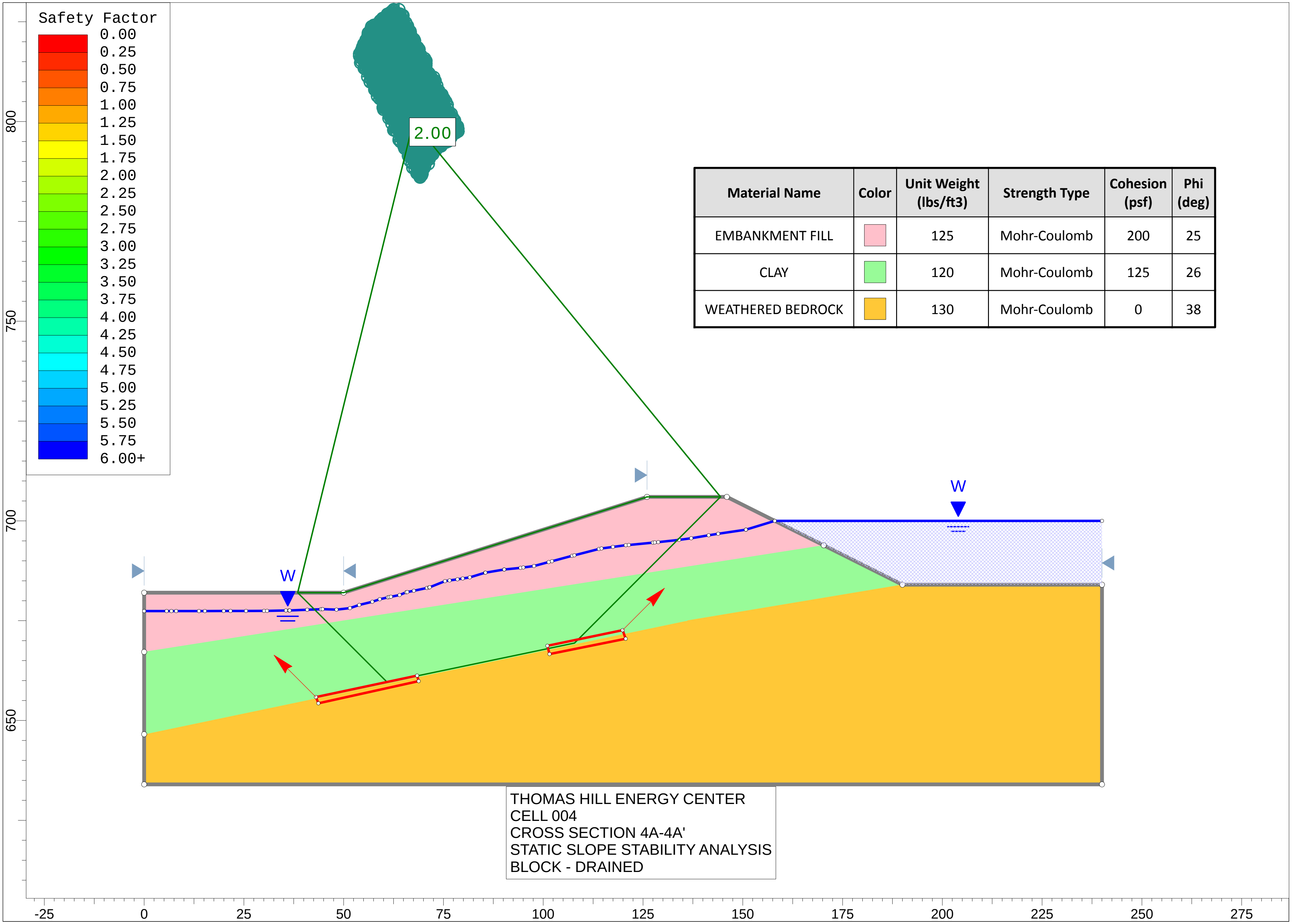
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL	🟥	125	Vertical Stress Ratio			0.288	480
CLAY	🟩	120	Vertical Stress Ratio			0.202	640
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	30		
FLY ASH/BOTTOM ASH/BOILER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

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



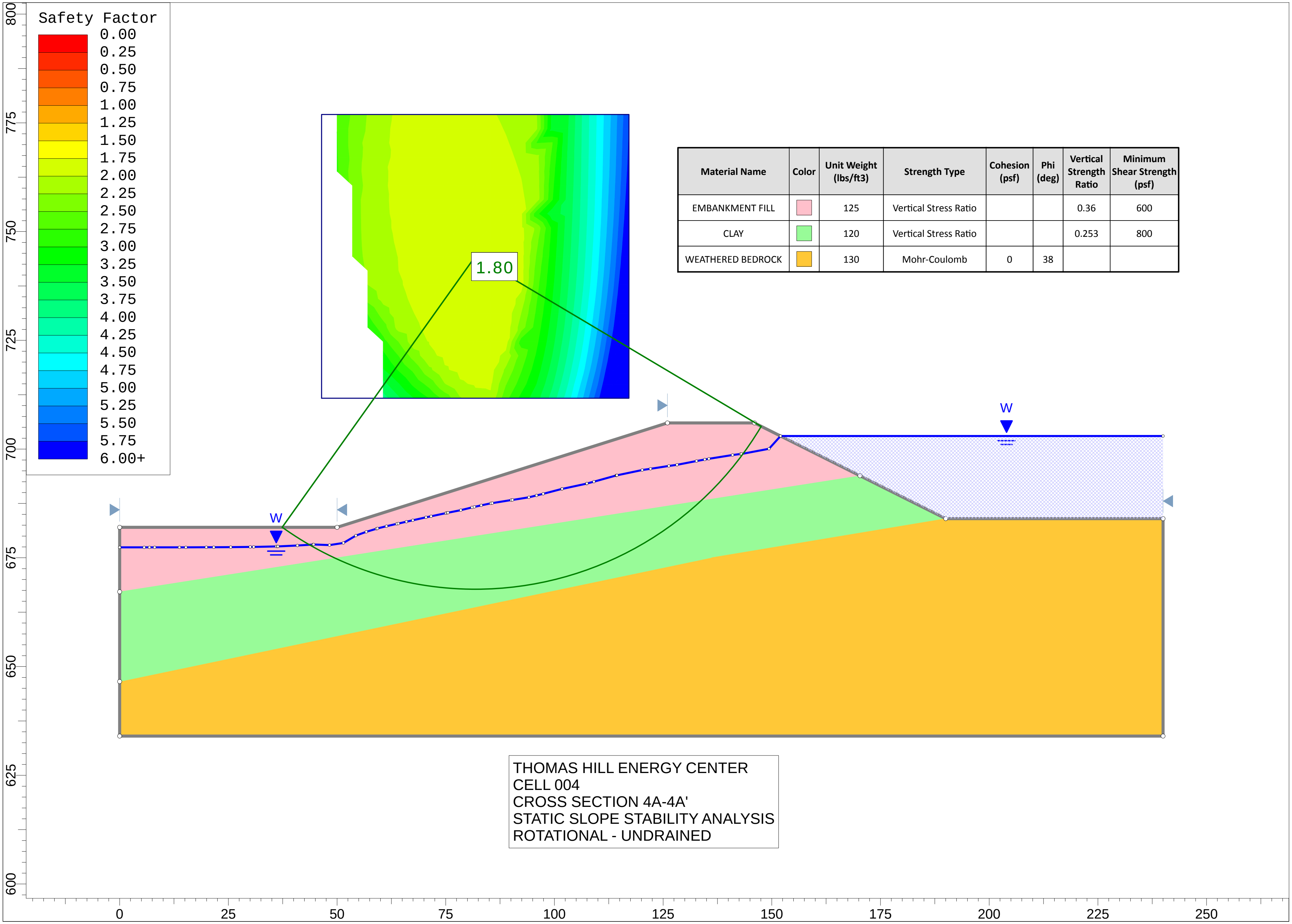
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL	🟥	125	Mohr-Coulomb	200	25
CLAY	🟩	120	Mohr-Coulomb	125	26
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	38

THOMAS HILL ENERGY CENTER
CELL 004
CROSS SECTION 4A-4A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - DRAINED



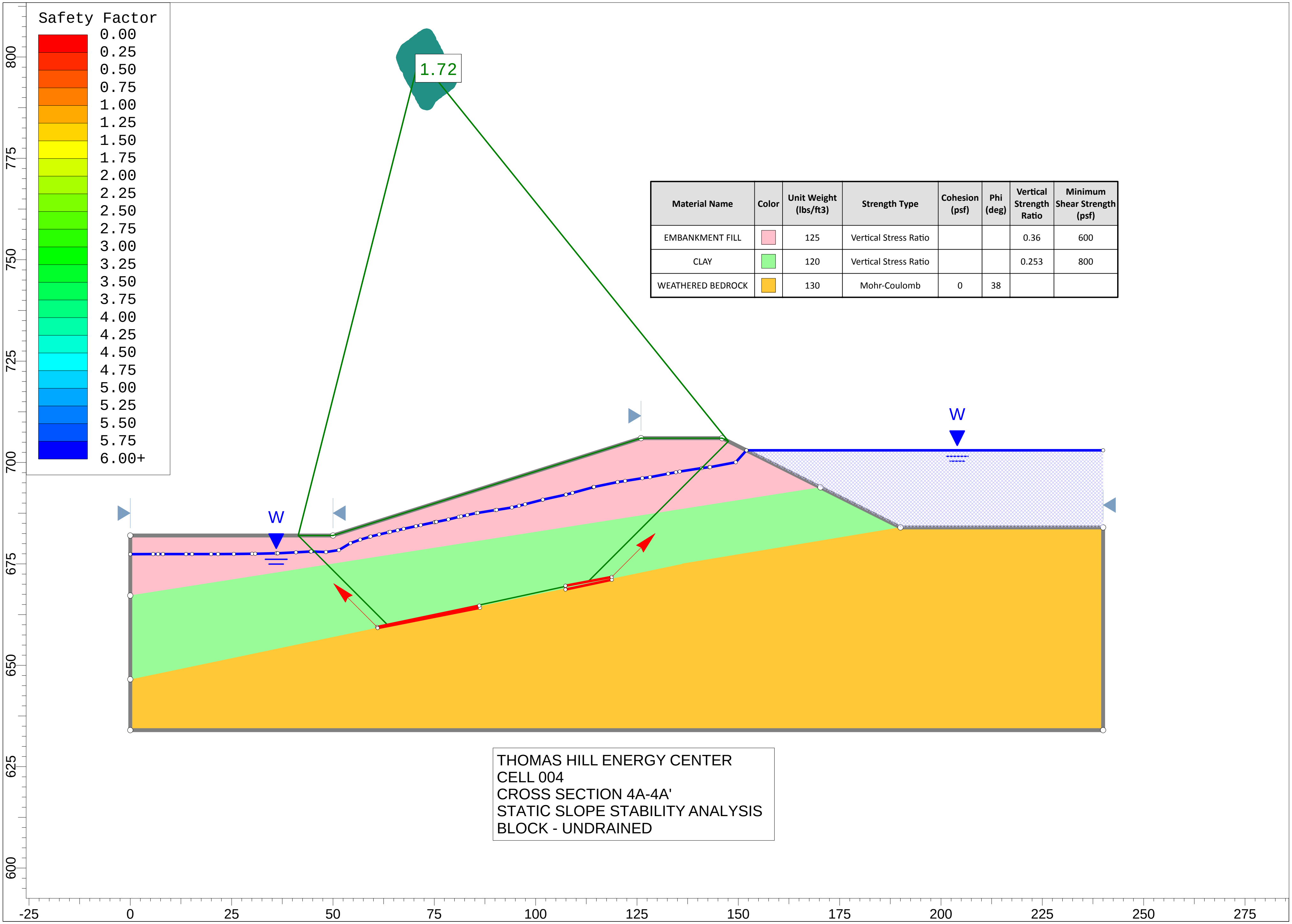
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL	🟥	125	Mohr-Coulomb	200	25
CLAY	🟩	120	Mohr-Coulomb	125	26
WEATHERED BEDROCK	🟧	130	Mohr-Coulomb	0	38

