


ALLIANT ENERGY
Wisconsin Power and Light Company
Ottumwa Generating Station

CCR SURFACE IMPOUNDMENT

SAFETY FACTOR ASSESSMENT


Report Issued: September 29, 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 assess the safety factors of each CCR unit at Ottumwa Generating Station in Ottumwa, Iowa in accordance with §257.73(b) and §257.73(e) of the CCR Rule. For purposes of this Report, "CCR unit" refers to an existing or inactive CCR surface impoundment.

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.

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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.

On August 5th, 2016, USEPA published revisions to the CCR Rule (the "Extension Rule") that extend the above requirements to inactive CCR surface impoundments with different deadlines. The effective date of the Extension Rule is October 4th, 2016.

1.2 Safety Factor Assessment Applicability

The Ottumwa Generating Station (OGS) in Ottumwa, Iowa (Figure 1) has one existing and one inactive CCR surface impoundments, identified as follows:

- OGS Ash Pond (existing)
- OGS Zero Liquid Discharge Pond (inactive)

Each of the identified 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

OGS is located approximately ten miles northwest of Ottumwa, Iowa on the western shore of the Des Moines River in Wapello County, at 20775 Power Plant Road, Ottumwa, Iowa (Figure 1). The McNeese Wildlife Area is located to the southeast of OGS. Middle Avery Creek, which flows to the northeast into the Des Moines River, is located to the south and east of OGS.

OGS is a fossil-fueled electric generating station consisting of one steam electric generating unit. Sub-bituminous coal is the primary fuel for producing steam. The burning of coal produces a by-product of CCR. The CCR at OGS is categorized into three types; bottom ash, fly ash, and flue gas desulfurization (scrubber) byproducts. The fly ash also can be subdivided into two types, economizer fly ash and precipitator fly ash.

The majority of precipitator fly ash is collected by the electrostatic precipitators and sent to the on-site storage silo located on the west side of the generating plant. Historically, the precipitator fly ash has then either been transported off-site for beneficial reuse or was placed in the fly ash reclamation processing area adjacent to the coal pile storage area for the purposes of producing hydrated fly ash. In the fly ash reclamation processing area, the fly ash was rolled out, compacted, hydrated, and allowed to dry into a very hard, cement-like material that was stored in this area until transported off-site. Although this fly ash hydrating process has occurred in the past, this process ceased prior to October 19, 2015.

The precipitator fly ash that is not collected by the electrostatic precipitators becomes part of the flue gas desulfurization pollution control process at OGS. Activated carbon is injected into the flue gas stream and binds with mercury. This flue gas stream travels to the spray dry desulfurization towers. From there, a water based slurry of hydrated (slaked) lime is injected into the spray dry desulfurization towers. The hydrated lime reacts with the sulfur compounds in the flue gas and the water evaporates. A precipitate is left that consists of activated carbon bound to mercury, calcium sulfate, calcium sulfite, unreacted slaked lime, and some unreacted fly ash. This flue gas stream is directed to the bag house where the particulate matter is removed. A portion of the solids are recycled back to the process and the rest of the scrubber byproducts are sent to the air quality control system byproduct silo. The material from the byproduct silo is mixed with water in a pin mixer to reduce dust, loaded into trucks, and transported to the off-site Ottumwa-Midland CCR landfill for disposal.

The bottom ash and economizer fly ash at OGS are sluiced to a surface impoundment identified as the OGS Ash Pond (Figure 2). The OGS Ash Pond is located east of the generating plant and is presently the only existing CCR surface impoundment at OGS.

In addition to the OGS Ash Pond, OGS has one inactive CCR surface impoundment identified as the OGS Zero Liquid Discharge (ZLD) Pond. The OGS ZLD Pond is located northeast of the generating plant and north of the OGS Ash Pond. The OGS ZLD Pond, presently, only receives surface water runoff from the surrounding area.

General Facility Information:

- Date of Initial Facility Operations: 1981
- NPDES Permit Number: IA90-001-01
- Latitude / Longitude: 41°5′53″N 92°33′17″W
- Nameplate Ratings: Unit 1 (1981) 725 MW

2.1 OGS Ash Pond

The OGS Ash Pond is located east of the generating plant on the eastern portion of the site. The OGS Ash Pond receives influent flows from the generating plant floor drains, oil/water separator, boiler blow down water, solid contact unit sludge, sluiced CCR (bottom ash and economizer fly ash), recirculating media sanitary treatment plant, and surface water runoff from the generating site proper.

The sluiced CCR is discharged into the west end of the OGS Ash Pond. The sluiced CCR is discharged into a collection pad area where the majority of CCR is recovered. A dozer is used to scrape the collection pad and push the CCR into a stockpile for dewatering. Once dewatered, the CCR is then loaded into over-the-road haul trucks for transporting off-site. The sluiced water from the CCR drains into a narrow channel that flows into the southwest portion of the OGS Ash Pond. Routine maintenance dredging of the narrow channel occurs as the CCR settles out in the channel. Approximately 4 million gallons per day (MGD) of process water is recirculated back into OGS for reuse.

The water in the OGS Ash Pond from other sources flows to the east and discharges through the facility's National Pollution Discharge Elimination System (NPDES) Outfall 001, located in the northeast corner of the OGS Ash Pond. NPDES Outfall 001 consists of a concrete discharge structure with a six foot wide overflow weir and includes a Parshall flume and instrumentation to measure the flow of the discharged water. The water flows through the NPDES Outfall 001 and discharges into an unnamed creek at an average rate of 1.54 MGD. The water flows through the NPDES Outfall 001 and discharges into an unnamed creek. The unnamed creek flows into the Des Moines River downstream of the water intake structure and before the confluence of Middle Avery Creek.

The surface area of the OGS Ash Pond is approximately 18 acres and has an embankment height of approximately 25 feet from the crest to the toe of the downstream slope. The interior storage depth of the OGS Ash Pond is approximately 20 feet. Currently, the total volume of impounded CCR and water within the OGS Ash Pond is approximately 556,000 cubic yards.

2.2 OGS Zero Liquid Discharge Pond

The OGS Zero Liquid Discharge (ZLD) Pond is located northeast of the generating plant on the eastern portion of the site and north of the OGS Ash Pond. The OGS ZLD Pond historically received influent flows from the generating plant that consisted of boiler wash water, air heater wash, turbine chemical cleaning water, and boiler chemical cleaning water. Presently, the OGS ZLD Pond only receives storm water runoff from the surrounding area, which includes the inactive hydrated fly ash area located west of the surface impoundment, as well as occasional excess storm water runoff from the coal pile storage area. One 24-inch diameter high-density polyethylene culvert connects the coal pile runoff pond to the OGS ZLD Pond. The culvert is used as an emergency overflow to route storm water from the coal pile runoff pond into the OGS ZLD Pond.

The OGS ZLD Pond does not currently discharge. Two 48-inch diameter concrete culverts, located along the south embankment, previously connected the OGS ZLD Pond to the OGS Ash Pond prior to being permanently sealed off with concrete.

The OGS ZLD Pond covers a surface area of approximately 19 acres and has an embankment height of approximately 29 feet from crest to toe of the downstream slope. The interior storage depth of the OGS ZLD Pond is approximately 25 feet. Based on readily available information, the OGS ZLD Pond has a total storage capacity of approximately 515,000 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
Post-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. The total stress parameters for compacted and stiff clay yield a conservative answer for safety

[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

factor, and 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

The soil conditions at the embankments is documented by SCS Engineers[2] boring logs MW-304 and MW-305, Figure 2. The results indicate that the embankments of both impoundments are constructed of stiff compacted clay from the site overlying the medium stiff native clay which overlies very dense sand of the Des Moines River. The boring logs are shown in Appendix A.

During the construction of the OGS in 1974, the native clay was sampled and tested for Atterberg limits, unconfined compressive strength and both consolidated undrained (CU) and unconsolidated undrain (UU) triaxial strength. The test results are shown in Appendix B and indicated that the native clay under the embankments is a low plasticity clay (CL) with unconfined compression values from 1,500 to 2,500 psf. Triaxial UU tests indicated a range of 750 to 2,000 psf for cohesion and the CU tests indicated 29˚ to 34˚ for friction angle and 0 to 600 psf cohesion. The CU test results imply the clay is normally consolidated.

Information on the compacted clay and river valley sand is available from the SCS soil boring standard split spoon (SPT) blowcount information, Appendix A. The Terzaghi and Peck relationship of SPT blowcount to clay cohesion for the average blowcounts in each clay layer yields a value of cohesion of 1,000 psf for the native clay and 1,600 psf for the embankment clay, Appendix C. The very dense sand is assigned a friction angle of 38˚, based on the correlation of cohesionless soil strength to density provided in NAVFACs DM-7[3], Appendix C.

