ALLIANT ENERGY
Wisconsin Power and Light Company
Edgewater Generating Station

CCR SURFACE IMPOUNDMENT

SAFETY FACTOR ASSESSMENT

Report Issued: September 21, 2016
Revision 0

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EXECUTIVE SUMMARY

This Safety Factor Assessment (Report) is prepared in accordance with the requirements of the United States Environmental Protection Agency (USEPA) published Final Rule for Hazardous and Solid Waste Management System – Disposal of Coal Combustion Residual (CCR) from Electric Utilities (40 CFR Parts 257 and 261, also known as the CCR Rule) published on April 17, 2015 and effective October 19, 2015.

This Report assesses the safety factors of each CCR unit at Edgewater Generating Station in Sheboygan, WI in accordance with §257.73(b) and §257.73(e) of the CCR Rule. For purposes of this Report, "CCR unit" refers to existing CCR surface impoundments.

Primarily, this Report is focused on assessing if each CCR surface impoundment achieves the minimum safety factors, which include:

- Static factor of safety under long-term, maximum storage pool loading condition,
- Static factor of safety under the maximum surcharge pool loading condition,
- Seismic factor of safety; and,
- Post-Liquefaction factor of safety for embankments constructed of soils that have susceptibility to liquefaction.

Table of Contents

Figures

Appendices

1 INTRODUCTION

The owner or operator of the Coal Combustion Residual (CCR) unit must conduct an initial and periodic safety factor assessments to determine if each CCR surface impoundment achieves the minimum safety factors, which include:

- Static factor of safety under long-term, maximum storage pool loading condition,
- Static factor of safety under the maximum surcharge pool loading condition,
- Seismic factor of safety; and,
- Post-Liquefaction factor of safety for embankments constructed of soils that have susceptibility to liquefaction.

This Report has been prepared in accordance with the requirements of §257.73(b) and §257.73(e) of the CCR Rule.

1.1 CCR Rule Applicability

The CCR Rule requires a periodic safety factor assessment by a qualified professional engineer (PE) for existing CCR surface impoundments with a height of 5 feet or more and a storage volume of 20 acre-feet or more; or the existing CCR surface impoundment has a height of 20 feet or more.

1.2 Safety Factor Assessment Applicability

The Edgewater Generating Station (EDG) in Sheboygan, WI (Figure 1) has four existing CCR surface impoundments, identified as follows:

- EDG Slag Pond
- EDG North A-Pond
- EDG South A-Pond
- EDG B-Pond

Each of the identified existing CCR surface impoundments meet the requirements of §257.73(b)(1) and/or §257.73(b)(2), they are subject to the periodic safety factor assessment requirements of §257.73(e) of the CCR Rule.

2 FACILITY DESCRIPTION

EDG is located on the south edge of the City of Sheboygan, Wisconsin along the western shore of Lake Michigan in Sheboygan County, at 3739 Lakeshore Drive, Sheboygan, Wisconsin (Figure 1).

EDG is a fossil-fueled electric generating station that initiated operations in 1930. EDG consists of two steam electric generating units (Unit 4 and Unit 5). A third steam electric generating unit (Unit 3) was removed from service in 2015. Sub-bituminous coal is the primary fuel used at EDG for producing steam. The burning of coal produces CCR byproducts. The CCR at EDG is categorized into five types: precipitator fly ash, slag, bottom ash, economizer ash, and scrubber byproducts.

The Unit 4 precipitator fly ash is collected by Unit 4's electrostatic precipitators and sent to an on-site storage silo located southwest of the generating plant. The precipitator fly ash is then transported off-site for either beneficial reuse or for disposal at the EDG I-43 CCR landfill. The Unit 5 precipitator fly ash is collected by Unit 5's electrostatic precipitators and sent to a separate on-site storage silo located southwest of the generating plant. Unit 5's precipitator fly ash is then transported off-site for beneficial reuse or for disposal at the EDG I-43 CCR landfill..

The slag at EDG is produced from Unit 4 and is sluiced from the generating plant to a surface impoundment identified as the EDG Slag Pond (Figure 2). The EDG Slag Pond is located southwest of the generating plant.

Byproducts from the circulating dry scrubber (CDS) system are transported offsite for disposal at the EDG I-43 CCR Landfill.

General Facility Information:

Date of Initial Facility Operations:	1930
WPDES Permit Number:	WI-0001589-07-0
Latitude / Longitude:	43.716153, -87.706262

Nameplate Ratings: Unit 1 (Retired)
Unit 2 (Retired)
Unit 3 (Retired)
Unit 4 351 MW
Unit 5 414 MW

2.1 EDG Slag Pond

The EDG Slag Pond is located southwest of the generating plant and north of the EDG North A-Pond. The EDG Slag Pond receives influent flow from the generating plant via the Unit 4 boiler slag tanks. The water-slag slurry discharges into the southwest portion of the EDG Slag Pond. The slag is dredged out of the EDG Slag Pond and stockpiled in a containerized area adjacent to the existing CCR surface impoundment for dewatering. The slag is then screened to separate the coarsely graded material from the finely graded material prior to being transported off-site for beneficial reuse. The water in the EDG Slag Pond flows to the southwest where it gravity flows through a V-notch weir and through a four feet wide concrete structure into a 48-inch diameter corrugated metal pipe. The water from the EDG Slag Pond, which combines with flows from the EDG North A-Pond and EDG South A-Pond in the 48-inch diameter corrugated metal pipe, flows to the south into the northwest corner of the EDG B-Pond.

The surface area of the EDG Slag Pond is approximately 2.2 acres and has an embankment height of approximately 12 feet from the crest to the toe of the downstream slope. The interior storage depth of the EDG Slag Pond is approximately 17 feet. The total volume of impounded CCR and water within the EDG Slag Pond is approximately 47,000 cubic yards.

2.2 EDG North A-Pond

The EDG North A-Pond is located southwest of the generating plant and south of the EDG Slag Pond. Historically, the EDG North A-Pond has received influent flows from the surge tank. Water in the surge tank includes excess process water from the Unit 5 hydrobin, steam water treatment reject water, and water from the facility floor drains. Therefore, the EDG North A-Pond has likely received residual bottom ash from the hydrobin system, de minimis quantities of fly ash from routine maintenance operations, coal fines, and other materials from the plant floor drains. The water was pumped from the surge tank to the EDG North A-Pond via a 10-inch diameter steel pipe. The steel pipe, at a location northeast of the EDG North A-Pond, splits into two separate 10-inch diameter pipes. Each pipe then discharged into the northeast corner of both the EDG North A-Pond and EDG South A-Pond. Currently, EDG North A-Pond does not receive operational process discharges from the generating plant, although it still has the ability to be routed to the EDG North A-Pond.

Previously, water within the EDG North A-Pond flowed to the west. The EDG North A-Pond discharge consists of an 18-inch diameter corrugated plastic pipe located in the southwest corner of the existing CCR surface impoundment. The water would flow through the corrugated plastic pipe to the west into a concrete sluice box. The water within the sluice box flows through a Parshall flume prior to discharging into a 48-inch diameter corrugated metal pipe, which also receives influent flow from the EDG Slag Pond and EDG South A-Pond, prior to gravity flowing to the south into the northwest corner of the EDG B-Pond. Presently, no water within the EDG North A-Pond discharges through the 18-inch diameter corrugated plastic pipe as the pipe has been plugged.

The surface area of the EDG North A-Pond is approximately 2.2 acres and has an embankment height of approximately 18 feet from the crest to the toe of the downstream slope. The interior storage depth of the EDG Secondary Ash Pond is approximately 21 feet. The total volume of impounded CCR and water within the EDG North A-Pond is approximately 73,000 cubic yards.

2.3 EDG South A-Pond

The EDG South A-Pond is located southwest of the generating plant and south of the EDG North A-Pond. As currently configured, the EDG South A-Pond receives influent flows from the surge tank. Water in the surge tank includes excess process water from the Unit 5 hydrobin, steam water treatment reject water, and water from the facility floor drains. Therefore, the EDG North A-Pond has likely received residual bottom ash from the hydrobin system, de minimis quantities of fly ash from routine maintenance operations, coal fines, and other materials from the plant floor drains. The water is pumped from the surge tank to the EDG South A-Pond via a 10-inch diameter steel pipe. The steel pipe, at a location northeast of the EDG North A-Pond, splits into two separate 10-inch diameter pipes. Each pipe then discharges into the northeast corner of both the EDG North A-Pond and EDG South A-Pond. Note, the EDG North A-Pond no longer receives operational process flows from the generating plant.

The water within the EDG South A-Pond flows to the west. The EDG South A-Pond consists of an 18-inch diameter corrugated plastic pipe located in the northwest corner of the existing CCR surface impoundment. The water flows through the corrugated plastic pipe to the west into a concrete sluice box. The water within the sluice box flows through a Parshall flume prior to discharging into a 48-inch diameter corrugated metal pipe, which also receives influent flow from the EDG Slag Pond, prior to gravity flowing to the south into the northwest corner of the EDG B-Pond.

The surface area of the EDG South A-Pond is approximately 2.2 acres and has an embankment height of approximately 18 feet from the crest to the toe of the downstream slope. The interior storage depth of the EDG South A-Pond is approximately 25 feet. The total volume of impounded CCR and water within the EDG South A-Pond is approximately 90,500 cubic yards.

2.4 EDG B-Pond

The EDG B-Pond is located southwest of the generating plant and south of the EDG South A-Pond. The EDG B-Pond receives influent flow via a 48-inch diameter corrugated metal pipe from the EDG Slag Pond and EDG South A-Pond. Additionally, the EDG B-Pond receives storm water drainage from a part of the closed ash landfill west of the EDG B-Pond. The storm water from the closed ash landfill discharges into the west side of the EDG B-Pond via a small corrugated plastic pipe.

The water in the EDG B-Pond flows to the east through an overflow weir wet well structure, Figure 2. The elevated weir prevents CCR that has settled in the EDG B-Pond from flowing out of the impoundment. The water gravity flows to the east through a 24-inch diameter corrugated metal pipe where it discharges into the west side of the EDG C-Pond. The water in the EDG C-Pond gravity flows to the east into the EDG F-Pond. The water in the EDG F-Pond flows through the facility's Wisconsin Pollution Discharge Elimination System (WPDES) Outfall 004 and discharges into Lake Michigan. As determined by WPL, process water discharging from the EDG B-Pond does not contain a significant quantity of CCR, and downstream impoundments contain only de minimis quantities of CCR.

The water surface area of the EDG B-Pond is approximately 1.9 acres and has an embankment height of approximately 24 feet from the crest to the toe of the downstream slope in EDG C-Pond. The interior storage depth of the EDG B-Pond is approximately 15 feet. The total volume of impounded CCR and water within the EDG B-Pond is approximately 46,500 cubic yards.

3 SAFETY FACTOR ASSESSMENT- §257.73(e)

This Report documents if each CCR surface impoundment achieves the minimum safety factors, which are identified on the table below.

Safety Factor Assessment	Minimum Safety Factor
Static Safety Factor Under Maximum Storage Pool Loading	1.50
Static Safety Factor Under Maximum Surcharge Pool Loading	1.40
Seismic Safety Factor	1.00
Liquefaction Safety Factor	1.20

3.1 Safety Factor Assessment Methods

The safety factor assessment is completed with the two dimensional limit-equilibrium slope stability analyses program STABL5M (1996)[1]. The program analyzes many potential failure circles or block slides by random generation of failure surfaces using the toe and crest search boundaries set for each analysis. The solution occurs by balancing the resisting forces along the failure plane due to the Mohr-Columb failure strength parameters of friction angle and cohesion. The gravity driving forces are divided by the resisting forces to produce a safety factor for the slope. The minimum of hundreds of searches is presented as the applicable safety factor.

There are both total stress and effective stress friction angle and cohesion values for clay. For the total stress case clay has only cohesion. For effective stress clay has both cohesion and friction angle. When clay receives a load that is applied only briefly (i.e., earthquake or high water), it responds as a total stress soil. For long term loadings such as normal water elevation, the clay resistance to failure is based on effective stress parameters. Because effective stress clay parameters are not readily available from the soil testing and because the total stress parameters for compacted and over consolidated clay yield a

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[1] STABL User Manual by Ronald A. Siegal, Purdue University, June 4, 1975 and STABL5 – The Spencer Method of Slices: Final Report by J. R. Carpenter, Purdue University, August 28, 1985

conservative answer for safety factor, the static analysis with normal operating water elevation is performed with the total stress parameters for the clay components in the embankments.

3.1.1 Soil Conditions in and under the impoundments

In December of 2010, Miller Engineers and Scientists installed thirteen soil borings through the embankments of the EDG CCR impoundments. The locations of the borings and cross-sections of the embankments are shown on Figures 2 through 5. The topography of the embankments was also determined in late 2010. Since no substantial changes have occurred at the EDG CCR impoundments since 2010, the 2010 investigative results combined with the present impoundment operating conditions (normal water elevations) are used in the stability analysis.

The soil boring logs, Appendix A, indicate that the embankments of the EDG CCR impoundments are constructed of very stiff to stiff compacted clay (CL). The embankment foundation is medium dense to very loose silt starting at elevation 586 feet and extending to a medium stiff clay at an elevation of 560 to 569 feet, Borings E, Q, and R in Appendix A. The borings on other cross-sections are not as deep but generally show the same subsurface layers with the exception of borings on the south incised slope of the impoundments which indicate the presence of CCR in the slope.

The properties of the clay in the embankment and the deeper natural clays used in the stability assessment are based on the pocket penetrometer readings shown on the boring logs. The cohesion values range from 1,500 to 4,000 psf.

The internal angle of friction for the medium dense to very loose silt layer under the embankment is selected based on Figure 3-7 Navfacs DM-7, Appendix B[2]. The internal friction angle is 27˚ where the silt is very loose to 30˚ where the silt is medium dense.

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[2] Naval Facilities Engineering Command, "Design Manual Soil Mechanics, Foundations, and Earth Structures", NAVFAC DM-7, March 1971

The upper layer of the embankment for the EDG South A-Pond is dense bottom ash a coarse grained soil and is assigned an internal angle of friction of 37˚. Loose saturated CCR behind the embankments is assigned an internal angle of friction of 27˚ the same as for the very loose silt foundation layer.

3.1.2 Design water surface in impoundments maximum normal pool and maximum pool under design inflow storm

The EDG CCR impoundments each have specific functions in the handling of process water from the EDG Plant. The Slag Pond is the settling basin for the coarse slag from the Unit 4 boiler, EDG South A-Pond is the settling basin for various sumps and boiler feed water conditioning reject, and EDG B-Pond is the final settling basin for the fines that do not get deposited in the other impoundments. The total process water flow from the plant is 4.8 MGD. In addition each impoundment does accept a small watershed area from the slope to the south of the impoundments on the closed landfill site.

The process water flows and the rainfall from a 1,000 year Type II SCS storm distribution are routed through the impoundments to create a maximum pool for each impoundment during the design storm. The normal operating flows in 2016 and the maximum storm pool are:

CCR Pond	Normal Pool Water Elevation (feet)	Maximum Pool Elevation (feet)	Embankment Crest Elevation (feet)
EDG Slag pond	606.6	607.5	609.7
EDG North A-Pond	607	609.1	611.8
EDG South A-Pond	609.2	610.0	611.9
EDG B-Pond	599.0	599.9	607.9

3.1.3 Selection of Seismic Design Parameters and Description of Method

The design earthquake ground acceleration is selected from the United States Geologic Survey (USGS) detailed seismic design maps based on the latitude and longitude of the EDG. The peak ground acceleration (PGA) value is selected for a 2% probability of exceedance in 50 years (2,500 year return period) as required by § 257.53. Since the site soils are clay with cohesion greater than 1,000 psf, excepting the silt layer, and extend to bedrock at 130 feet[3], the site class as defined in the 2009 International Building Code 1613.5.5 is Site Class D. For Site Class D the ground surface PGA for slope stability and liquefaction assessment is 0.05g, Appendix C.

3.1.4 Liquefaction Assessment Method and Parameters

Certain soils may have zero effective stress (liquefaction) during an earthquake or from static shear of a saturated embankment slope. Soils that will liquefy include loose or very loose uniform fine sand or silt, and low plasticity clay (plastic index of less than 12). The liquefaction resistance of a soil is based on its strength and effective confining stress. The strength of the saturated silt is measured by the SPT results shown on the borings in Appendix A. Some of the site clay has plastic index less than 12 as shown on Figures 3 through 5. However the clay is stiff or very stiff and not subject to liquefaction.

The test results for Boring E located on the north embankment of EDG B-Pond, Figure 2 at the highest embankment height and with the lowest silt strength measured indicate the silt is very loose (SPT blowcount less than 5 blows per foot).

The simplified assessment of liquefaction procedure as first proposed by Seed and most recently updated and published by Idriss and Boulanger[4] is used to assess the potential for liquefaction of the silt. The procedure uses the strengths determined by the SPT test adjusted to normalize for overburden pressure and for fines content to determine the cyclic resistance ratio for the soil at earthquake magnitude 7.5 and at 1 atmosphere pressure. The cyclic resistance ratio is then adjusted for the actual earthquake magnitude of the design event which is 7.7 for a New Madrid Fault source earthquake[5]. The cyclic stress ratio caused by the design surface PGA is then used to determine the actual cyclic

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[3] Ground water well records on file with the State of Wisconsin for area near EDG

[4] Idriss I. M. and R. W. Boulanger, "Soil Liquefaction During Earthquakes", EERI MNO-12, 2008.

[5] Elnashi et al, "Impact of Earthquakes on the Central USA", FEMA Report 8-02, Mid-American Earthquake Center, 2002

stress ratio at 65% of maximum strain at depth in the soil profile. The cyclic resistance ratio is divided by the cyclic stress ratio to determine the factor of safety for liquefaction.

The results for the soil profile of Boring E at the north end of the west embankment of the EDG B-Pond are shown in Appendix C. The results indicate the silt layer will not liquefy during the site design earthquake.

3.2 EDG Slag Pond

The critical EDG Slag Pond cross-section analyzed for slope stability is cross-section P-P', Figure 2. The section is the north slope of the EDG Slag Pond and is more critical than the slightly higher East slope due to the proximity of the pond water surface to the crest of the slope. The cross-section is shown on Figure 4 and does not include the foundation soil below the recorded impoundment bottom. For analysis, the soil profile was extended using the results of the deeper borings Q and R, Figure 5, to include the loose silt and deeper medium stiff clay foundation soils.

3.2.1 Static Safety Factor Assessment Under Maximum Storage Pool Loading - §257.73(e)(1)(i)

The EDG Slag Pond receives 3.7 cubic feet per second of average process water flow from sluicing of bottom slag from Boiler 4. The process flow maintains a maximum average storage pool of 606.6 feet in the impoundment. Analysis of both circular and block sliding surfaces, Appendix D, show a minimum factor of safety of 8.6 for the circular failure surface passing through the foundation soil.

3.2.2 Static Safety Factor Assessment Under Maximum Surcharge Pool Loading - §257.73(e)(1)(ii)

The EDG Slag Pond will contain the 1,000 year return period design storm through a combination of storage in the impoundment and discharge to the EDG B-Pond. The maximum surcharge pool elevation is 607.5 at the peak of the storm. Analysis for both circular and block sliding surface, Appendix D, show a minimum factor of safety of 8.5 for the circular surface passing through the foundation soil.

3.2.3 Seismic Safety Factor Assessment - §257.73(e)(1)(iii)

The EDG Slag Pond was assigned a pseudo-static earthquake coefficient equal to 0.05 g acceleration and a vertical downward component equal to $^{2}/_{3}$ of the horizontal component (0.03 g) as recommended by Newmark[6]. Analysis for both a circular and block sliding surface, Appendix D, show a minimum factor of safety of 5.9 for the circular sliding surface through the foundation soil.

3.2.4 Liquefaction Safety Factor Assessment - §257.73(e)(1)(iv)

The EDG Slag Pond foundation soil (very loose to loose silt) is susceptible to liquefaction. An analysis of liquefaction potential, Section 3.1.4, shows that the design earthquake does not cause liquefaction and no post-liquefaction stability analysis is required.

3.3 EDG North A-Pond

The critical EDG North A-Pond cross-section analyzed for slope stability is cross-section N-N′, Figure 2. The section is the East slope of the EDG North A-Pond and is the only outside embankment slope for the impoundment. The cross-section is shown on Figure 4 and does not include the foundation soil below the recorded impoundment bottom. For analysis, the soil profile was extended using the results of the deeper borings Q and R, Figure 5, to include the loose silt and deeper medium stiff clay foundation soils.

3.3.1 Static Safety Factor Assessment Under Maximum Storage Pool Loading - §257.73(e)(1)(i)

The EDG North A-Pond is a zero-discharge pond that no longer receives process water flow. In addition, the outlet of the North A-Pond is blocked to prevent discharge of ponded water to EDG B-Pond. The normal water elevation in the impoundment due to exfiltration loss and evaporation is elevation 607 feet. Analysis of both circular and block sliding surfaces, Appendix D, show a minimum factor of safety of 3.7 for the circular failure surface passing through the foundation soil.

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[6] Newmark, N. M. and W. J. Hall, “Earthquake Spectra and Design”, EERI Monograph, Earthquake Engineering Research Institute, Berkeley, California, 1982

3.3.2 Static Safety Factor Assessment Under Maximum Surcharge Pool Loading - §257.73(e)(1)(ii)

The EDG North A-Pond will contain the 1,000 year return period design storm through storage in the impoundment without discharge. The maximum surcharge pool elevation is 609.1 at the peak of the storm. Analysis for both circular and block sliding surface, Appendix D, show a minimum factor of safety of 3.6 for the circular surface passing through the foundation soil.

3.3.3 Seismic Safety Factor Assessment - §257.73(e)(1)(iii)

The EDG North A-Pond was assigned a pseudo-static earthquake coefficient equal to 0.05 g acceleration and a vertical downward component equal to $^2/_3$ of the horizontal component (0.03 g) as recommended by Newmark[7]. Analysis for both a circular and block sliding surface, Appendix D, show a minimum factor of safety of 2.8 for the circular sliding surface through the foundation soil.

3.3.4 Liquefaction Safety Factor Assessment - §257.73(e)(1)(iv)

The EDG North A-Pond foundation soil (very loose to loose silt) is susceptible to liquefaction. An analysis of liquefaction potential, Section 3.1.4, shows that the design earthquake does not cause liquefaction and no post-liquefaction stability analysis is required.

3.4 EDG South A-Pond

The critical EDG South A-Pond cross-section analyzed for slope stability is cross-section I-I′, Figure 2. The section is the Southeast corner slope of the EDG South A-Pond and is more critical than Section R-R′ due to its overall height and the toe of the slope being in EDG C-Pond. The cross-section is shown on Figure 3 and does not include the complete depth of the foundation soil below the recorded impoundment bottom. For analysis, the soil profile was extended using the results of the deeper borings Q and R, Figure 5 to include the deeper medium stiff clay foundation soils below the loose silt.

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[7] Newmark, N. M. and W. J. Hall, "Earthquake Spectra and Design", EERI Monograph, Earthquake Engineering Research Institute, Berkeley, California, 1982

3.4.1 Static Safety Factor Assessment Under Maximum Storage Pool Loading - §257.73(e)(1)(i)

The EDG South A-Pond receives 3.7 cubic feet per second of average process water flow from plant sumps and reject treatment water. The process flow maintains a maximum average storage pool of 609.2 feet in the impoundment. Analysis of both circular and block sliding surfaces, Appendix D, show a minimum factor of safety of 2.3 for the circular failure surface passing through the foundation soil.

3.4.2 Static Safety Factor Assessment Under Maximum Surcharge Pool Loading - §257.73(e)(1)(ii)

The EDG South A-Pond will contain the 1,000 year return period design storm through a combination of storage in the impoundment and discharge to the EDG B-Pond. The maximum surcharge pool elevation is 610.0 at the peak of the storm. Analysis for both circular and block sliding surface, Appendix D, show a minimum factor of safety of 2.3 for the circular surface passing through the foundation soil.

3.4.3 Seismic Safety Factor Assessment - §257.73(e)(1)(iii)

The EDG South A-Pond was assigned a pseudo-static earthquake coefficient equal to 0.05 g acceleration and a vertical downward component equal to $^2/_3$ of the horizontal component (0.03 g) as recommended by Newmark[8]. Analysis for both a circular and block sliding surface, Appendix D, show a minimum factor of safety of 1.7 for the circular sliding surface through the foundation soil.

3.4.4 Liquefaction Safety Factor Assessment - §257.73(e)(1)(iv)

The EDG South A-Pond foundation soil (very loose to loose silt) is susceptible to liquefaction. An analysis of liquefaction potential, Section 3.1.4, shows that the design earthquake does not cause liquefaction and no post-liquefaction stability analysis is required.

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[8] Newmark, N. M. and W. J. Hall, "Earthquake Spectra and Design", EERI Monograph, Earthquake Engineering Research Institute, Berkeley, California, 1982

3.5 EDG B-Pond

The critical EDG B-Pond cross-section analyzed for slope stability is cross-section E-E′, Figure 2. The section is the East slope of the EDG B-Pond and is more critical than Section Q-Q′ due to its overall height and the toe of the slope being in EDG C-Pond. The cross-section is shown on Figure 3. Since Boring E does not show a clay cohesion value for the clay below the loose silt layer, a value of 1,500 psf similar to Section I-I′ was assigned to the foundation clay.

3.5.1 Static Safety Factor Assessment Under Maximum Storage Pool Loading - §257.73(e)(1)(i)

The EDG B-Pond receives 7.4 cubic feet per second of average process water flow from EDG Slag Pond and South A-Pond. The process flow is controlled by an overflow weir and maintains a maximum average storage pool of 599.0 feet in the impoundment. Analysis of both circular and block sliding surfaces, Appendix D, show a minimum factor of safety of 2.6 for the circular failure surface passing through the foundation soil.

3.5.2 Static Safety Factor Assessment Under Maximum Surcharge Pool Loading - §257.73(e)(1)(ii)

The EDG B-Pond will contain the 1000 year return period design storm through a combination of storage in the impoundment and discharge to the EDG C-Pond. The maximum surcharge pool elevation is 599.9 at the peak of the storm. Analysis for both circular and block sliding surface, Appendix D, show a minimum factor of safety of 2.7 for the circular surface passing through the foundation soil.

3.5.3 Seismic Safety Factor Assessment - §257.73(e)(1)(iii)

The EDG B-Pond was assigned a pseudo-static earthquake coefficient equal to 0.05 g acceleration and a vertical downward component equal to $^2/_3$ of the horizontal component (0.03 g) as recommended by Newmark[9]. Analysis for both a circular and

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[9] Newmark, N. M. and W. J. Hall, "Earthquake Spectra and Design", EERI Monograph, Earthquake Engineering Research Institute, Berkeley, California, 1982

block sliding surface, Appendix D, show a minimum factor of safety of 2.0 for the circular sliding surface through the foundation soil.

3.5.4 Liquefaction Safety Factor Assessment - §257.73(e)(1)(iv)

The EDG B-Pond foundation soil (very loose to loose silt) is susceptible to liquefaction. An analysis of liquefaction potential, Section 3.1.4, shows that the design earthquake does not cause liquefaction and no post-liquefaction stability analysis is required.

4 RESULTS SUMMARY

The results of the safety factor assessment indicate that the EDG embankments meet the requirements of § 257.73(e). The results are:

	Static Stability Normal Water Elevation	**Static Stability Flood Water Elevation**	**Pseudo Static Earthquake with Normal Water Elevation**	**Liquefaction Potential**	**Post-Earthquake Static Stability Normal Water Elevation**
Required Safety Factor	1.5	1.4	1.0		1.2
EDG Slag Pond	8.6	8.5	5.9	no	
EDG North A-Pond	3.7	3.6	2.8	no	
EDG South A-Pond	2.3	2.3	1.7	no	
EDG B-Pond	2.6	2.7	2.0	no	

5 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

To meet the requirements of 40 CFR 257.73(e)(2), I Mark W. Loerop hereby certify that I am a licensed professional engineer in the State of Wisconsin; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in 40 CFR 257.73(b) and 40 CFR 257.73(e).

MARK W.
LOEROP
E-43783-6
NAPERVILLE
IL

By:

Name: MARK LOEROP

Date: 10/5/2016

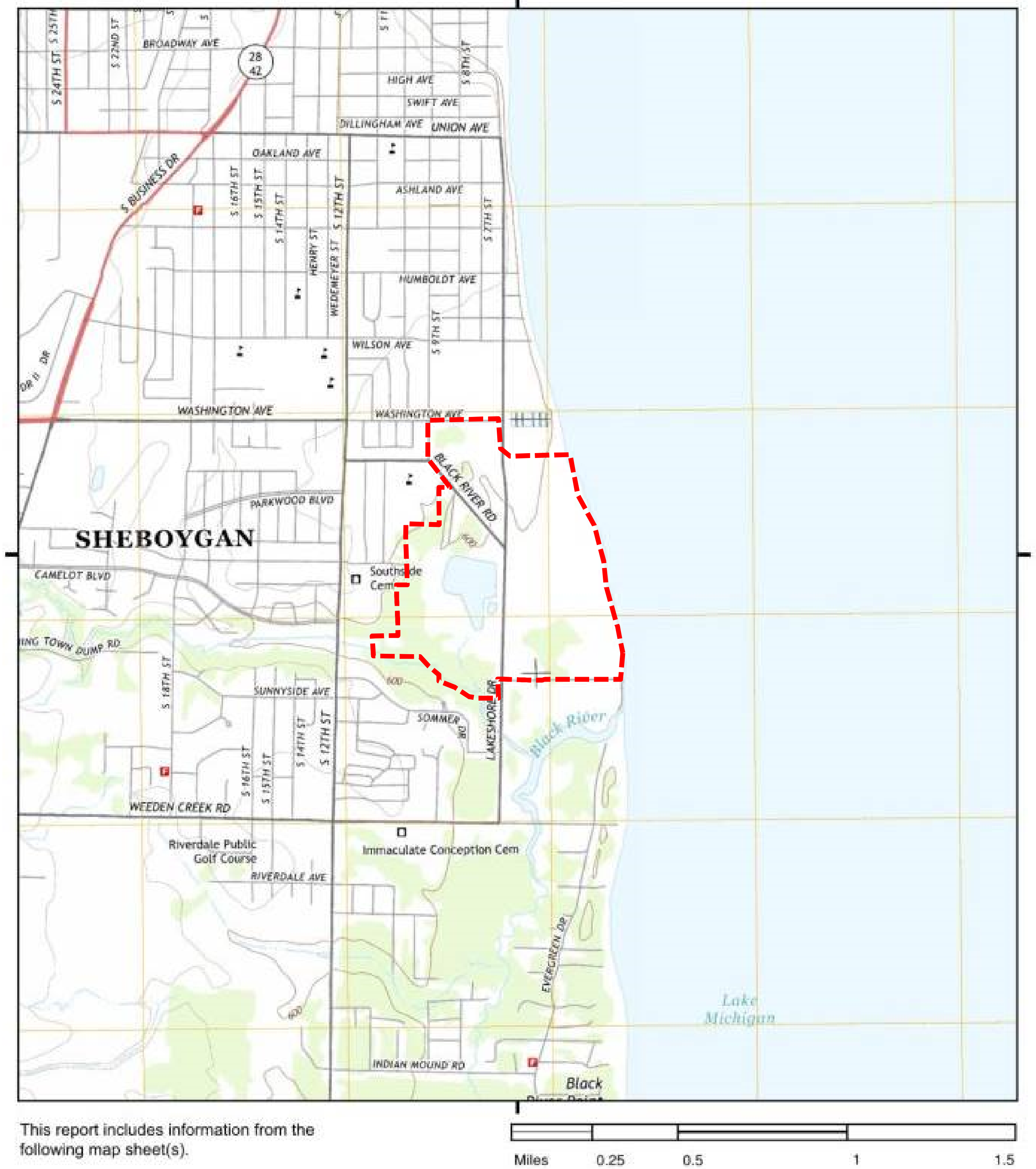
FIGURES

Alliant Energy
Wisconsin Power and Light Company
Edgewater Generating Station
Sheboygan, WI

Safety Factor Assessment

Historical Topo Map

2013



This report includes information from the following map sheet(s).