THOMAS HILL ENERGY CENTER
CELL 004
CROSS SECTION 4A-4A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - DRAINED



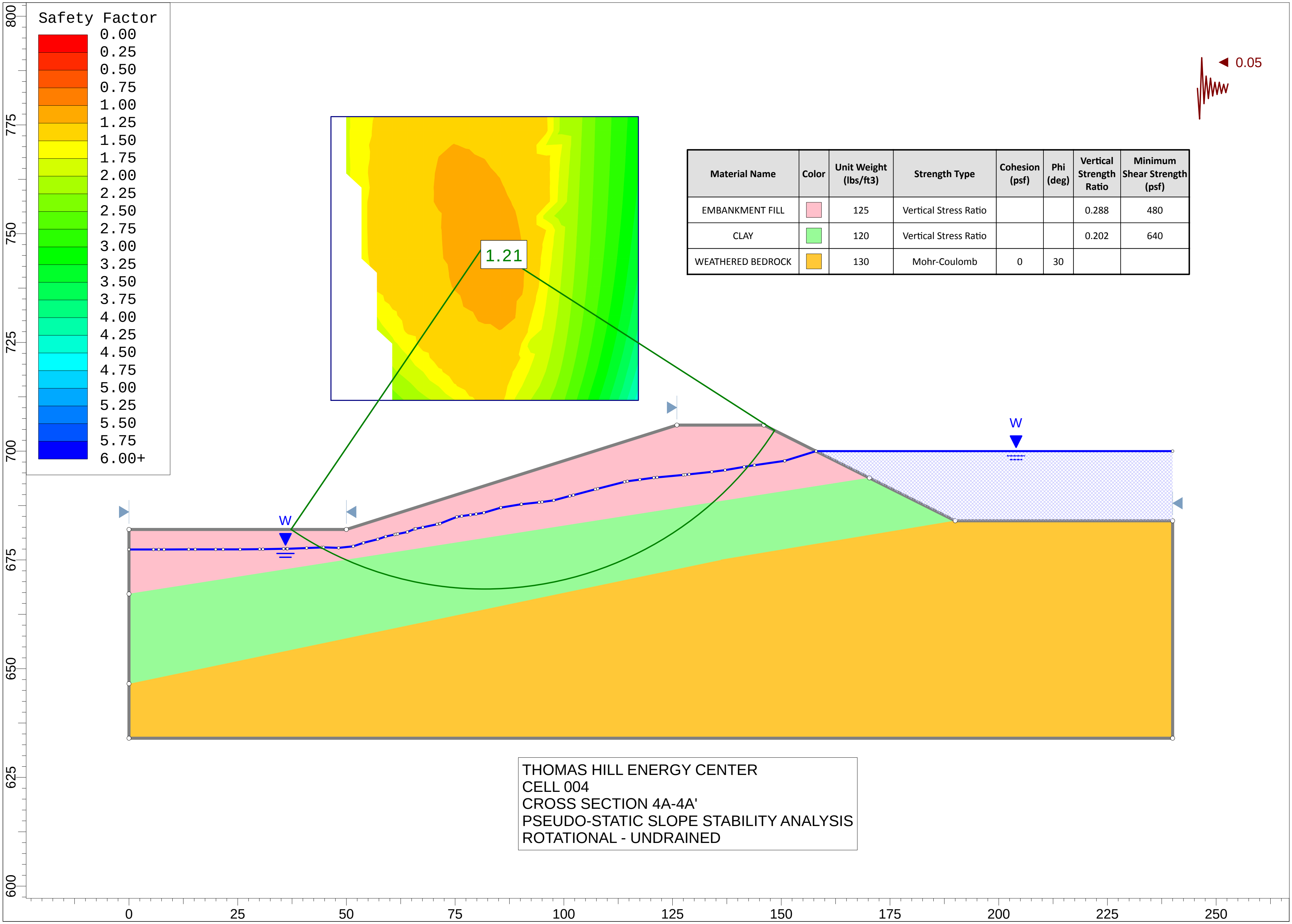
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL	🟥	125	Vertical Stress Ratio			0.36	600
CLAY	🟩	120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	38		

THOMAS HILL ENERGY CENTER
CELL 004
CROSS SECTION 4A-4A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



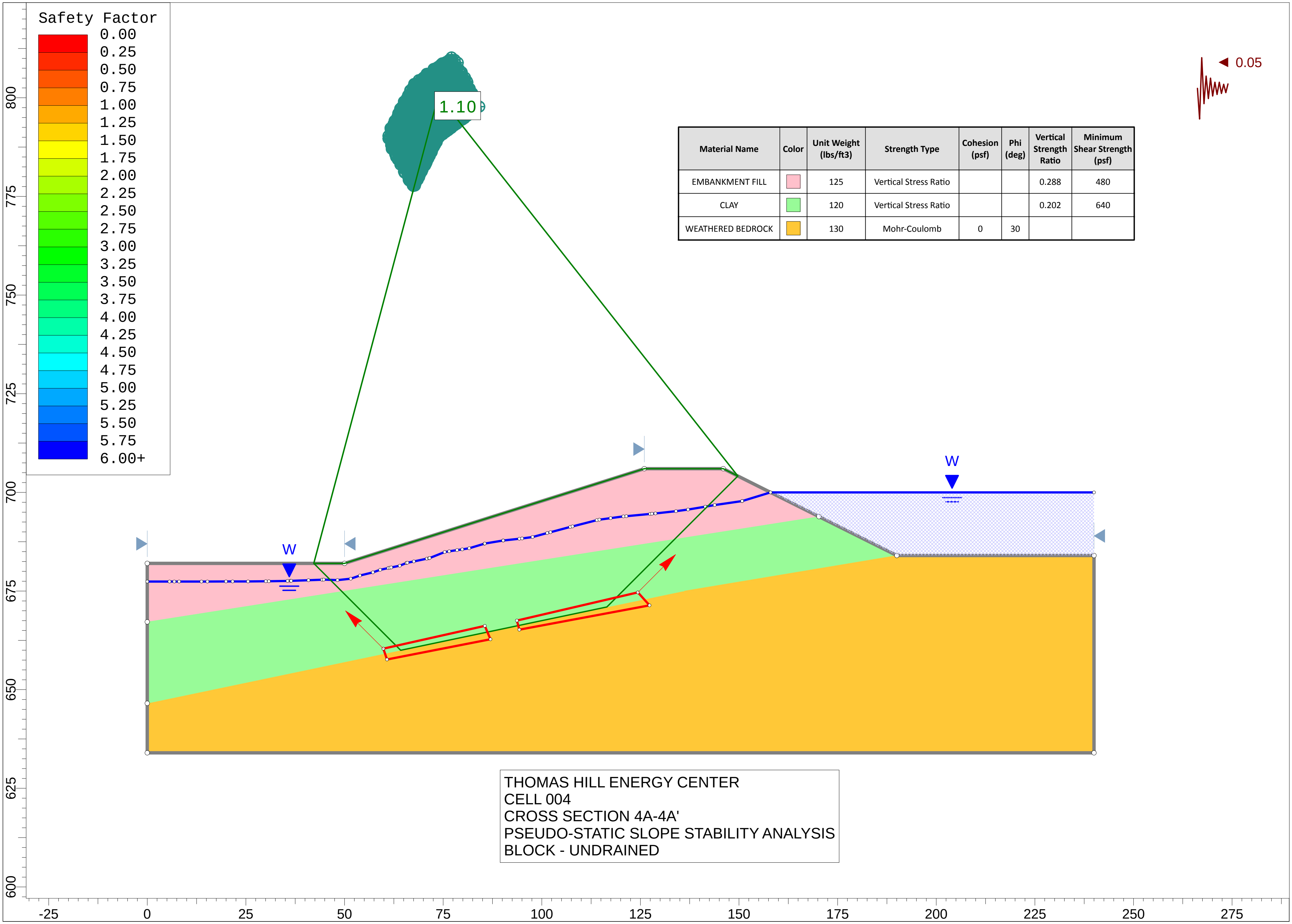
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL	🟥	125	Vertical Stress Ratio			0.36	600
CLAY	🟩	120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK	🟧	130	Mohr-Coulomb	0	38		

THOMAS HILL ENERGY CENTER
CELL 004
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		