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[2] SCS Engineers, "Ottumuwa Generating Station – Monitoring Well Construction Documentation", April 15, 2016
[3] Naval Facilities Engineering Command, Soil Mechanics, Foundations, and Earth Structures, Figure 3-7, NAVFAC DM-7, January 1971

The analysis was completed with a cohesion value of 1,600psf for the embankment clay, 1000 psf for the native clay and a friction angle of 38° for the very dense sand.

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

The OGS Ash Pond receives both circulating sluicing water and other process water sources from the facility. The sluicing water is recirculated back into facility. The other sources of water discharge at an average rate of 1.54 MGD. The impoundment discharge is controlled by a six foot wide weir with its top elevation at approximately 675.5 feet making the normal impoundment water elevation approximately 676 feet. During the design inflow storm the water elevation increases to elevation 677.25 feet.

The OGS ZLD Pond only receives water from storm flows and its normal water elevation is determined by the balance of rainfall and evaporation. The impoundment has a clay bottom and embankment so exfiltration seepage is not significant. The normal water elevation based on topographic surveys is approximately elevation 673 feet. During the design inflow storm the water elevation rises to 675.25 feet.

The water elevation in the embankment is assumed to conservatively exit at the toe of the embankment and saturated the native clay and river sand at the toe. This provides a conservative strength projection for the soils at the toe of the embankment.

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 OGS. 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, or very dense sand and extend to bedrock at elevation 625 feet[4], the site class as defined in the 2009 International Building

[4]Cross Section KK, Appendix B

Code 1613.5.5 is Site Class D. For Site Class D the ground surface Peak Ground Acceleration (PGA) for slope stability and liquefaction assessment is 0.058g, Appendix D.

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 (PI) of less than 12). The native clay and embankment both have PI higher than 12 and are stiff and medium stiff in consistency. The river valley sand is very dense.

None of the soil types at OGS is susceptible to liquefaction and no analysis of liquefaction potential is required for the embankments.

3.2 OGS Ash Pond

The critical cross-section for the OGS Ash Pond is the location where the embankment toe is closest to Middle Avery Creek, just upstream of the railroad embankment, Figure 2. At this location, top of the creek bank is approximately 25 feet from the toe of the embankment. For determination of safety factors, the bottom of Middle Avery Creek was taken to be in the very dense sand and the water elevation in the creek was set at the same elevation.

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

The OGS Ash Pond receives 2.4 cubic feet per second of process water flow that discharges over the outlet weir. The process flow maintains a maximum average storage pool of 676 feet in the impoundment. Analysis of both circular and block sliding surfaces, Appendix E, show a minimum factor of safety of 2.1 for the circular failure surface passing through the foundation soil and exiting in Middle Avery Creek.

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

The OGS Ash Pond will contain the 100 year return period design storm through a combination of storage in the impoundment and discharge to the Middle Avery Creek.

The maximum surcharge pool elevation is 677.25 at the peak of the storm. Analysis for both circular and block sliding surface, Appendix E, show a minimum factor of safety of 2.1 for the circular surface passing through the foundation soil and exiting in Middle Avery Creek.

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

The OGS Ash Pond was assigned a pseudo-static earthquake coefficient equal to 0.058 g acceleration and a vertical downward component equal to $^2/_3$ of the horizontal component (0.039 g) as recommended by Newmark[5]. Analysis for both a circular and block sliding surface, Appendix E, show a minimum factor of safety of 1.7 for the circular sliding surface through the foundation soil and into Middle Avery Creek.

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

The OGS Ash Pond foundation and embankment soils are not susceptible to liquefaction, Section 3.1.4.

3.3 OGS Zero Liquid Discharge Pond

The critical cross-section for the OGS ZLD Pond is the location where the embankment is highest in the southern part of the embankment, Figure 2. At this location, the Des Moines River bank is approximately 500 feet to the northeast from the toe of the embankment. For determination of safety factors, the water elevation in the embankment was set at the toe with the native clay in the river valley assumed to be saturated.

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

The OGS ZLD Pond receives only storm water inflow. Its normal water elevation is control by the balance between storm water inflow and evaporation. A normal water elevation of 673 feet was selected as representative of measurements taken on the impoundment water elevation. Analysis of both circular and block sliding surfaces,

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

Appendix E, show a minimum factor of safety of 3.0 for the circular failure surface passing through the foundation soil.

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

The OGS ZLD Pond will contain the 100 year return period design storm through storage in the impoundment without discharge. The maximum surcharge pool elevation is 677.25 feet at the conclusion of the storm. Analysis for both circular and block sliding surface, Appendix E, show a minimum factor of safety of 2.9 for the block slide surface passing through the foundation clay.

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

The OGS ZLD Pond was assigned a pseudo-static earthquake coefficient equal to 0.058 g acceleration and a vertical downward component equal to $^{2}/_{3}$ of the horizontal component (0.039 g) as recommended by Newmark[6]. Analysis for both a circular and block sliding surface, Appendix E, show a minimum factor of safety of 2.5 for the circular sliding surface through the foundation soil.

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

The OGS ZLD Pond foundation and embankment soils are not susceptible to liquefaction, Section 3.1.4.

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

4 Results Summary

The results of the safety factor assessment indicate that the OGS 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
OGS Ash Pond	2.1	2.1	1.7	no	
OGS ZLD Pond	3.0	2.9	2.5	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 Iowa; 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).

LICENSED PROFESSIONAL ENGINEER
MARK W. LOEROP
22197
IOWA

By: ______________________

Name: Mark Loerop

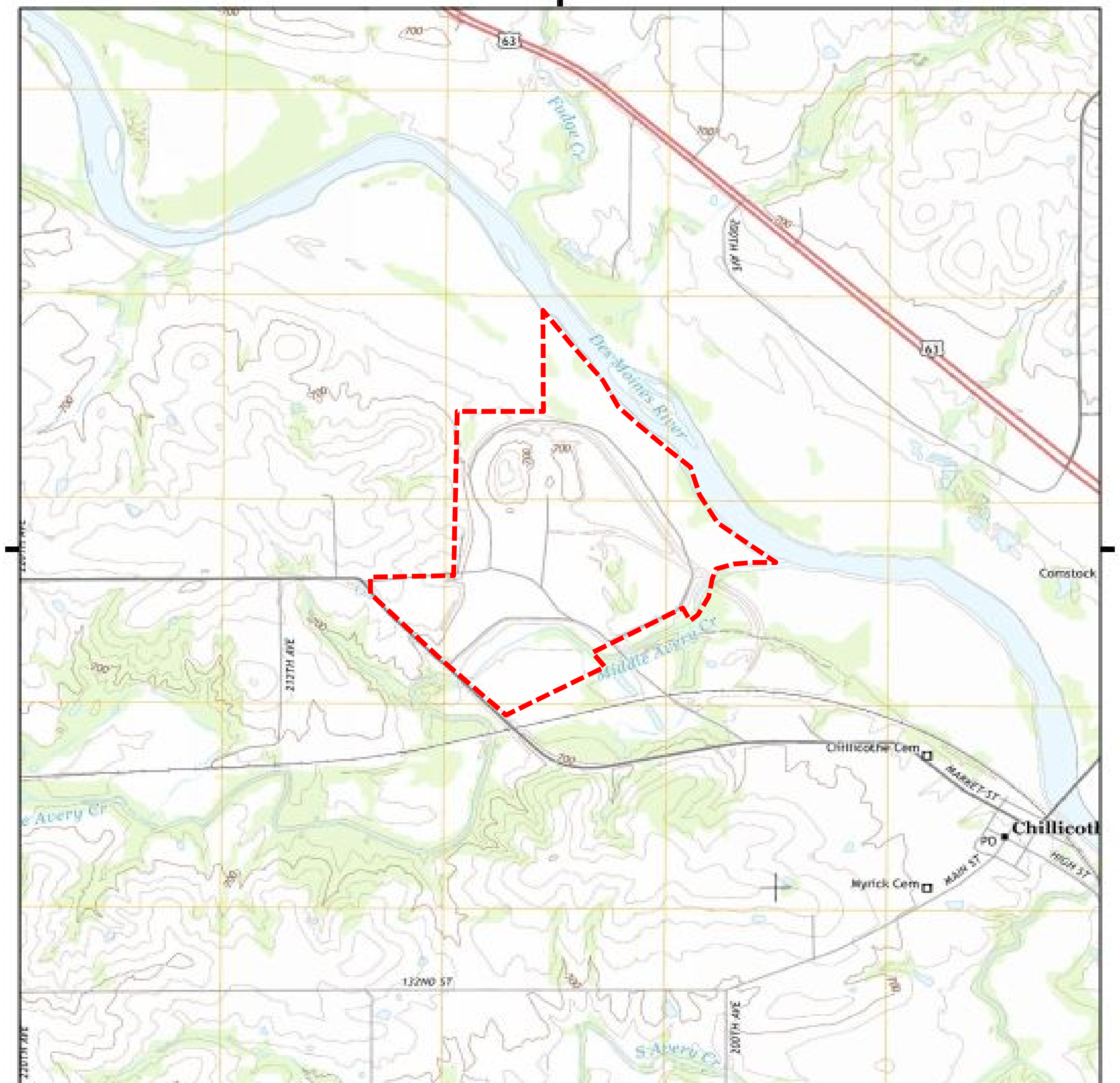
Date: 9/30/2016

FIGURES

Alliant Energy
Wisconsin Power and Light Company
Ottumwa Generating Station
Ottumwa, Iowa