NW N NE
W E
SW S SE

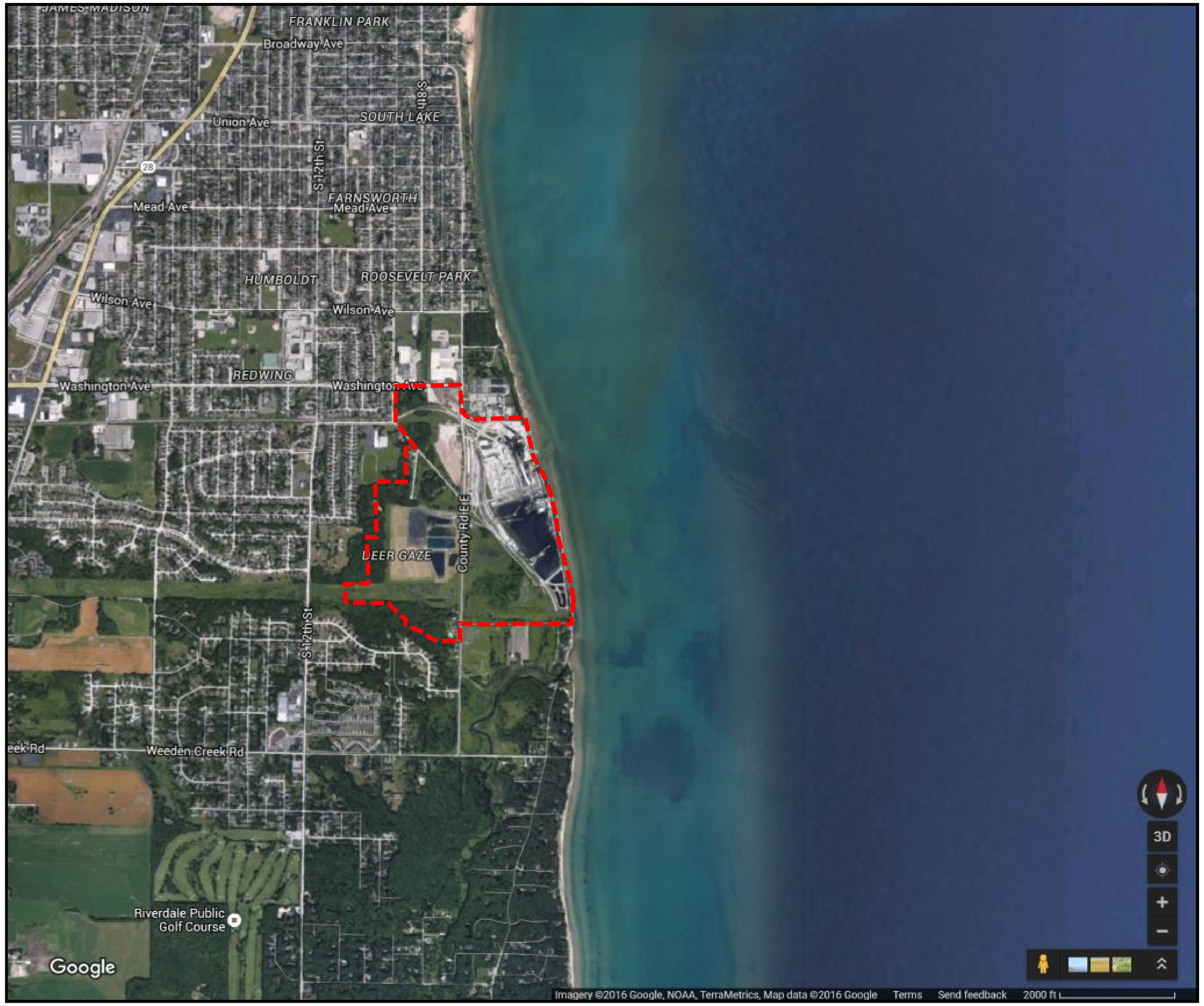
TP, Sheboygan South, 2013, 7.5-minute

SITE NAME: Edgewater Generating Station
ADDRESS: 3739 Lakeshore Drive
Sheboygan, WI 53081
CLIENT: Environmental Site Assessors

N

4555570 - 9 page 4

Historical Aerial Photo



🟥 Approximate Property Boundary

HARD HAT SERVICES ™
Engineering, Construction and Management Solutions

Site Location
Edgewater Generating Station
Wisconsin Power and Light Company

Drawing
Figure 1

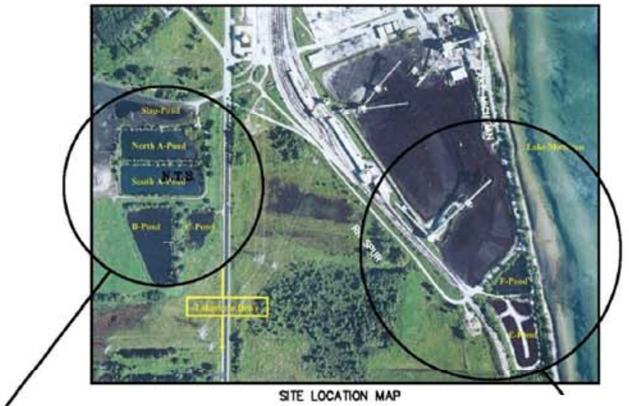
Date
7/12/2016

LEGEND

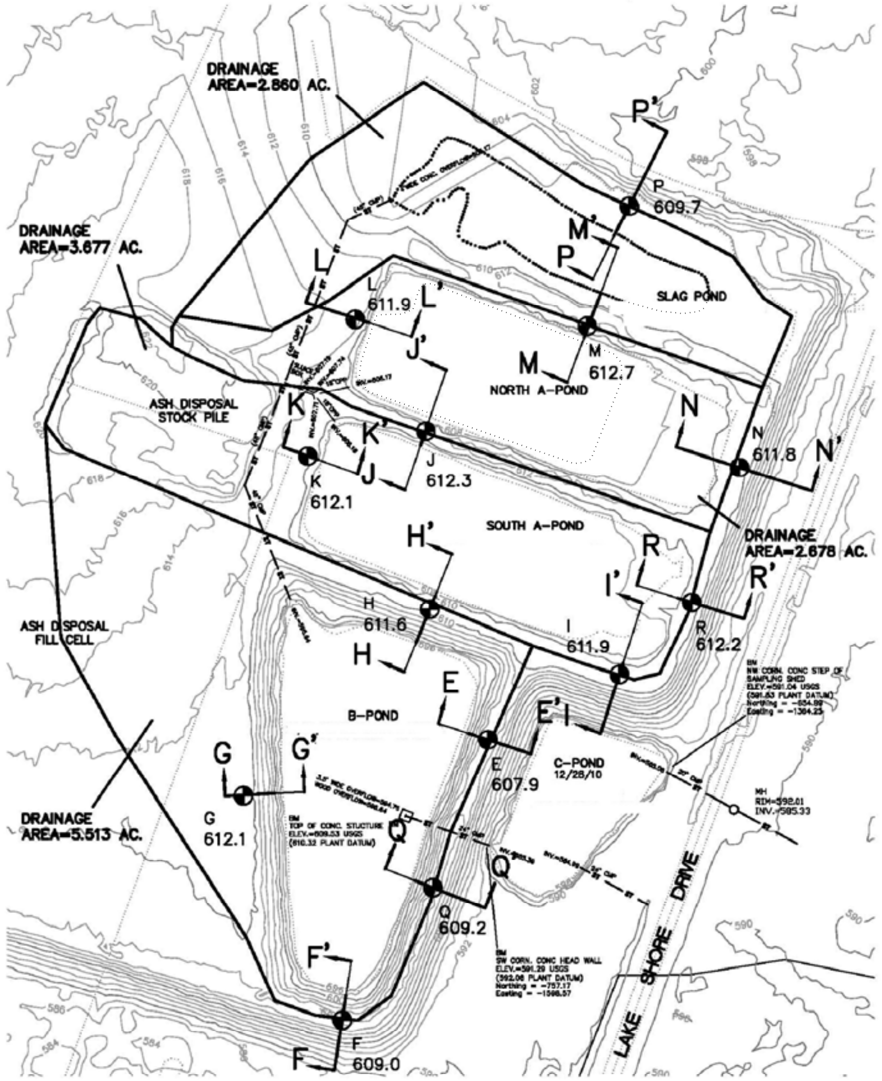
● A 589.5 MILLER ENGINEERS & SCIENTISTS JANUARY AND FEBRUARY 2011 SOIL EXPLORATION BORINGS & GROUND ELEVATION MEASUREMENTS

A A' BERM CROSS SECTION LOCATION

MAP SOURCE:
MODIFIED FROM MILLER ENGINEERS SCIENTISTS, ASH POND SLOPE STABILITY EVALUATION, IMPOUNDMENT ANALYSIS, SHEET 1 OF 5, FEB. 25, 2011.



SITE LOCATION MAP



BM
WILSON GPS MONUMENT
PID DE7583
LOCATED 279' SOUTH OF THE CENTERLINE OF BLACK RIVER ROAD
AND 37' EAST OF THE CENTERLINE OF LAKE SHORE DRIVE
ELEV.=586.86 NAVD88

ELEVATIONS IN NGVD DATUM
UNLESS NOTED OTHERWISE.
PLANT DATUM= NGVD+ 0.79'

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REV	DATE	BY	DESCRIPTION
5			
4			
3			
2			
1			

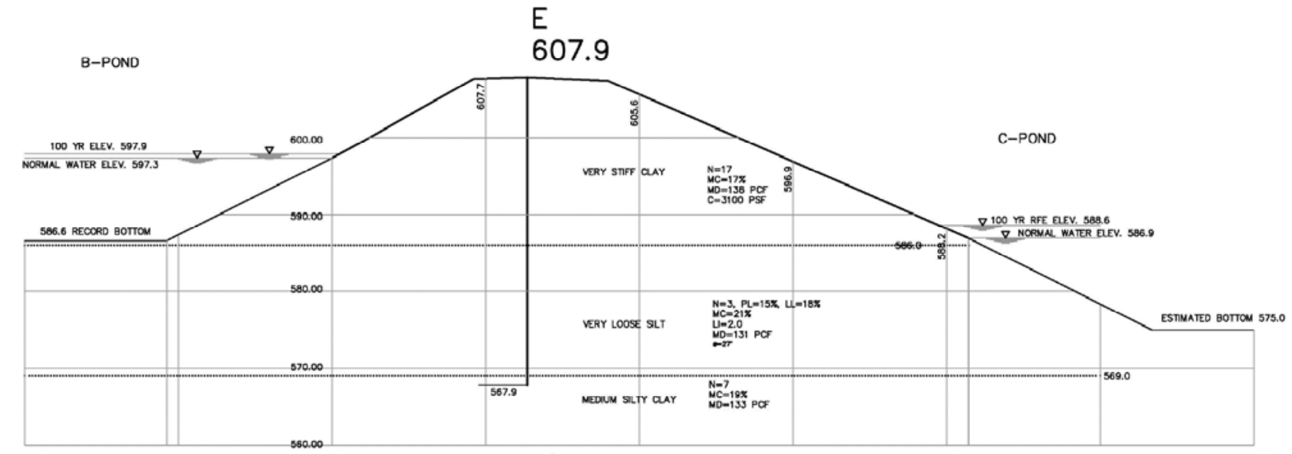
hard hat™ SERVICES

SCALE: AS SHOWN
DATE: 7-18-16
DRAWN BY: JFD
CHKD BY: MWL
APRVD BY: TJH

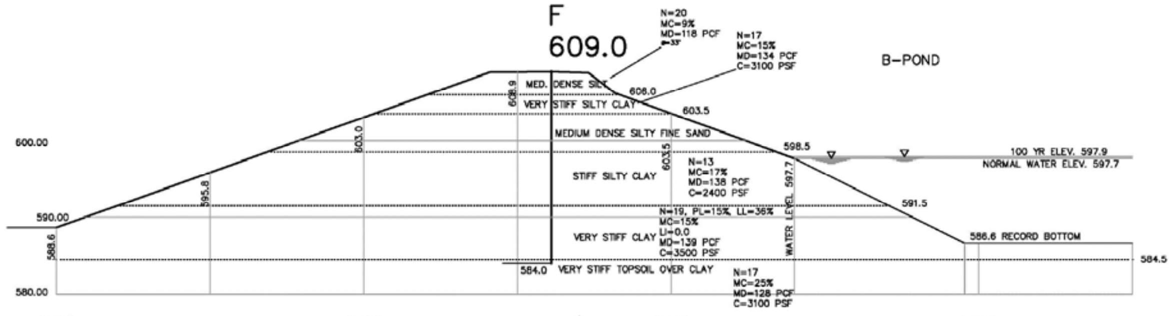
CLIENT / LOCATION
ALLIENT ENERGY
EDGEWATER GENERATING STATION
SHEBOYGAN WISCONSIN

DRAWING DESCRIPTION
SAFETY FACTOR ASSESSMENT
BORING AND CROSS-SECTION LOCATIONS

JOB 154.018.012.006
SHT. FIGURE 2
DWG. ----------

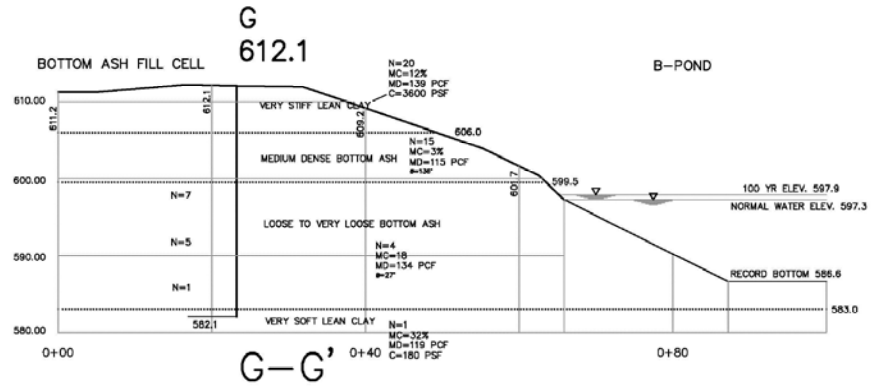


E—E'

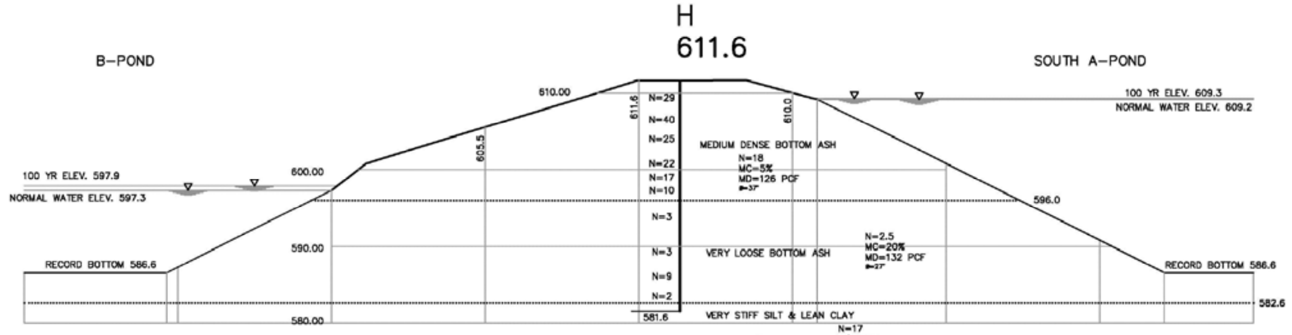


F—F'

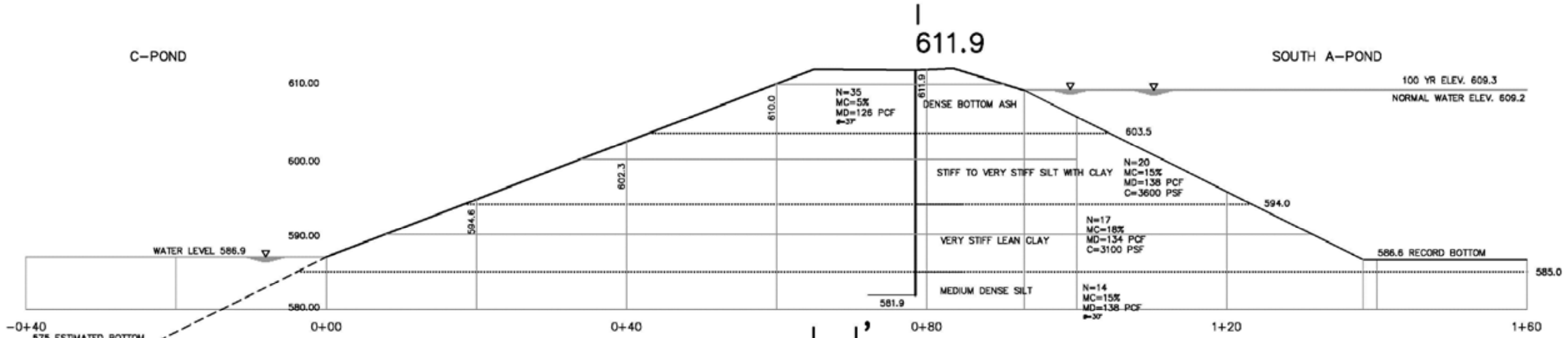
MAP SOURCE:
MODIFIED FROM MILLER ENGINEERS SCIENTISTS, ASH POND SLOPE STABILITY EVALUATION, IMPOUNDMENT ANALYSIS, SHEET 3 OF 5, FEB. 25, 2011.



G—G'



H—H'

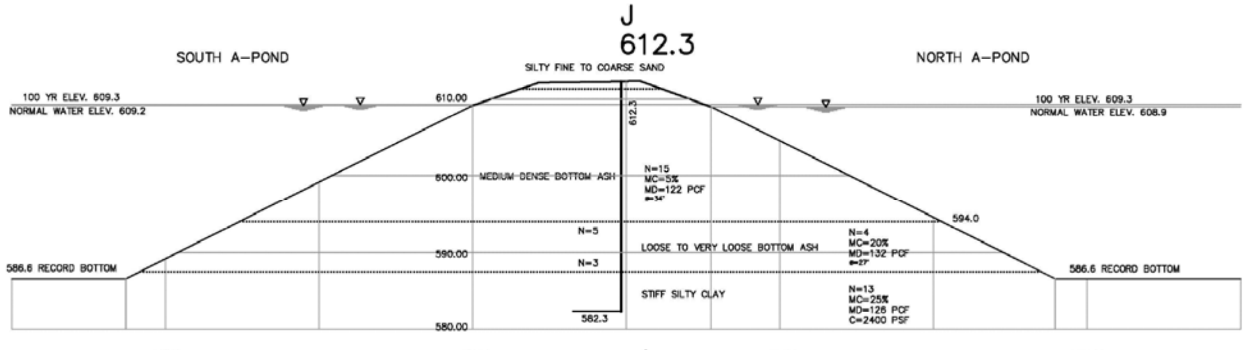


I—I'

LEGEND

…………	SOIL LAYER BOUNDARY USED IN STABILITY ANALYSIS
N=	SPT BLOW COUNTS
MC=	SOIL MOISTURE CONTENT
MD=	SOIL MOIST DENSITY
C=	SOIL COHESIVE STRENGTH
Ø =	ESTIMATED SOIL INTERNAL ANGLE OF FRICTION

GRAPHIC SCALE
0 10 0
(IN FEET)



J—J'

NOTICE	REV	DATE	BY	DESCRIPTION
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	4			
	3			
	2			
	1			

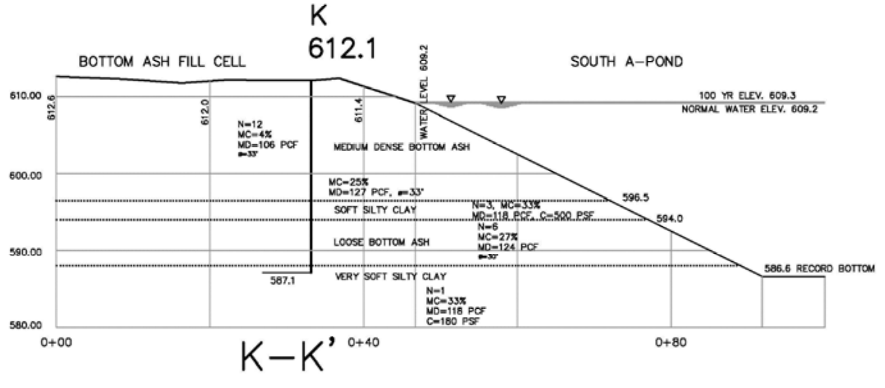
hard hat™ SERVICES

SCALE:	AS SHOWN
DATE:	7-18-16
DRAWN BY:	JFD
CHKD BY:	MWL
APRVD BY:	TJH

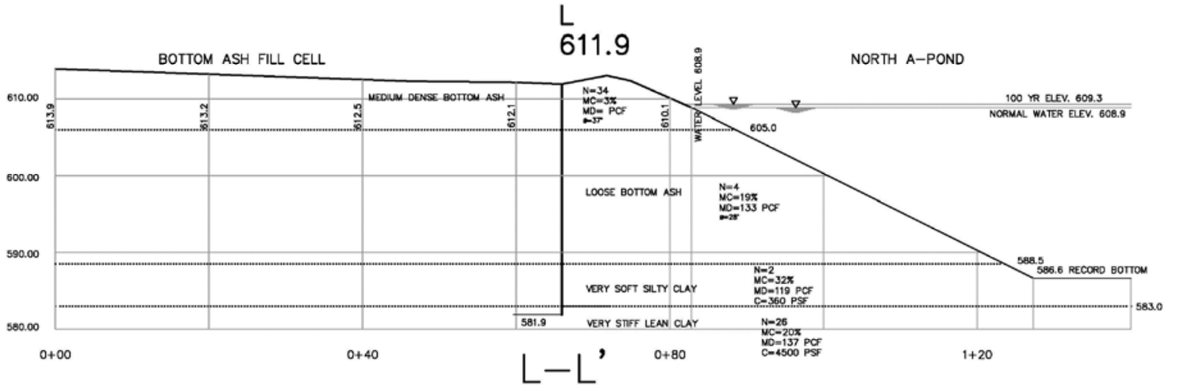
CLIENT / LOCATION
ALLIENT ENERGY
EDGEWATER GENERATING STATION
SHEBOYGAN WISCONSIN

DRAWING DESCRIPTION
SAFETY FACTOR ASSESSMENT
CROSS-SECTIONS
EDG POND B AND SOUTH-A POND

JOB 154.018.012.006
SHT. FIGURE 3
DWG. __________

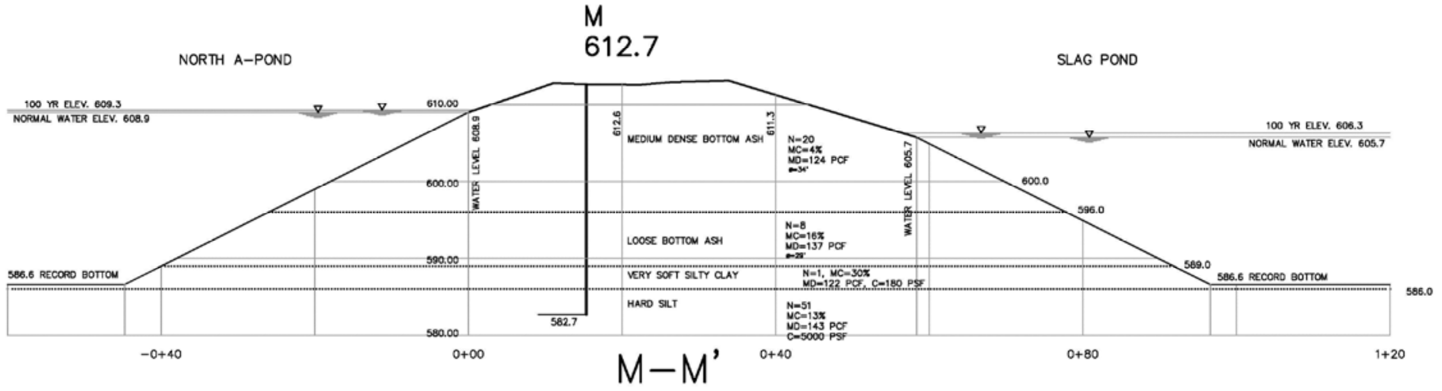


K–K'



L–L'

MAP SOURCE:
MODIFIED FROM MILLER ENGINEERS SCIENTISTS, ASH POND SLOPE STABILITY EVALUATION, IMPOUNDMENT ANALYSIS, SHEET 4 OF 5, FEB. 25, 2011.



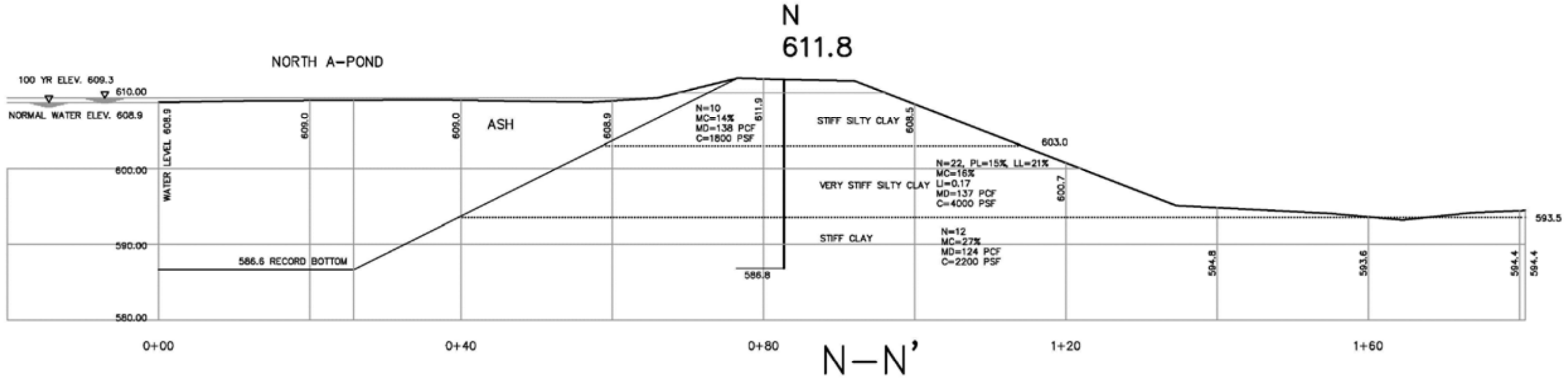
M–M'

LEGEND

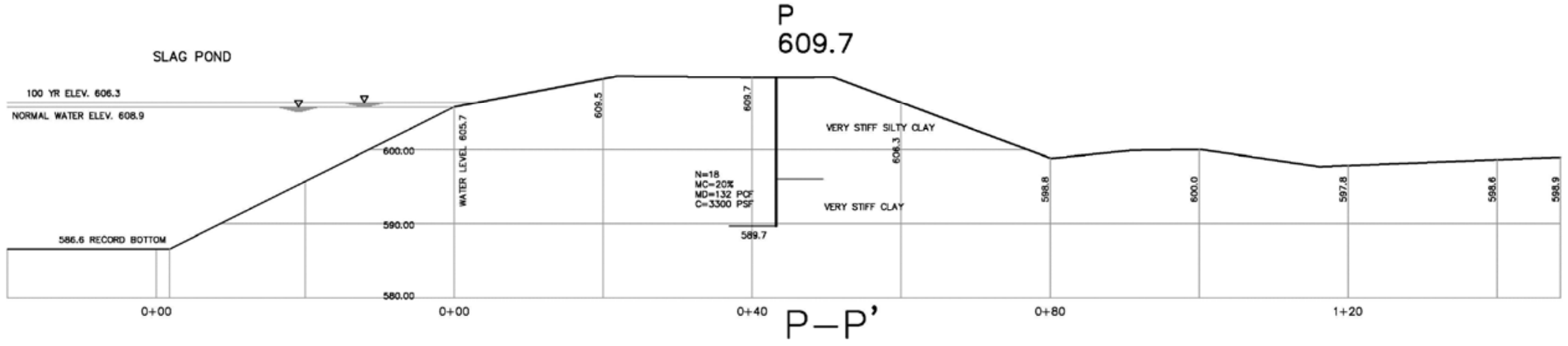
- ·········· SOIL LAYER BOUNDARY USED IN STABILITY ANALYSIS
- N= SPT BLOW COUNTS
- MC= SOIL MOISTURE CONTENT
- MD= SOIL MOIST DENSITY
- C= SOIL COHESIVE STRENGTH
- Ø = ESTIMATED SOIL INTERNAL ANGLE OF FRICTION

GRAPHIC SCALE

(IN FEET)



N–N'



P–P'

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	4			
	3			
	2			
	1			
	REV	DATE	BY	DESCRIPTION

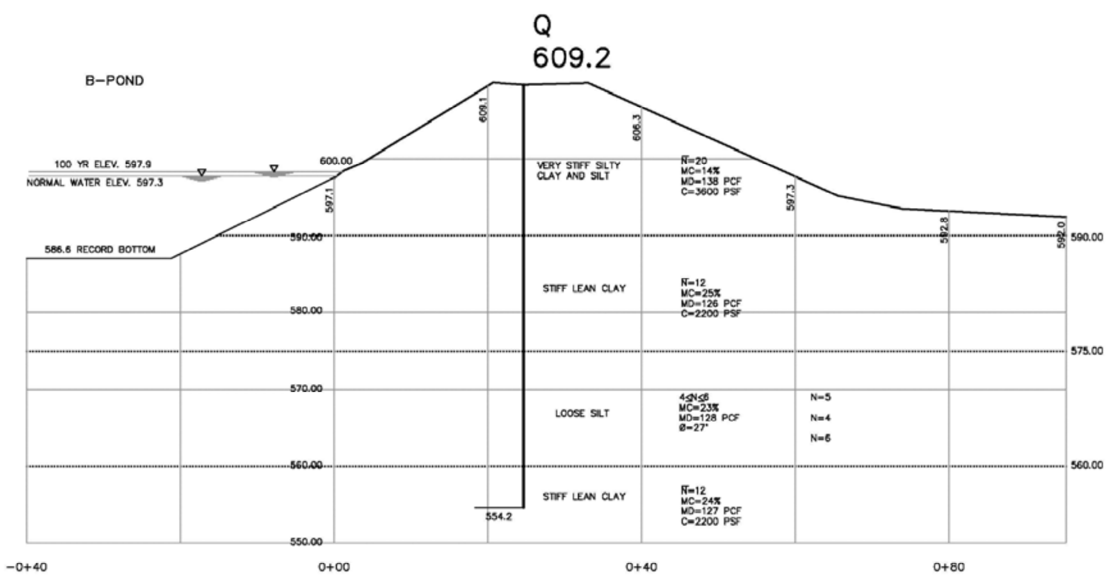
hard hat™
SERVICES

SCALE:	AS SHOWN
DATE:	7-18-16
DRAWN BY:	JFD
CHKD BY:	MWL
APRVD BY:	TJH

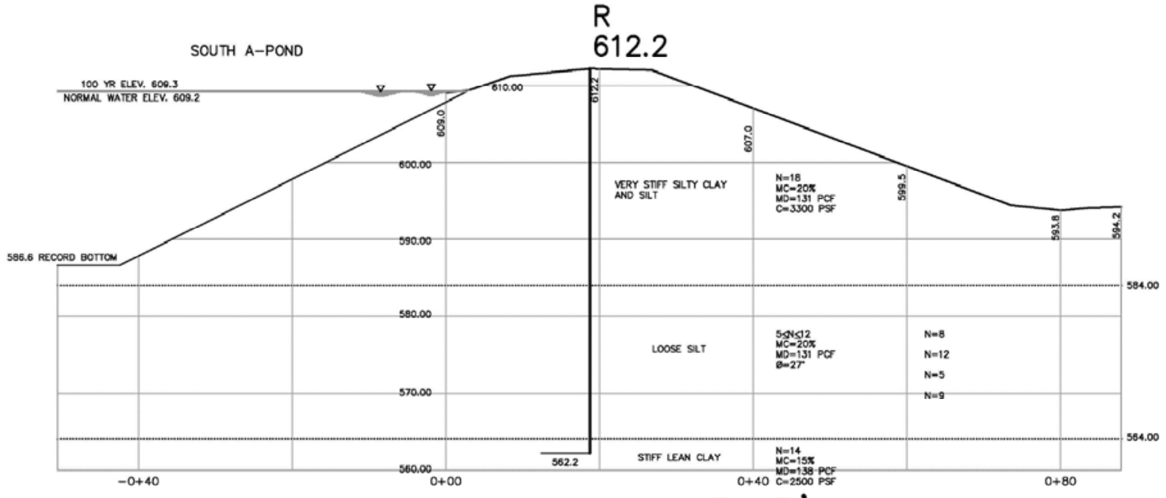
CLIENT / LOCATION
ALLIENT ENERGY
EDGEWATER GENERATING STATION
SHEBOYGAN WISCONSIN

DRAWING DESCRIPTION
SAFETY FACTOR ASSESSMENT
CROSS-SECTIONS
EDG POND A-NORTH AND SLAG POND

JOB 154.018.012.006
SHT. FIGURE 4
DWG. __________



Q–Q'



R–R'

MAP SOURCE:
MODIFIED FROM MILLER ENGINEERS SCIENTISTS, ASH POND SLOPE STABILITY EVALUATION, IMPOUNDMENT ANALYSIS, SHEET 5 OF 5, FEB. 25, 2011.