THOMAS HILL ENERGY CENTER
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		

THOMAS HILL ENERGY CENTER
CELL 004
CROSS SECTION 4A-4A'
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED

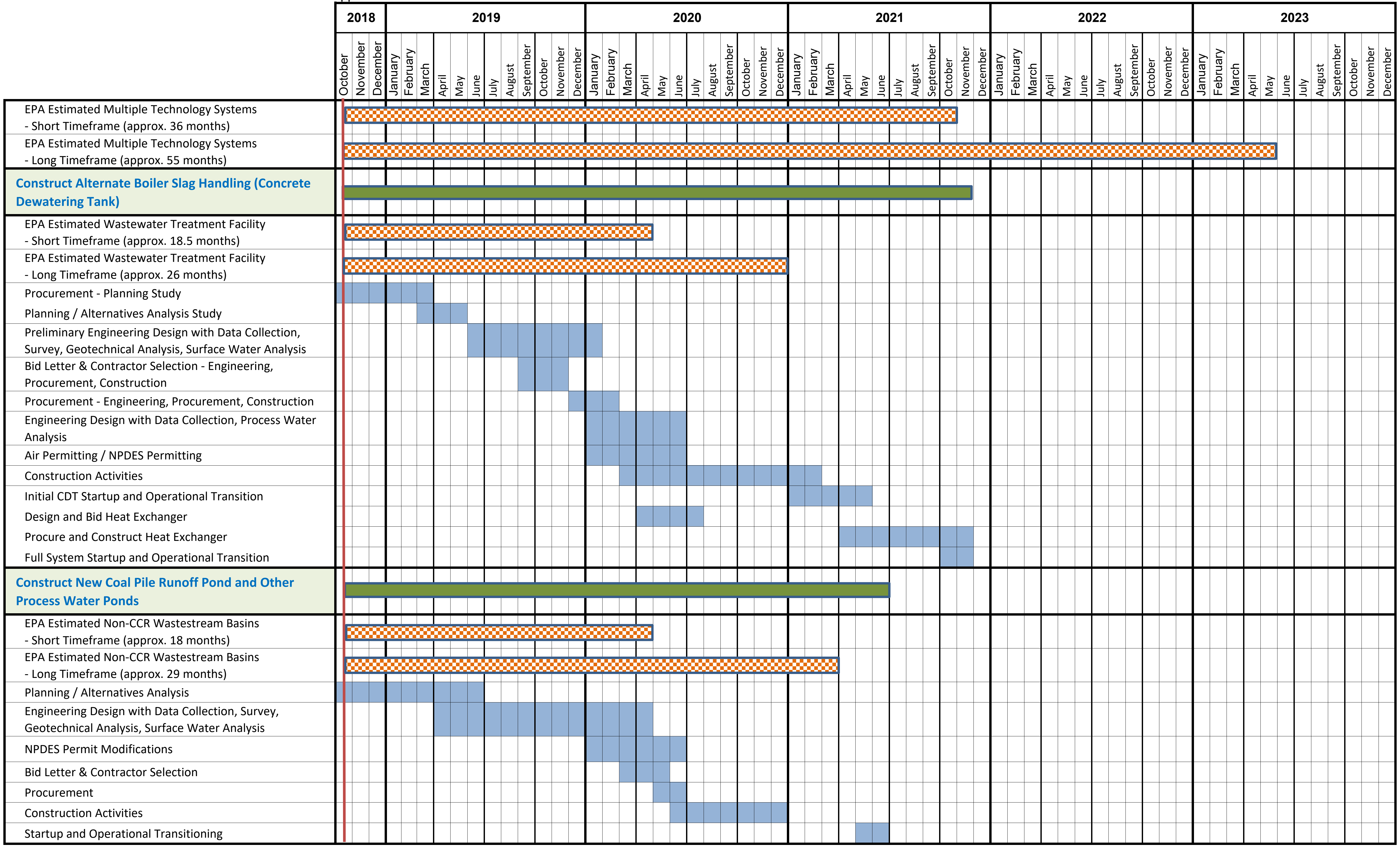
ATTACHMENT 2

UPDATED APPENDIX A – NO ALTERNATE CAPACITY SCHEDULE

Associated Electric Cooperative, Inc.
Thomas Hill Energy Center
Clifton Hill, Missouri

Deadline to Initiate Closure
CCR and Non-CCR Alternative Capacity Extensions

Note: EPA Timeframes taken from Final Rule for Holistic Approach to Closure Part A



ATTACHMENT 3

CCR GROUNDWATER MONITORING NETWORK DESCRIPTION, THOMAS HILL ENERGY CENTER, CLIFTON HILL, MISSOURI DATED APRIL 2019

CCR GROUNDWATER MONITORING NETWORK DESCRIPTION
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Clifton Hill, Missouri

File No. 128064-006
April 2019

HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.706.1303

16 April 2019
File No. 128064-006

Associated Electric Cooperative, Inc.
2814 South Golden Ave
PO Box 754
Springfield, MO 65801-0754

Attention: Jenny Burns
Senior Environmental Analyst

Subject: CCR Groundwater Monitoring Network Description for the Thomas Hill Energy Center
Ash Pond System
Clifton Hill, Missouri

Dear Ms. Burns:

This letter provides a summary description of the hydrogeologic units beneath the coal combustion residuals (CCR) impoundments at Ash Pond 001 (referred to as Cell 1), Inactive Cell 2 West, Cell 3, and Cell 4 (Ash Pond System) at the Thomas Hill Energy Center (THEC) located in Clifton Hill, Missouri (Site), and the groundwater monitoring network established to monitor groundwater quality beneath the Ash Pond System. The location of the THEC facility and the associated CCR management units are shown on Figure 1. This document also describes the site-specific data used to support design of the groundwater monitoring network. The site-specific data were developed during previous studies and monitoring well installation efforts. The groundwater monitoring system has been designed in accordance with the requirements of the United States Environmental Protection Agency rule regulating the disposal of CCRs as solid waste under Subtitle D of the Resource Conservation and Recovery Act, published in the Federal Register on 17 April 2015 and effective 19 October 2015 (CCR Rule) and subsequent rulemaking revisions.

Due to the EPA Response to Partial Vacatur effective 4 October 2016, Associated Electric Cooperative Inc. (AECI) is required to install a CCR Rule compliant groundwater monitoring network at the Inactive Cell 2 West at THEC. The purpose of updating this Groundwater Monitoring Network Description is to incorporate the Inactive Cell 2 West CCR unit into the Ash Pond System CCR unit.

CCR Management Units

AECI operates three active CCR management units and one inactive CCR unit that are referred to as the Ash Pond System at THEC. The location of the Ash Pond System is shown on Figure 1.

Ash Pond System Hydrogeologic Units

The THEC facility and Ash Pond System lie within the eastern portion of the Western Interior Coal Province of the Central Lowlands physiographic province. Geologic units that underlie the Ash Pond System are roughly horizontal with a slight regional dip northwest and consist of surficial glacial and alluvial materials underlain by the Breezy Hill, Lagonda, Bevier, and Verdigris formations.

UNSATURATED MATERIAL OVERLYING THE UPPERMOST AQUIFER

The alluvial aquifer underlying the Ash Pond System is unconfined; the unsaturated material above the uppermost aquifer is of the same alluvial materials as the saturated aquifer. The thickness of the unsaturated materials observed at the Ash Pond System is based on the observed static water level and corresponds to the linear distance from ground surface to the uppermost aquifer. Haley & Aldrich, Inc. (Haley & Aldrich) has made direct observation of the unsaturated material overlaying the uppermost aquifer based on recent drilling (August 2015 and March 2017) conducted at the Ash Pond System. Based on direct observations made during groundwater monitoring conducted between August 2016 and September 2018, the unsaturated material overlying the uppermost aquifer at the Site is approximately up to 42 feet thick.

UPPERMOST AQUIFER

Section §257.53 of the CCR Rule defines an aquifer as the geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs. The uppermost aquifer is defined in Section §257.53 of the CCR Rule as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility boundary.

The water-bearing geologic formation nearest the natural ground surface at the Ash Pond System that is capable of yielding groundwater to wells or springs is the combined Pleistocene glacial till and Prairie Hill Mine Spoils, hereafter referred to as the glacial till aquifer, as well as the Lagonda and Breezy Hill formations, where present. In isolated locations, the Breezy Hill limestone is present above the Lagonda, but is in hydraulic communication with the Lagonda formation and both are in communication with the glacial till. Groundwater occurs in the sand and gravel lenses of the glacial till (Association of Missouri Geologists, 1995), and generally within the spoil materials that are composed of excavated glacial material and limited amounts of Lagonda and Verdigris formation materials including mined coal residuals and thin coal seams. The glacial till is underlain by the Breezy Hill and Lagonda formations which constitute a local limestone and shale aquifer. Although the glacial till, Breezy Hill, and Lagonda are not continuous at the Site they are all in communication, are primarily unconfined, and act as one aquifer which will hereafter be referred to as the uppermost aquifer. The saturated thickness of the uppermost aquifer beneath the Ash Pond System is approximately 15 to 39 feet thick, based on observations made during groundwater monitoring conducted between August 2016 and September 2018.

Review of the Missouri Department of Natural Resources (MDNR) Well Information Management System (WIMS) Database indicates that the glacial till aquifer is not used for water supply wells in the vicinity of the Ash Pond System. The nearest water well (#00256551) listed in the WIMS Database is a high-yield, public well located approximately 4.33 miles east of the complex. It is reported to be completed at a depth of 500 feet below ground surface (bgs), producing groundwater at a reported rate of 750 gallons per minute (gpm). It is stratigraphically separated from the glacial till aquifer at the Ash Pond System and does not draw water from the glacial till aquifer. Although the glacial till aquifer is not locally used as a drinking water aquifer in the immediate vicinity of the Ash Pond System, the formation does contain sufficient water to support low-yield wells and springs. The formation also contains sufficient water to facilitate consistent groundwater monitoring of the saturated formation directly beneath the CCR units and is therefore characterized as the uppermost aquifer beneath the Ash Pond System.

The materials comprising the upper aquifer unit were observed directly during drilling and installation of piezometers and monitoring wells at the Site. Figure 2 shows the location of the wells installed and boring logs with well construction details are included in Appendix A. The drilling, completion, and testing of these monitoring wells yielded site-specific geologic data that were used in combination with site-specific data developed during previous characterization and well installation activities to determine the appropriate number, depth, and spacing of the monitoring wells at the Ash Pond System.

Based on groundwater elevations measured between August 2016 and in September 2018, the groundwater gradient in the upper aquifer unit is approximately 0.016 to 0.017 feet per foot (feet/foot) and is primarily unconfined. Although the upper aquifer unit is primarily unconfined, the heterogeneity of the material may cause isolated areas with confined or semi-confined conditions. The groundwater flow in the upper aquifer unit is to the southwest. The down gradient monitoring wells were sited at locations based on observed groundwater elevation conditions.

Hydraulic conductivity of the uppermost aquifer is based on data collected during initial characterization of the facility and published values. Based on results of permeameter tests, the hydraulic conductivity of the glacial till ranges from 1.1 x 10^{-5} feet per day (feet/day) in gray till to 0.57 feet/day in the sandy till (Shell, 1981), with conductivities of other types of material present in the upper aquifer unit falling between these values.

Based on estimates for similar material, effective porosity of the shale is estimated to be 0.6 to 1.6 percent. The calculated groundwater flow velocity is approximately 160 feet per year (feet/year). The groundwater flow rate was calculated using hydraulic conductivity values and effective porosity values obtained from the cited references and groundwater elevation data measured in May 2017.

The Middle Fork of the Little Chariton River channel is down gradient of the Ash Pond System. The Little Chariton River is a relatively small river and is topographically and stratigraphically lower than the lowest monitoring well at the Ash Pond System. Consequently, there is no potential for changes in river stage to affect the groundwater elevations or flow at the Site. No changes in groundwater elevations or flow direction have been observed at the Ash Pond System related to stage changes on the Little Chariton River.

CONFINING LAYER BELOW THE UPPERMOST AQUIFER

The uppermost aquifer unit is underlain by the Bevier coal and the Verdigris formation, with the upper portion of the Verdigris formation being comprised of an underclay beneath the coal. The permeability of the underclay below the Bevier coal is approximately 2 x 10^{-6} feet/day (Shell, 1981). This value is a geometric mean of several hydraulic permeameter tests conducted by Shell during site characterization. The combined Bevier coal and underclay have a thickness of between 3 and 5 feet. Wells completed below the Bevier coal and underclay, in the limestone portion of the Verdigris formation, have piezometric groundwater elevations that extend above the coal throughout the Site, indicating an upward hydraulic gradient. Hydraulic potentials encountered in water-bearing rocks in the competent Verdigris present below the Bevier coal and underlay have hydraulic potential approximately 60 feet or more above the coal (Shell, 1981). The Verdigris formation has very low transmissivity 0.007 gallons per day per foot (Shell, 1981), and is therefore not typically used locally for water supply.

Based on groundwater elevations measured between August 2016 and September 2018 as part of the CCR Rule compliance activities, the groundwater gradient in the uppermost aquifer unit is approximately 0.016 to 0.022 feet/foot and is primarily unconfined. Although the uppermost aquifer unit is primarily unconfined, the heterogeneity of the material may cause isolated areas with confined or semi-confined conditions. The groundwater flow in the uppermost aquifer is to the southwest. The hydrogeologic characterization data for the Ash Pond System described above are summarized in Table I.