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, Chillicothe, 2013, 7.5-minute

Miles 0.25 0.5 1 1.5

SITE NAME: Ottumwa Generating Station
ADDRESS: 20775 Power Plant Road
Ottumwa, IA 52501
CLIENT: Environmental Site Assessors

N

4555570 - 5 page 4

Historical Aerial Photo 4/13/2016

Approximate Property Boundary

HARD HAT SERVICES ™
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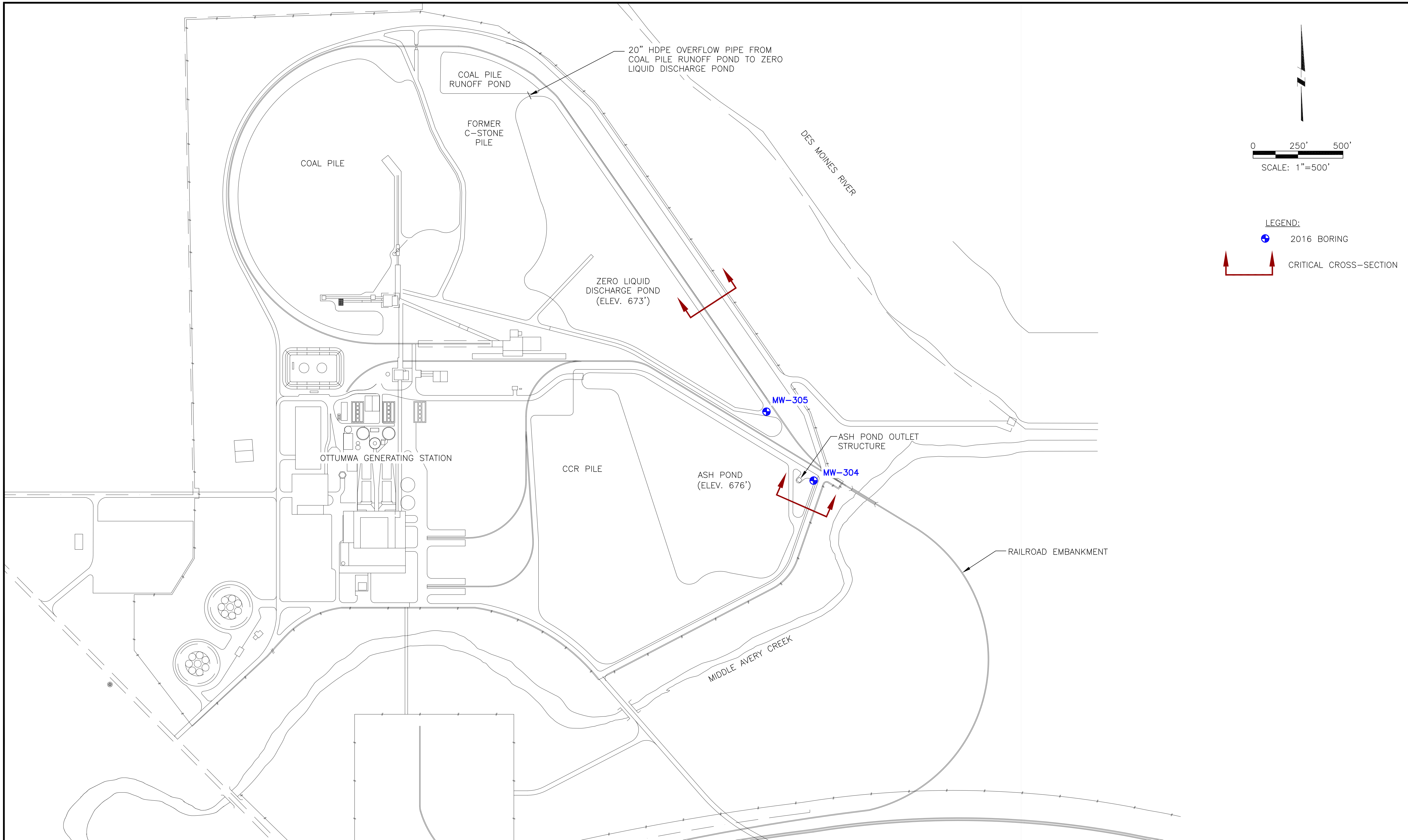
Site Location
Ottumwa Generating Station
Intersate Power and Light Company

Drawing	Figure 1
Date	7/12/2016



REV	DATE	BY	DESCRIPTION
5			
4			
3			
2			
1			

hard hat™ SERVICES
solutions and action

SCALE:	AS SHOWN
DATE:	8–29–16
DRAWN BY:	JFD
CHKD BY:	THJ
APRVD BY:	MWL

CLIENT / LOCATION
INTERSTATE POWER AND LIGHT (IPL)
OTTUMWA GENERATING STATION
OTTUMWA, IA

DRAWING DESCRIPTION
SAFETY FACTOR ASSESSMENT
CRITICAL CROSS–SECTION LOCATION

JOB 154.018.002.003
SHT. FIGURE 2
DWG. 154.018.002.003–D2

APPENDIX A – 2016 Soil Borings

Alliant Energy
Wisconsin Power and Light Company
Ottumwa Generating Station
Ottumwa, Iowa

Safety Factor Assessment

SCS ENGINEERS
Environmental Consultants and Contractors

SOIL BORING LOG INFORMATION

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name: IPL- Ottumwa Generating Station SCS#: 25215135.40	License/Permit/Monitoring Number:	Boring Number: MW-304	
Boring Drilled By: Name of crew chief (first, last) and Firm: Todd Schmalfeld, Cascade Drilling	Date Drilling Started: 11/11/2015	Date Drilling Completed: 11/11/2015	Drilling Method: 4-1/4 hollow stem auger
Unique Well No.: / DNR Well ID No.: / Common Well Name: MW-304	Final Static Water Level: Feet	Surface Elevation: 680.1 Feet	Borehole Diameter: 8.5 in
Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒; State Plane 401,152 N, 1,903,287 E S/C/N; SE 1/4 of NE 1/4 of Section 26, T 73 N, R 15 W	Lat ° ' " / Long ° ' "	Local Grid Location: Feet ☐ N ☐ S, Feet ☐ E ☐ W	
Facility ID: / County: Wapello	Civil Town/City/ or Village: Ottumwa		

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			0–1	TOPSOIL.	TOPSOIL									
			1–12.5	FAT CLAY, black (10YR 2/1).	CH									
S1	23	4 5 4 5	10–12							M				
			12.5–15	FAT CLAY, yellowish brown (10YR 5/4).	CH									
S2	19.5	4 4 5 5	12.5–14.5							M				
			15–16	FAT CLAY, yellowish brown (10YR 3/4).	CH									

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: [signature] for Kyle Kramer

Firm: SCS Engineers, 2830 Dairy Drive Madison, WI 53718 Tel: (608) 224-2830 Fax:

SCS ENGINEERS
Environmental Consultants and Contractors

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-304

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
S3	12	3 3 4 5	17	FAT CLAY, yellowish brown (10YR 3/4). *(continued)*	CH					M				
S4	22	4 3 7 12	18–19							M				
S5	23	2 7 8 9	20–21							M				
S6	23	3 4 8 6	22–24							M				
S7	23	5 11 15 11	25–26							M				
S8	15	4 4 5 6	27–29							M				
S9	18	4 6 9 9	30–31							M				
S10	24	4 6 7 6	32–34							M				
S11	16	2 2 4 6	35–36	FAT CLAY, DARK OLIVE BROWN (2.5Y 3/3).	CH					M				
S12	24	4 3 5 5	37–39							M				
S13	18	2 3 3 3	40–42							M				

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SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-304

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			43	FAT CLAY, DARK OLIVE BROWN (2.5Y 3/3). *(continued)*	CH									
S14	24	3 4 9 14	44	SANDY SILT, very dark gray.	ML					W				
				POORLY GRADED SAND, medium grained, gray (5Y 6/1), (weathered bedrock).	SP									
			45											
S16	15	30 50/.4	46							W				
			47											
			48											
S17	5	33 50/.2	49							W				
			50											
S18		50/.4	51							W				
			52	End of Boring at 52 feet bgs.										