LEGEND

········	SOIL LAYER BOUNDARY USED IN STABILITY ANALYSIS
N=	SPT BLOW COUNTS
MC=	SOIL MOISTURE CONTENT
MD=	SOIL MOIST DENSITY
C=	SOIL COHESIVE STRENGTH
Ø =	ESTIMATED SOIL INTERNAL ANGLE OF FRICTION

GRAPHIC SCALE

(IN FEET)

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REV	DATE	BY	DESCRIPTION
5			
4			
3			
2			
1			

hard hat™ SERVICES

SCALE:	AS SHOWN
DATE:	7-18-16
DRAWN BY:	JFD
CHKD BY:	MWL
APRVD BY:	TJH

CLIENT / LOCATION
ALLIENT ENERGY
EDGEWATER GENERATING STATION
SHEBOYGAN WISCONSIN

DRAWING DESCRIPTION
SAFETY FACTOR ASSESSMENT
CROSS-SECTIONS AT BORING Q AND R
DEEP SOIL BORINGS

JOB 154.018.012.006
SHT. FIGURE 5
DWG. __________

APPENDIX A – Soil Boring Logs

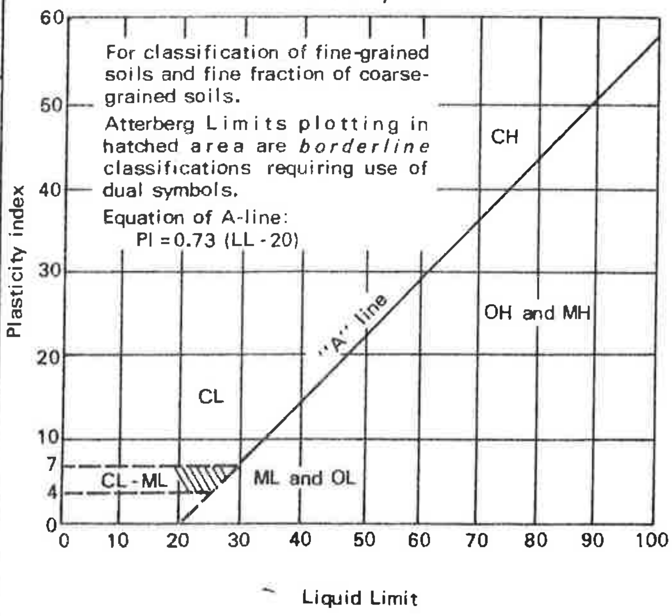
Alliant Energy
Wisconsin Power and Light Company
Edgewater Generating Station
Sheboygan, WI

Safety Factor Assessment

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation: D 2487 – 69 AND D 2488 – 69

(Unified Soil Classification System)

Major divisions			Group symbols	Typical names	Classification criteria		
Coarse-grained soils More than 50% retained on No. 200 sieve*	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines Less than 5% pass No. 200 sieve . . . . . . GW, GP, SW, SP More than 12% pass No. 200 sieve . . . . . . GM, GC, SM, SC 5 to 12% pass No. 200 sieve . . . . . . *Borderline* classifications requiring use of dual symbols	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are *borderline* classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean sands	SW	Well-graded sands and gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		Sands with fines	SM	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are *borderline* classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils 50% or more passes No. 200 sieve*	Silts and clays Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	**Plasticity Chart**  For classification of fine-grained soils and fine fraction of coarse-grained soils. Atterberg Limits plotting in hatched area are *borderline* classifications requiring use of dual symbols. Equation of A-line: PI = 0.73 (LL - 20) 		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and clays Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		Pt	Peat, muck and other highly organic soils			

***Based on the material passing the 3 in. (76 mm) sieve.**

LOG OF TEST BORING
GENERAL NOTES

Descriptive Soil Classification

GRAIN SIZE TERMINOLOGY

Soil Fraction	Particle Size	U.S. Sieve Size
Boulders	Larger Than 12"	Larger Than 12"
Cobbles	3" to 12"	3" to 12"
Gravel: Coarse	3/4" to 3"	3/4" to 3"
Fine	4.76mm to 3/4"	#4 to 3/4"
Sand: Coarse	2.00mm to 4.76mm	#10 to #4
Medium	0.42mm to 2.00mm	#40 to #10
Fine	0.074mm to 0.42mm	#200 to #40
Fines	Less Than 0.074mm	Smaller Than #200
Silt	0.005mm to 0.074mm	Smaller Than #200
Clay	Smaller Than 0.005mm	

(Plasticity characteristics differentiate between silt and clay.)

COMPOSITION TERMINOLOGY (ASTM D2487)

Primary Constituent:

Gravel		Sand		Fines (Silt or Clay)	
with sand	>=15% sand	with gravel	>=15% gravel	with gravel	15-29% gravel
with silt	5-12% silt	with silt	5-12% silt	gravelly	>=30% gravel
with clay	5-12 clay	with clay	5-12% clay	with sand	15-29% sand
silty	>12% silt	silty	>12% silt	sandy	>=30%sand
clayey	>12% clay	clayey	>12% clay		

RELATIVE DENSITY
COHESIONLESS SOILS

Term	"N" Value
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	over 50

The penetration resistance, N, is the summation of the number of blows required to affect two successive 6" penetrations of the 2" split-barrel sampler. The sampler is driven with a 140 lb. weight falling 30" and is seated to a depth of 6" before commencing the standard penetration test (ASTM 1586).

CONSISTENCY
COHESIVE SOILS

Term	pp (tons/sq. ft.)	"N" Value
Very Soft	0.00 to 0.25	<2
Soft	0.25 to 0.50	2-4
Medium	0.50 to 1.00	4-8
Stiff	1.00 to 2.00	8-15
Very Stiff	2.00 to 4.00	15-30
Hard	over 4.00	>30

PLASTICITY

Term	Plasticity Index
None to slight	0 to 4
Slight	5 to 7
Medium	8 to 22
High to Very High	over 22

SYMBOLS

DRILLING AND SAMPLING

CS--Continuous Sampling
RC--Rock Coring: Size AW, BW, NW, 2" W
RQD--Rock Quality Designator
RB--Rock Bit
FT--Fish Tail
DC--Drove Casing
C--Casing: Size 2 1/2", NW, 4", HW
CW--Clear Water
DM--Drilling Mud
HSA--Hollow Stem Auger
FA--Flight Auger
HA--Hand Auger
SS--2" Diameter Split-Barrel Sample
2ST--2" Diameter Thin-Walled Tube Sample
3ST--3" Diameter Thin-Walled Tube Sample
PT--3" Diameter Piston Tube Sample
AS--Auger Sample
PS--Pitcher Sample
NR--No Recovery
VS--Vane Shear Test

LABORATORY TESTS

pp--Penetrometer Reading, tons/sq.ft.
qu--Unconfined Strength, tons/sq. ft.
MC--Moisture Content, %
LL--Liquid Limit, %
PL--Plastic Limit, %
PI--Plasticity Index, %
SL--Shrinkage Limit, %
LI--Loss on Ignition, %
D--Dry Unit Weight, lbs./cu. ft.
pH--Measure of Soil Alkalinity or Acidity
FS--Free Swell, %
HNu--ppmv as Benzene
TLV--ppmv as Hexane
TPH--Total Petroleum Hydrocarbons, ppm

WATER LEVEL MEASUREMENTS

▼--Water Table Interpretation

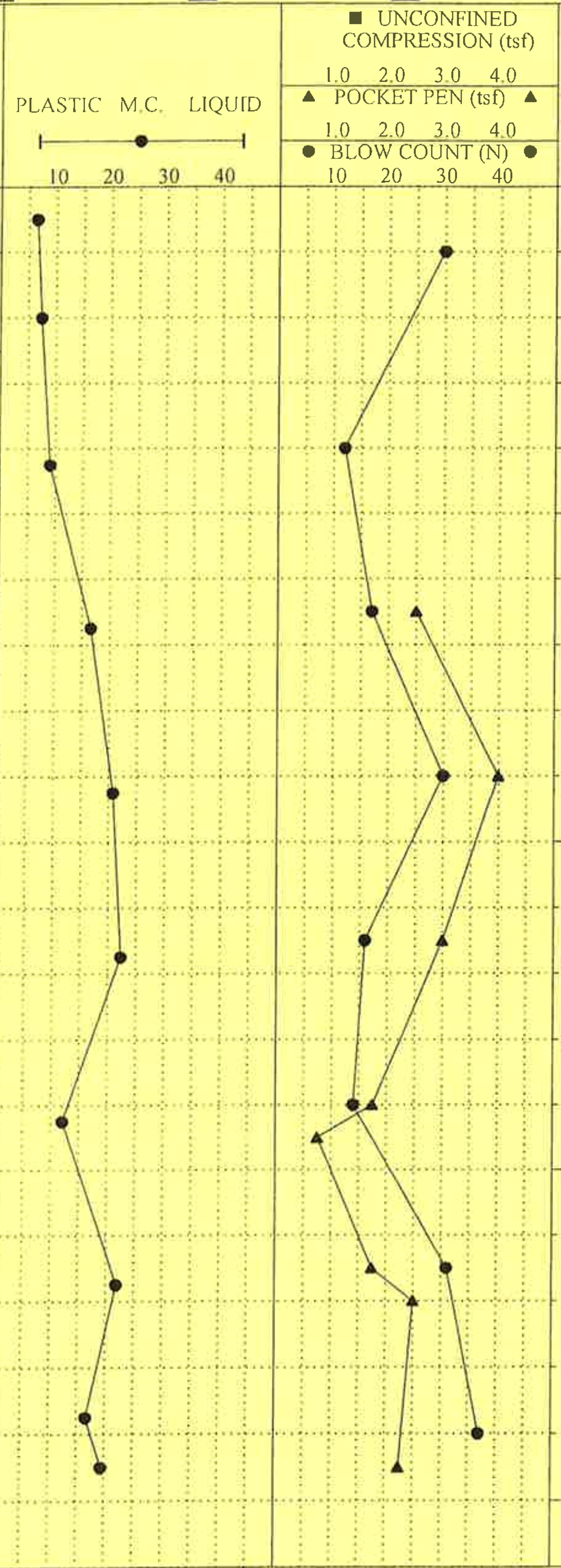
Note: Water level measurements recorded in notes on the boring logs represent conditions at the time indicated and may not reflect static levels, especially in cohesive soils.

MILLER
ENGINEERS
SCIENTISTS

Project: **POND STABILITY EVALUATION**	Job No: **10-1-18634**	Boring No: **C**
Client: **ALLIANT UTILITIES**	Drilled By: **M&K ENV & SOILS DRILLING**	Elevation: **590.1**
Location: **EDGEWATER - SHEBOYGAN, WI**	Drilling Begun: **12/20/10**	Drilling Completed: **12/20/10**

SAMPLE TYPE ▮ 1" Geoprobe ○ No Recovery G Grab Sample ⌇ Auger Sample ■ 3" Shelby Tube ◣ 2" Split Spoon

ELEV. / DEPTH (ft) 590.1	SAMPLE NO.	RECOVERY (in.)	SPT (N)	SOIL DESCRIPTION	USC
0	1			FILL: SILT with clay and trace fine to coarse sand and fine gravel - moist, brown (10YR 5/4)	ML
	2	3	30	... - spoon driven 3" only, sample frozen.	ML
	3	12	12	FILL: SILTY FINE SAND - moist, medium dense, dark yellowish brown (10YR 4/4)	SM
585.1 / 5	4	16	17	FILL: LEAN CLAY with little silt, trace roots - moist, very stiff, dark yellowish brown (10YR 4/4)	CL
	5	18	30	... trace cinders	CL
580.1 / 10	6	18	16	LEAN CLAY (native) - moist, very stiff, brown (10YR 4/3)	CL
	7	18	14	... with little silt and fine to coarse sand - wet, stiff, brown (10YR 4/3)	CL
575.1 / 15	8	18	31	... with trace silt and fine to medium sand- wet, very stiff, brown 10YR 4/3)	CL
	9	16	37	SANDY SILT - wet, brown (10YR 4/3)	ML
				... - wet, hard, grayish brown (10YR 5/2)	ML
570.1 / 20				Boring terminated at 20 feet.	



MILLER ENGINEERS SCIENTISTS

	Water Level	Cave-in Depth
Date 12/20/2010 Time ______	dry ft.	13 ft.
Date ________ Time ______	______ ft.	______ ft.
Date ________ Time ______	______ ft.	______ ft.

Borehole Abandonment

Date: 12/20/2010

Material: **BENTONITE**

Crew: **M&K Drill/WGF**

Rig: **Mobile B52**

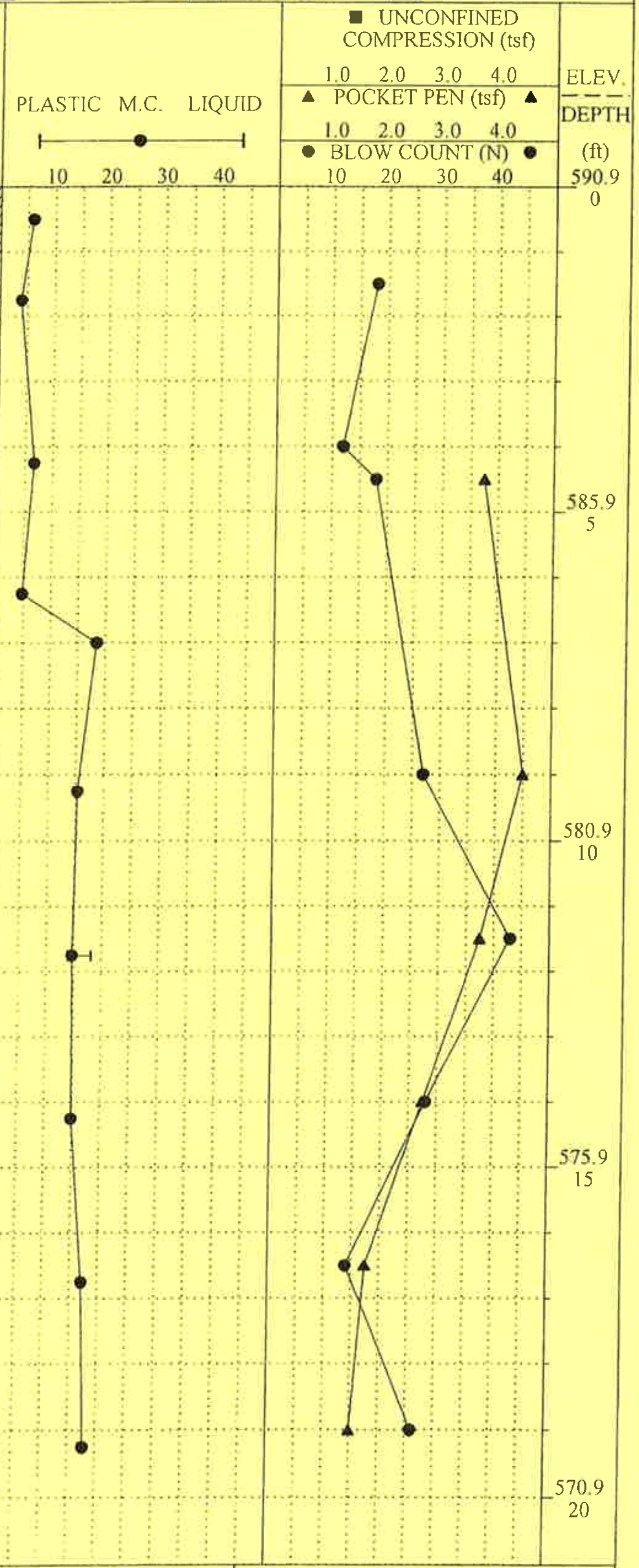
Method: **HSA**

Page 1 of 1

Project: **POND STABILITY EVALUATION**	Job No: **10-1-18634**	Boring No: **D**
Client: **ALLIANT UTILITIES**	Drilled By: **M&K ENV & SOILS DRILLING**	Elevation: **590.9**
Location: **EDGEWATER - SHEBOYGAN, WI**	Drilling Begun: **12/10/10**	Drilling Completed: **12/10/10**

SAMPLE TYPE ▮ 1" Geoprobe ○ No Recovery G Grab Sample ⟦ Auger Sample ■ 3" Shelby Tube ◣ 2" Split Spoon

ELEV. / DEPTH (ft) 590.9	SAMPLE NO.	SAMPLE TYPE	RECOVERY (in.)	SPT (N)	SOIL DESCRIPTION	USC
0	1	⟦			FILL: SILTY CLAY with fine to coarse sand - moist, light yellow brown (2.5YR 6/4)	CL ML
	2	◣	13	18	FILL: SILTY FINE SAND - moist, medium dense, olive yellow (2.5YR 6/6)	SM
585.9 5	3	◣	15	12 18	...	SM
	4	◣	14		... with occasional fine gravel- light gray (2.5YR 7/2)	SM
					LEAN CLAY (native) - moist, very stiff, brown (7.5YR 5/4)	CL
580.9 10	5	◣	18	27	... with roots - moist, very stiff, yellowish brown (10YR 5/6)	CL
	6	◣	14	43	SILT with little CLAY - moist, hard, light brown gray (10YR 6/2)	ML
575.9 15	7	◣	18	28	SILT with little CLAY - moist to wet, very stiff, pink gray (7.5YR 6/2)	ML
	8	◣	18	14	... wet, stiff, light brown gray (10YR 6/2)	ML
	9	◣	18	26	SILT wih little fine sand and clay - wet, very stiff, light brown gray (10YR 6/2)	ML
570.9 20					Boring terminated at 20 feet.	



MILLER ENGINEERS SCIENTISTS

	Water Level	Cave-in Depth
Date ________ Time ________	________ ft.	________ ft.
Date ________ Time ________	________ ft.	________ ft.
Date ________ Time ________	________ ft.	________ ft.

Borehole Abandonment

Date: **12/10/2010**

Material: **BENTONITE**

Crew: **M&K Drill/WGF**

Rig: **Mobile B52**

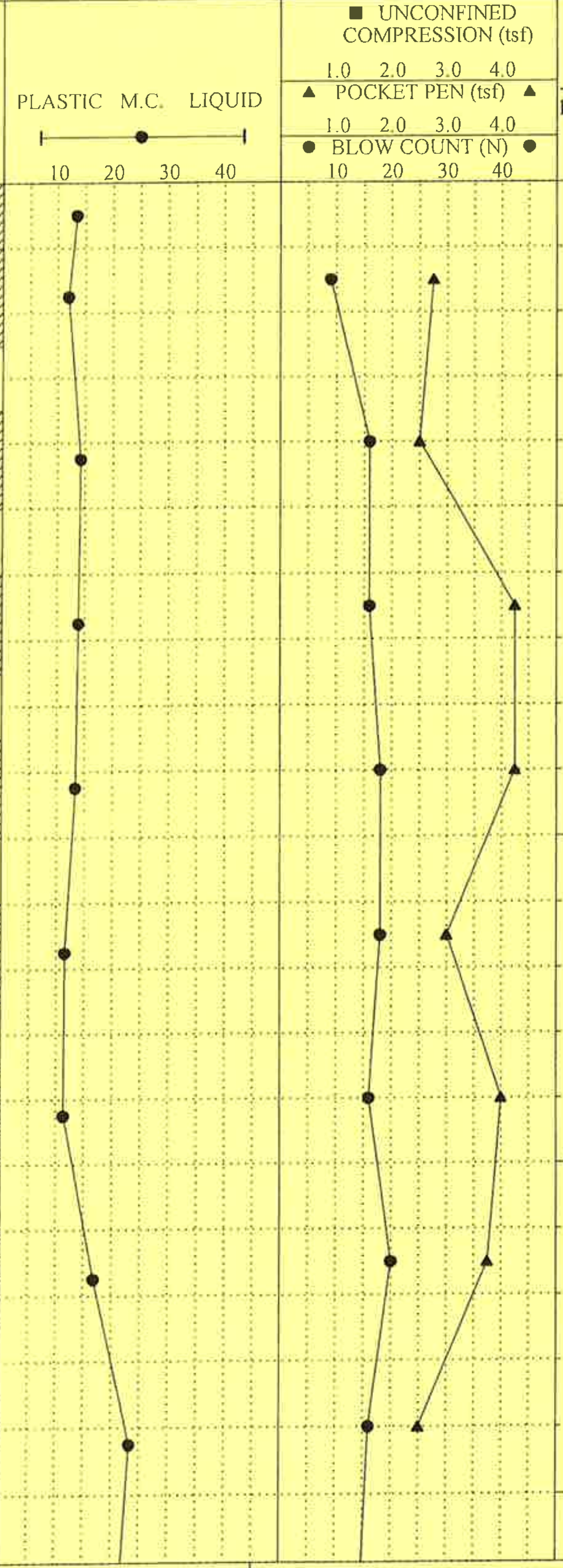
Method: **HSA**

GEOTLOG GINT 18634.GPJ MLLR_ENG.GDT 2/9/11 09:59

Project: **POND STABILITY EVALUATION**	Job No: **10-1-18634**	Boring No: **E**
Client: **ALLIANT UTILITIES**	Drilled By: **M&K ENV & SOILS DRILLING**	Elevation: **607.9**
Location: **EDGEWATER - SHEBOYGAN, WI**	Drilling Begun: **12/21/10**	Drilling Completed: **12/21/10**

SAMPLE TYPE ▮ 1" Geoprobe ○ No Recovery G Grab Sample ⌇ Auger Sample ■ 3" Shelby Tube ◣ 2" Split Spoon

ELEV. DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	RECOVERY (in.)	SPT (N)	SOIL DESCRIPTION	USC
607.9 0	1	⌇			FILL: LEAN CLAY - moist, brown (7.5YR 4/4)	CL
	2	◣	18	9	FILL: LEAN CLAY, trace roots and cinder - moist, stiff, brown (7.5YR 5/4)	CL
	3	◣	18	16	... CLAY interbedded with silt seams - moist, very stiff, brown (7.5YR 4/4)	CL
602.9 5						
	4	◣	18	16	...	CL
	5	◣	18	18	... dark brown (7.5YR 3/3)	CL
597.9 10						
	6	◣	18	18	... brown (7.5YR 5/4)	CL
	7	◣	18	16	... trace fine to medium sand - brown (7.5YR 4/4)	CL
592.9 15						
	8	◣	18	20	... dark brown (7.5YR 3/4)	CL
	9	◣	18	16	LEAN CLAY (native) with trace roots, wood, and occasional fine gravel - moist, very stiff, dark brown (7.5YR 3/3)	CL
587.9 20						



ELEV. DEPTH (ft)
607.9 0
602.9 5
597.9 10
592.9 15
587.9 20

MILLER ENGINEERS SCIENTISTS

	Water Level	Cave-in Depth
Date 12/21/2010 Time ______	3 ft.	32.5 ft.
Date ______ Time ______	______ ft.	______ ft.
Date ______ Time ______	______ ft.	______ ft.

Borehole Abandonment
Date: **12/21/2010**
Material: **BENTONITE**

Crew: **M&K Drill/WGF**
Rig: **Mobile B52**
Method: **HSA**

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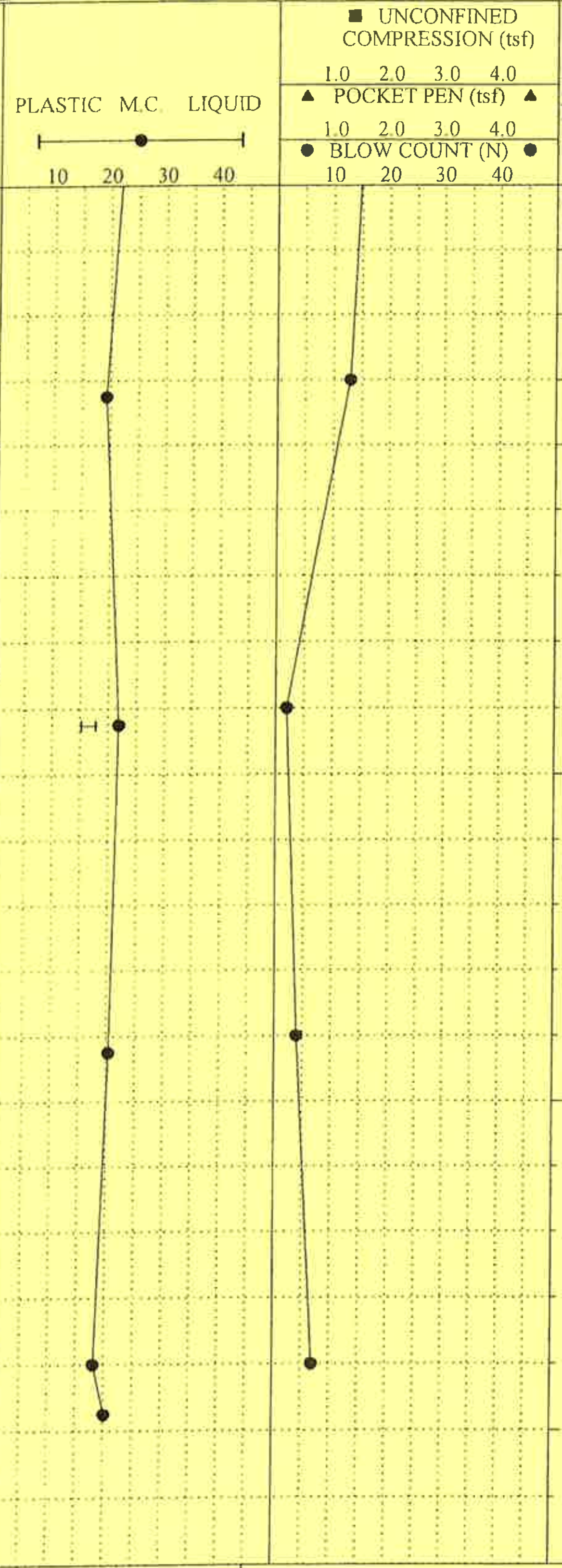
Page 2 of 2

Project: **POND STABILITY EVALUATION**	Job No: **10-1-18634**	Boring No: **E**
Client: **ALLIANT UTILITIES**	Drilled By: **M&K ENV & SOILS DRILLING**	Elevation: **607.9**
Location: **EDGEWATER - SHEBOYGAN, WI**	Drilling Begun: **12/21/10**	Drilling Completed: **12/21/10**

SAMPLE TYPE ▮ 1" Geoprobe ○ No Recovery Ⓖ Grab Sample ▯ Auger Sample ■ 3" Shelby Tube ◣ 2" Split Spoon

ELEV. / DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	RECOVERY (in.)	SPT (N)	SOIL DESCRIPTION	USC	ELEV. / DEPTH (ft)
	10	◣	16	13	SILT - wet, medium dense, brown (10YR 4/3)	ML	
582.9 / 25							582.9 / 25
	11	◣	15	2	SILT with clay - wet, very loose, dark yellowish brown (10YR 4/4)	ML	
577.9 / 30							577.9 / 30
	12	◣	18	4	SILT with little clay, trace fine sand - wet, very loose, brown (10YR 4/3)	ML	
572.9 / 35							572.9 / 35
	13	◣	18	7	...	SM	
					SILTY CLAY - wet, brown (10YR 4/3)	CL ML	
567.9 / 40							567.9 / 40
					Boring terminated at 40 feet.		



MILLER ENGINEERS SCIENTISTS

	Water Level	Cave-in Depth
Date 12/21/2010 Time ______	3 ft.	32.5 ft.
Date ________ Time ______	______ ft.	______ ft.
Date ________ Time ______	______ ft.	______ ft.

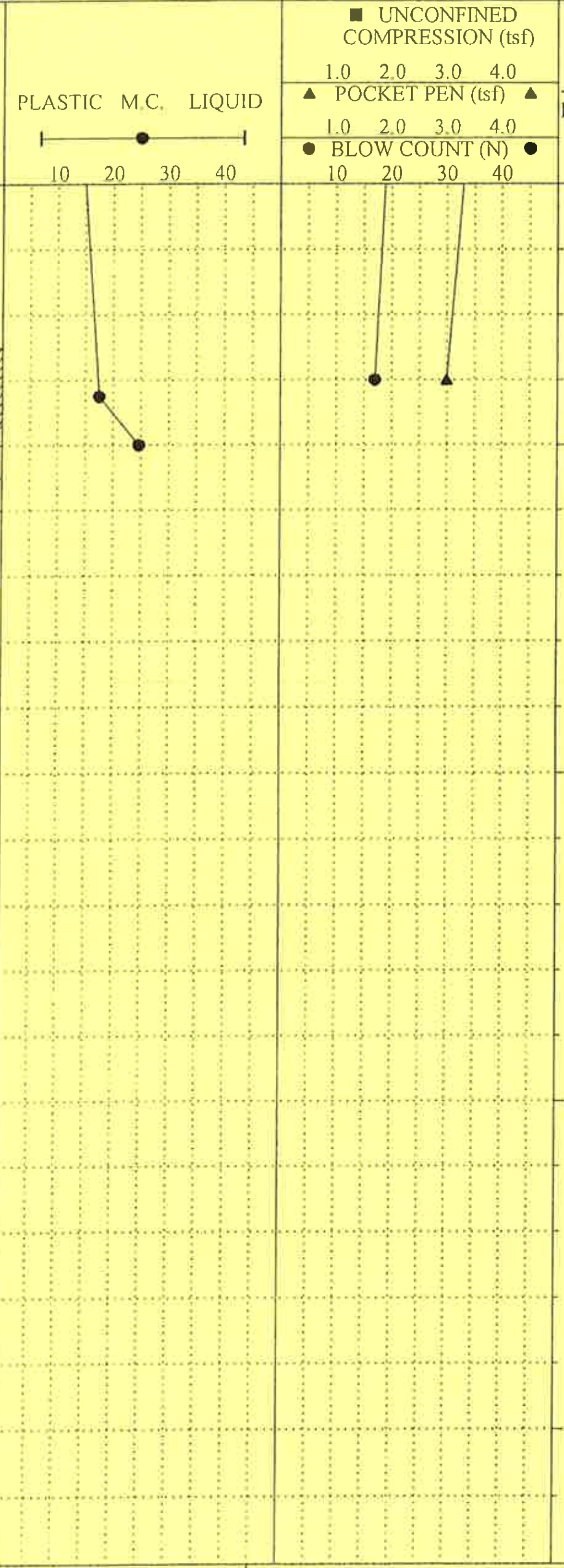
Borehole Abandonment
Date: 12/21/2010
Material: **BENTONITE**

Crew: **M&K Drill/WGF**
Rig: **Mobile B52**
Method: **HSA**

Project: **POND STABILITY EVALUATION**	Job No: **10-1-18634**		Boring No: **F**
Client: **ALLIANT UTILITIES**	Drilled By: **M&K ENV & SOILS DRILLING**		Elevation: **609.0**
Location: **EDGEWATER - SHEBOYGAN, WI**	Drilling Begun: **12/21/10**		Drilling Completed: **12/21/10**

SAMPLE TYPE ▮ 1" Geoprobe ○ No Recovery G Grab Sample ▯ Auger Sample ■ 3" Shelby Tube ◣ 2" Split Spoon

ELEV. / DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	RECOVERY (in.)	SPT (N)	SOIL DESCRIPTION	USC
	10	◣	18	17	... with trace medium sand - moist, very stiff, dark brown (7.5YR 3/4)	CL
584.0 25					SILT topsoil with CLAY (native), trace fine sand and roots - moist, stiff, black (10YR 2/1)	ML
					Boring terminated at 25 feet.	
579.0 30						
574.0 35						
569.0 40						



ELEV. / DEPTH (ft): 584.0 25; 579.0 30; 574.0 35; 569.0 40

MILLER ENGINEERS SCIENTISTS

	Water Level	Cave-in Depth
Date 12/21/2010 Time ______	dry ft.	26 ft.
Date ________ Time ______	______ ft.	______ ft.
Date ________ Time ______	______ ft.	______ ft.