Ash Pond System Groundwater Monitoring System

Based on the close configuration of the four CCR units, the groundwater monitoring system has been set up as a multi-unit monitoring system. The groundwater monitoring system at the Ash Pond System was designed to monitor the uppermost aquifer beneath the CCR units which consists of glacial till, Breezy Hill, and Lagonda formations. Not all formations are present across the Site, but they are all in hydraulic communication with one another and are isolated from the formations below by the Bevier clay and underclay. The monitoring system includes two up gradient monitoring wells and four down gradient monitoring wells. The up gradient monitoring wells (MW-1 and MW-2R) are sited at locations representative of background groundwater quality. The down gradient monitoring wells (MW-3, MW-4, MW-5, and MW-6) are sited based on site-specific conditions at locations that are representative of groundwater flowing beneath the Ash Pond System. Supplemental piezometers are monitored for groundwater elevation only to confirm groundwater flow direction. Published information indicates that the regional groundwater flow direction is to the southwest, consistent with surface water features, and the same flow direction is observed at the Ash Pond System monitoring network. The monitoring wells are sited at locations to detect migration of groundwater along representative flow paths in the uppermost aquifer beneath the Ash Pond System based on the observed groundwater flow direction. The locations of the Ash Pond System monitoring wells are provided on Figure 2. The monitoring wells were cased and the annular space sealed in conformance with MDNR Monitoring Well Construction Code standards. Monitoring well construction details are included in Table II. Monitoring well as-built diagrams and boring logs are provided in Appendix A.

Measurement, Sampling, and Analytical Devices

AECI has installed dedicated sampling pumps in the Ash Pond System groundwater monitoring system. The monitoring wells and other measurement, sampling, and analytical devices are in good operating order and will be maintained so that they perform to the design specifications throughout the life of the monitoring program. The measurement, sampling, and other analytical devices are described in the Sampling and Analysis Plan established for Ash Pond System.

Summary

This letter provides a hydrogeologic description of the uppermost aquifer, unsaturated materials, and confining units underlying the Ash Pond System. The hydrogeologic description is based on site-specific characterization data collected during recent drilling and characterization activities and previous investigations. These data have been used to develop a multi-unit groundwater monitoring system at the CCR management unit with an appropriate number of wells intersecting groundwater flow paths that are representative of groundwater flowing beneath the CCR management units. The number, spacing, and depth of the monitoring wells are based on site-specific data, and the resultant groundwater monitoring system is compliant with the CCR Rule.

Sincerely yours,
HALEY & ALDRICH, INC.

Steve Putrich
Principal Engineer

Mark Nicholls, P.G.
Lead Hydrogeologist

Attachments:
Table I: Hydrogeologic Characterization Data for Ash Pond System CCR Management Unit
Table II: Groundwater Monitoring Well Construction Information
Figure 1: Thomas Hill Energy Center Site Location Map
Figure 2: Thomas Hill Energy Center Ash Pond System Monitoring Well Location Map
Appendix A: Monitoring Well As-Built Diagrams and Boring Logs

References

1. Association of Missouri Geologists, 1995. Field Trip Guide Book, Mining and Mine Reclamation in North Central Missouri near Moberly, Missouri. 29 September.
2. Shell Engineering and Associates, 1981. Engineering Study and Report for Solid Waste Disposal Permit, Thomas Hill Operation. 15 June.
3. U.S. Environment Protection Agency, 2015. 40 CFR Parts 257 and 261, *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule.* 17 April.

Revision No.	**Date**	**Notes**
0	October 2017	Original
1	April 2019	Inclusion of Inactive Cell 002 West into Ash Pond System CCR Management Unit

TABLES

TABLE I
HYDROGEOLOGIC CHARACTERIZATION DATA FOR ASH POND SYSTEM CCR MANAGEMENT UNIT
CCR GROUNDWATER MONITORING NETWORK DESCRIPTION
THOMAS HILL ENERGY CENTER - CLIFTON HILL, MISSOURI

Unsaturated Material Overlying the Uppermost Aquifer	
Stratigraphic Unit	Glacial Till
Lithology	Clay, silts, and sand
Unsaturated Thickness	up to 42 feet[a]
Hydraulic Conductivity	0.05 – 1 feet per day[b]
Uppermost Aquifer Characteristics	
Stratigraphic Unit	Glacial Till and Lagonda formation
Glacial Till Lithology	Clay, silt, and sand
Lagonda formation Lithology	Shale and limestone
Aquifer Thickness	15 to 39 feet[a]
Groundwater Gradient	0.016 to 0.022[a]
Hydraulic Conductivity	0.05 – 1 feet per day[b]
Effective Porosity	0.06 – 0.16[c]
Groundwater Flow Direction	Southwest
Groundwater Flow Velocity	160 feet / year[d]
Confining Unit Below the Uppermost Aquifer Characteristics	
Stratigraphic Unit	Bevier formation
Lithology	Coal and underclay
Unit Thickness	3 to 5 feet
Hydraulic Conductivity	2x10^{-6}[c]
Effective Porosity	Not available

Notes:

[a] *= Data based groundwater elevation data between August 2016 and September 2018*

[b] *= Based on the Shell, 1981 values and MW-6 low flow sampling results*

[c] *= Shell, 1981. Appendix A, Table 1, Results of Falling Head Permeameter Testing.*

[d] *= An upper bound value based on the hydraulic parameters above*

TABLE II

GROUNDWATER MONITORING WELL CONSTRUCTION INFORMATION

CCR GROUNDWATER MONITORING NETWORK DESCRIPTION

THOMAS HILL ENERGY CENTER - CLIFTON HILL, MISSOURI

Location	Well Identification	Well Installation Date	Casing Diameter (inches)	Blank Casing Type	Screened Casing Type	Slot Size (inch)	Top of Screen (feet btoc)	Bottom of Screen (feet btoc)	Well Depth (feet btoc)	Depth to Water[a] (feet btoc)	Water Level Elevation (feet amsl)	Water Column Depth (feet)	Northing (SP NAD27)	Easting (SP NAD27)	Ground Surface Elevation (feet amsl)	Top of Casing Elevation (feet amsl) (NAVD29)	Casing Stickup (feet)
Pond Complex																	
Up Gradient	MW-1	8/25/2015	2	Schd 40 PVC	Schd 40 PVC	0.010	22.34	32.34	32.34	2.3	744.64	30.04	1352441.02	462928.89	744.50	746.94	2.44
	MW-2R	3/20/2017	2	Schd 40 PVC	Schd 40 PVC	0.010	62.52	72.52	72.52	42.3	737.66	30.22	1351328.86	464284.73	777.94	779.96	2.02
Down Gradient	MW-3	8/19/2015	2	Schd 40 PVC	Schd 40 PVC	0.010	25.90	36.90	36.90	3.86	688.33	33.04	1349532.33	460183.30	688.99	692.19	3.20
	MW-4	8/2/2016	2	Schd 40 PVC	Schd 40 PVC	0.010	24.96	35.50	35.50	5.25	678.23	30.25	1349757.46	459870.66	681.52	683.48	1.96
	MW-5	8/3/2016	2	Schd 40 PVC	Schd 40 PVC	0.010	30.48	40.50	40.50	1.55	685.98	38.95	1349974.58	459869.75	685.05	687.53	2.48
	MW-6	8/25/2015	2	Schd 40 PVC	Schd 40 PVC	0.010	15.50	25.50	25.50	10.3	694.75	15.20	1350264.13	459992.76	702.65	705.05	2.40

NOTES:

[a] *Depth to water elevations from 10 September 2018 groundwater elevation survey*

amsl - above mean sea level

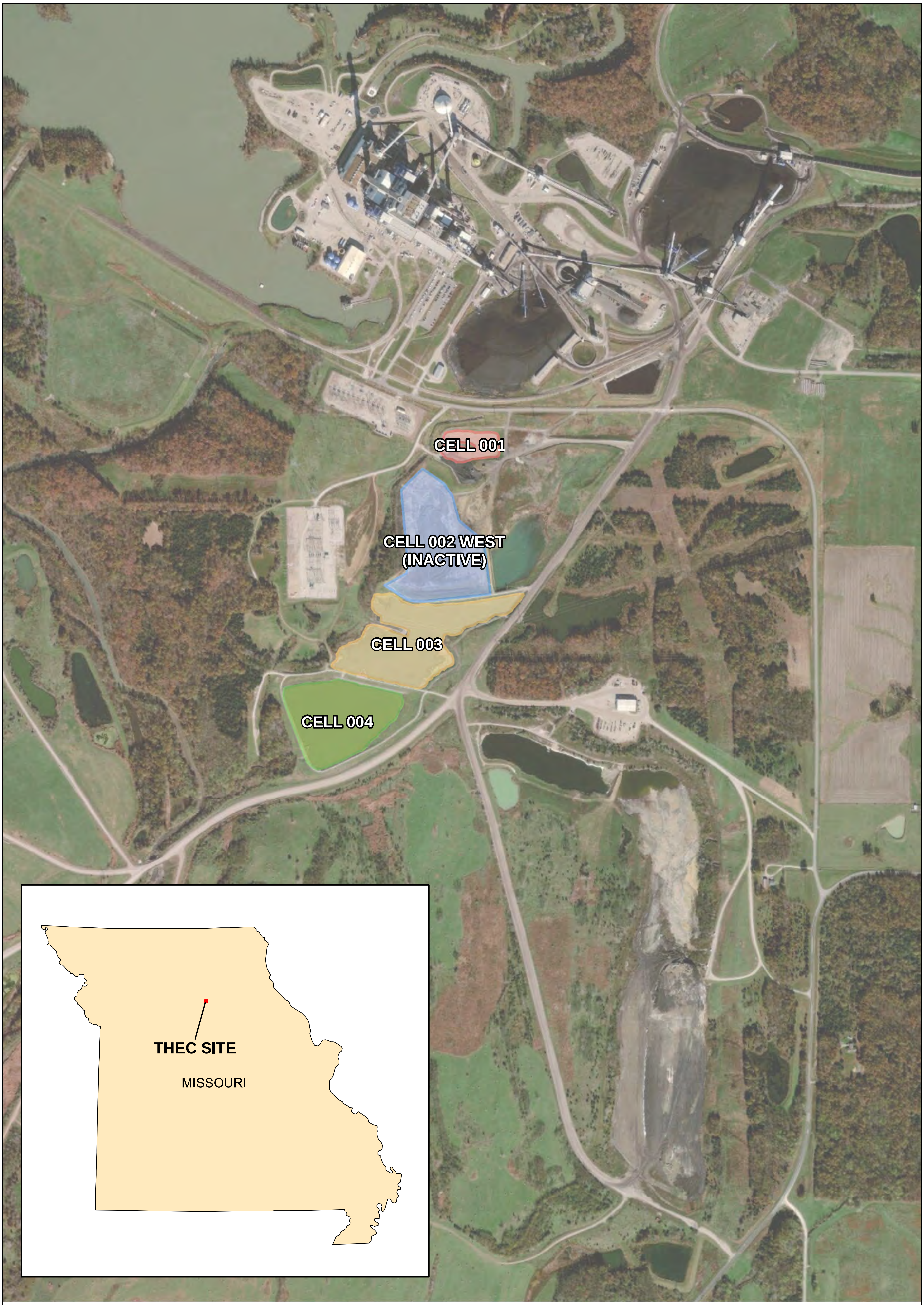
bgs - below ground surface

btoc - below top of casing

Schd 40 PVC - Schedule 40 polyvinyl chloride

Survey Data from Gredell Engineering Resources, Inc., April 6, 2017

FIGURES



LEGEND

- 🟥 CELL 001
- 🟦 CELL 002 WEST (INACTIVE)
- 🟨 CELL 003
- 🟩 CELL 004

NOTE

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. AERIAL IMAGERY SOURCE: ESRI, 15 JANUARY 1999. IMAGERY AT THIS SCALE MAY NOT REFLECT CURRENT SURFACE FEATURES.