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SOIL BORING LOG INFORMATION

Route To: Watershed/Wastewater ☐ Remediation/Redevelopment ☐ Waste Management ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
IPL- Ottumwa Generating Station SCS#: 25215135.40		MW-305

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Todd Schmalfeld Cascade Drilling	12/7/2015	12/8/2015	4-1/4 hollow stem auger

Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		MW-305	Feet	681.5 Feet	8.5 in

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 401,473 N, 1,903,023 E S/C/N
SE 1/4 of NE 1/4 of Section 26, T 73 N, R 15 W
Lat ° ' " Long ° ' "
Local Grid Location ☐ N Feet ☐ S ☐ E Feet ☐ W

Facility ID	County	Civil Town/City/ or Village
	Wapello	Ottumwa

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
				TOPSOIL	TOPSOIL									
			1	GRAVEL	GP									
			2–9	FAT CLAY	CH									
			10	FAT CLAY, very dark grayish brown (10YR 3/2).										
S1	18	3 6 9 11	11							W				
			13	same as above except, brown (10YR 4/3).										
S2	22	3 7 14 22	14							W				
			15–16											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm	
[signature] for Kyle Kramer	SCS Engineers 2830 Dairy Drive Madison, WI 53718	Tel: (608) 224-2830 Fax:

Boring Number MW-305

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
S3	22	5 15 14 15	17	FAT CLAY *(continued)*										
S4	20	3 5 13 15	18, 19		CH									
S5	24	4 5 7 11	20, 21, 22	FAT CLAY WITH SILT, dark gray (10YR 4/1).						M				
S6	20	7 11 15 20	23, 24	same as above except, very dark brown (10YR 2/2).						M				
S7	24	4 8 11 12	25, 26, 27	same as above except, very dark gray (10YR 3/1).	CH					M				
S8	24	8 12 16 21	28, 29, 30							M				
S9	13	4 4 7 12	31, 32							M				
S10	24	5 6 9	33, 34, 35	LEAN CLAY, very dark brown (10YR 2/2).						W				
S11	24	4 4 5 7	36, 37		CL					W				
S12	22	2 2 3 5	38, 39, 40	same as above except, very dark grayish brown (10YR 3/2).						W				
S13	6	3 9 11	41, 42	POORLY GRADED SANDY GRAVEL, fine, brown (10YR 4/3).	GPS					W				water @ 41.0 ft bgs.

Boring Number MW-305

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			43	POORLY GRADED SAND, medium grained, yellowish brown (10YR 5/4), (weathered bedrock). *(continued)*	SP									
S14	22	23 50	44							S				
			45											
S15	6	5 10 50	46		SP					S				
			47											
			48											
S16	6	50	49							S				
			50	End of Boring at 50 ft bgs.										

APPENDIX B – 1974 Soil Laboratory Results

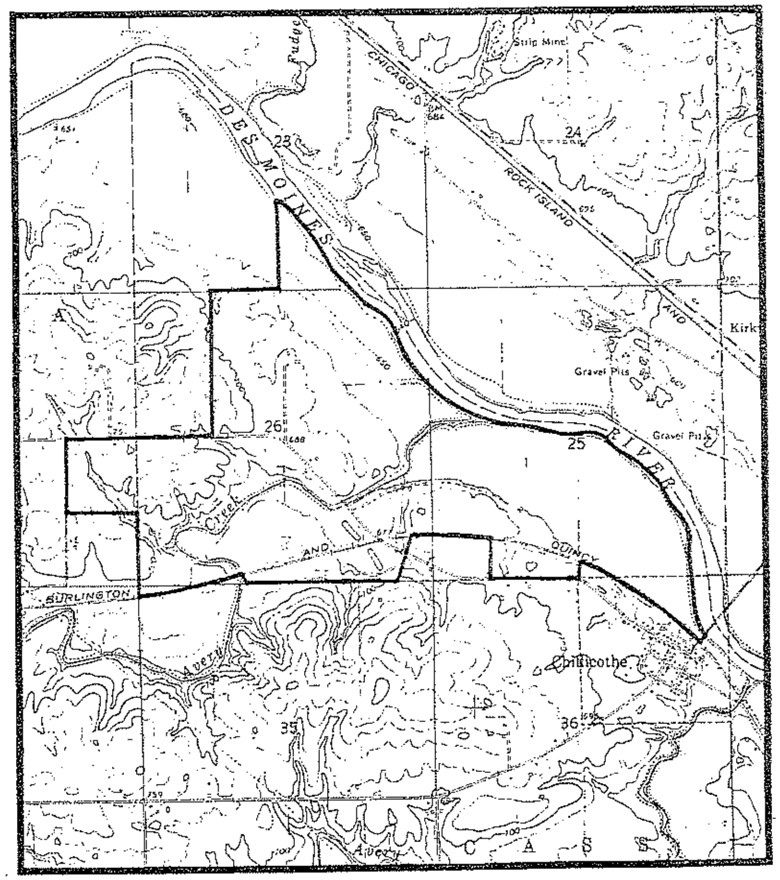
Alliant Energy
Wisconsin Power and Light Company
Ottumwa Generating Station
Ottumwa, Iowa