Borehole Abandonment

Date: 12/21/2010

Material: BENTONITE

Crew: **M&K Drill/WGF**

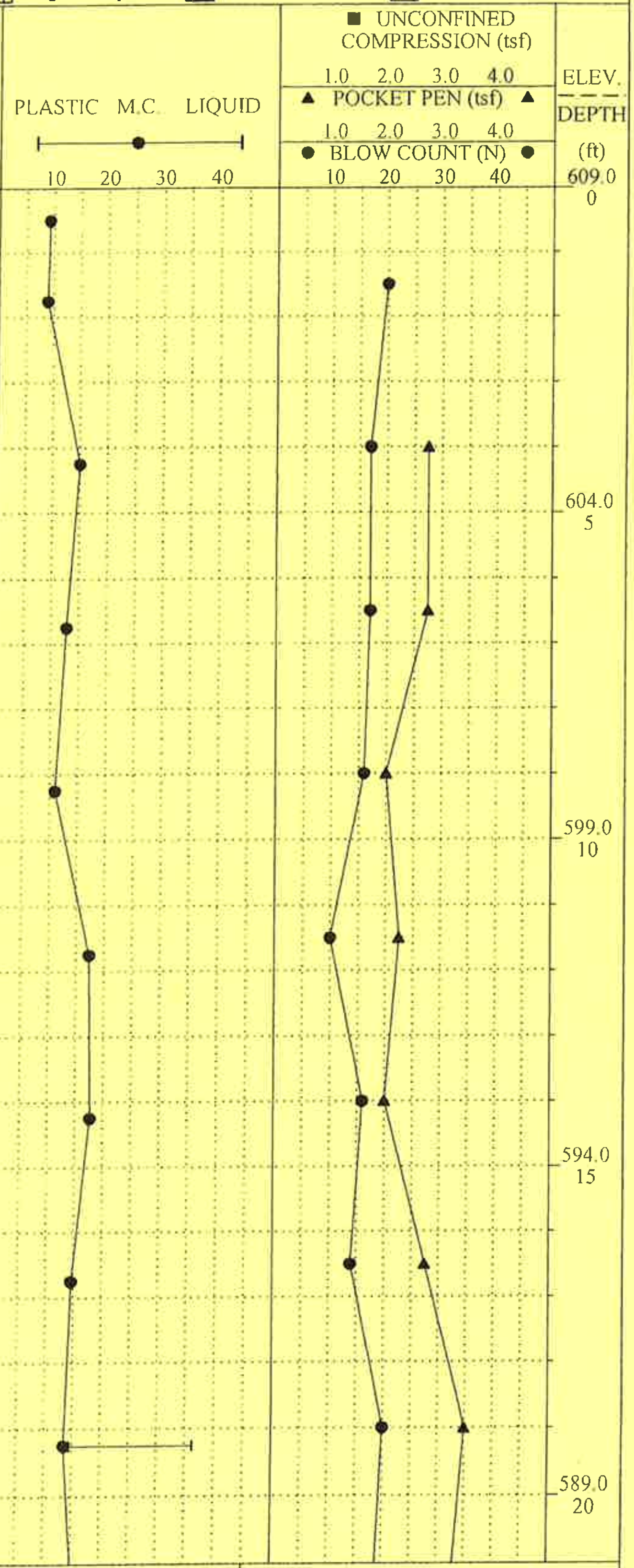
Rig: **Mobile B52**

Method: **HSA**

Project:	**POND STABILITY EVALUATION**	Job No:	**10-1-18634**	Boring No:	**F**
Client:	**ALLIANT UTILITIES**	Drilled By:	**M&K ENV & SOILS DRILLING**	Elevation:	**609.0**
Location:	**EDGEWATER - SHEBOYGAN, WI**	Drilling Begun:	**12/21/10**	Drilling Completed:	**12/21/10**

SAMPLE TYPE ▌ 1" Geoprobe ○ No Recovery G Grab Sample ⌇ Auger Sample ■ 3" Shelby Tube ◣ 2" Split Spoon

ELEV. DEPTH (ft) 609.0	SAMPLE NO.	SAMPLE TYPE	RECOVERY (in.)	SPT (N)	SOIL DESCRIPTION	USC
0	1	Auger Sample			FILL: SILT with trace to little clay and fine sand - dry, medium dense, dark yellowish brown (10YR 4/4)	ML
	2	2" Split Spoon	18	20	...	ML
	3	2" Split Spoon	18	17	FILL: SILTY CLAY with trace fine sand - moist, very stiff, dark yellowish brown (10YR 4/4)	CL ML
604.0 5						
	4	2" Split Spoon	17	17	FILL: SILTY FINE SAND interbedded with silty clay - moist, medium dense, brown (7.5YR 5/3)	SM
	5	2" Split Spoon	18	16	... strong brown (7.5YR 4/6)	SM
599.0 10						
	6	2" Split Spoon	18	10	FILL: SILTY CLAY with trace fine sand, interbedded with silty fine sand - moist, stiff, brown (10YR 4/3)	CL ML
	7	2" Split Spoon	18	16	FILL: TOPSOIL/ROOT Layer over SILTY CLAY interbedded with silty fine sand and topsoil - moist, stiff, brown (10YR 4/3)	CL ML
594.0 15						
	8	2" Split Spoon	18	14	... brown (7.5YR 5/4)	CL ML
	9	2" Split Spoon	17	20	FILL: CLAY interbedded with silty fine sand - moist, very stiff, brown (7.5YR 5/4)	CL
589.0 20						



MILLER ENGINEERS SCIENTISTS

	Water Level	Cave-in Depth
Date 12/21/2010 Time ______	dry ft.	26 ft.
Date ______ Time ______	ft.	ft.
Date ______ Time ______	ft.	ft.

Borehole Abandonment

Date: **12/21/2010**

Material: **BENTONITE**

Crew: **M&K Drill/WGF**

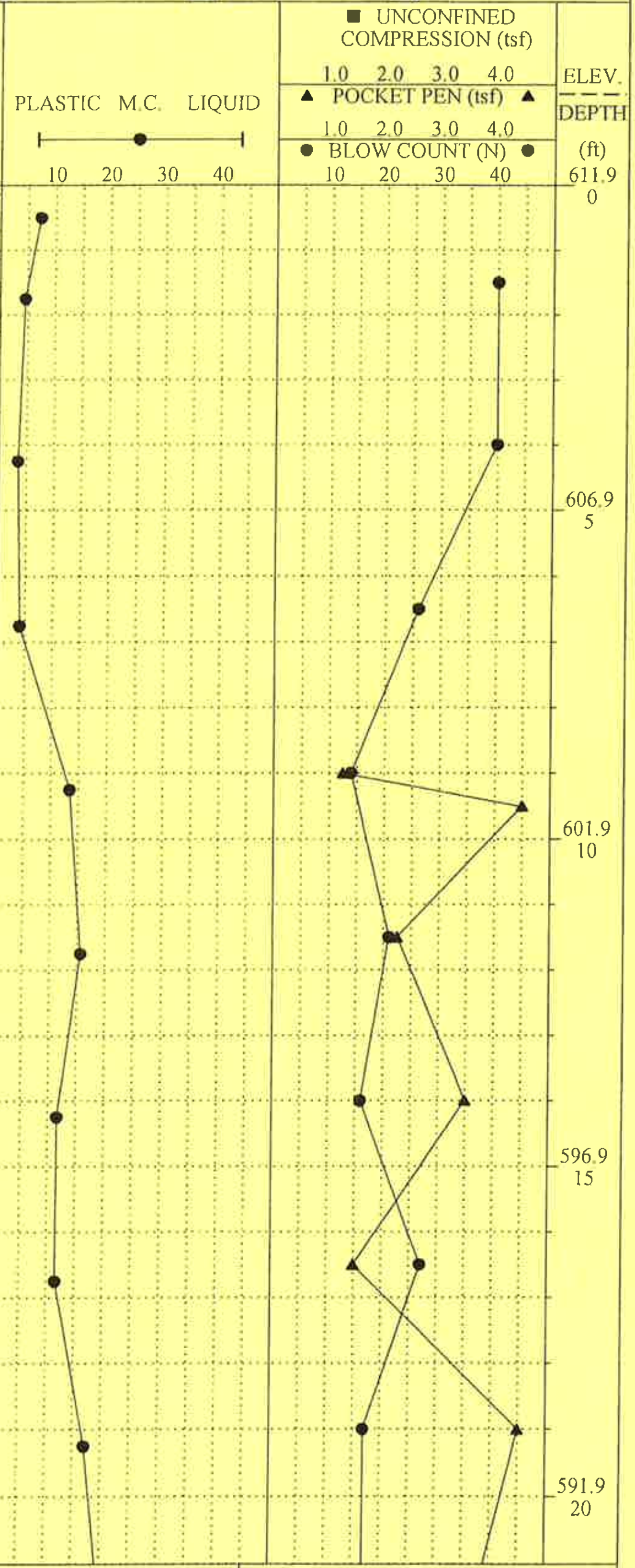
Rig: **Mobile B52**

Method: **HSA**

Project:	**POND STABILITY EVALUATION**	Job No:	**10-1-18634**	Boring No:	**1**
Client:	**ALLIANT UTILITIES**	Drilled By:	**M&K ENV & SOILS DRILLING**	Elevation:	**611.9**
Location:	**EDGEWATER - SHEBOYGAN, WI**	Drilling Begun:	**12/21/10**	Drilling Completed:	**12/21/10**

SAMPLE TYPE ▮ 1" Geoprobe ○ No Recovery Ⓖ Grab Sample ⟅⟆ Auger Sample ■ 3" Shelby Tube ◣ 2" Split Spoon

ELEV. / DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	RECOVERY (in.)	SPT (N)	SOIL DESCRIPTION	USC
611.9 / 0	1	⟅⟆			FILL: Bottom ash - moist, black (10YR 2/1)	SP
	2	◣	14	40	FILL: Bottom ash - moist, dense, black (10YR 2/1)	SP
	3	◣	16	40	...	SP
606.9 / 5						
	4	◣	15	26	...	SP
	5	◣	17	14	FILL: SILT with clay - moist, medium dense, yellowish brown (10YR 5/4)	ML
601.9 / 10						
	6	◣	18	21	...	ML
	7	◣	18	16	FILL: SILTY CLAY - moist, very stiff, dark yellowish brown (10YR 3/6)	CL ML
596.9 / 15						
	8	◣	18	27	FILL: SILT with clay pockets - moist, medium dense, dark yellowish brown (10YR 3/6)	ML
	9	◣	17	17	LEAN CLAY (Native) - moist, very stiff, strong brown (7.5YR 4/6)	CL
591.9 / 20						



MILLER ENGINEERS SCIENTISTS

	Water Level	Cave-in Depth
Date 12/21/2010 Time ____	dry ft.	27 ft.
Date ____ Time ____	____ ft.	____ ft.
Date ____ Time ____	____ ft.	____ ft.

Borehole Abandonment
Date: 12/21/2010
Material: BENTONITE

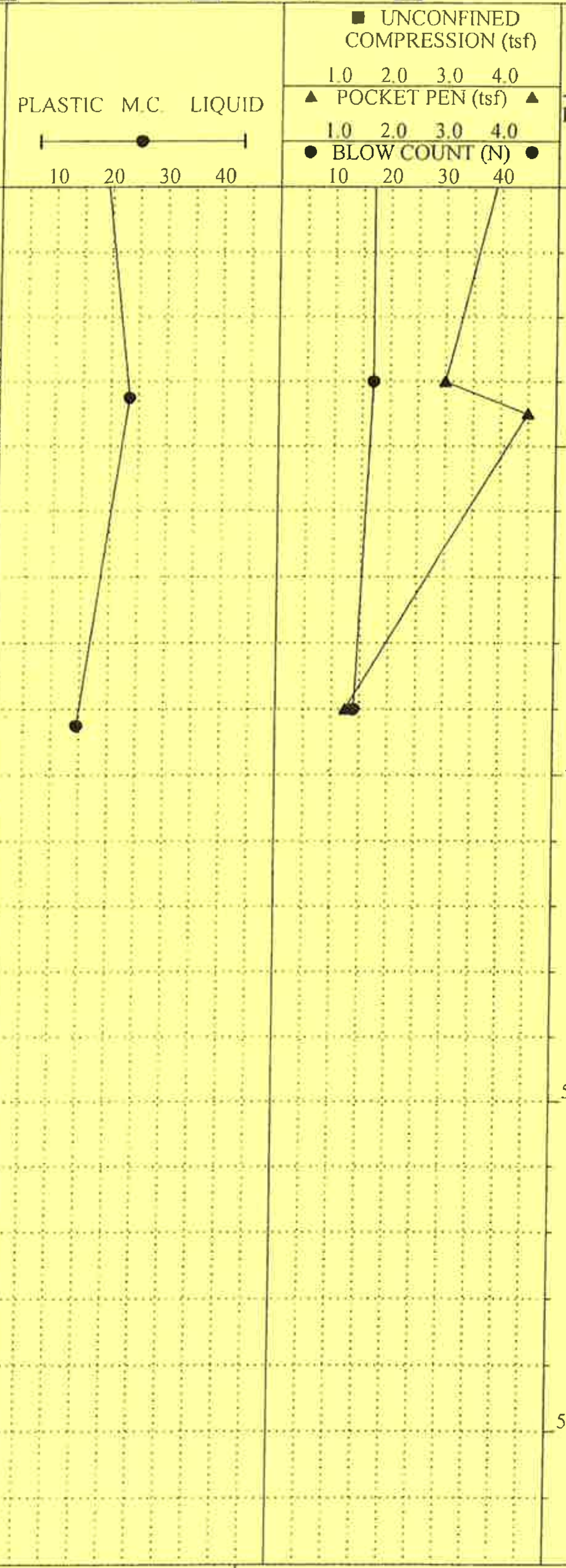
Crew: **M&K Drill/WGF**
Rig: **Mobile B52**
Method: **HSA**

Page **2** of **2**

Project: **POND STABILITY EVALUATION**	Job No: **10-1-18634**	Boring No: **I**
Client: **ALLIANT UTILITIES**	Drilled By: **M&K ENV & SOILS DRILLING**	Elevation: **611.9**
Location: **EDGEWATER - SHEBOYGAN, WI**	Drilling Begun: **12/21/10**	Drilling Completed: **12/21/10**

SAMPLE TYPE ▮ 1" Geoprobe ○ No Recovery Ⓖ Grab Sample ⌇ Auger Sample ■ 3" Shelby Tube ◣ 2" Split Spoon

ELEV. / DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	RECOVERY (in.)	SPT (N)	SOIL DESCRIPTION	USC	ELEV. / DEPTH (ft)
	10	◣	18	17	LEAN CLAY with trace medium sand - moist, very stiff, strong brown (7.5YR 4/6)	CL	
586.9 25							586.9 25
	11	◣	18	14	SILT with little clay - wet, medium dense, brown (7.5YR 5/2)	ML	
581.9 30							581.9 30
					Boring terminated at 30 feet.		
576.9 35							576.9 35
571.9 40							571.9 40



MILLER ENGINEERS SCIENTISTS

	Water Level	Cave-in Depth
Date 12/21/2010 Time ____	dry ft.	27 ft.
Date ____ Time ____	ft.	ft.
Date ____ Time ____	ft.	ft.

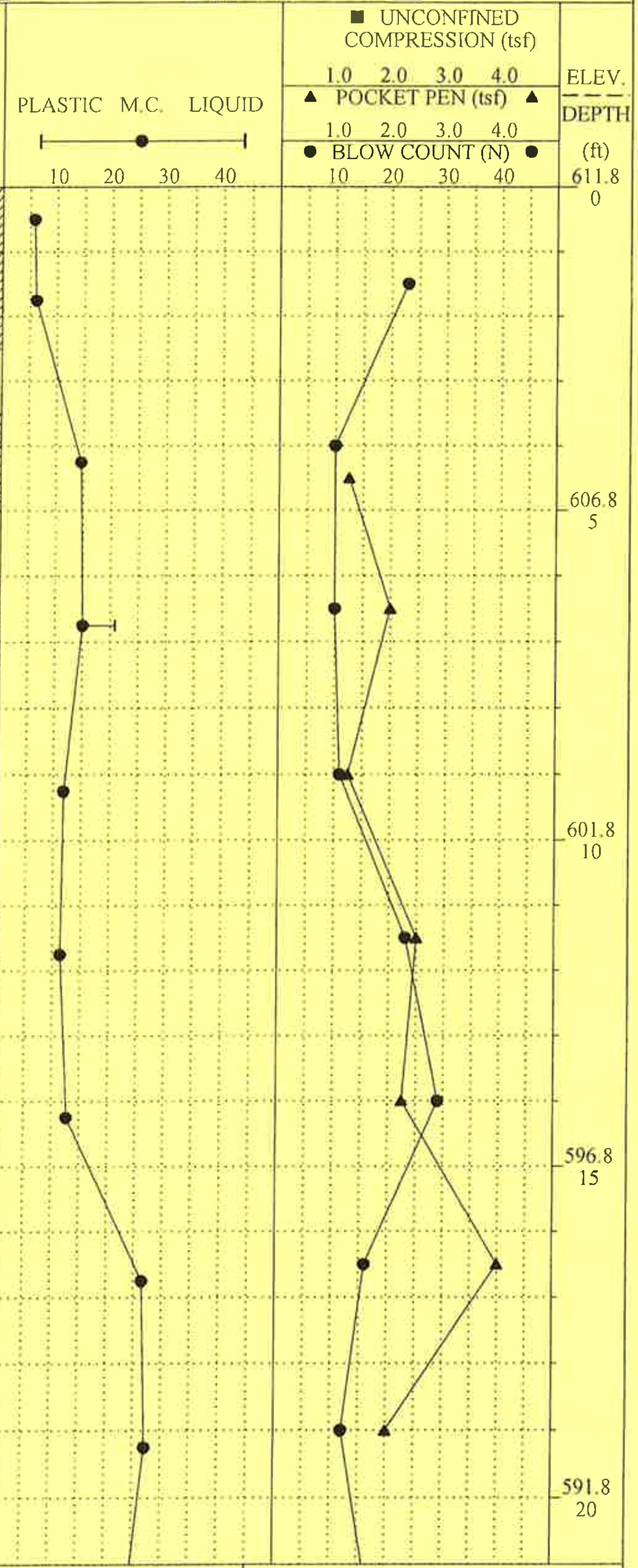
Borehole Abandonment
Date: 12/21/2010
Material: **BENTONITE**

Crew: **M&K Drill/WGF**
Rig: **Mobile B52**
Method: **HSA**

Project: **POND STABILITY EVALUATION**	Job No: **10-1-18634**	Boring No: **N**
Client: **ALLIANT UTILITIES**	Drilled By: **M&K ENV & SOILS DRILLING**	Elevation: **611.8**
Location: **EDGEWATER - SHEBOYGAN, WI**	Drilling Begun: **12/21/10**	Drilling Completed: **12/21/10**

SAMPLE TYPE: 1" Geoprobe ○ No Recovery Grab Sample Auger Sample ■ 3" Shelby Tube ◪ 2" Split Spoon

ELEV. / DEPTH (ft) 611.8	SAMPLE NO.	SAMPLE TYPE	RECOVERY (in.)	SPT (N)	SOIL DESCRIPTION	USC
0	1	Auger Sample			FILL: SILTY CLAY with fine to coarse sand and bottom ash - moist, very stiff, very dark brown (10YR 2/1)	CL ML
	2	2" Split Spoon	11	23	...	CL ML
	3	2" Split Spoon	15	10	... stiff, black (7.5YR 2/1) ... yellowish brown (10YR 5/4)	CL ML CL ML
606.8 / 5						
	4	2" Split Spoon	14	10	FILL: SILTY CLAY with clay layers - moist, medium dense, yellowish brown	CL ML
	5	2" Split Spoon	15	11	...	CL ML
601.8 / 10						
	6	2" Split Spoon	18	23	... very stiff, brown (10YR 5/3)	CL ML
	7	2" Split Spoon	18	29	... brown (10YR 4/3)	CL ML
596.8 / 15						
	8	2" Split Spoon	18	16	FILL: CLAY with trace bottom ash and wood - moist, very stiff, dark yellowish brown (10YR 3/4)	CL
	9	2" Split Spoon	18	12	CLAY (native) - moist, stiff, brown (7.5YR 4/4)	CL
591.8 / 20						



MILLER ENGINEERS SCIENTISTS

	Water Level	Cave-in Depth
Date 12/21/2010 Time ____	dry ft.	29 ft.
Date ____ Time ____	ft.	ft.
Date ____ Time ____	ft.	ft.

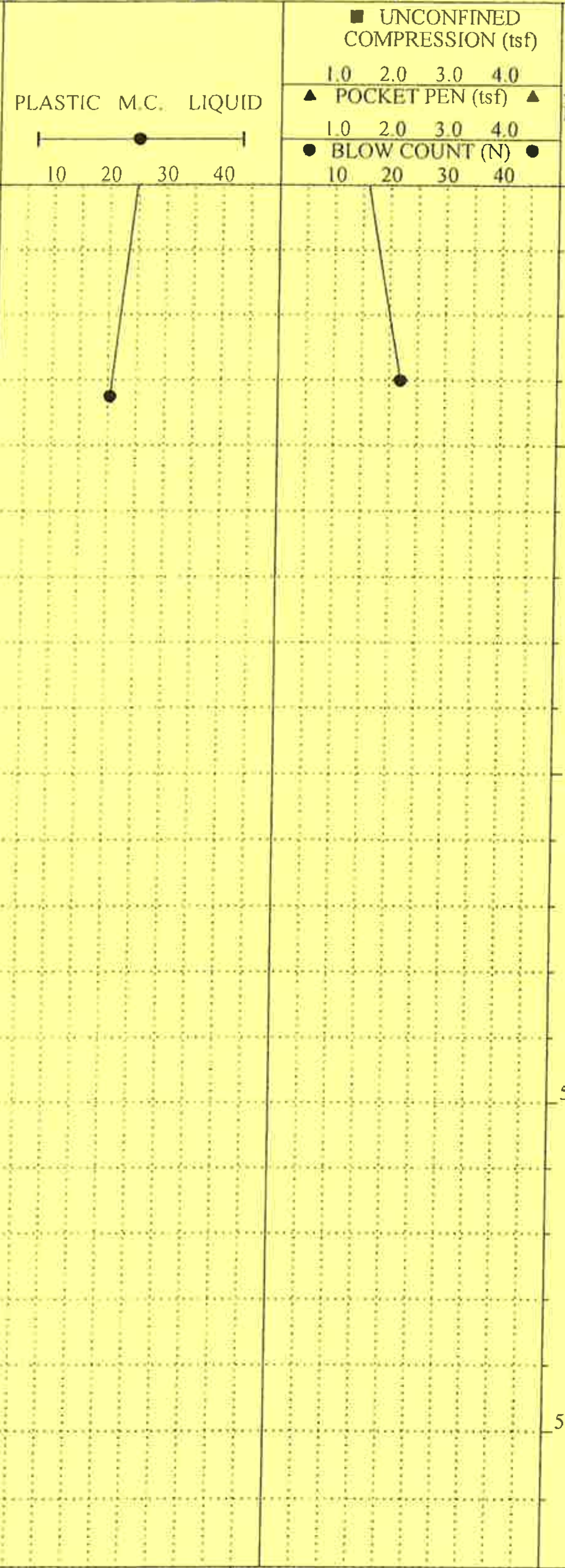
Borehole Abandonment
Date: **12/21/2010**
Material: **BENTONITE**

Crew: **M&K Drill/WGF**
Rig: **Mobile B52**
Method: **HSA**

Project: **POND STABILITY EVALUATION**
Job No: **10-1-18634**
Boring No: **N**
Client: **ALLIANT UTILITIES**
Drilled By: **M&K ENV & SOILS DRILLING**
Elevation: **611.8**
Location: **EDGEWATER - SHEBOYGAN, WI**
Drilling Begun: **12/21/10**
Drilling Completed: **12/21/10**

SAMPLE TYPE ▮ 1" Geoprobe ○ No Recovery Ⓖ Grab Sample ▯ Auger Sample ■ 3" Shelby Tube ◣ 2" Split Spoon

ELEV. / DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	RECOVERY (in.)	SPT (N)	SOIL DESCRIPTION	USC	ELEV. / DEPTH (ft)
	10	◣	13	22	... wet, very stiff, strong brown (7.5YR 4/4)	CL	
586.8 25					Boring terminated at 25 feet.		586.8 25
581.8 30							581.8 30
576.8 35							576.8 35
571.8 40							571.8 40



MILLER ENGINEERS SCIENTISTS

Date	Time	Water Level	Cave-in Depth
12/21/2010		dry ft.	29 ft.
		ft.	ft.
		ft.	ft.

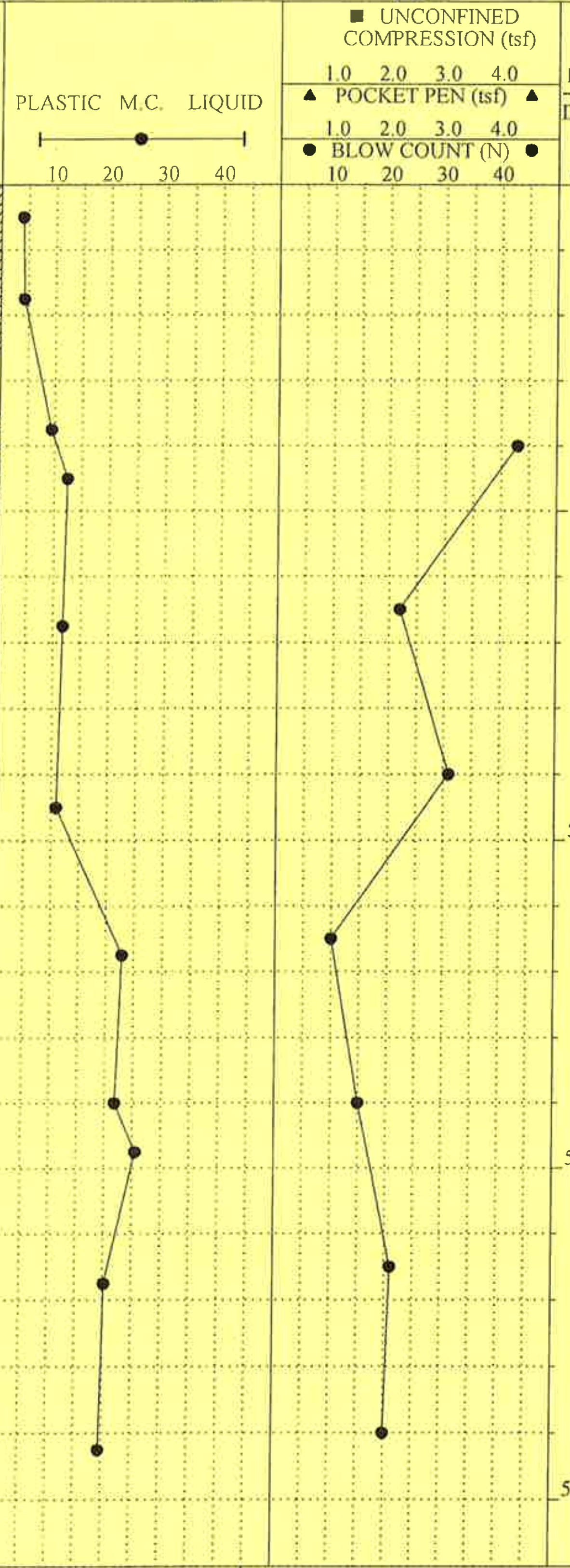
Borehole Abandonment
Date: **12/21/2010**
Material: **BENTONITE**

Crew: **M&K Drill/WGF**
Rig: **Mobile B52**
Method: **HSA**

Project: **POND STABILITY EVALUATION**	Job No: **10-1-18634**	Boring No: **P**
Client: **ALLIANT UTILITIES**	Drilled By: **M&K ENV & SOILS DRILLING**	Elevation: **609.7**
Location: **EDGEWATER - SHEBOYGAN, WI**	Drilling Begun: **12/20/10**	Drilling Completed: **12/20/10**

SAMPLE TYPE: ▮ 1" Geoprobe ○ No Recovery G Grab Sample ⌇ Auger Sample ■ 3" Shelby Tube ◣ 2" Split Spoon

ELEV. / DEPTH (ft) 609.7	SAMPLE NO.	SAMPLE TYPE	RECOVERY (in.)	SPT (N)	SOIL DESCRIPTION	USC
0	1	⌇			FILL: SILTY CLAY with FINE TO COARSE SAND - moist, very dark brown (7.5YR 2.5/2)	CL ML
	2	◣	5		... 35 blow counts for 3", sample frozen	CL ML
	3	◣	18	43	FILL: SILTY CLAY with clay pockets - moist, dense, yellowish brown (10YR 5/8) FILL: CLAY with SILT layers - moist, dense, brown (10YR 4/3)	CL ML CL ML
604.7 / 5						
	4	◣	18	22	... very stiff, yellowish brown to gray brown (10YR 5/4 and 10YR 5/2)	CL
	5	◣	18	31	... FILL: SILT with CLAY and trace fine sand - moist, vert stiff, dark brown	CL CL ML
599.7 / 10						
	6	◣	16	10	CLAY - moist, stiff	CL
	7	◣	16	15	CLAY (native) with silt layers and pockets, trace fine gravel and topsoil- moist, stiff, dark brown (7.5YR 3/3)	CL
594.7 / 15						
	8	◣	18	21	CLAY with trace roots - moist, very stiff, brown mottling (7.5YR 4/4)	CL
	9	◣	18	20	... with gray mottling	CL
589.7 / 20						
					Boring terminated at 20 feet.	



MILLER ENGINEERS SCIENTISTS

	Water Level	Cave-in Depth
Date 12/20/2010 Time ______	dry ft.	16 ft.
Date ______ Time ______	______ ft.	______ ft.
Date ______ Time ______	______ ft.	______ ft.