HALEY ALDRICH

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

THOMAS HILL ENERGY CENTER
SITE LOCATION MAP

MARCH 2019
SCALE: AS SHOWN

FIGURE 1

LEGEND

- ⌖ THEC CCR MONITORING WELL
- ⌖ PIEZOMETRIC OBSERVATION ONLY
- 🟥 CELL 001
- 🟦 CELL 002 WEST (INACTIVE)
- 🟨 CELL 003
- 🟩 CELL 004
- ← GROUNDWATER FLOW DIRECTION

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. THEC CCR MONITORING ACCOMPLISHED VIA A MULTI-UNIT GROUNDWATER MONITORING SYSTEM, REFERRED TO AS THE ASH POND SYSTEM, THAT INCLUDES: CELL 001, INACTIVE CELL 002, CELL 003, AND CELL 004.

3. AERIAL IMAGERY SOURCE: ESRI, 15 JANUARY 1999. IMAGERY AT THIS SCALE MAY NOT REFLECT CURRENT SURFACE FEATURES.

0 400 800
SCALE IN FEET

HALEY ALDRICH

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

THOMAS HILL ENERGY CENTER
ASH POND SYSTEM
MONITORING WELL LOCATION MAP

aeci

MARCH 2019
SCALE: AS SHOWN

FIGURE 2

APPENDIX A

Monitoring Well As-Built Diagrams and Boring Logs

HALEY&
ALDRICH

BORING LOGS

Well No. MW-1

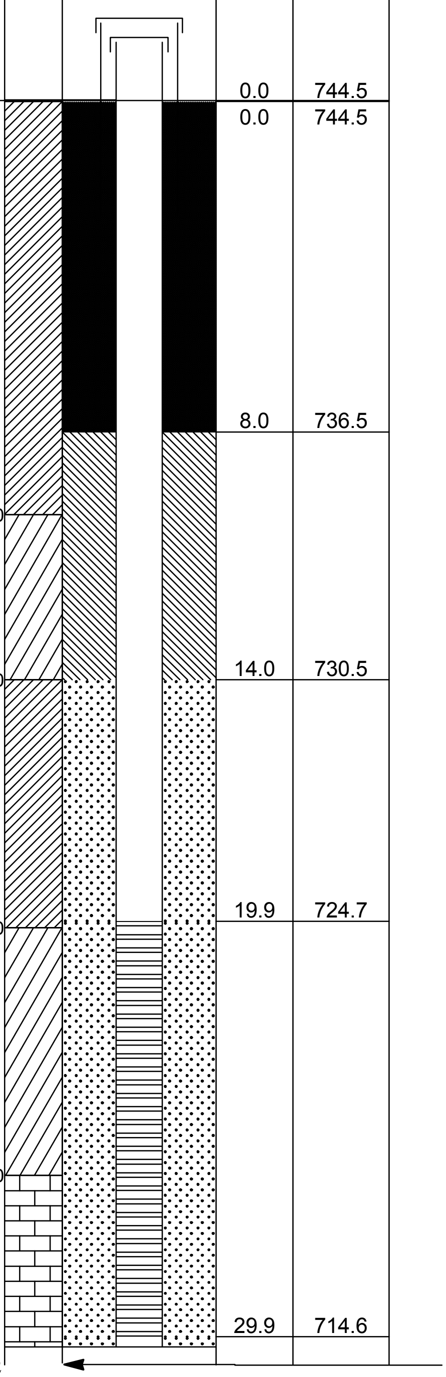
Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

Well Diagram

- ▥ Riser Pipe
- ▤ Screen
- ▒ Filter Sand
- ▓ Cuttings
- ■ Grout
- ░ Concrete
- ▧ Bentonite Seal

File No.	128064-001
Date Installed	25 Aug 2015
H&A Rep.	D. Andersen
Location	See Plan
Ground El.	744.5
Datum	NGVD

SOIL/ROCK CONDITIONS	DEPTH (ft.)
CHFat clay with sand.	0
CL Lean clay with sand.	10.0
CH Fat clay with sand.	14.0
CLLean clay with sand.	20.0
LIMESTONE Grey-tan colored, sandy, crystalline.	26.0
	30.2



DEPTH (ft.)	ELEVATION (ft.)
0.0	744.5
0.0	744.5
8.0	736.5
14.0	730.5
19.9	724.7
29.9	714.6

WELL CONSTRUCTION DETAILS

Type of protective cover LOCKING CAP

Height of Guard Pipe above ground surface 2.9 ft

Height of top of riser above ground surface 2.4 ft

Type of protective casing Guard Pipe

Length 5.0 ft

Inside diameter 4 inches

Depth of bottom of Guard Pipe 2.1 ft

Type of riser pipe Schedule 40 PVC

Inside diameter of riser pipe 2 inch

Depth of bottom of riser pipe 19.9 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	0.0 ft	8.0 ft
Bentonite	8.0 ft	6.0 ft
	-	-

Diameter of borehole 9.5 inch

Depth to top of well screen 19.9 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 29.9 ft

Bottom of silt trap NA

Depth of bottom of borehole 30.2 ft

HALEY& ALDRICH

BORING LOGS

Well No. MW-2R

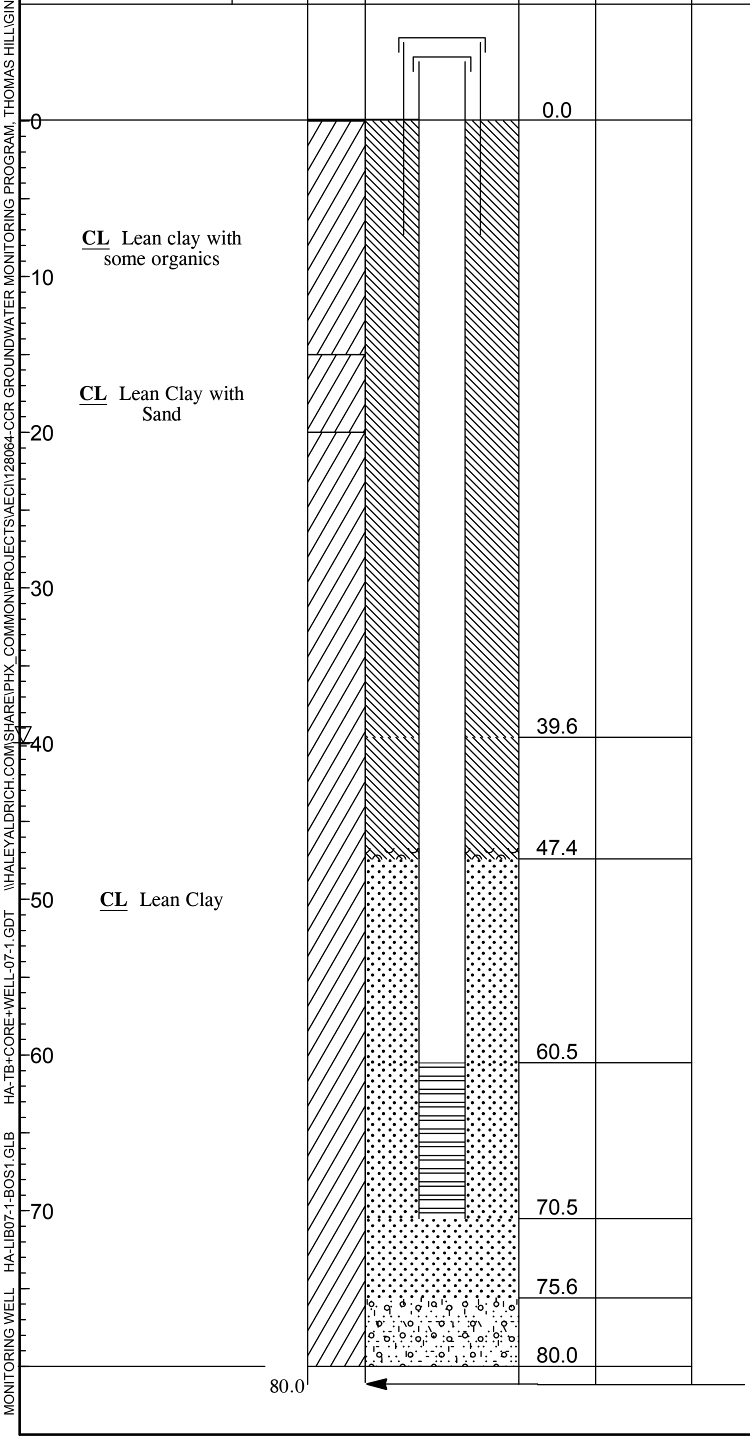
Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	

Well Diagram

- ▥ Riser Pipe
- ▤ Screen
- ░ Filter Sand
- ▒ Cuttings
- ■ Grout
- ⁘ Concrete
- ▧ Bentonite Seal

File No.	128064-001
Date Installed	20 Mar 2017
H&A Rep.	B. Kienenberger
Location	See Plan
Ground El.	
Datum	NGVD

SOIL/ROCK CONDITIONS	DEPTH (ft.)
CL Lean clay with some organics	0
CL Lean Clay with Sand	15
CL Lean Clay	20
	80.0



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: 2 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: 60.5 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite Grout	0.0 ft	39.6 ft
Bentonite	39.6 ft	7.1 ft
	-	-

Diameter of borehole: 8 inch

Depth to top of well screen: 60.5 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: 70.5 ft