Safety Factor Assessment

APPENDICES

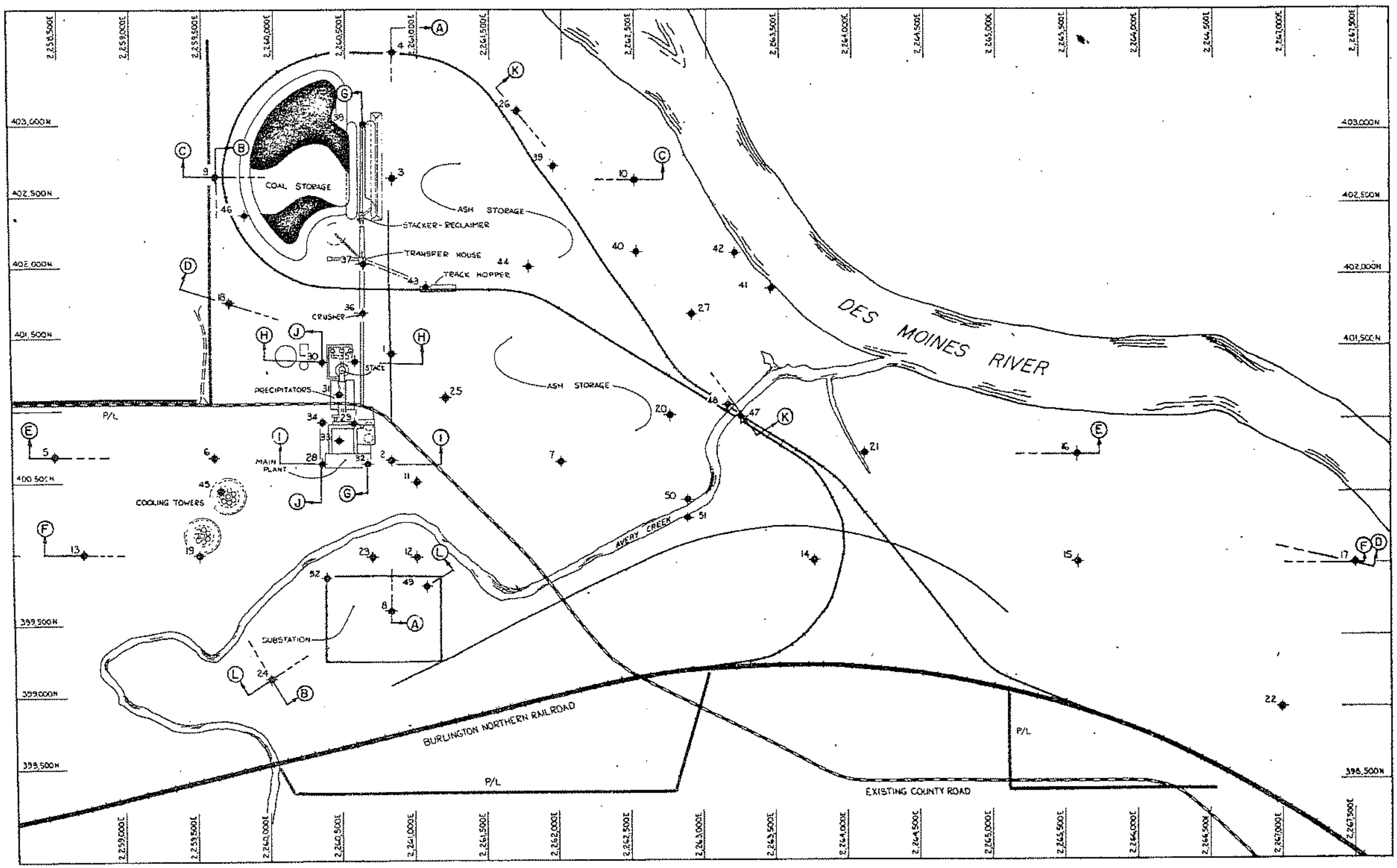
APPENDIX A

MAPS



VICINITY MAP
OTTUMWA GENERATING STATION-UNIT I
CHILLICOTHE, IOWA

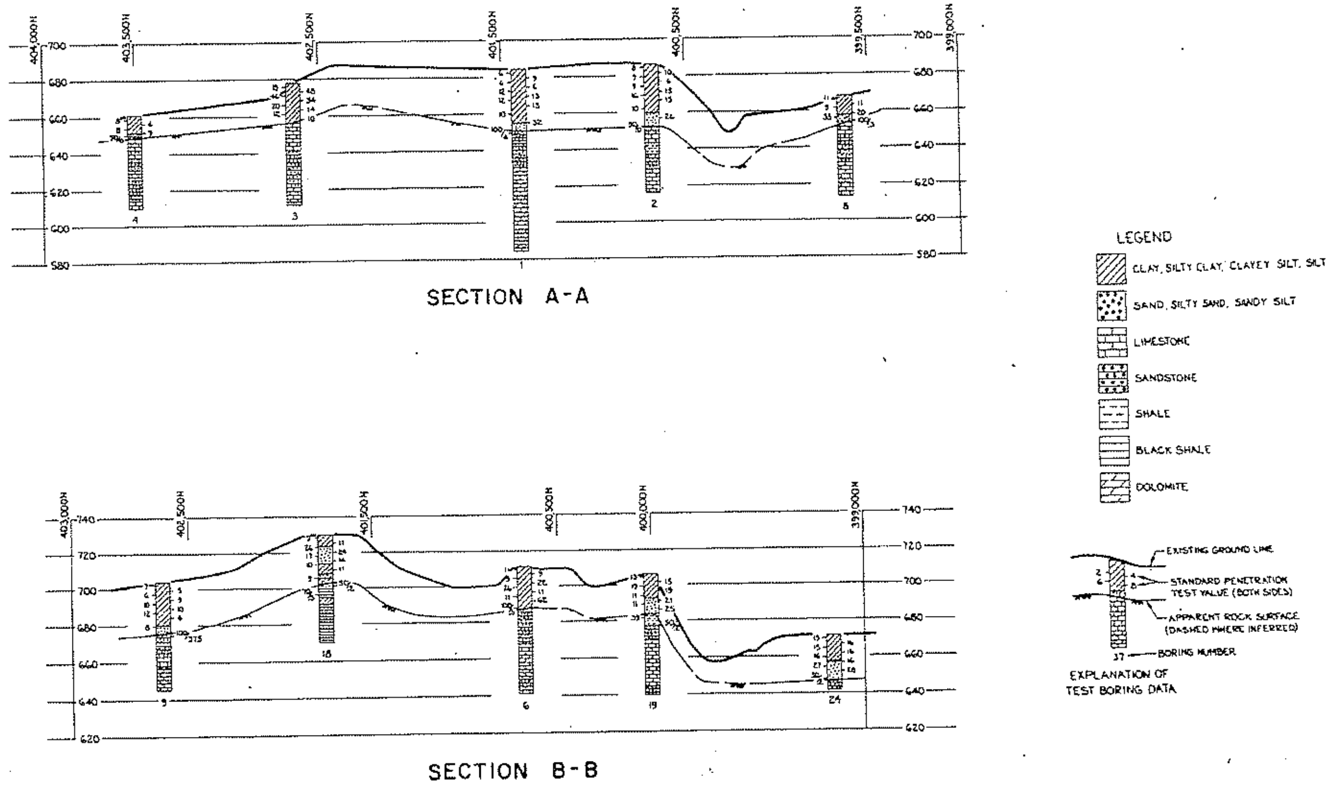
FIGURE I



ATEC ASSOCIATES

PLAN OF BORINGS

OTTUMWA GENERATING STATION-UNIT I
CHILLICOTHE, IOWA FIGURE 2



HORIZONTAL SCALE 1 INCH=600 FEET
VERTICAL EXAGGERATION 10:1

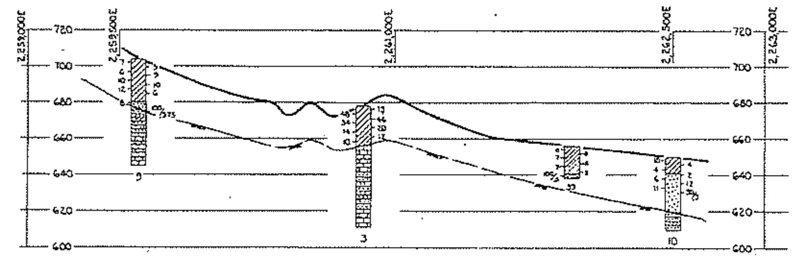
0 500 1000 1500
FEET

GENERALIZED SOIL AND ROCK PROFILES

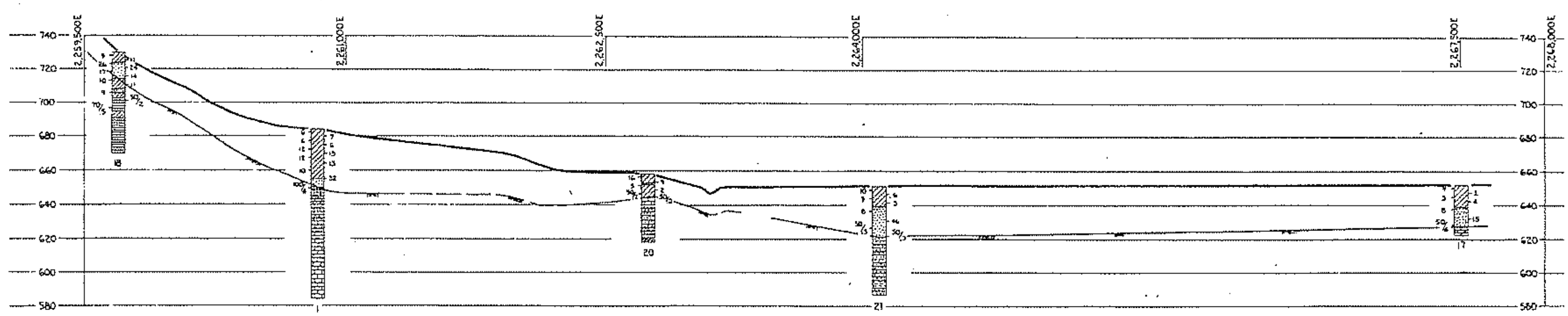
OTTUMWA GENERATING STATION-UNIT 1
CHILLICOTHE, IOWA

FIGURE 3

ATEC ASSOCIATES



SECTION C-C



SECTION D-D

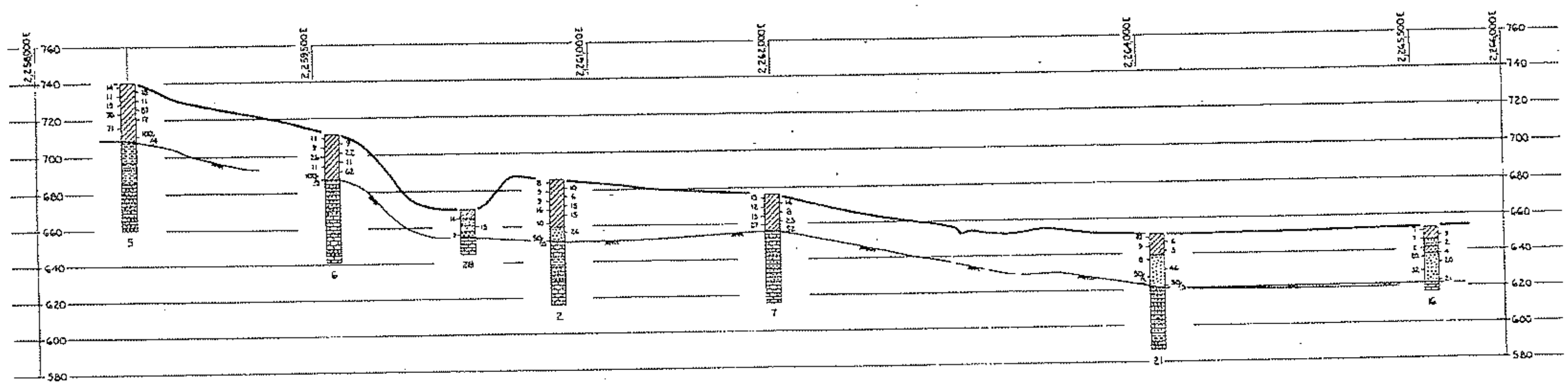
HORIZONTAL SCALE 1 INCH=600 FEET
VERTICAL EXAGGERATION 10:1