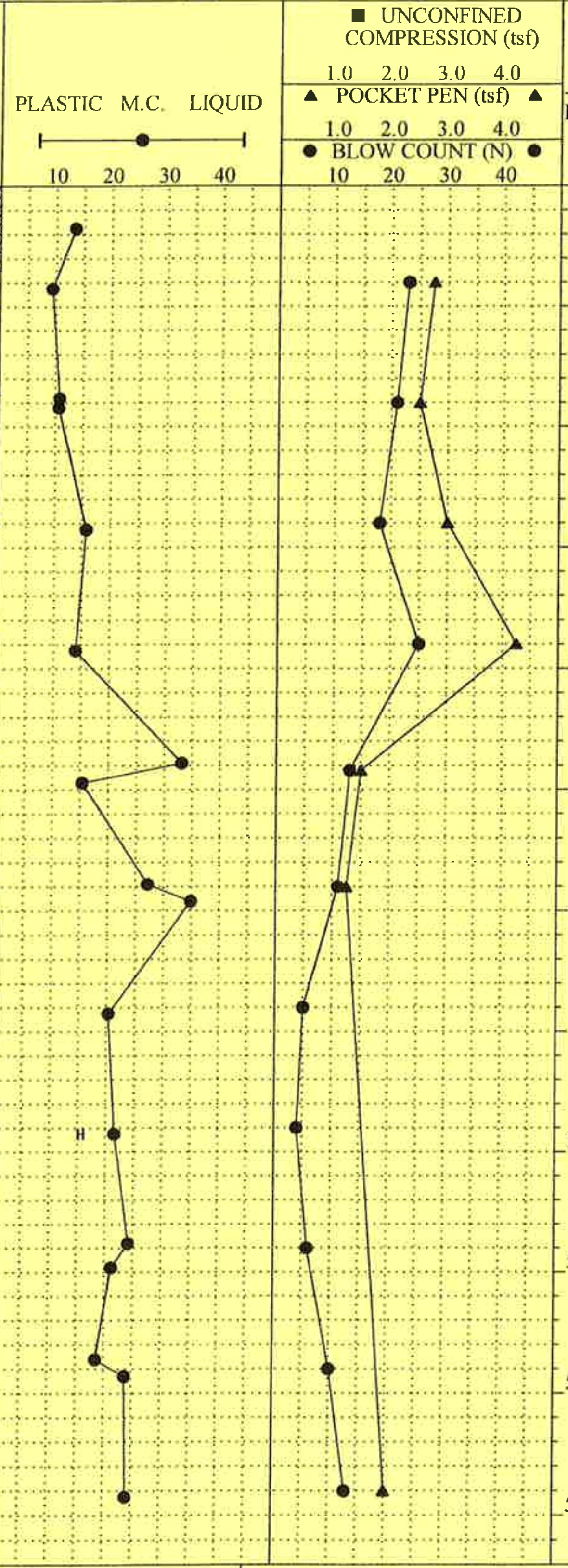
Borehole Abandonment
Date: **12/20/2010**
Material: **BENTONITE**

Crew: **M&K Drill/WGF**
Rig: **Mobile B52**
Method: **HSA**

Project: **POND STABILITY EVALUATION**	Job No: **10-1-18634**	Boring No: **Q**
Client: **ALLIANT UTILITIES**	Drilled By: **M&K ENV & SOILS DRILLING**	Elevation: **609.2**
Location: **EDGEWATER - SHEBOYGAN, WI**	Drilling Begun: **2/23/11**	Drilling Completed: **2/23/11**

SAMPLE TYPE ▮ 1" Geoprobe ○ No Recovery Ⓖ Grab Sample }} Auger Sample ■ 3" Shelby Tube ◣ 2" Split Spoon

ELEV. / DEPTH (ft) 609.2	SAMPLE NO.	SAMPLE TYPE	RECOVERY (in.)	SPT (N)	SOIL DESCRIPTION	USC
0	1	}}			FILL: Lean clay - moist, brown (7.5YR 4/4)	CL
604.2 5	2	◣	18	23	FILL: Silt with layers of lean clay and silty fine sand, occasional gravel - moist, very stiff, brown (7.5YR 5/4)	ML
599.2 10	3	◣	18	21	... - moist, medium dense, brown (7.5YR 5/4)	ML
594.2 15	4	◣	18	18	FILL: Silty clay with sand - moist, very stiff, brown (7.5YR 5/4)	CL ML
589.2 20	5	◣	18	25	Fill: Sandy lean clay, trace black topsoil, trace fine sand - moist, very stiff, dark brown (10YR 3/3)	CL
584.2 25	6	◣	18	13	Fill: Lean clay - moist, stiff, dark brown (10YR 4/4)	CL
579.2 30	7	◣	18	11	Silty clay with trace roots - moist to wet, stiff, light olive gray (5YR 6/2) with sand seams with black (10YR 2/1) lean clay	CL ML
574.2 35	8	◣	16	5	Silty fine sand - wet, medium, grayish brown (10YR 5/2)	SM
569.2 40	9	◣	18	4	Silt - soft, brown (10YR 4/3)	ML
564.2 45	10	◣	18	6	... medium, brown (10YR 5/3)	ML
559.2 50	11	◣	18	10	... - wet, loose, brown (10YR 5/3) Lean clay - moist, stiff, brown (7.5YR 4/4)	ML CL
554.2 55	12	◣	18	13	Lean clay (lacustrine) - moist, stiff, dark brown (7.5YR 3/4) Boring terminated at 55 feet.	CL



MILLER ENGINEERS SCIENTISTS

	Water Level	Cave-in Depth
Date ______ Time ______	______ ft.	______ ft.
Date ______ Time ______	______ ft.	______ ft.
Date ______ Time ______	______ ft.	______ ft.

Borehole Abandonment
Date: **2/23/2011**
Material: **BENTONITE**

Crew: **M&K Drill/WGF**
Rig: **Mobile B52**
Method: **Mud Rotary**

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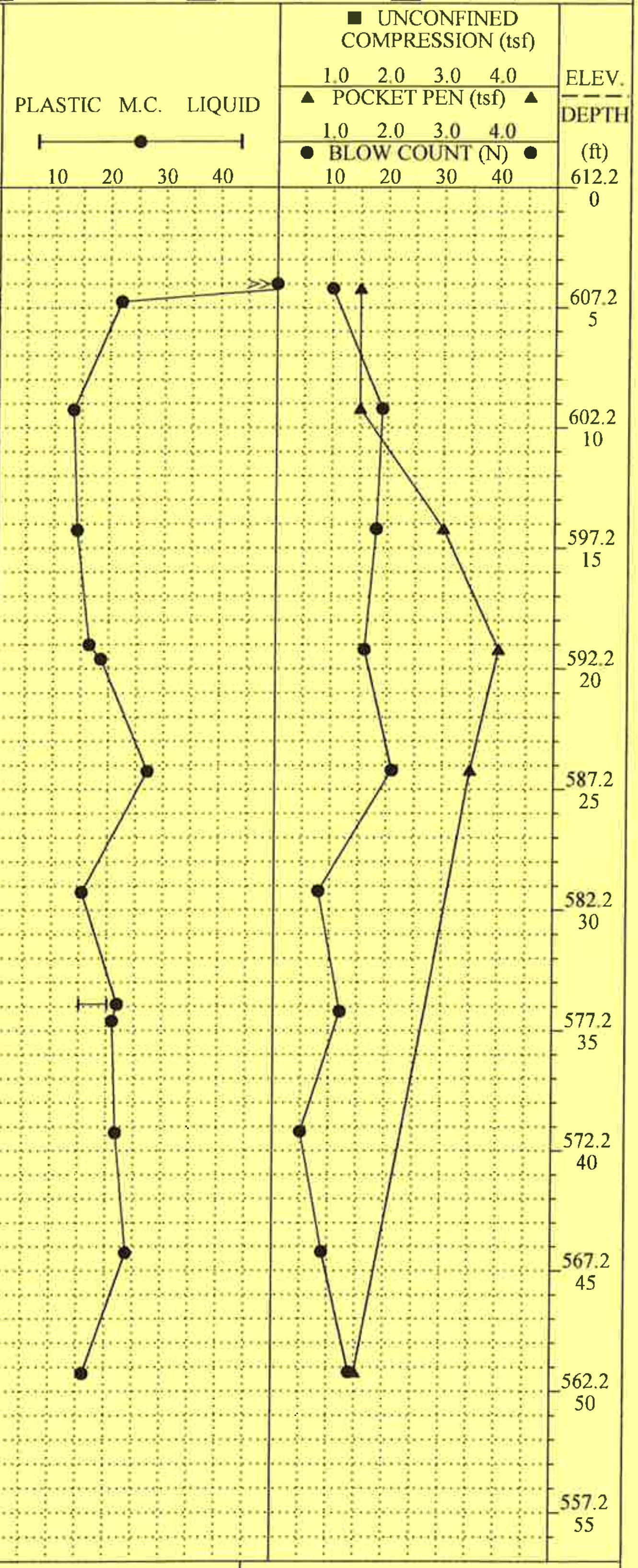
Page 1 of 1

Project: **POND STABILITY EVALUATION**	Job No: **10-1-18634**	Boring No: **R**
Client: **ALLIANT UTILITIES**	Drilled By: **M&K ENV & SOILS DRILLING**	Elevation: **612.2**
Location: **EDGEWATER - SHEBOYGAN, WI**	Drilling Begun: **2/24/11**	Drilling Completed: **2/24/11**

SAMPLE TYPE ▮ 1" Geoprobe ○ No Recovery Ⓖ Grab Sample ▯ Auger Sample ■ 3" Shelby Tube ◪ 2" Split Spoon

ELEV. DEPTH (ft) 612.2	SAMPLE NO.	SAMPLE TYPE	RECOVERY (in.)	SPT (N)	SOIL DESCRIPTION	USC
0						
607.2 5	1	◪	11	10	Fill: bottom ash - moist, loose, black (7.5YR 2.5/1) Fill: Lean clay - moist, stiff, dark brown (10YR 3/3)	SP CL
602.2 10	2	◪	18	19	Fill: Silt interbedded with silty clay - moist, stiff to very stiff, yellowish brosn (10YR 5/8)	ML
597.2 15	3	◪	14	18	Fill: Silt with clay - moist, very stiff, brown (7.5YR 4/4)	ML
592.2 20	4	◪	18	16	Fill: Topsoil with cinders - moist, stiff, dark gray brown (10YR 4/2) Fill: Lean clay - moist, very stiff, dark brown (10YR 2/2)	CL CL
587.2 25	5	◪	18	21	Native lean clay till with occasional coarse sand - moist, very stiff, strong brown (7.5YR 4/6)	CL
582.2 30	6	◪	18	8	Silt - wet, loose, yellowish brown (10YR 5/4) ... gravel noted at 31.5 feet.	ML
577.2 35	7	◪	16	12	Silty clay - wet, stiff, brown (10YR 4/3)	CL ML
572.2 40	8	◪	18	5	Silt - wet, loose, brown (10YR 4/3)	ML
567.2 45	9	◪	17	9	...	ML
562.2 50	10	◪	18	14	Lean clay with trace sand - wet, stiff, dark yellowish brown (10YR 4/4) Boring terminated at 50 feet.	CL
557.2 55						



MILLER ENGINEERS SCIENTISTS

		Water Level	Cave-in Depth
Date ________	Time ______	______ft.	________ ft.
Date ________	Time ______	______ft.	________ ft.
Date ________	Time ______	______ft.	________ ft.

Borehole Abandonment

Date: **2/24/2011**

Material: **BENTONITE**

Crew: **M&K Drill/WGF**

Rig: **Mobile B52**

Method: **Mud Rotary**

APPENDIX B – Soil Strength Properties

Alliant Energy
Wisconsin Power and Light Company
Edgewater Generating Station
Sheboygan, WI

Safety Factor Assessment

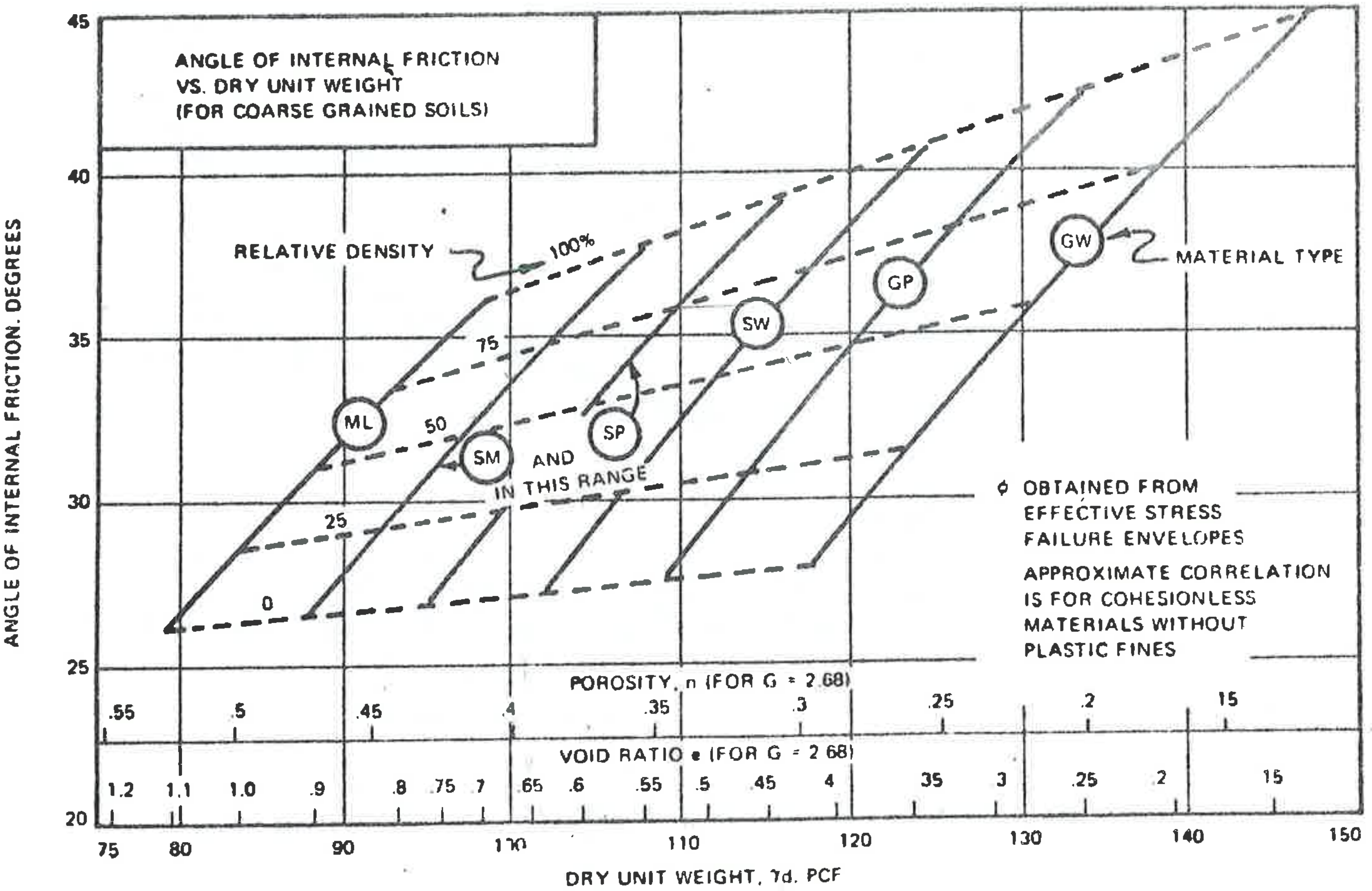


Fig. 8. Correlations Between the Effective Friction Angle in Triaxial Compression and the Dry Density, Relative Density, Grain Size, and Gradation for Granular Soils (After DM-7).

$$\gamma_m = \frac{(1 + w_{sat})\,\gamma_w}{w_{sat} + \frac{1}{G_s}}$$

APPENDIX C – Earthquake and Liquefaction Analysis

Alliant Energy
Wisconsin Power and Light Company
Edgewater Generating Station
Sheboygan, WI

Safety Factor Assessment

USGS Design Maps Detailed Report

ASCE 7-10 Standard (43.707°N, 87.707°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

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]	$S_S = 0.067$ g
From Figure 22-2 [2]	$S_1 = 0.040$ 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 11.4.3 — Site Coefficients and Risk–Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Table 11.4–1: Site Coefficient F_a

Site Class	Mapped MCE $_R$ Spectral Response Acceleration Parameter at Short Period				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
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	$\boxed{1.6}$	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 S_S

For Site Class = D and S_S = 0.067 g, F_a = 1.600

Table 11.4–2: Site Coefficient F_v

Site Class	Mapped MCE $_R$ Spectral Response Acceleration Parameter at 1–s Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	$\boxed{2.4}$	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.040 g, F_v = 2.400

Equation (11.4–1): $S_{MS} = F_aS_S = 1.600 \text{ x } 0.067 = 0.107$ g

---

Equation (11.4–2): $S_{M1} = F_vS_1 = 2.400 \text{ x } 0.040 = 0.095$ g

---

Section 11.4.4 — Design Spectral Acceleration Parameters

Equation (11.4–3): $S_{DS} = ⅔ S_{MS} = ⅔ \text{ x } 0.107 = 0.071$ g

---

Equation (11.4–4): $S_{D1} = ⅔ S_{M1} = ⅔ \text{ x } 0.095 = 0.063$ g

---

Section 11.4.5 — Design Response Spectrum

From Figure 22-12 [3] T_L = 12 seconds

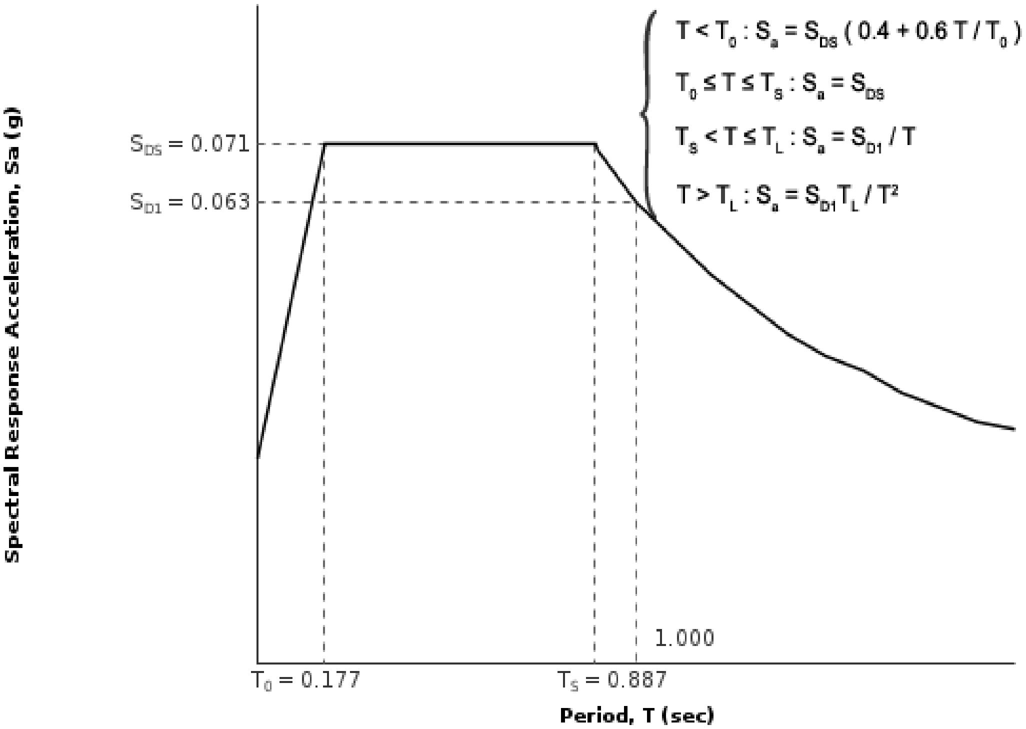
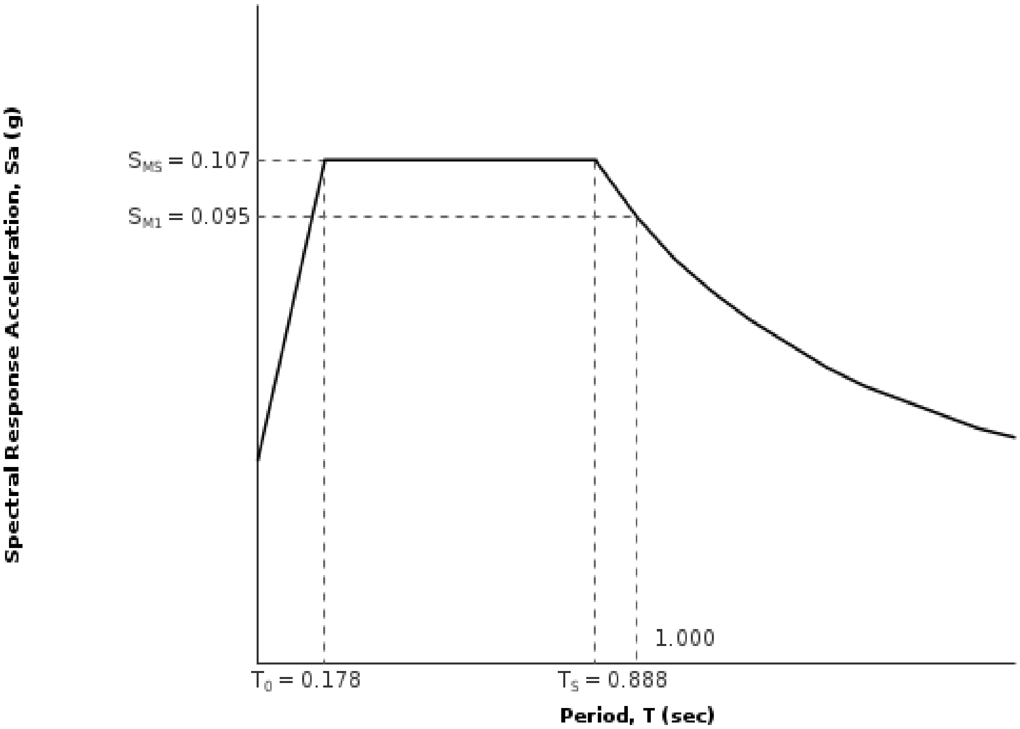


Figure 11.4–1: Design Response Spectrum

Section 11.4.6 — Risk-Targeted Maximum Considered Earthquake (MCE_R) Response Spectrum

The MCE_R Response Spectrum is determined by multiplying the design response spectrum above by 1.5.



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

From Figure 22-7 [4] PGA = 0.031

Equation (11.8–1): $PGA_M = F_{PGA}PGA = 1.600 \text{ x } 0.031 = 0.05 \text{ g}$

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 = 0.031 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} = 0.909

From Figure 22-18 [6] C_{R1} = 0.876

Section 11.6 — Seismic Design Category

Table 11.6-1 Seismic Design Category Based on Short Period Response Acceleration Parameter

VALUE OF S_{DS}	**RISK CATEGORY**		
	I or II	**III**	**IV**
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 0.071 g, Seismic Design Category = A

Table 11.6-2 Seismic Design Category Based on 1-S Period Response Acceleration Parameter

VALUE OF S_{D1}	**RISK CATEGORY**		
	I or II	**III**	**IV**
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.063 g, Seismic Design Category = A

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ "the more severe design category in accordance with Table 11.6-1 or 11.6-2" = A

Note: See Section 11.6 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 22-1*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-1.pdf
2. *Figure 22-2*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-2.pdf
3. *Figure 22-12*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-12.pdf
4. *Figure 22-7*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-7.pdf
5. *Figure 22-17*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-17.pdf
6. *Figure 22-18*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-18.pdf

Simplified Seed and Idriss Liquefaction Analysis
SPT Based Analysis
Edgewater Generating Station
Interstate Electric Power
Equations from "Soil Liquefaqction During Earthqakes" Idriss & Boulanger
Soil Conditions at Boring E Figure 3
Edgewater Generating Station

Input Parameters:

Peak Ground Acceleration (g) =	0.05
Earthquake Magnitude, M =	7.7
Water Table Depth (ft) =	10
Average Soil Density above water table (lb/ft^3) =	115.0
Average Soil Density below water table (lb/ft^3) =	120.0
Borehole Diameter (mm) =	100

Rod Lengths assumed equal to depth plus 5.0 feet (for the above ground extension)

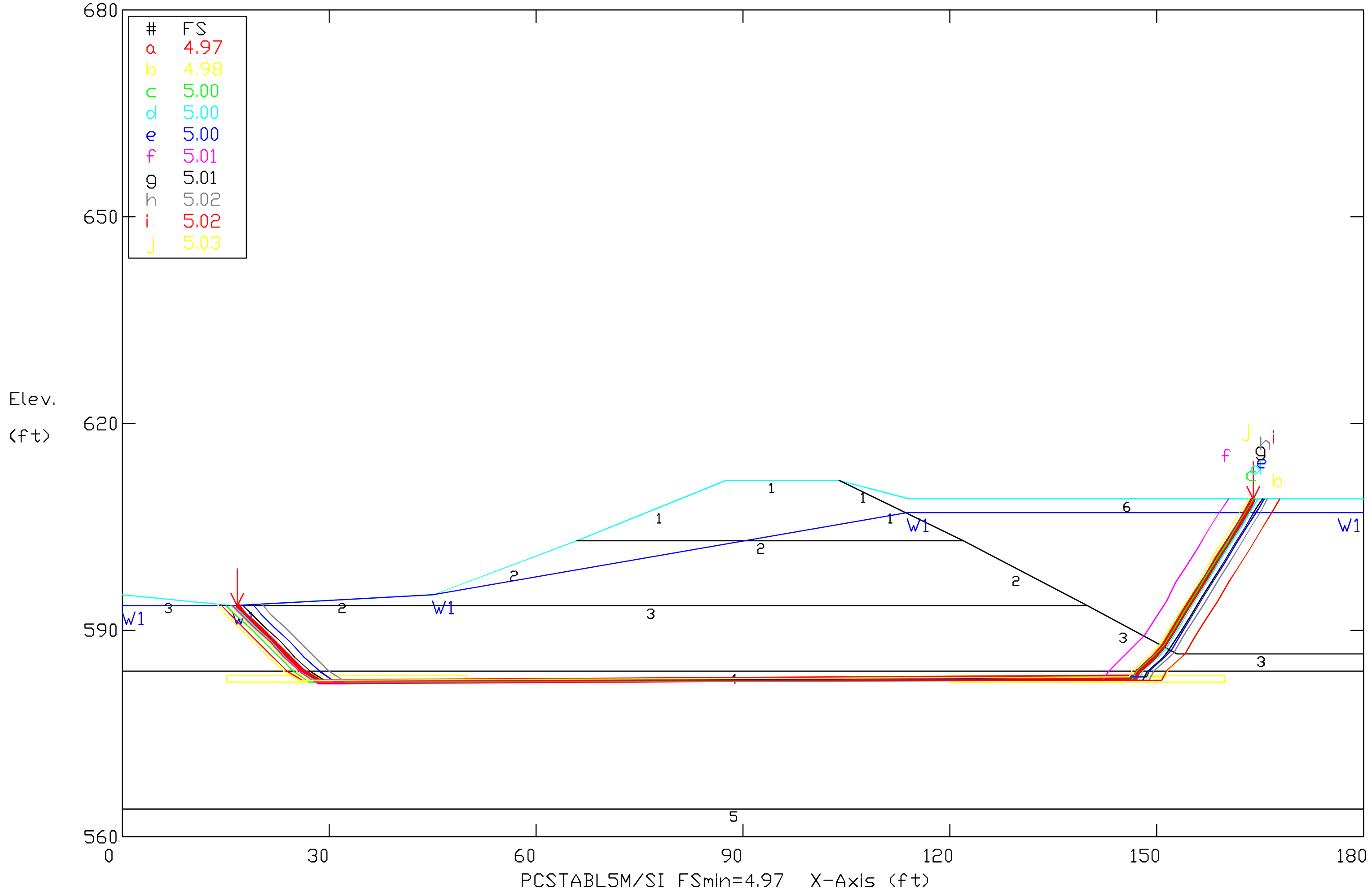
SPT #	Depth (ft)	Measured N	Soil Type (USCS)	Flag "Clay" "Unsaturated"	Fines Content (%)	Energy Ratio, ER (%)	C_e	C_b	C_r	N_{60}	σ_{vc} (lb/ft^2)	σ_{vc}' (lb/ft^2)	C_n	$(N_1)_{60}$	ΔN for fines content	$(N_1)_{60\text{-cs}}$	Stress Reduction Coeff, r_d	CSR	MSF for sand	k_σ for sand	CRR 7.5M & 1 atm	CRR	Factor of Safety
2	3	9	CL	Clay		75%	1.25	1	0.75	8.4	345	345	1.70	n.a.	n.a.	n.a.	1.00	0.033	0.95	1.10	n.a.	n.a.	n.a.
3	4.5	16	CL	Clay		75%	1.25	1	0.75	15.0	518	518	1.70	n.a.	n.a.	n.a.	1.00	0.032	0.95	1.10	n.a.	n.a.	n.a.
4	6.5	16	CL	Clay		75%	1.25	1	0.8	16.0	748	748	1.68	n.a.	n.a.	n.a.	0.99	0.032	0.95	1.10	n.a.	n.a.	n.a.
5	9.5	18	CL	Clay		75%	1.25	1	0.85	19.1	1093	1093	1.39	n.a.	n.a.	n.a.	0.99	0.032	0.95	1.10	n.a.	n.a.	n.a.
6	11.5	18	CL	Clay		75%	1.25	1	0.85	19.1	1330	1236	1.31	n.a.	n.a.	n.a.	0.98	0.034	0.95	1.10	n.a.	n.a.	n.a.
7	14.5	16	CL	Clay		75%	1.25	1	0.85	17.0	1690	1409	1.23	n.a.	n.a.	n.a.	0.97	0.038	0.95	1.10	n.a.	n.a.	n.a.
8	16.5	20	CL	Clay		75%	1.25	1	0.95	23.8	1930	1524	1.18	n.a.	n.a.	n.a.	0.97	0.040	0.95	1.10	n.a.	n.a.	n.a.
9	19.5	16	CL	Clay		75%	1.25	1	0.95	19.0	2290	1697	1.12	n.a.	n.a.	n.a.	0.96	0.042	0.95	1.07	n.a.	n.a.	n.a.
10	24.5	13	ML		50	75%	1.25	1	0.95	15.4	2890	1985	1.03	15.9	5.6	21.6	0.94	0.044	0.95	1.01	0.226	0.217	2.00
11	29.5	2	ML		50	75%	1.25	1	1	2.5	3490	2273	0.97	2.4	5.6	8.0	0.92	0.046	0.95	0.99	0.105	0.099	2.00
12	34.5	4	ML		50	75%	1.25	1	1	5.0	4090	2561	0.91	4.5	5.6	10.2	0.90	0.047	0.95	0.98	0.119	0.111	2.00
13	39.5	7	CL	Clay		75%	1.25	1	1	8.8	4690	2849	0.86	n.a.	n.a.	n.a.	0.88	0.047	0.95	0.91	n.a.	n.a.	n.a.