Bottom of silt trap: NA

Depth of bottom of borehole: 80.0 ft

HALEY& ALDRICH

BORING LOGS

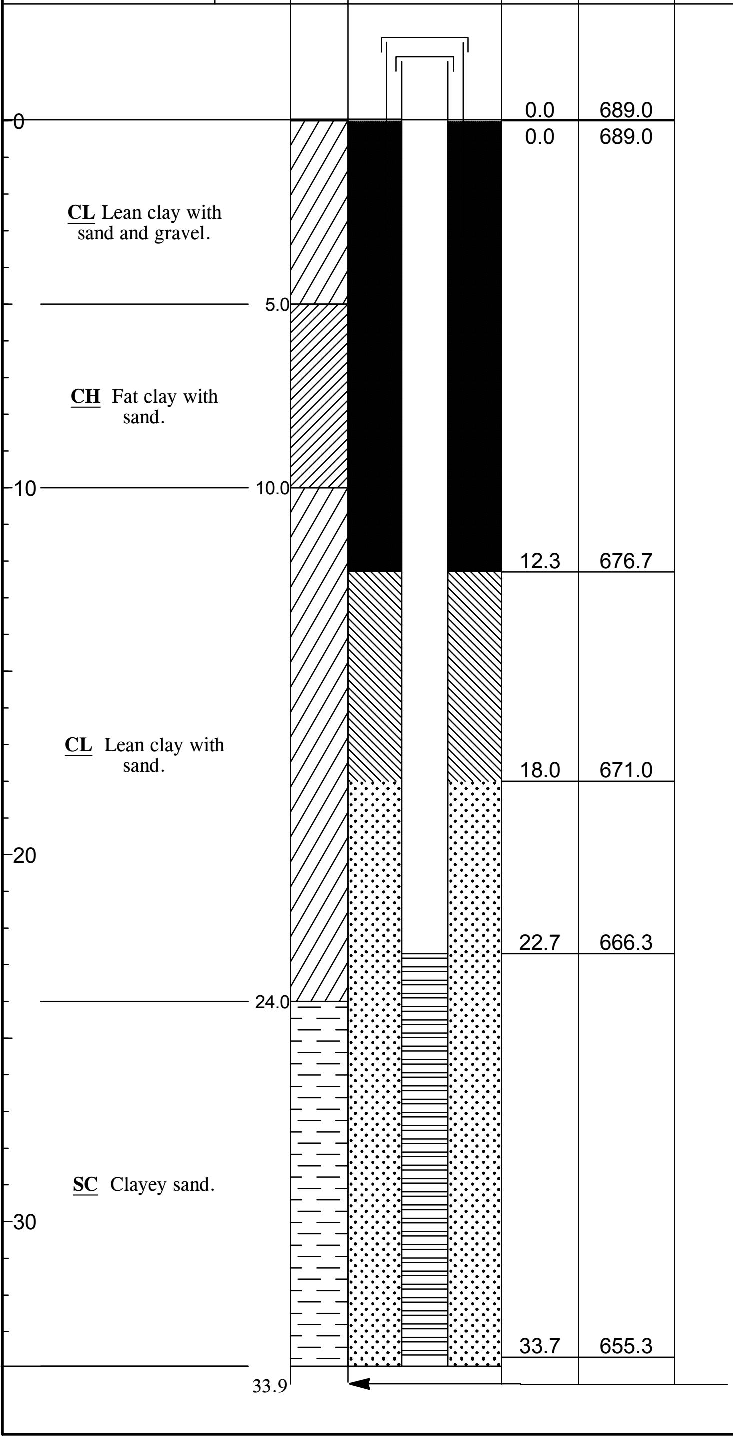
Well No. MW-3

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.	128064-001
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.	0
CH Fat clay with sand.	5.0
CL Lean clay with sand.	10.0
SC Clayey sand.	24.0
	33.9

WELL DETAILS DEPTH (ft.)	ELEVATION (ft.)
0.0	689.0
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 3.7 ft

Height of top of riser above ground surface 3.2 ft

Type of protective casing Guard Pipe

Length 5.0 ft

Inside diameter 4 inches

Depth of bottom of Guard Pipe 1.3 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

HALEY & ALDRICH

BORING LOGS

Well No. MW-4

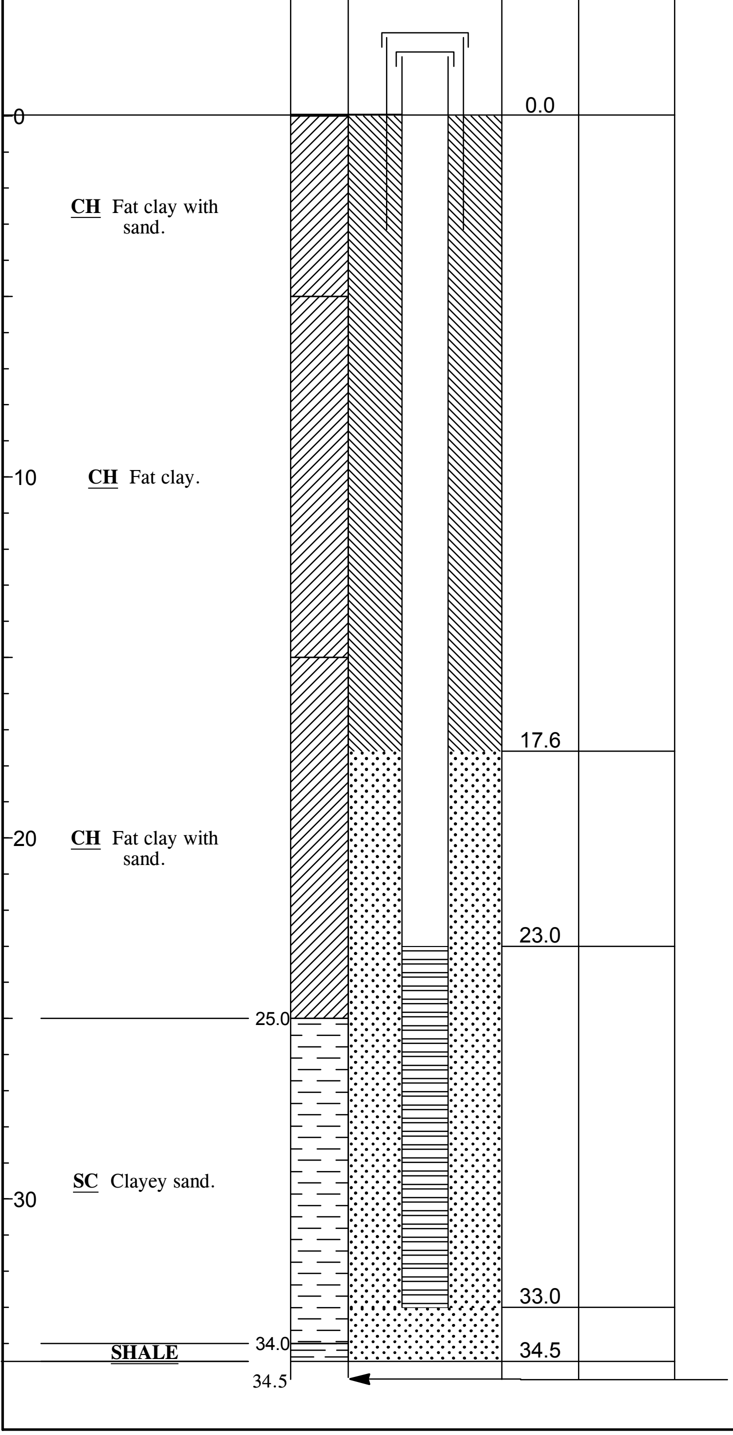
Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

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.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)	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 2 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 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 Backfill 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

HALEY&
ALDRICH

BORING LOGS

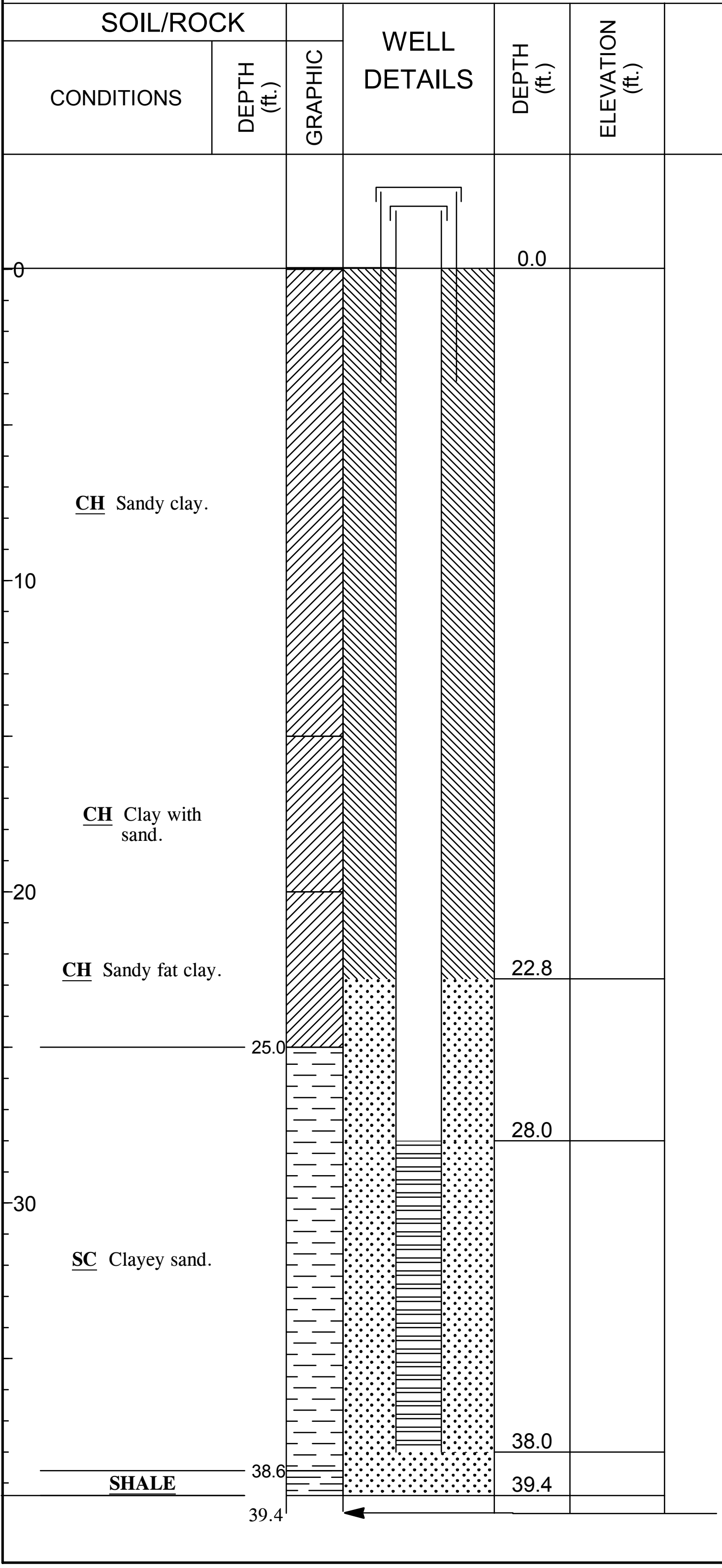
Well No. MW-5

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	03 Aug 2016
H&A Rep.	P. Kroger
Location	See Plan
Ground El.	
Datum	NGVD



WELL CONSTRUCTION DETAILS

Type of protective cover LOCKING CAP

Height of Guard Pipe above ground surface 2.0 ft

Height of top of riser above ground surface 1.5 ft

Type of protective casing Guard Pipe

Length 5.0 ft

Inside diameter 2 inches

Depth of bottom of Guard Pipe 3.0 ft

Type of riser pipe Schedule 40 PVC

Inside diameter of riser pipe 2 inch

Depth of bottom of riser pipe 28.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite	0.0 ft	22.8 ft
-	-	-
-	-	-

Diameter of borehole 10 inch

Depth to top of well screen 28.0 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 38 ft

Bottom of silt trap NA

Depth of bottom of borehole 39.4 ft

BORING LOGS

Well No. MW-6

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

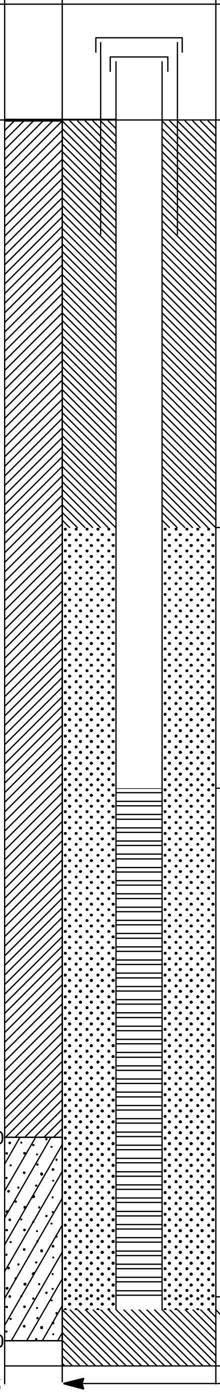
Well Diagram

▥	Riser Pipe
▤	Screen
▒	Filter Sand
▓	Cuttings
■	Grout
▨	Concrete
▧	Bentonite Seal