ATEC ASSOCIATES

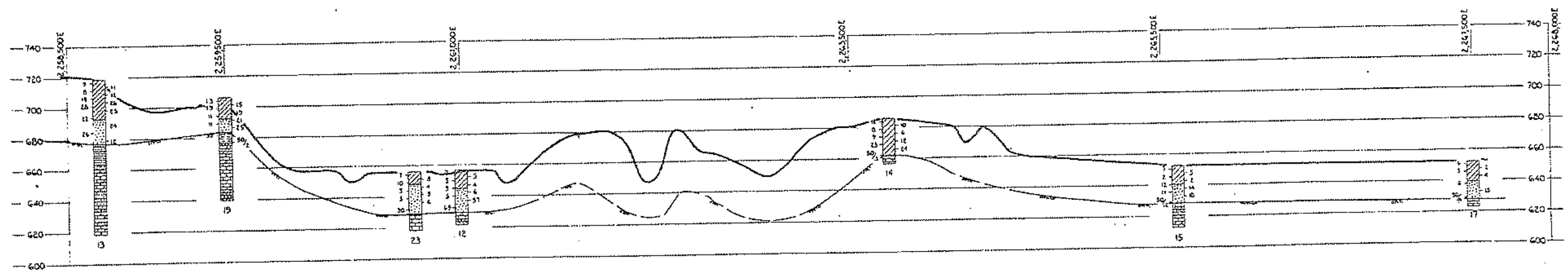
GENERALIZED SOIL AND ROCK PROFILES

OTTUMWA GENERATING STATION-UNIT I
CHILLICOTHE, IOWA

FIGURE 4



SECTION E-E



SECTION F-F

HORIZONTAL SCALE 1 INCH=600 FEET
VERTICAL EXAGGERATION 10:1

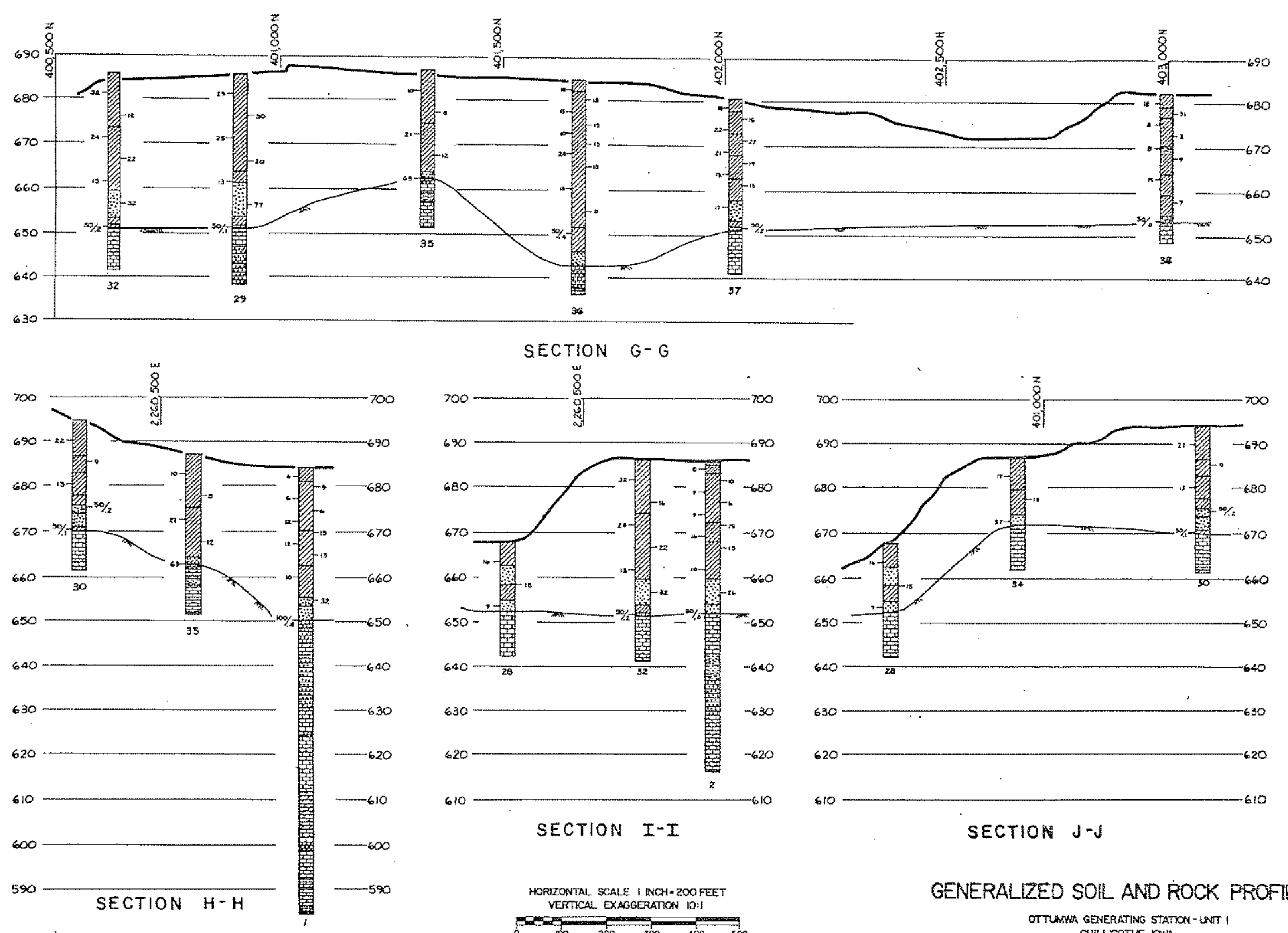
0 500 1000 1500
FEET

GENERALIZED SOIL AND ROCK PROFILES

OTTUMWA GENERATING STATION-UNIT 1
CHILLICOTHE, IOWA

FIGURE 5

ATEC ASSOCIATES

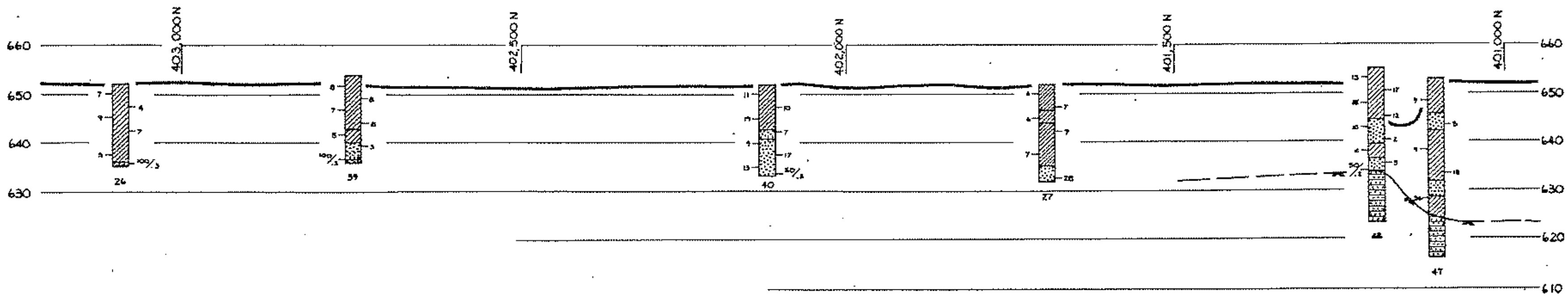


ATEC ASSOCIATES

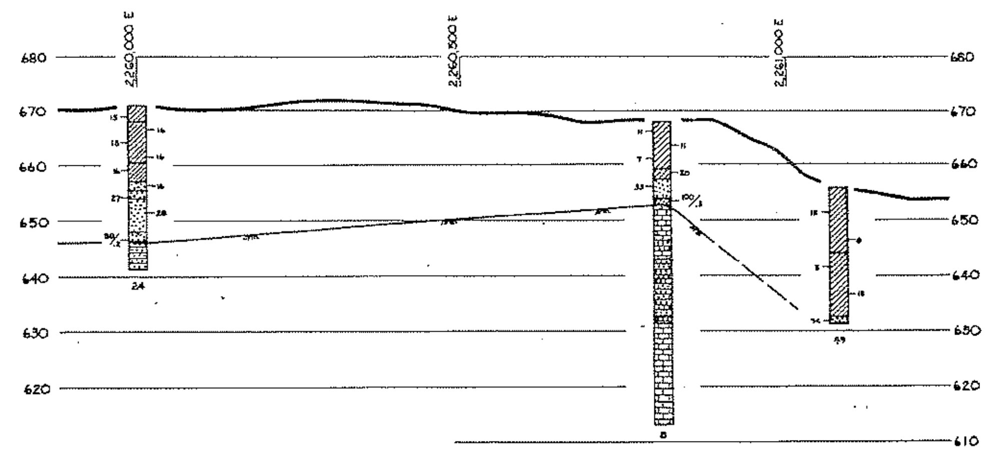
GENERALIZED SOIL AND ROCK PROFILES

OTTUMWA GENERATING STATION - UNIT 1
CHILLICOTHE, IOWA

FIGURE 6

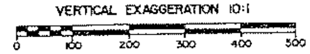


SECTION K-K



SECTION L-L

HORIZONTAL SCALE 1 INCH=200 FEET
VERTICAL EXAGGERATION 10:1



GENERALIZED SOIL AND ROCK PROFILES

OTTUMWA GENERATING STATION - UNIT I
CHILLICOTHE, IOWA
FIGURE 7

ATEC ASSOCIATES

APPENDIX C

LABORATORY TESTING PROGRAM

Discussion of Laboratory Investigation

The split spoon samples were inspected and classified in accordance with the Unified Classification System and the field boring logs were edited as necessary. To aid in classifying the soils and to determine general soil characteristics, natural moisture and density determinations, Atterberg limits tests and sieve analyses were performed on selected samples. The organic contents of some samples were estimated from loss-on-ignition tests.

The undisturbed Shelby tube samples were extruded from the tubes, classified, and natural moistures and densities determined. Atterberg limits tests were performed on selected Shelby tube samples. In order to determine compressibility characteristics, twelve consolidation tests were performed on samples selected to be critical based on probable locations of structures and the results of field and laboratory tests. The conventional load increment ratio of two was employed throughout each test.

To provide undrained shear strength estimates, unconfined compression tests and unconsolidated-undrained triaxial tests were performed on some of the undisturbed samples. Consolidated-undrained triaxial tests (with pore pressure measurements) were performed to determine effective strength parameters. All consolidated-undrained triaxial samples were saturated prior to consolidation.

Compaction tests (according to both ASTM D-698 and ASTM D-1557) were performed on selected bag samples taken from potential on-site borrow areas. Strength and permeability tests were conducted on recompacted samples.

Unconfined compression tests were performed on certain of the rock core samples. Abrasion, soundness and chemical tests were conducted on some of the limestone samples from the eastern portion of the site.

The results of all tests are included in the remainder of Appendix C and Appendices D, E, F, G, H and I.

Ottumwa Generating Station-Unit 1
(E-7566)

Table C-1 SUMMARY OF LABORATORY TEST RESULTS
Split-Spoon Samples

Boring No.	Depth ft	Natural Dry Density, lbs/cu.ft	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Loss-on-Ignition %