APPENDIX D – Slope Stability Analysis

Alliant Energy
Wisconsin Power and Light Company
Edgewater Generating Station
Sheboygan, WI

Safety Factor Assessment

EGS Section-N with Normal Water Level Static Case (A Pond North @ 607')
Ten Most Critical. E:EGS40B.PLT 07-13-16 7:20pm



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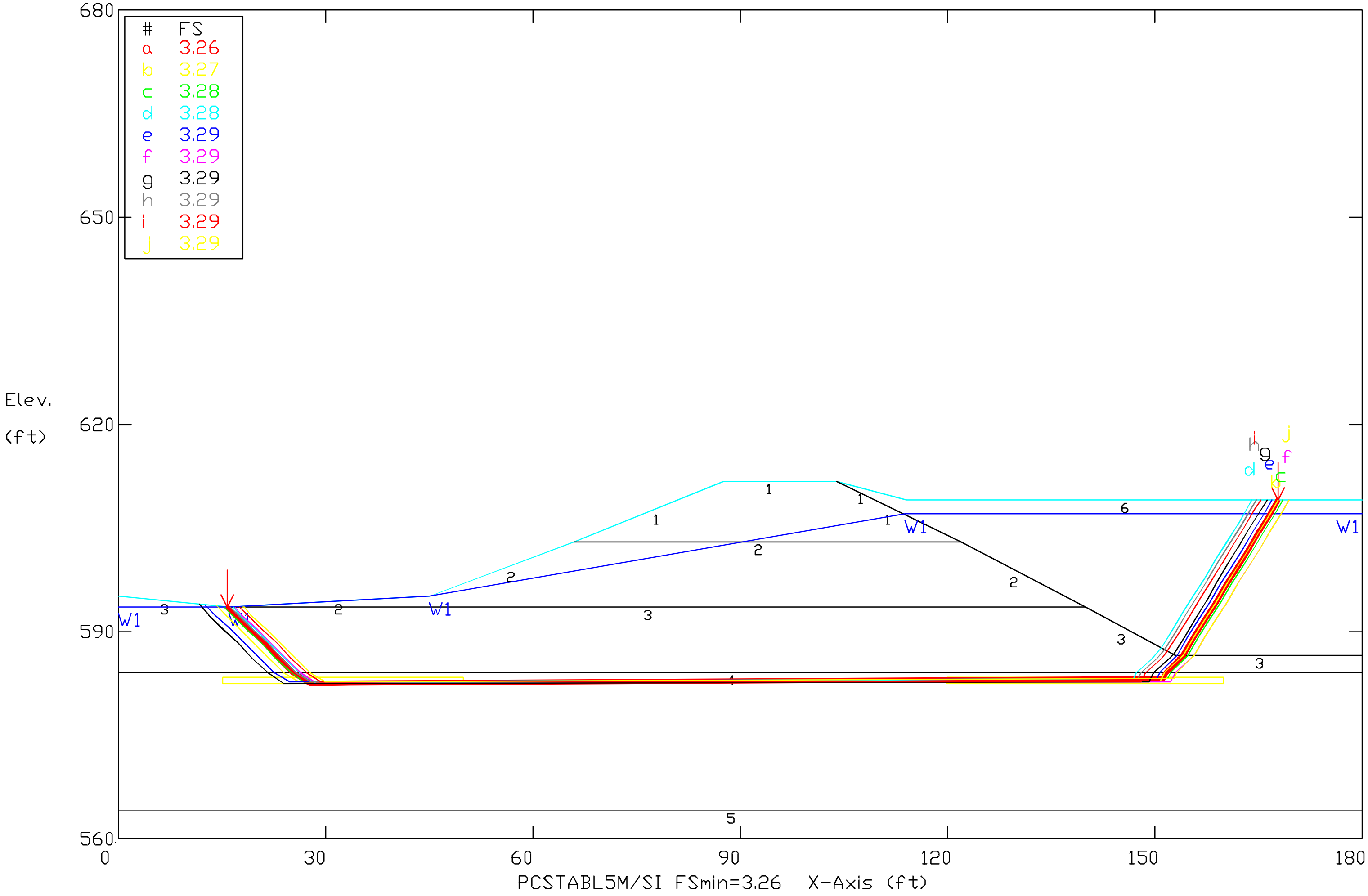
1 Clay	120	120	1800	0	0	0	W1
2 Clay	125	125	4000	0	0	0	W1
3 Clay	120	120	2200	0	0	0	W1
4 Silt	110	110	0	27	0	0	W1
5 Clay	120	120	2500	0	0	0	W1
6 Ash	120	120	0	27	0	0	W1

EGS Section-N with Normal Water Level Earth Quake Case (A Pond North @ 607')
Ten Most Critical. E:EGS40BEQ.PLT 07-13-16 7:21pm



Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Clay	120	120	1800	0	0	0	W1
2 Clay	125	125	4000	0	0	0	W1
3 Clay	120	120	2200	0	0	0	W1
4 Silt	110	110	0	27	0	0	W1
5 Clay	120	120	2500	0	0	0	W1
6 Ash	120	120	0	27	0	0	W1

EGS Section-N with Normal Water Level Static Case (A Pond North @ 607')
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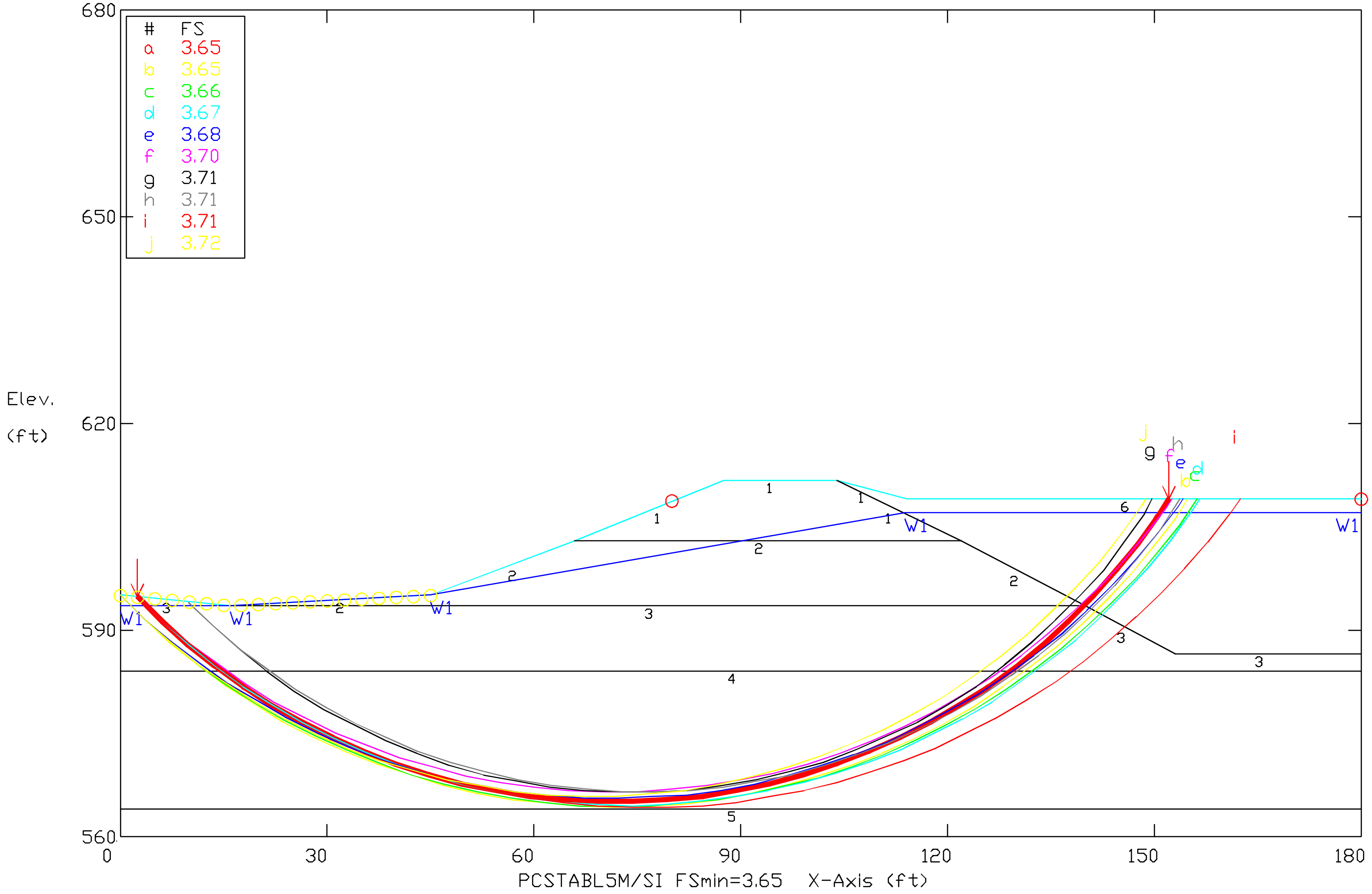

Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Clay	120	120	1800	0	0	0	W1
2 Clay	125	125	4000	0	0	0	W1
3 Clay	120	120	2200	0	0	0	W1
4 Silt	110	110	0	27	0	0	W1
5 Clay	120	120	2500	0	0	0	W1
6 Ash	120	120	0	27	0	0	W1

EGS Section-N with Normal Water Level Earth Quake Case (A Pond North @ 607')
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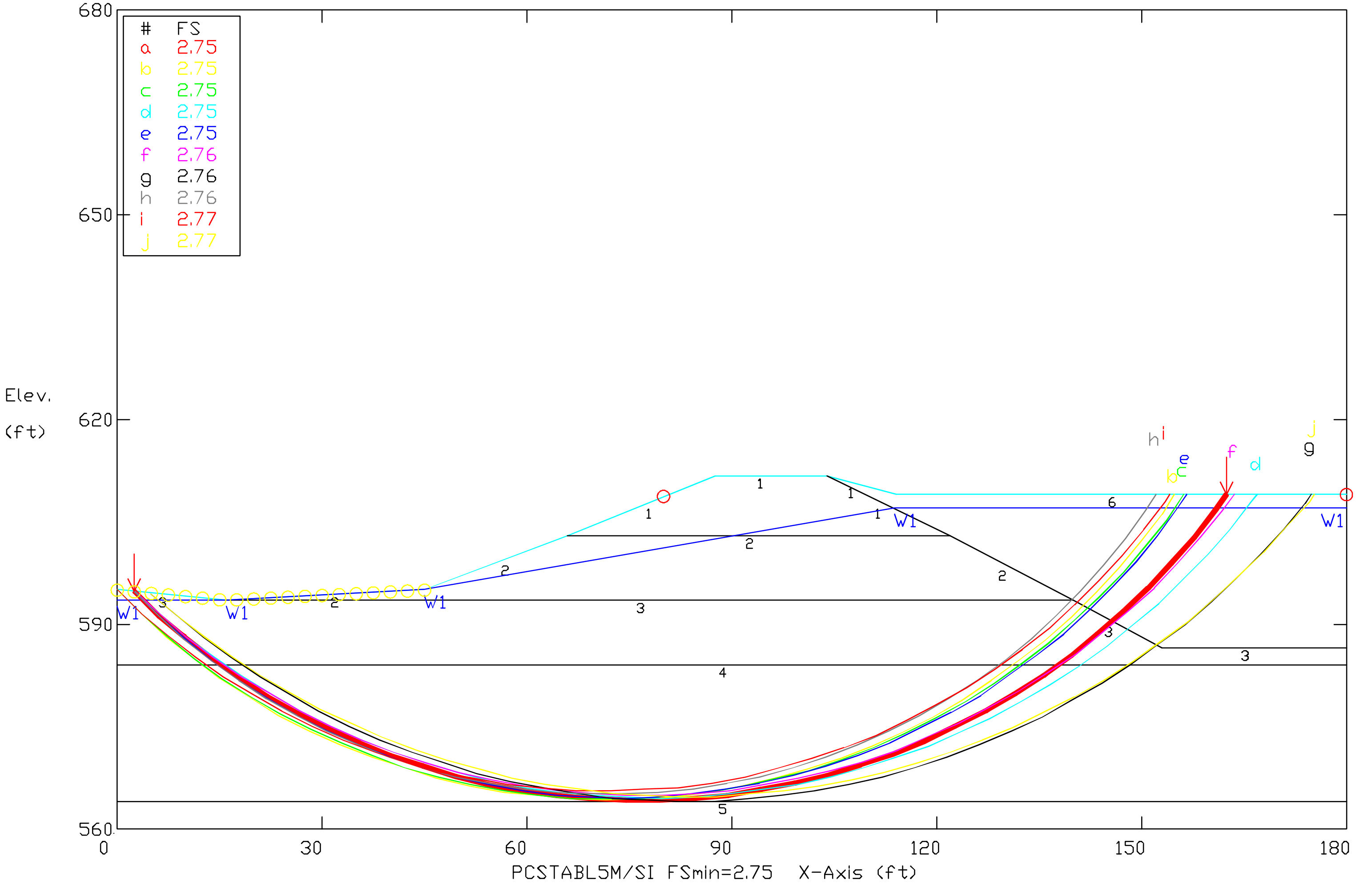

Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Clay	120	120	1800	0	0	0	W1
2 Clay	125	125	4000	0	0	0	W1
3 Clay	120	120	2200	0	0	0	W1
4 Silt	110	110	0	27	0	0	W1
5 Clay	120	120	2500	0	0	0	W1
6 Ash	120	120	0	27	0	0	W1

EGS Section-N with 1,000 Yr. Water Level Static Case (A Pond North @ 609')
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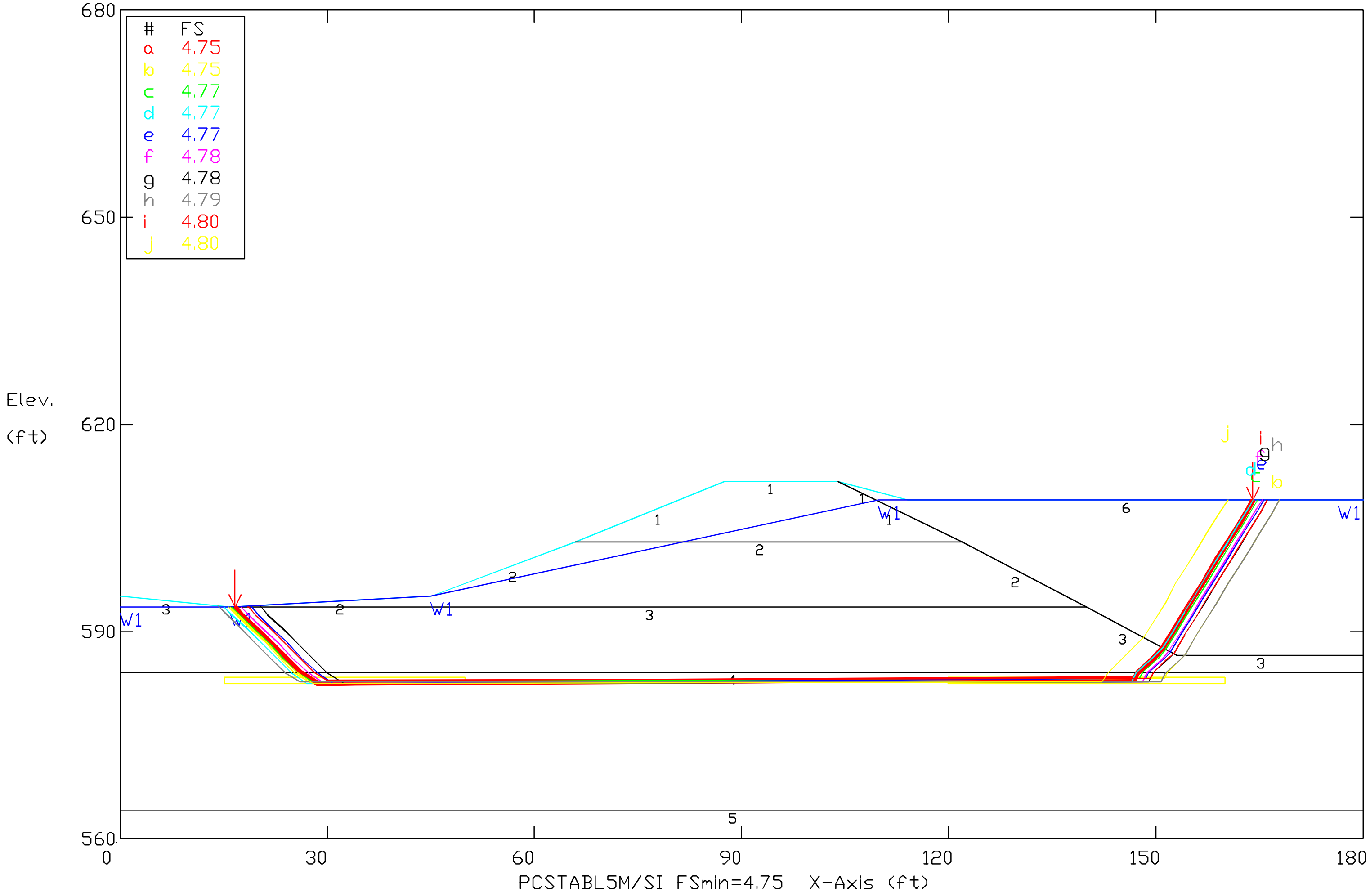

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1 Clay	120	120	1800	0	0	0	W1
2 Clay	125	125	4000	0	0	0	W1
3 Clay	120	120	2200	0	0	0	W1
4 Silt	110	110	0	27	0	0	W1
5 Clay	120	120	2500	0	0	0	W1
6 Ash	120	120	0	27	0	0	W1

EGS Section-N with 1,000 Yr. Water Level Static Case (A Pond North @ 609')
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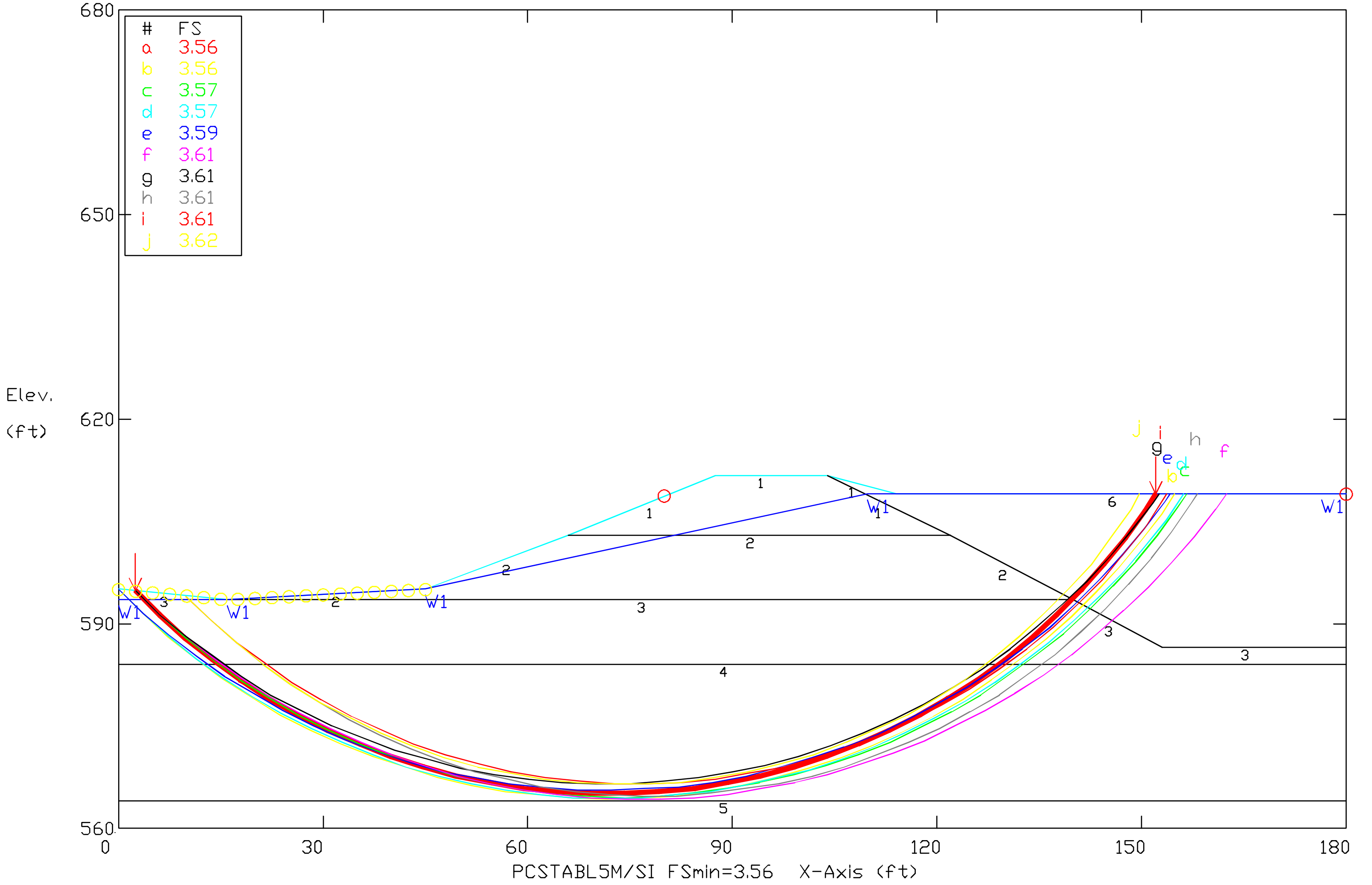

Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Clay	120	120	1800	0	0	0	W1
2	Clay	125	125	4000	0	0	0	W1
3	Clay	120	120	2200	0	0	0	W1
4	Silt	110	110	0	27	0	0	W1
5	Clay	120	120	2500	0	0	0	W1
6	Ash	120	120	0	27	0	0	W1

EGS Section-P with Normal Water Level Static Case (Slag Pond @ 606.7')
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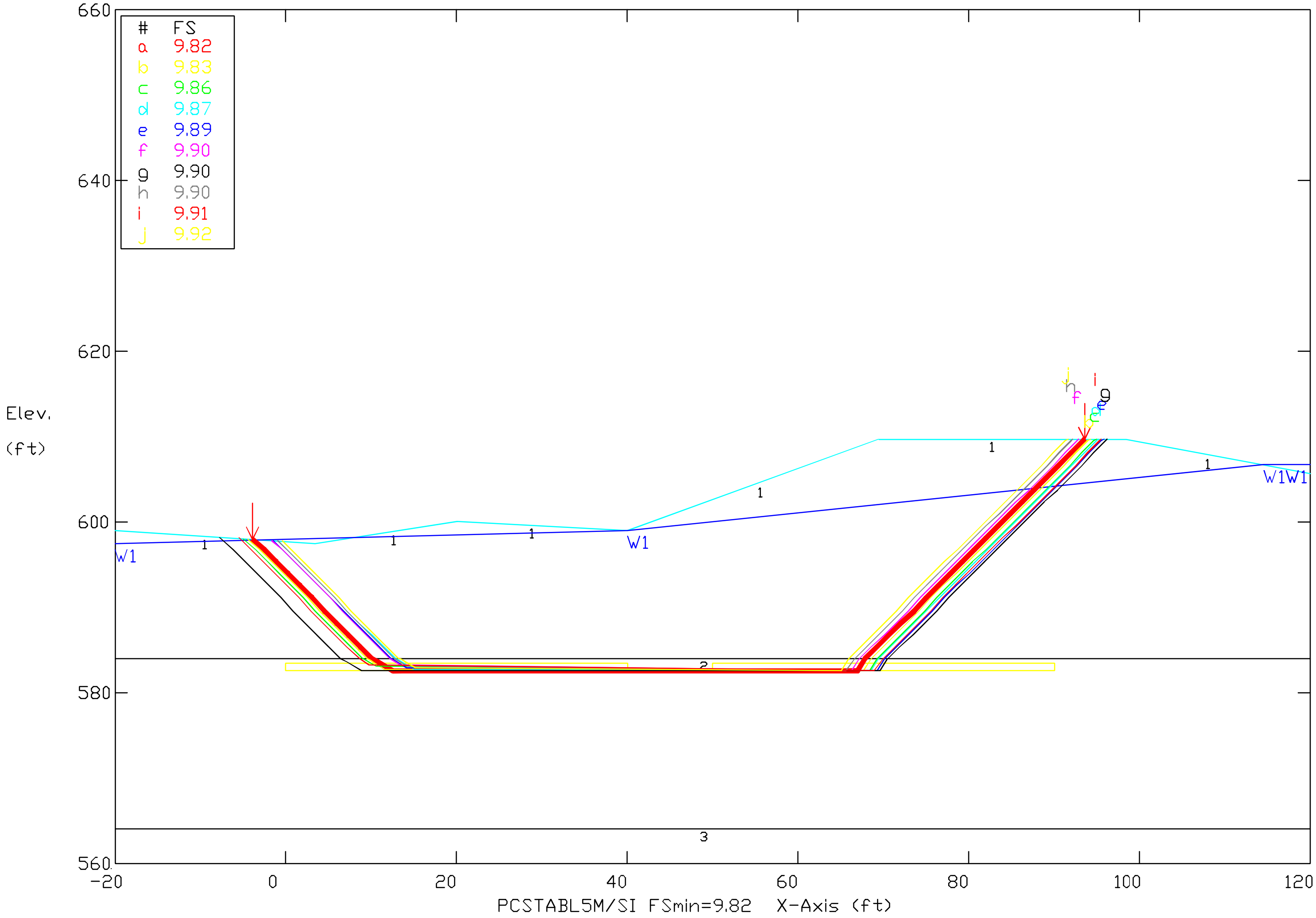

Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Clay	125	125	3300	0	0	0	W1
2 Silt	110	110	0	27	0	0	W1
3 Clay	120	120	2500	0	0	0	W1

EGS Section-P with Normal Water Level Earth Quake Case (Slag Pond @ 606.7')
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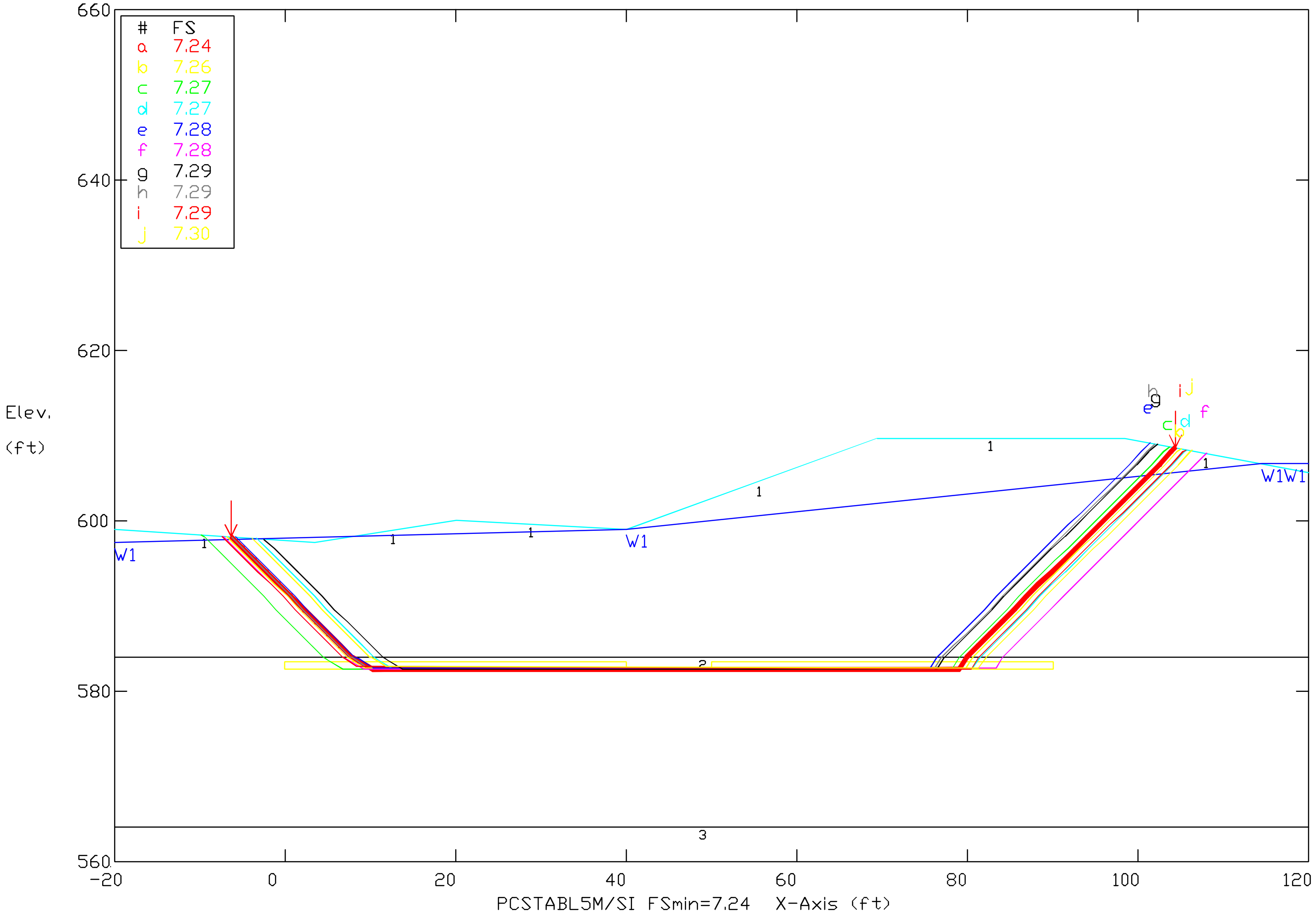

Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Clay	125	125	3300	0	0	0	W1
2	Silt	110	110	0	27	0	0	W1
3	Clay	120	120	2500	0	0	0	W1

EGS Section-P with Normal Water Level Static Case (Slag Pond @ 606.7')
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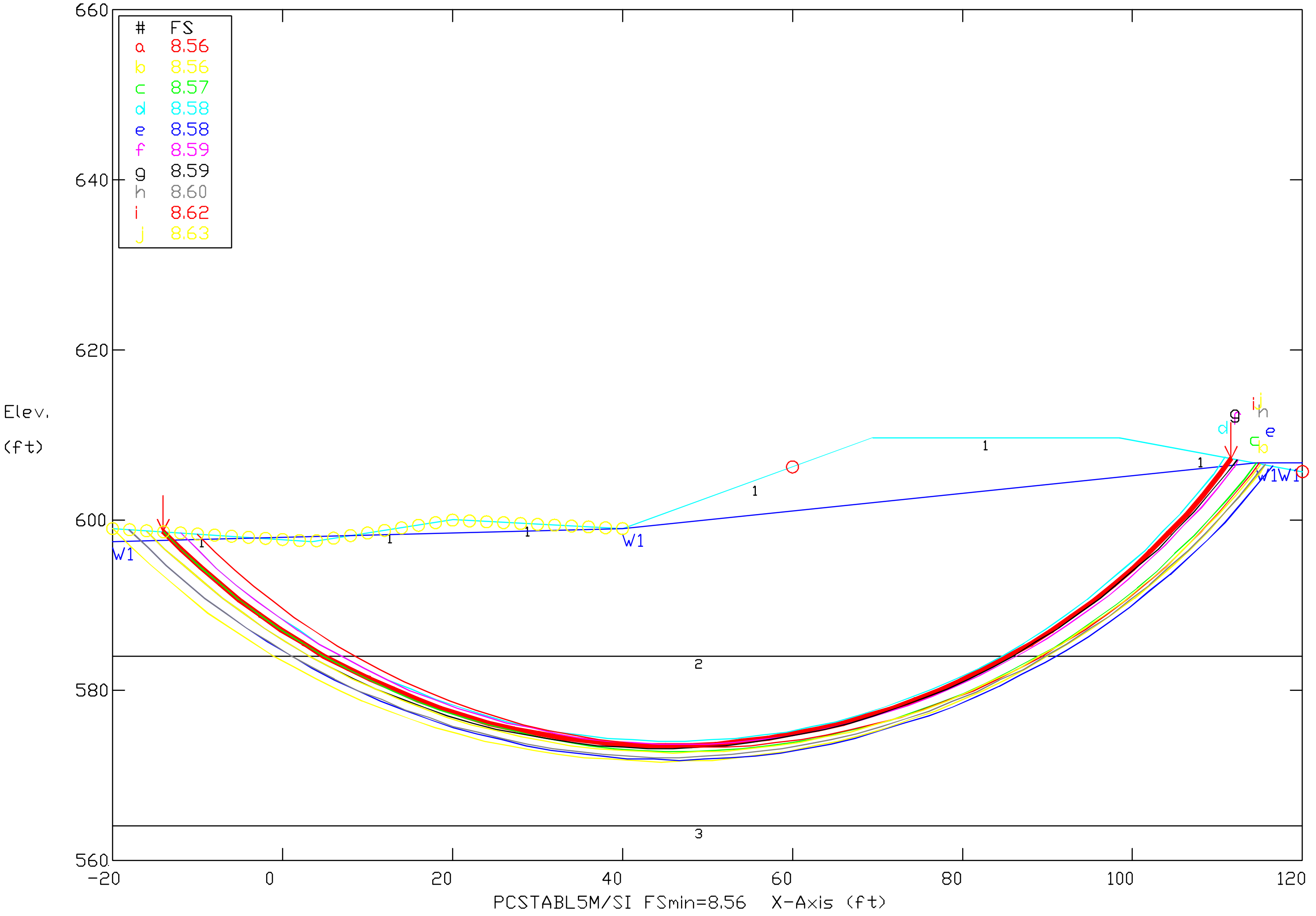

Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Clay	125	125	3300	0	0	0	W1
2 Silt	110	110	0	27	0	0	W1
3 Clay	120	120	2500	0	0	0	W1

EGS Section-P with Normal Water Level Earth Quake Case (Slag Pond @ 606.7')
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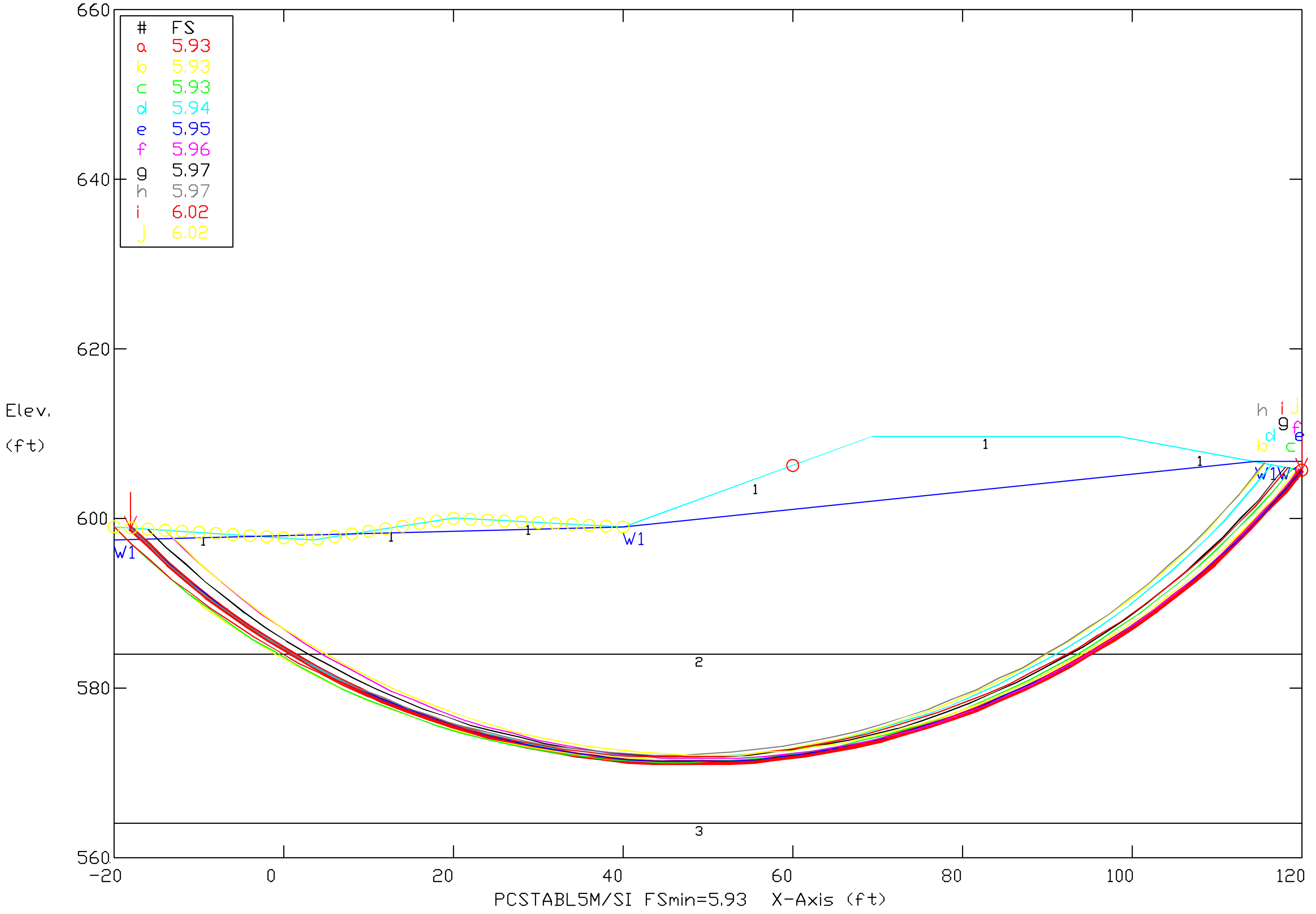
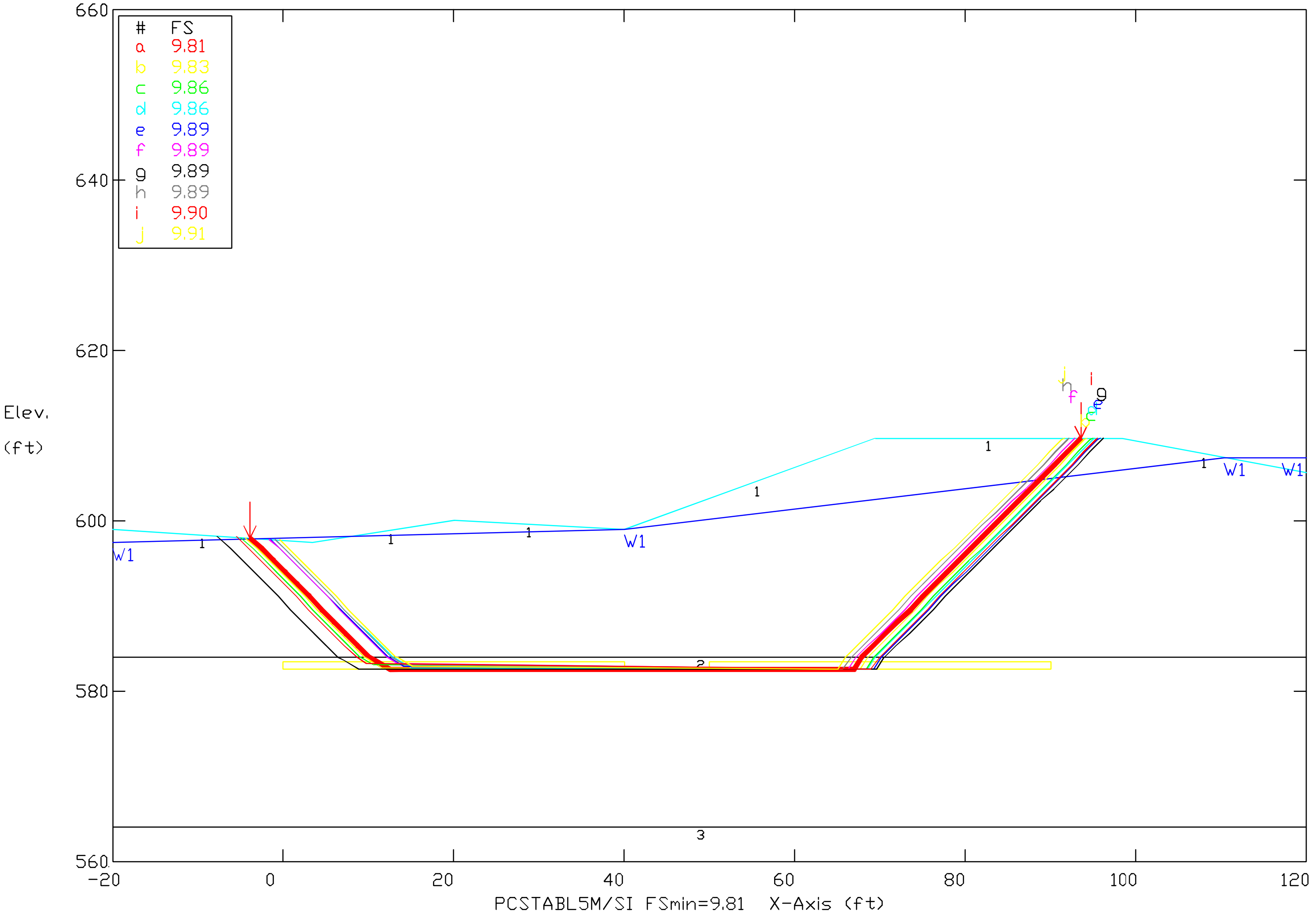


Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Clay	125	125	3300	0	0	0	W1
2 Silt	110	110	0	27	0	0	W1
3 Clay	120	120	2500	0	0	0	W1

EGS Section-P with 1,000 yr. Water Level Static Case (Slag Pond @ 607.5')

Ten Most Critical. E:EGS51B.PLT 07-13-16 7:37pm



Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Clay	125	125	3300	0	0	0	W1
2 Silt	110	110	0	27	0	0	W1
3 Clay	120	120	2500	0	0	0	W1

EGS Section-P with 1,000 yr. Water Level Static Case (Slag Pond @ 607.5')
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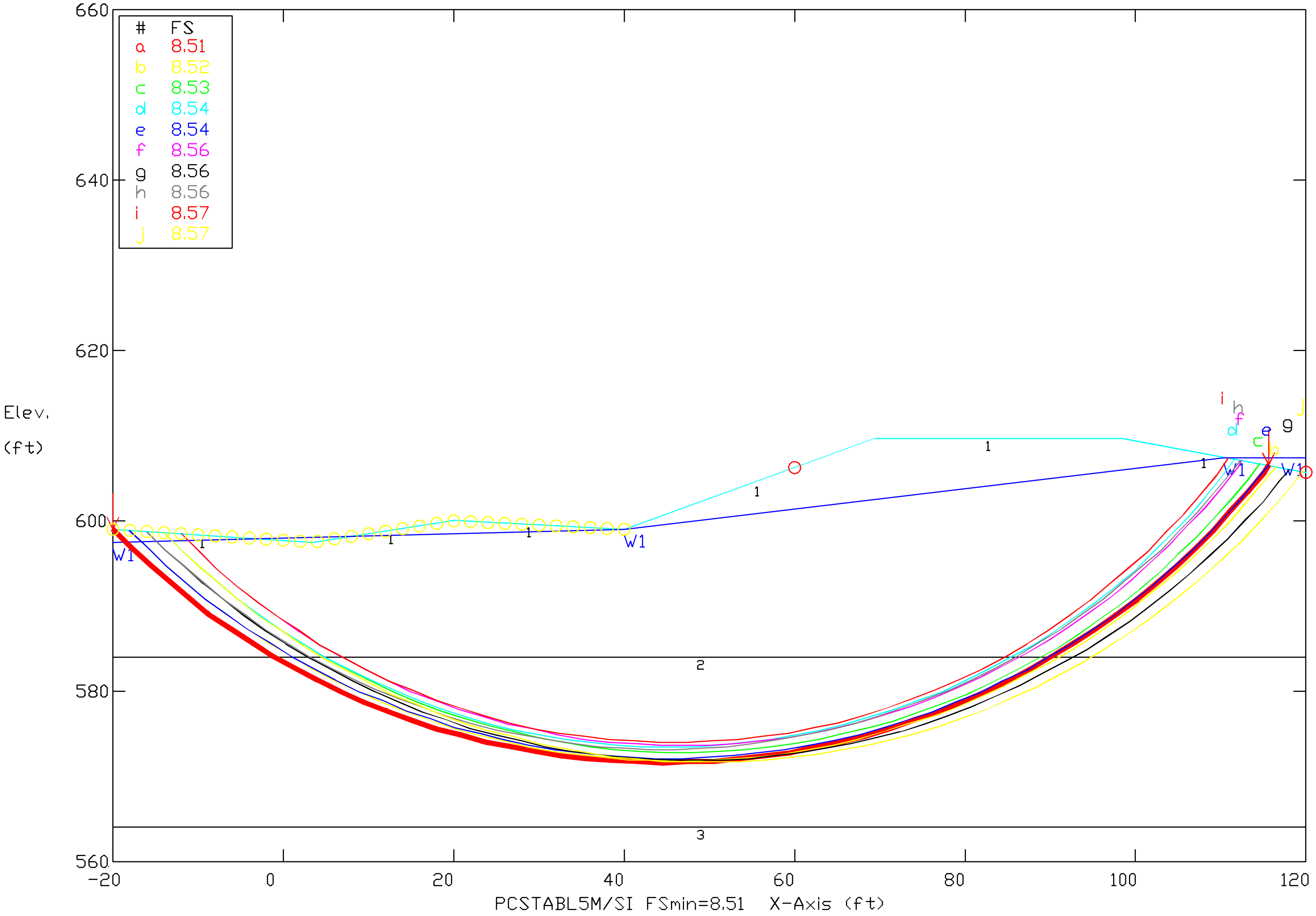

Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Clay	125	125	3300	0	0	0	W1
2 Silt	110	110	0	27	0	0	W1
3 Clay	120	120	2500	0	0	0	W1

EGS Section-E with Normal Water Level Static Case (B Pond @ 598.8')
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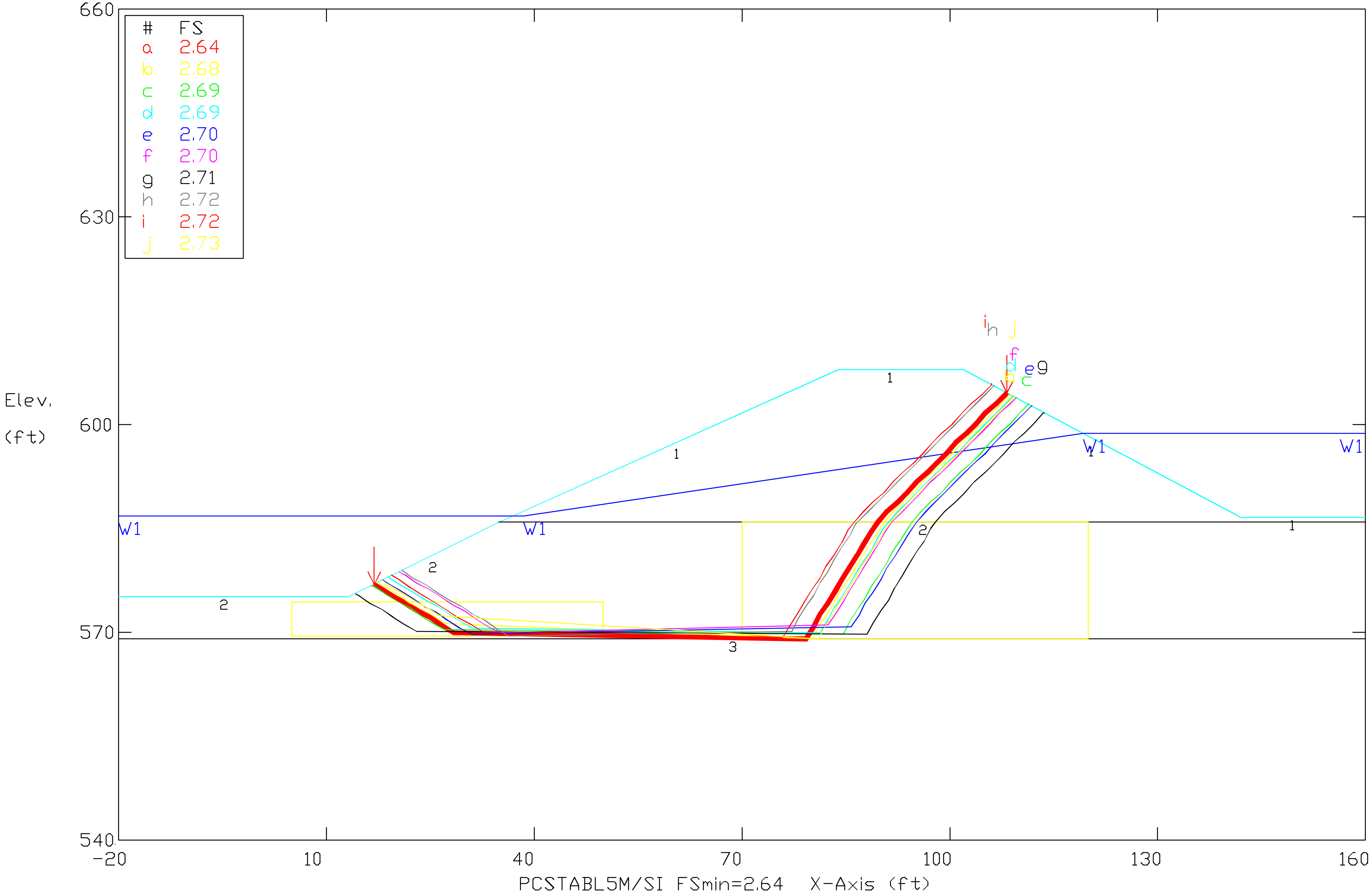
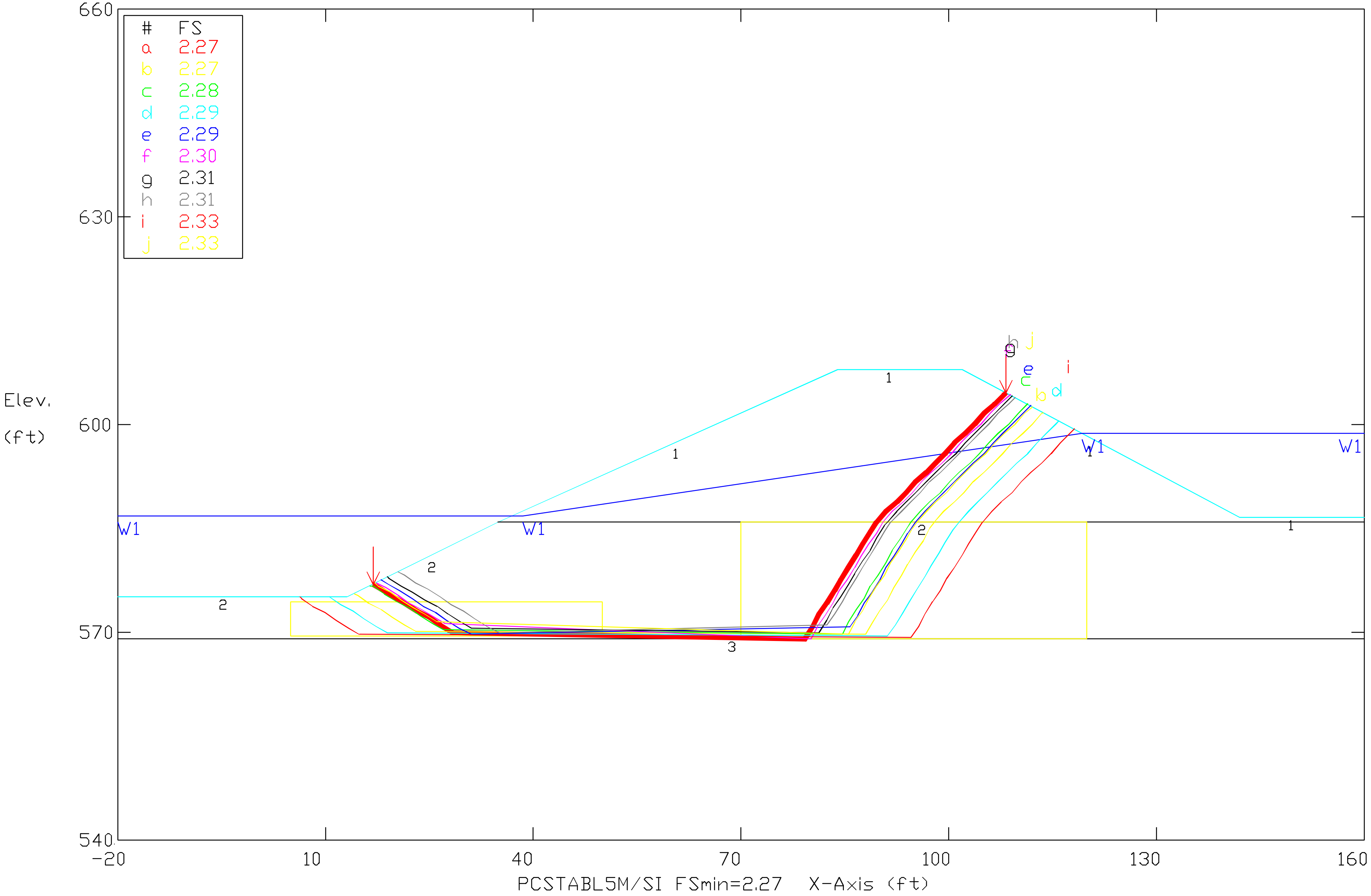


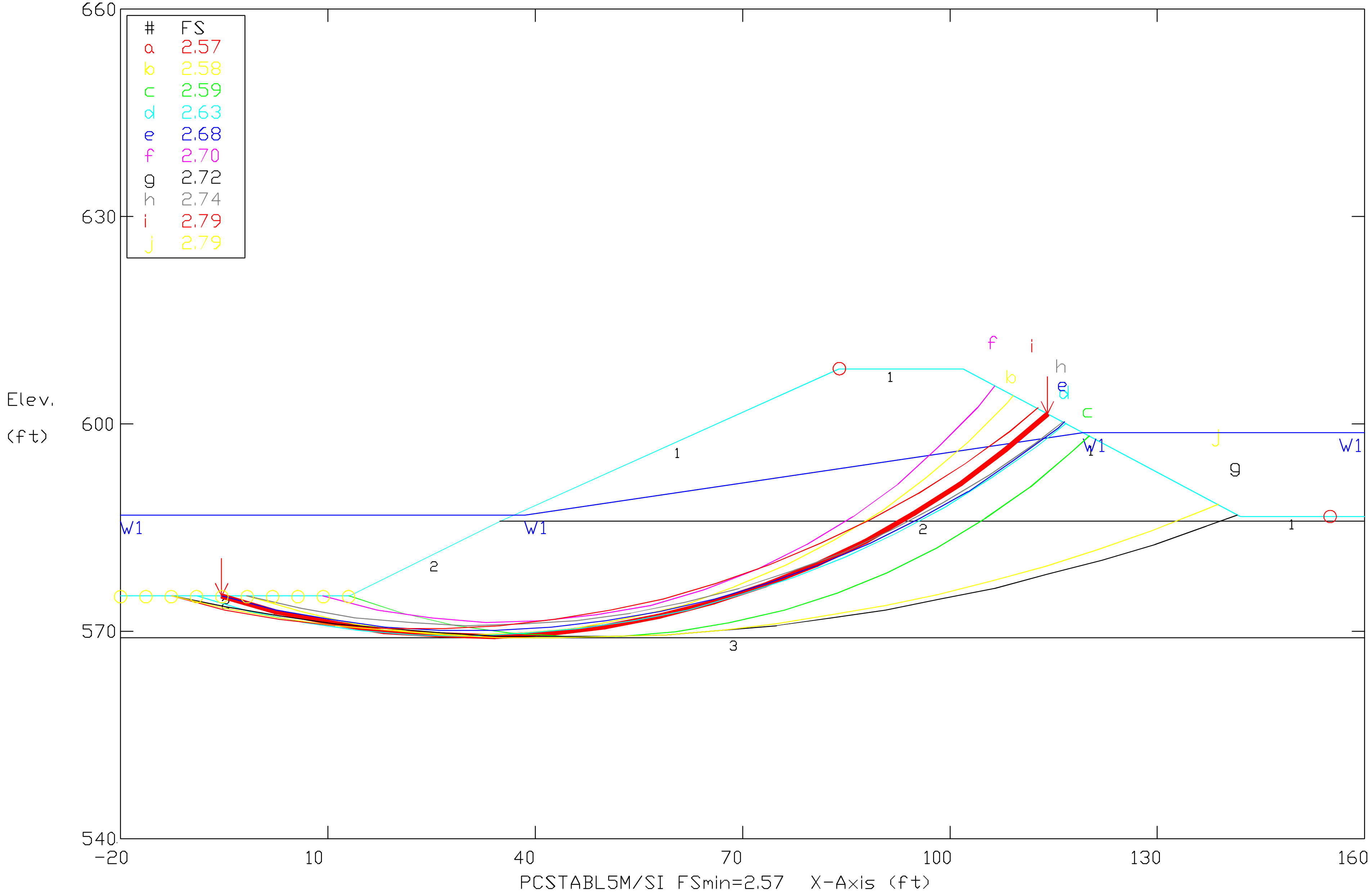
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Clay	125	125	3100	0	0	0	W1
2 Silt	110	110	0	27	0	0	W1
3 Clay	120	120	1500	0	0	0	W1

EGS Section-E with Normal Water Level Earth Quake Case (B Pond @ 598.8')
Ten Most Critical. E:EGS60BEQ.PLT 07-13-16 7:59pm



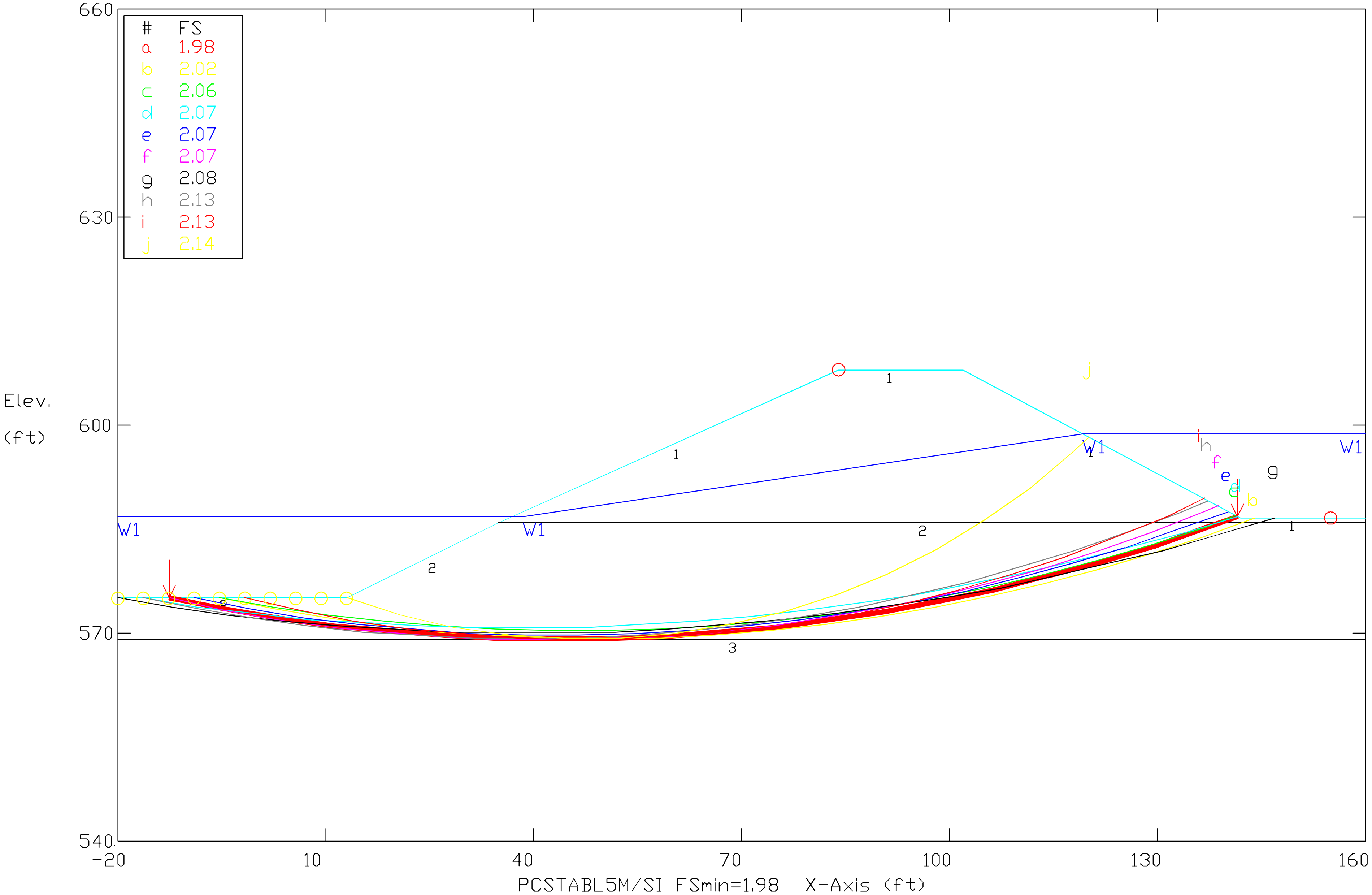
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Clay	125	125	3100	0	0	0	W1
2 Silt	110	110	0	27	0	0	W1
3 Clay	120	120	1500	0	0	0	W1

EGS-Section E with Normal Water Level Static Case (B Pond @ 598.8')
Ten Most Critical. E:EGS60C.PLT 07-13-16 8:08pm



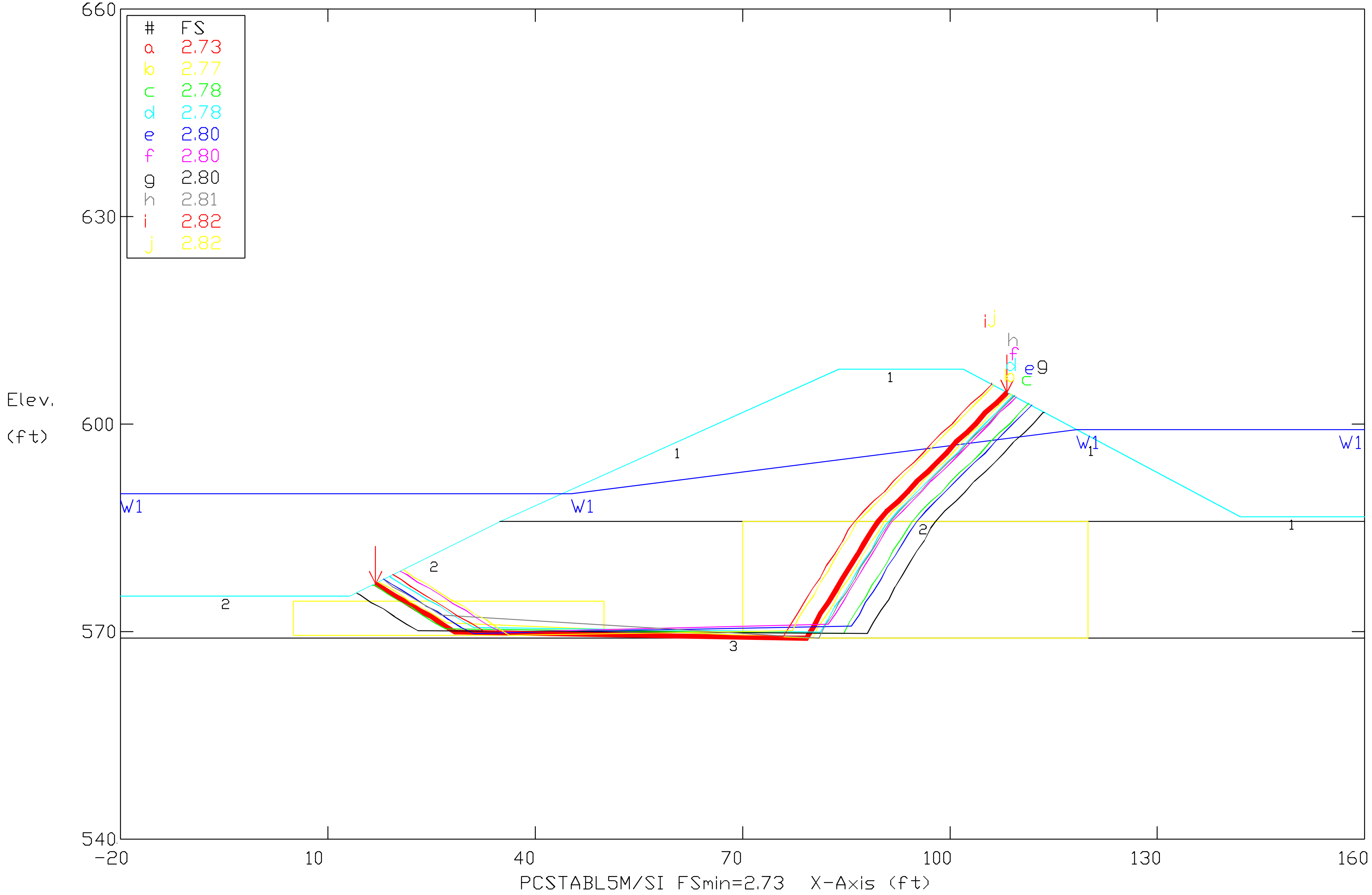
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Clay	125	125	3100	0	0	0	W1
2 Silt	110	110	0	27	0	0	W1
3 Clay	120	120	1500	0	0	0	W1