File No.	128064-001
Date Installed	25 Aug 2015
H&A Rep.	D. Andersen
Location	See Plan
Ground El.	702.7
Datum	NGVD

SOIL/ROCK

CONDITIONS	DEPTH (ft.)
0	
10 **CH** Fat clay with sand.	
20	20.0
GC Clayey gravel with sand. Rounded quartzose river gravel and sub-angular feldspathic gravel	24.0
	24.5



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 2.9 ft

Height of top of riser above ground surface 2.4 ft

Type of protective casing Guard Pipe

Length 5.0 ft

Inside diameter 4 inches

Depth of bottom of Guard Pipe 2.1 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

HALEY ALDRICH

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. TPZ-1

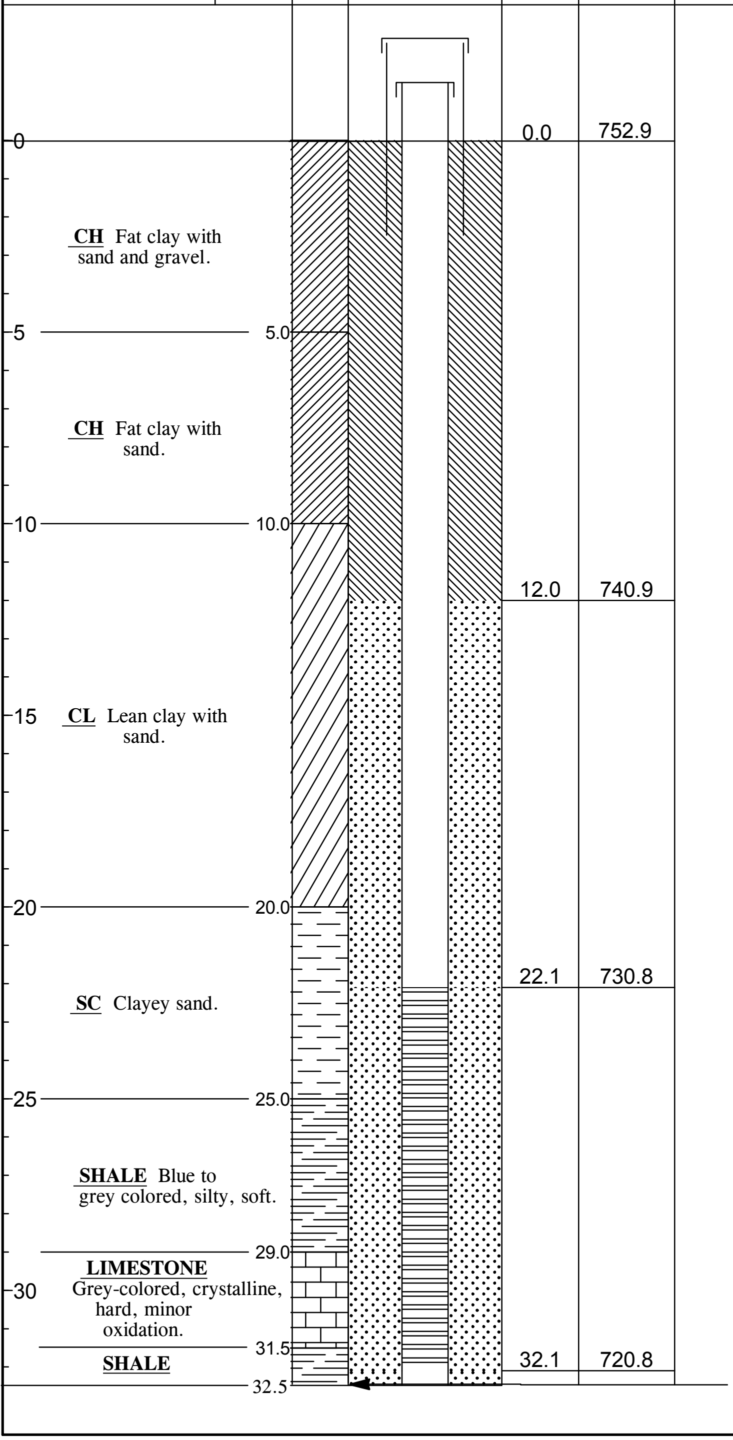
Project Thomas Hill Energy Center
Location Clifton Hill, MO
Client Associated Electric Cooperative, Inc.
Contractor Bulldog Drilling
Driller C. Dutton

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. 752.9
Datum NGVD



CONDITIONS	DEPTH (ft.)
CH Fat clay with sand and gravel.	5.0
CH Fat clay with sand.	10.0
CL Lean clay with sand.	20.0
SC Clayey sand.	25.0
SHALE Blue to grey colored, silty, soft.	29.0
LIMESTONE Grey-colored, crystalline, hard, minor oxidation.	31.5
SHALE	32.5

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 22.1 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite	0.0 ft	12.0 ft
	-	-
	-	-

Diameter of borehole 9.5 inch

Depth to top of well screen 22.1 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 32.1 ft

Bottom of silt trap NA

Depth of bottom of borehole 32.5 ft

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. TPZ-3

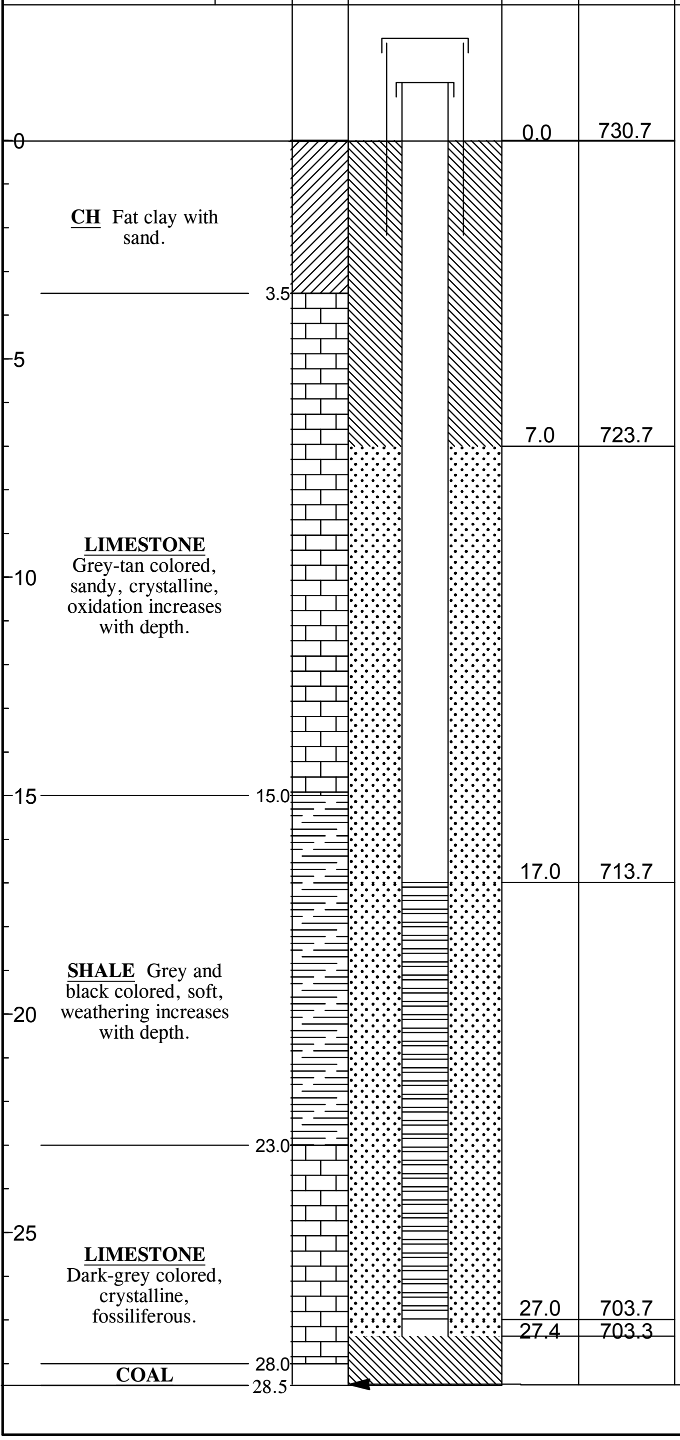
Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

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.) | GRAPHIC | WELL DETAILS | DEPTH (ft.) | ELEVATION (ft.)



CH Fat clay with sand.

LIMESTONE Grey-tan colored, sandy, crystalline, oxidation increases with depth.

SHALE Grey and black colored, soft, weathering increases with depth.

LIMESTONE Dark-grey colored, crystalline, fossiliferous.

COAL

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

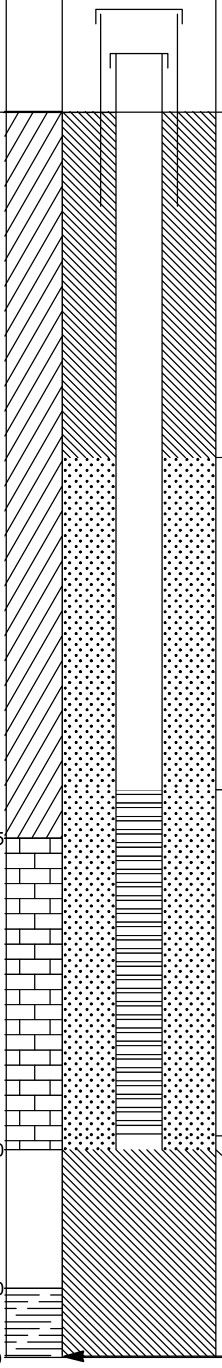
Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