1	1.0-2.5		37.3				4.8
1	3.5-5.0	93.5	29.7				
1	6.0-7.5		28.9				
1	8.5-10.0		28.5	37	25	12	
1	11.0-12.5		25.0				
1	13.5-15.0		26.7				
1	16.0-17.5	106.3	22.6	49	23	16	
1	18.5-20.0		22.5				
1	23.5-25.0		20.9	32	20	11	
2	1.0-2.5		22.8				
2	3.5-5.0		30.0				
2	6.0-7.5		28.1				
2	8.5-10.0	98.3	30.0	41	25	16	
2	11.0-12.5		20.2				
2	13.5-15.0		21.5				
2	16.0-17.5	108.2	20.2				
2	18.5-20.0		25.9				
2	23.5-25.0		26.8				
3	1.0-2.5		23.6				
3	3.5-5.0		16.4				
3	6.0-7.5		13.2				
3	8.5-10.0		17.5				
3	11.0-12.5	113.2	17.0	45	23	19	
3	13.5-15.0		22.2				
3	16.0-17.5		20.9				
3	18.5-20.0		23.0				
4	1.0-2.5		21.3				2.8
4	3.5-5.0		24.2				
4	6.0-7.5	104.1	23.5	30	21	9	
5	1.0-2.5		21.0				
5	3.5-5.0		22.5				
5	6.0-7.5		27.3				
5	8.5-10.0		16.7				
5	11.0-12.5		13.4				
5	13.5-15.0		14.9				
5	16.0-17.5		10.3				
5	18.5-20.0		24.1				

cont'd.

Ottumwa Generating Station-Unit 1
(E-7566)

Table C-1 SUMMARY OF LABORATORY TEST RESULTS
Split-Spoon Samples (ccnt.d)

Boring No.	Depth ft	Natural Dry Density, lbs/cu.ft	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Loss-on-Ignition %
6	1.0-2.5		17.8				
6	3.5-5.0		20.6				
6	6.0-7.5		25.1				
6	8.5-10.0		13.0				
6	11.0-12.5		14.0				
6	13.5-15.0		53.3	90	33	57	
7	1.0-2.5		29.9				
7	3.5-5.0		28.9				
7	6.0-7.5		27.6				
7	8.5-10.0		26.5	33	20	13	
7	11.0-12.5		25.8				
7	13.5-15.0		25.8				
7	16.0-17.5		25.2				
8	1.0-2.5		16.7				
8	3.5-5.0		24.6				
8	6.0-7.5	98.8	27.1	37	25	12	
8	8.5-10.0		10.9				
8	11.0-12.5		11.5				
9	1.0-2.5		28.7				
9	3.5-5.0		36.8				
9	6.0-7.5		26.7	61	20	41	
9	8.5-10.0		23.9				
9	11.0-12.5		26.7				
9	13.5-15.0		18.8				
9	16.0-17.5		21.4				
9	18.5-20.0		22.6	56	21	35	
10	1.0-2.5		28.0				1.5
10	3.5-5.0		30.0				4.2
10	6.0-7.5		28.7	56	25	31	
10	8.5-10.0		36.0				
11	1.0-2.5		21.2				
11	3.5-5.0		26.1				
11	6.0-7.5		27.1				
11	8.5-10.0		21.2				
11	11.0-12.5		21.8				
11	13.5-15.0		21.5				
11	16.0-17.5		19.2				
11	18.5-20.0		20.0				

cont'd.

Ottumwa Generating Station-Unit 1
(E-7566)

Table C-1 SUMMARY OF LABORATORY TEST RESULTS
Split-Spoon Samples(cont'd.)

Boring No.	Depth ft	Natural Dry Density, lbs/cu.ft	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Loss-on-Ignition %
12	1.0-2.5		18.1				
12	3.5-5.0		19.7				
12	6.0-7.5		24.4				
12	8.5-10.0		22.6				
12	11.0-12.5		23.0				
12	13.5-15.0		21.8				
13	1.0-2.5		27.2				
13	3.5-5.0		26.1				
13	6.0-7.5		19.8				
13	18.5-20.0		18.3	57	18	39	
14	1.0-2.5		19.8				
14	3.5-5.0		23.1				
14	6.0-7.5		20.7	44	21	23	
14	8.5-10.0		26.1				
14	11.0-12.5		25.9				
14	13.5-15.0		19.5				
15	1.0-2.5		31.8				
15	3.5-5.0		26.3				
15	6.0-7.5		27.0				
15	8.5-10.0		33.2				
16	1.0-2.5		23.9				
16	3.5-5.0		27.1				
16	11.0-12.5		28.6				
16	13.5-15.0		29.4				
17	1.0-2.5		24.1				
17	3.5-5.0		22.0				
17	6.0-7.5		34.1				
17	8.5-10.0		31.2				
18	1.0-2.5		24.7				
18	3.5-5.0		24.6	57	18	39	
18	6.0-7.5		24.8				
18	16.0-17.5		18.0				
18	18.5-20.0		22.9	47	24	23	

cont'd.

Ottumwa Generating Station-Unit 1
(E-7566)

Table C-1 SUMMARY OF LABORATORY TEST RESULTS
Split-Spoon Samples (cont'd.)