EGS-Section E with Normal Water Level Earth Quake Case (B Pond @ 598.8')
Ten Most Critical. E:EGS60CEQ.PLT 07-13-16 8:10pm



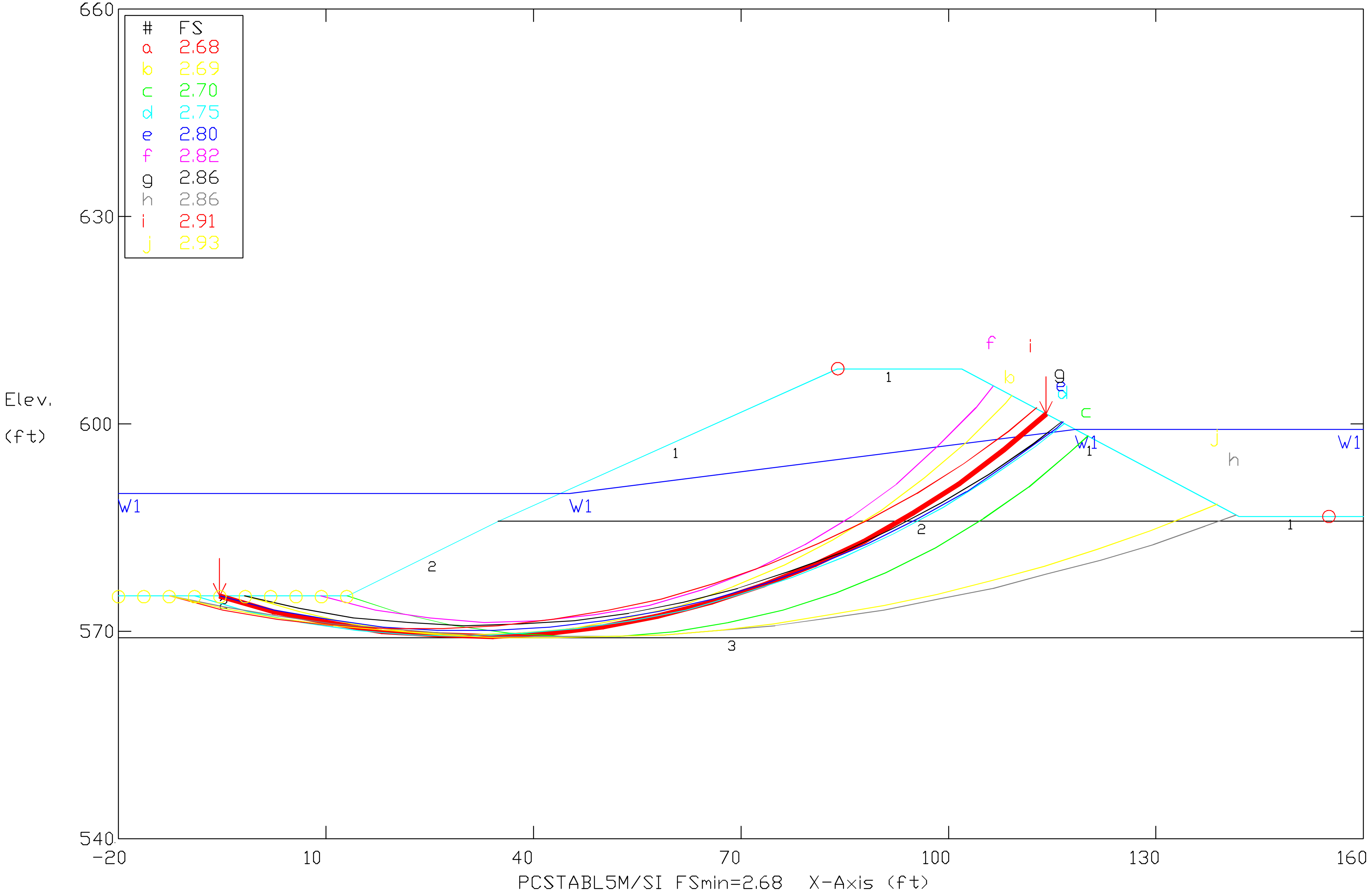
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Clay	125	125	3100	0	0	0	W1
2 Silt	110	110	0	27	0	0	W1
3 Clay	120	120	1500	0	0	0	W1

EGS Section-E with 1,000 yr. Water Level Static Case (B Pond @ 599.2')
Ten Most Critical. E:EGS61B.PLT 07-13-16 8:22pm



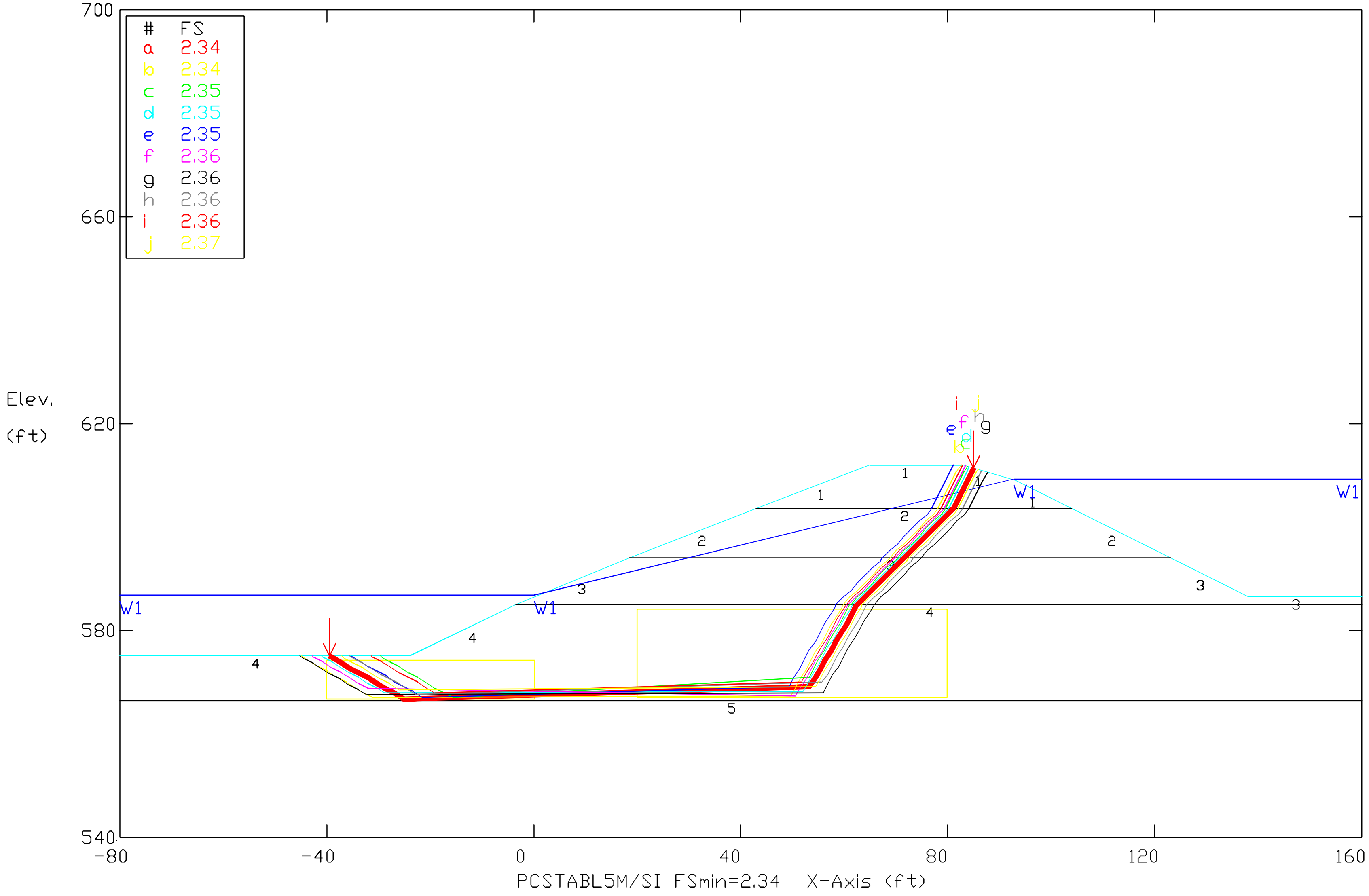
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Clay	125	125	3100	0	0	0	W1
2 Silt	110	110	0	27	0	0	W1
3 Clay	120	120	1500	0	0	0	W1

EGS Section-E with 1,000 yr. Water Level Static Case (B Pond @ 599.2')
Ten Most Critical. E:EGS61C.PLT 07-13-16 8:17pm



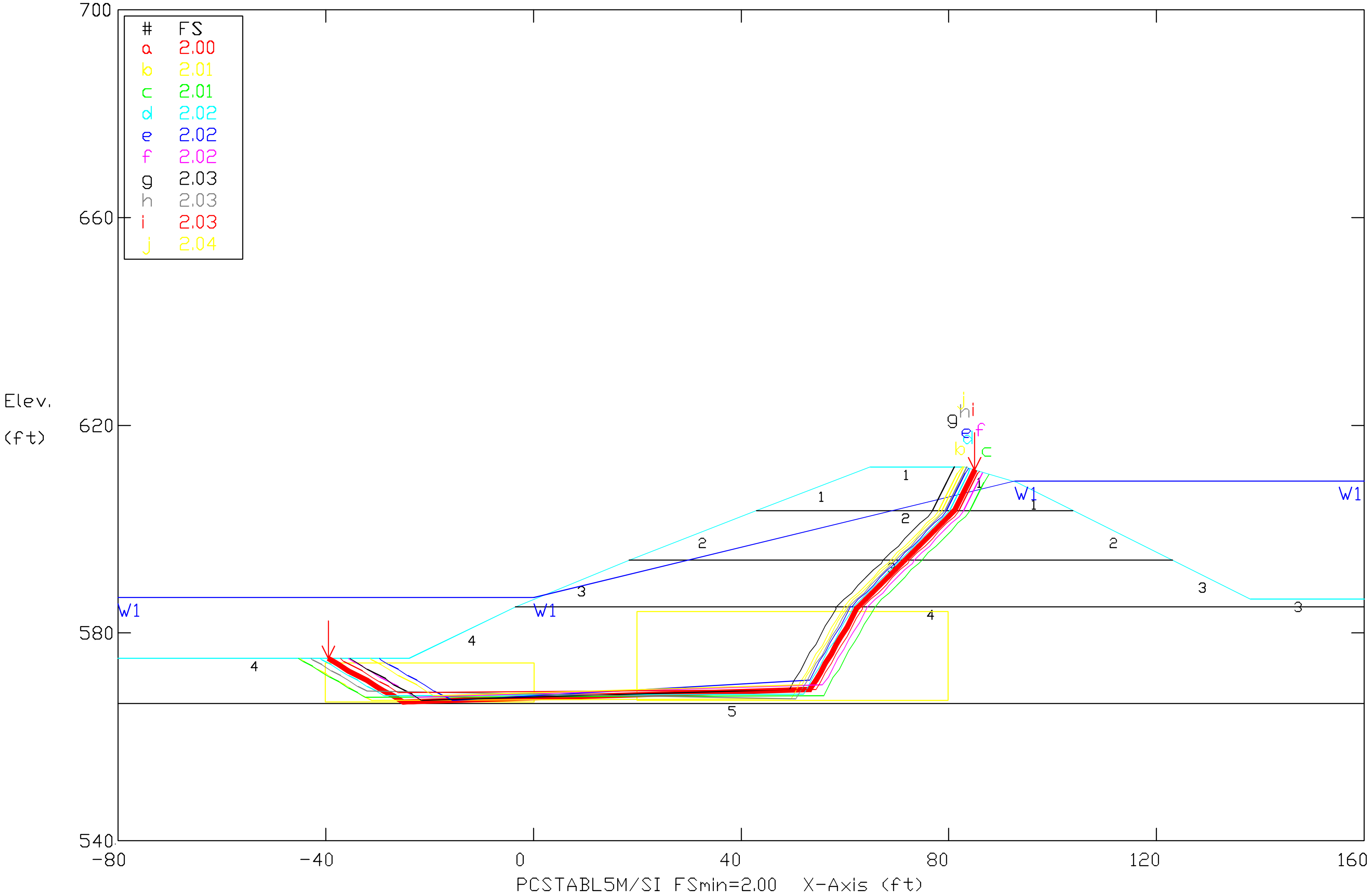
Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Clay	125	125	3100	0	0	0	W1
2	Silt	110	110	0	27	0	0	W1
3	Clay	120	120	1500	0	0	0	W1

EGS Section-I with Normal Water Level Static Case (South A Pond @ 609.2')
Ten Most Critical. E:EGS70B.PLT 07-14-16 6:56am



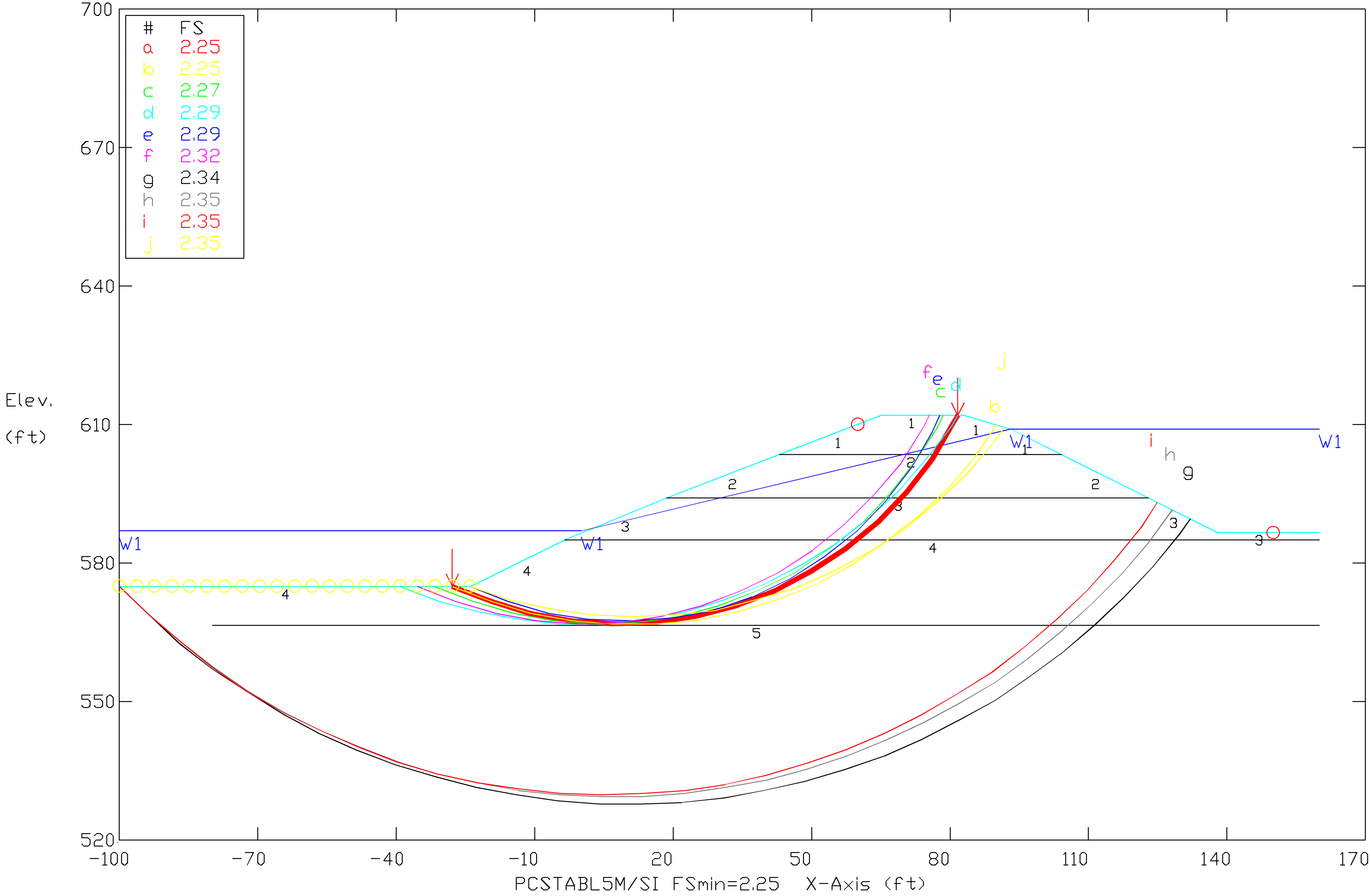
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Ash	125	125	0	37	0	0	W1
2 Mixture	125	125	3600	0	0	0	W1
3 Clay	125	125	3100	0	0	0	W1
4 Silt	110	110	0	30	0	0	W1
5 Clay	120	120	1500	0	0	0	W1

EGS Section-I with Normal Water Level Earth Quake Case (South A Pond @ 609.2')
Ten Most Critical. E:EGS70BEQ.PLT 07-14-16 6:59am



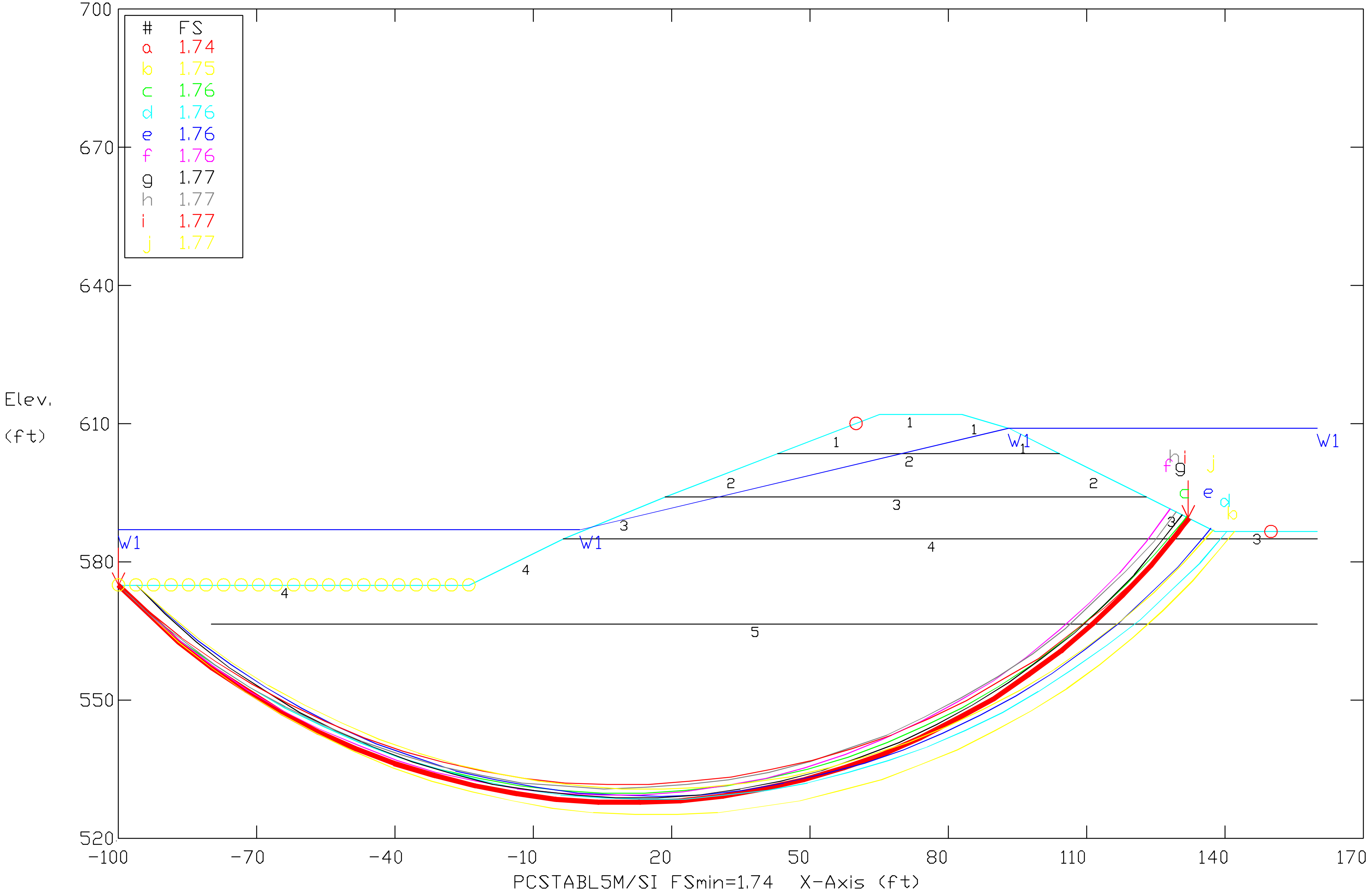
Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Ash	125	125	0	37	0	0	W1
2	Mixture	125	125	3600	0	0	0	W1
3	Clay	125	125	3100	0	0	0	W1
4	Silt	110	110	0	30	0	0	W1
5	Clay	120	120	1500	0	0	0	W1

EGS Section-I with Normal Water Level Static Case (South A Pond @ 609.2')
Ten Most Critical. E:EGS70C.PLT 07-14-16 7:12am



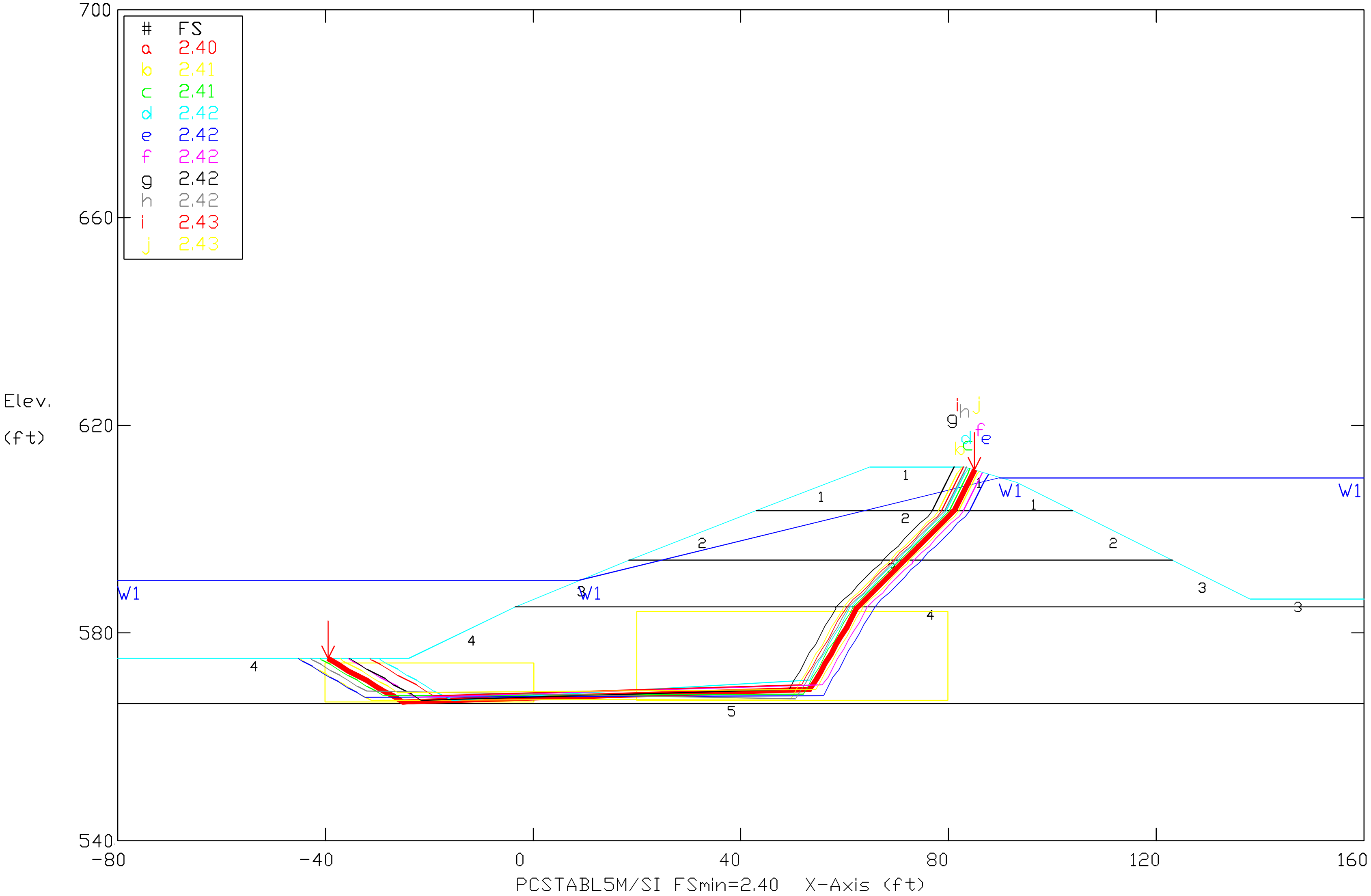
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Ash	125	125	0	37	0	0	W1
2 Mixture	125	125	3600	0	0	0	W1
3 Clay	125	125	3100	0	0	0	W1
4 Silt	110	110	0	30	0	0	W1
5 Clay	120	120	1500	0	0	0	W1

EGS Section-I with Normal Water Level Earth Quake Case (South A Pond @ 609.2')
Ten Most Critical. E:EGS70CEQ.PLT 07-14-16 7:09am



Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Ash	125	125	0	37	0	0	W1
2	Mixture	125	125	3600	0	0	0	W1
3	Clay	125	125	3100	0	0	0	W1
4	Silt	110	110	0	30	0	0	W1
5	Clay	120	120	1500	0	0	0	W1

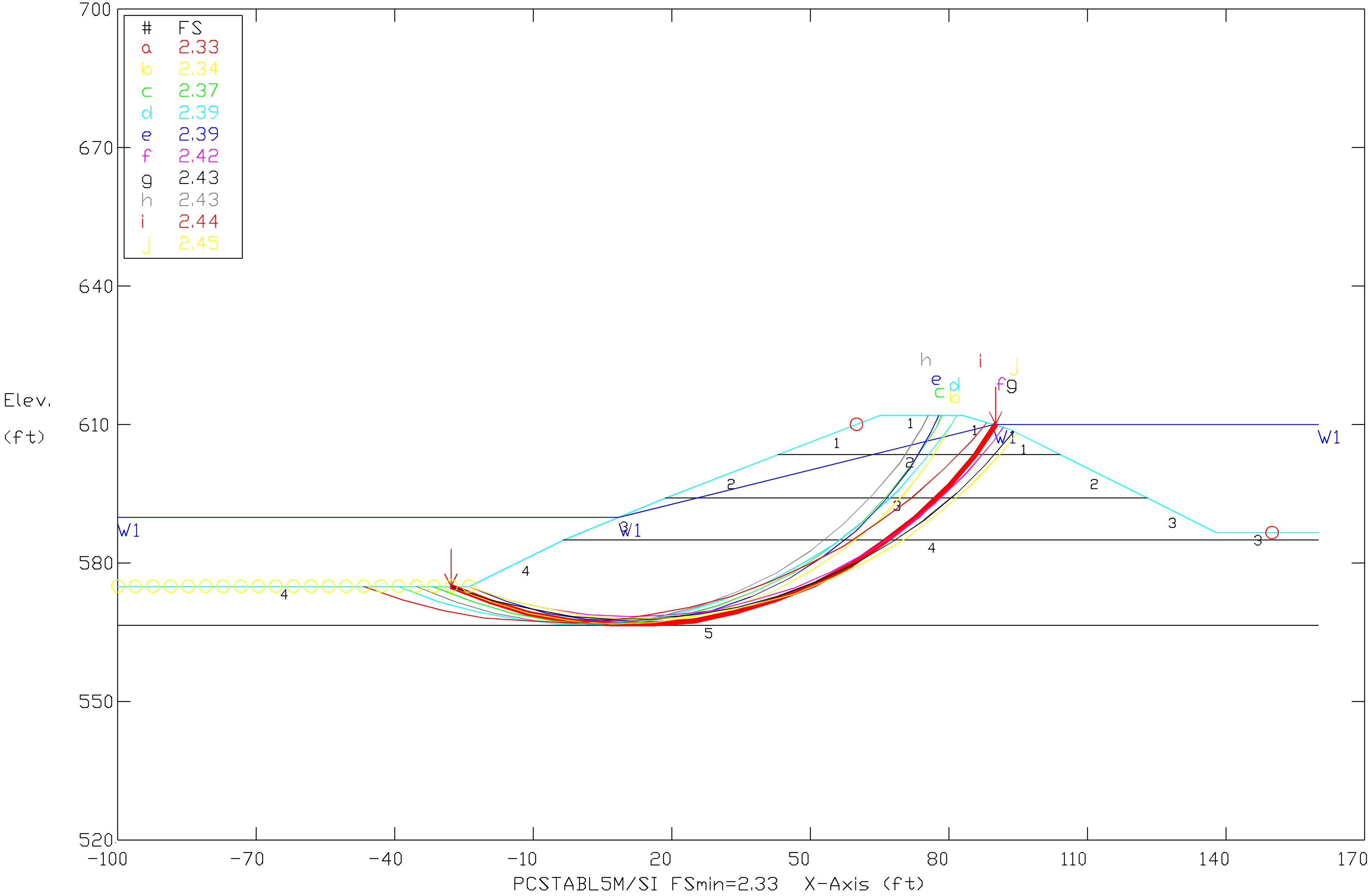
EGS Section-I with 1,000 yr. water level Static Case (South A Pond @ 609.97')
Ten Most Critical. E:EGS71B.PLT 07-14-16 7:24am



Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Ash	125	125	0	37	0	0	W1
2 Mixture	125	125	3600	0	0	0	W1
3 Clay	125	125	3100	0	0	0	W1
4 Silt	110	110	0	30	0	0	W1
5 Clay	120	120	1500	0	0	0	W1

EGS Section-I with 1,000 yr. water level Static Case (South A Pond @ 609.97')

Ten Most Critical. E:EGS71C.PLT 07-14-16 7:38am



Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Ash	125	125	0	37	0	0	W1
2	Mixture	125	125	3600	0	0	0	W1
3	Clay	125	125	3100	0	0	0	W1
4	Silt	110	110	0	30	0	0	W1
5	Clay	120	120	1500	0	0	0	W1