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

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

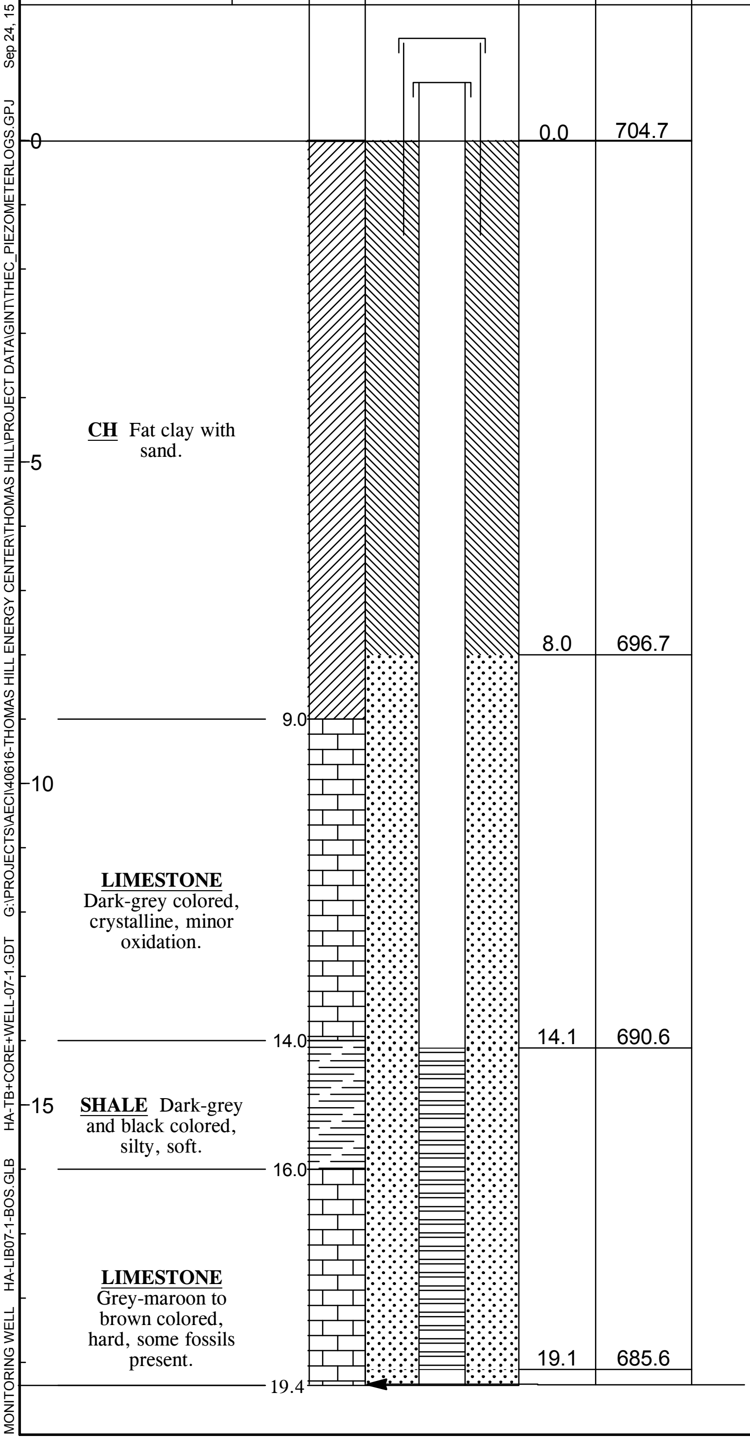
Well Diagram

▥	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



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

Well No. TPZ-16

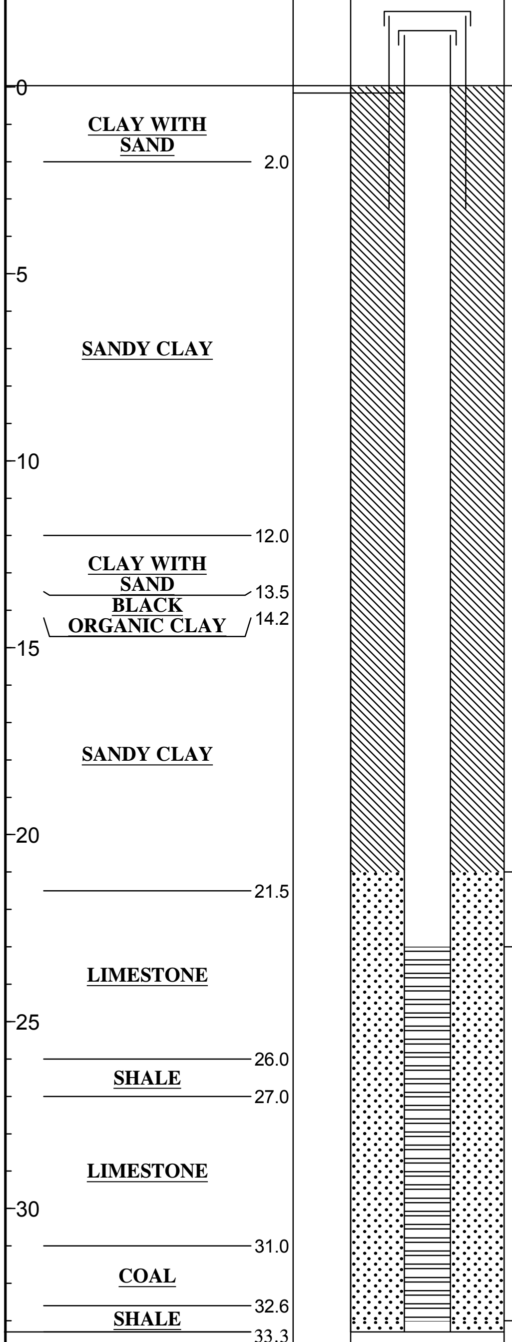
Project Thomas Hill Energy Center
Location Clifton Hill, MO
Client Associated Electric Cooperative, Inc.
Contractor Bulldog Drilling
Driller C. Dutton

Well Diagram
▯ Riser Pipe
▤ Screen
░ Filter Sand
▒ Cuttings
■ Grout
▵ Concrete
▧ Bentonite Seal

File No. 128064-006
Date Installed 15 Mar 2018
H&A Rep. P. Kroger
Location See Plan

Ground El. 710.3
Datum NAD 29

SOIL/ROCK CONDITIONS	DEPTH (ft.)
CLAY WITH SAND	2.0
SANDY CLAY	12.0
CLAY WITH SAND	13.5
BLACK ORGANIC CLAY	14.2
SANDY CLAY	21.5
LIMESTONE	26.0
SHALE	27.0
LIMESTONE	31.0
COAL	32.6
SHALE	33.3



DEPTH (ft.)	ELEVATION (ft.)
0.0	710.3
21.0	689.3
23.0	687.3
33.0	677.3

WELL CONSTRUCTION DETAILS

Type of protective cover LOCKING CAP

Height of Guard Pipe above ground surface 3.0 ft

Height of top of riser above ground surface 2.6 ft

Type of protective casing Guard Pipe

Length 5.0 ft

Inside diameter 4 inches

Depth of bottom of Guard Pipe 2.0 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 Grout	0.0	21.0
	-	-
	-	-

Diameter of borehole 9.5 in.

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 Backfill around Screen No. 12-20 silica sand

Depth to bottom of well screen 33 ft

Bottom of silt trap 33.3 ft

Depth of bottom of borehole 33.3 ft

COMMENTS:

HALEY ALDRICH

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. TPZ-17

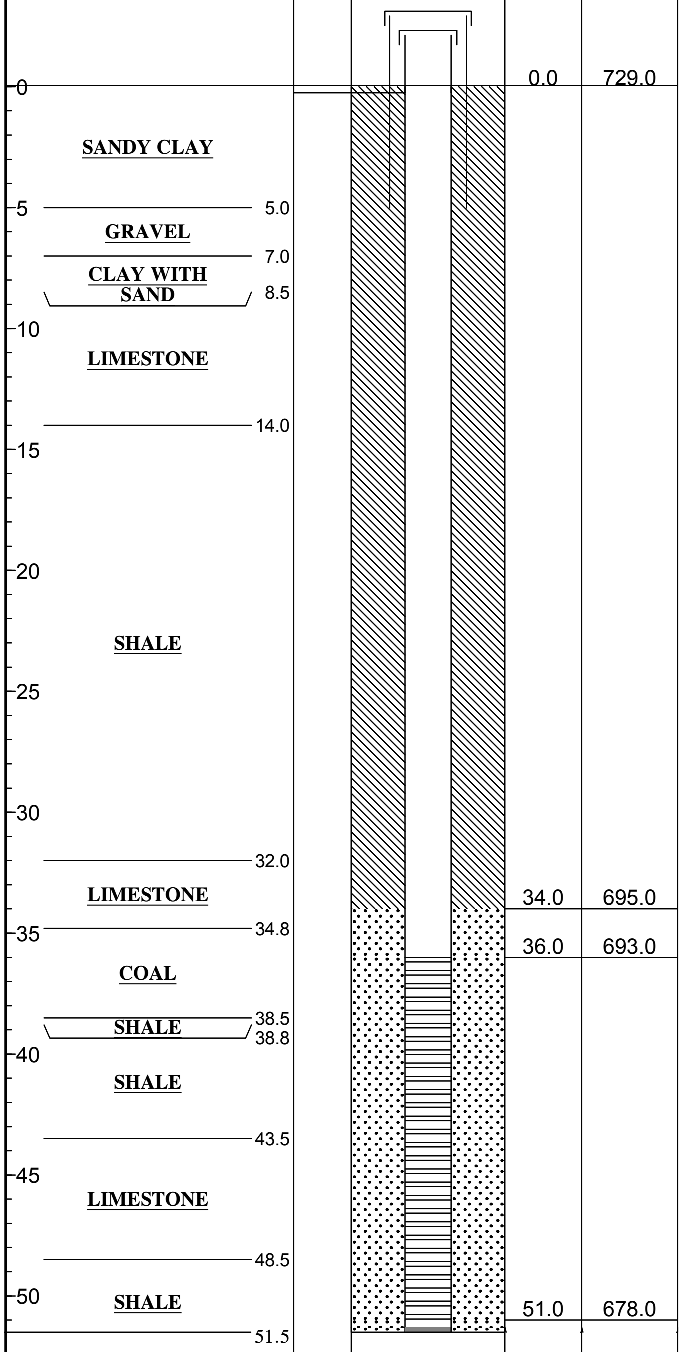
Project Thomas Hill Energy Center
Location Clifton Hill, MO
Client Associated Electric Cooperative, Inc.
Contractor Bulldog Drilling
Driller C. Dutton

Well Diagram
- ◫ Riser Pipe
- ▤ Screen
- ░ Filter Sand
- ▒ Cuttings
- ■ Grout
- ⛬ Concrete
- ▨ Bentonite Seal

File No. 128064-006
Date Installed 21 Mar 2018
H&A Rep. P. Kroger
Location See Plan

Ground El. 729.0
Datum NAD 29

SOIL/ROCK CONDITIONS	DEPTH (ft.)
SANDY CLAY	5.0
GRAVEL	7.0
CLAY WITH SAND	8.5
LIMESTONE	14.0
SHALE	32.0
LIMESTONE	34.8
COAL	38.5
SHALE	38.8
SHALE	43.5
LIMESTONE	48.5
SHALE	51.5



DEPTH (ft.)	ELEVATION (ft.)
0.0	729.0
34.0	695.0
36.0	693.0
51.0	678.0

WELL CONSTRUCTION DETAILS

Type of protective cover LOCKING CAP

Height of Guard Pipe above ground surface 2.7 ft

Height of top of riser above ground surface 2.3 ft

Type of protective casing Guard Pipe

Length 5.0 ft

Inside diameter 4 inches

Depth of bottom of Guard Pipe 2.3 ft

Type of riser pipe Schedule 40 PVC

Inside diameter of riser pipe 2 inch

Depth of bottom of riser pipe 36.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite	0.0	34.0
-	-	-
-	-	-

Diameter of borehole 9.5 in.

Depth to top of well screen 36.0 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 33 ft

Bottom of silt trap 51.3 ft

Depth of bottom of borehole 51.5 ft

COMMENTS:

HA-LIB09-BOS - SONIC.GLB GW INSTALLATION REPORT-07-1 WESTAR G:\PROJECTS\AECI\128064-CCR GROUNDWATER MONITORING PROGRAM, THOMAS HILL\GINT\TPZ-16 TPZ 17.GPJ May 18, 18