Boring No.	Depth ft	Natural Dry Density, lbs/cu.ft	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Loss-on-Ignition %
19	1.0-2.5		19.3				
19	3.5-5.0		15.8				
19	6.0-7.5		22.0				
19	8.5-10.0		16.9				
19	13.5-15.0		17.4				
19	16.0-17.5		18.5				
20	1.0-2.5		23.0				
20	3.5-5.0		20.7				
21	1.0-2.5		22.2				
21	3.5-5.0		28.5				
21	6.0-7.5		26.1				
21	8.5-10.0		34.6				
22	1.0-2.5		33.2				
22	3.5-5.0		32.1				
22	6.0-7.5		30.0				
22	8.5-10.0		33.4	38	23	15	
24	1.0-2.5		23.8				
24	3.5-5.0		25.2				
24	6.0-7.5		28.3	44	22	22	
24	8.5-10.0		22.6				
25	1.0-2.5		22.2				
25	3.5-5.0		25.1				
25	6.0-7.5		29.3				
25	8.5-10.0		26.5				
26	1.0-2.5		28.2				5.3
26	3.5-5.0		27.9				3.0
26	6.0-7.5		29.3				
26	8.5-10.0		30.3				
26	13.5-15.0		31.8	54	27	27	
27	1.0-2.5		30.5				4.1
27	3.5-5.0		30.9	51	24	27	4.5
27	6.0-7.5		33.9				
27	8.5-10.0		26.0	51	28	23	
27	11.0-12.5		29.8				

Ottumwa Generating Station-Unit 1
(E-7566)

Table C-1 SUMMARY OF LABORATORY TEST RESULTS
Split-Spoon Samples

Boring No.	Depth ft	Natural Dry Density, lbs/cu.ft	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Loss-on-Ignition %
28	3.5-5.0		18.5				
29	13.5-15.0		22.0	60	20	40	
30	3.0-5.0		26.2				
30	8.5-10.0		25.3	35	21	14	
30	13.5-15.0		19.3				
31	3.5-5.0		28.7				
31	8.5-10.0		24.4				
32	3.5-5.0		22.5				
33	23.5-25.0		29.8	57	21	36	
34	3.5-5.0		23.0				
35	3.5-5.0		27.6				
35	8.5-10.0		27.6				
36	1.0-2.5		20.7				3.1
36	3.5-5.0		25.3				
36	6.0-7.5		24.2				
36	8.5-10.0		24.2				
36	11.0-12.5		23.8	36	16	20	
36	13.5-15.0		25.5				
36	28.5-30.0		22.7				
37	1.0-2.5		21.4				
37	3.5-5.0		21.0				
37	6.0-7.5		23.4				
37	8.5-10.0		21.5				
37	11.0-12.5		20.2				
37	13.5-15.0		20.7				
37	16.0-17.5		17.5				
37	18.5-20.0		22.3				
38	1.0-2.5		18.6				
38	3.5-5.0		21.1				
38	6.0-7.5		27.7				
38	8.5-10.0		27.3				
38	11.0-12.5		25.8				
38	13.5-15.0		43.2				
38	23.5-25.0		29.2	43	22	21	

Ottumwa Generating Station-Unit 1
(E-7566)

Table C-1

SUMMARY OF LABORATORY TEST RESULTS
Split-Spoon Samples

Boring No.	Depth ft	Natural Dry Density, lbs/cu.ft	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Loss-on-Ignition %
39	1.0-2.5		28.7				5.6
39	3.5-5.0		32.8				
39	6.0-7.5		26.5				
39	8.5-10.0		29.5				
39	11.0-12.5		35.9				
39	13.5-15.0		35.2				
39	16.0-17.0		11.4				
40	1.0-2.5		29.0				
40	3.5-5.0		31.5	56	18	38	
40	6.0-7.5		27.2				
40	8.5-9.0		27.4				
41	1.0-2.5		21.3				4.2
41	3.5-5.0		16.1				
41	6.0-7.5		22.2				
41	8.5-10.0		23.7				
41	11.0-11.8		25.3				
42	1.0-2.5		20.4				
42	3.5-5.0		19.9				
42	6.0-7.5		20.3				
42	8.5-10.0		26.2				
42	11.0-12.5		25.7				
43	3.5-5.0		25.4				
43	8.5-10.0		26.1				
43	13.5-15.0		21.0				
43	18.5-20.0		24.3				
44	1.0-2.5		11.9				5.0
44	3.5-5.0		11.3				
44	16.0-17.5		23.3				
45	3.5-5.0		17.0				
45	8.5-10.0		18.3				
45	13.5-15.0		18.9				
45	18.5-20.0		20.4				
45	23.5-25.0		23.2				
46	1.0-2.5		25.0				3.3
46	3.5-5.0		27.2				
46	6.0-7.5		27.4				
46	8.5-10.0		25.2	32	13	19	

Ottumwa Generating Station-Unit 1
(E-7566)

Table C-1

SUMMARY OF LABORATORY TEST RESULTS
Split-Spoon Samples

Boring No.	Depth ft	Natural Dry Density, lbs/cu.ft	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Loss-on-Ignition %
46	11.0-12.5		23.8				
46	13.5-15.0		25.4				
46	16.0-17.5		22.5				
46	18.5-20.0		27.0				
47	3.5-5.0		25.2				
47	13.5-15.0		24.2				2.8
47	18.5-20.0		30.9	40	22	18	
48	1.0-2.5		22.9				
48	3.5-5.0		25.0				
48	6.0-7.5		25.4				
48	8.5-10.0		24.6				
48	16.0-17.5		40.4				
49	3.5-5.0		22.5				
49	8.5-10.0		25.2				
49	13.5-15.0		31.2				
49	18.5-20.0		32.1				
50	3.5-5.0		18.8				
50	8.5-10.0		17.9				
50	13.5-15.0		24.3				
50	18.5-20.0		30.6				
51	3.5-5.0		13.5				
51	8.5-10.0		16.5				
51	13.5-15.0		24.1				
51	18.5-20.0		28.0	32	17	15	
52	1.0-2.5		24.4				
52	3.5-5.0		24.1	37	18	19	

Ottumwa Generating Station-Unit 1
(E-7566)

Table C-2

SUMMARY OF LABORATORY TEST RESULTS
Undisturbed Samples

Boring No.	Depth, ft	Natural Dry Density, lbs/cu.ft	Natural Moisture Content, %	Atterberg Limits % LL	PL	PI	Unconfined Compressive Strength, tsf
1A	6.0-8.0	96.4	28.2				0.71
1A	8.0-10.0	98.4	26.6				0.96 *
4A	3.0-5.0	100.2	24.8				0.63
4A	6.0-8.0	101.9	23.6				
8A	5.0-7.0	95.2	28.2				*
8A	7.0-9.0	99.5	25.2				1.15
9A	4.0-5.0	79.8	39.7				
9A	5.0-6.0	94.6	29.2				
9A	6.0-6.5		46.3				
9A	6.5-8.0	100.5	26.3				1.88
9A	13.0-14.5	106.5	22.5				**
9A	18.0-19.0	96.4	27.6				
9A	19.0-20.0	110.0	19.6				0.75
9A	22.0-24.0	99.9	25.7				0.42
10A	3.0-5.0	90.8	30.0				*
10A	5.0-7.0	94.4	28.5				**
10A	7.0-9.0	97.5	26.4				* **
12A	2.0-4.0	93.1	31.0				
12A	4.0-6.0	100.6	23.3				
12A	7.0-9.0	104.4	22.6				
14A	4.0-6.0	94.5	29.3				
14A	8.0-10.0	94.6	28.5				
14A	10.0-12.0	98.5	27.9				
15A	2.0-4.0	94.7	28.8				
15A	5.0-7.0	93.4	28.9				
15A	8.0-10.0	88.4	33.7				
15A	10.0-12.0	95.7	25.5				
18A	3.0-5.0	101.0	25.0				1.20
18A	19.0-21.0	107.8	20.6				**
26A	3.0-5.0	88.8	31.9				0.14
26A	9.0-9.5		34.4				
26A	9.5-11.0	97.3	26.9				0.97
26A	13.0-15.0	87.6	33.6				0.36 *
27	6.0-8.0	90.5	31.2				0.74 *
27A	13.0-15.0	92.6	30.9				0.91

cont'd.

Ottumwa Generating Station-Unit 1
(E-7566)

Table C-2

SUMMARY OF LABORATORY TEST RESULTS
Undisturbed Samples

Boring No.	Depth, ft	Natural Dry Density, lbs/cu.ft	Natural Moisture Content, %	Atterberg Limits % LL	PL	PI	Unconfined Compressive Strength, tsf
36	10.0-12.0	101.4	22.5				0.81
36	12.0-14.0	104.9	22.1				
36	18.0-20.0	103.3	24.1				
36	23.0-25.0	104.7	20.3				
36	28.0-29.9	95.2	27.4				1.11
38	7.0-8.9	93.3	28.5	37	20	17	0.66 *
38	9.0-11.0	88.1	30.5				
38	14.0-15.9	97.2	30.9				1.18
38	18.0-20.0	103.3	23.3				
38	23.0-25.0	107.1	19.6				
39	3.0-5.0	85.7	32.4	52	25	27	0.70 *
39	11.0-13.0	89.5	29.3				
39	13.0-15.0	82.0	38.8	42	25	17	* **
40	3.0-5.0	87.5	31.9				1.24
41	3.0-5.0	105.1	15.0				
41	8.0-10.0	99.3	22.3	41	16	25	**
42	2.0-4.0	102.1	20.1				
42	10.0-12.0	96.5	26.6	34	22	12	
43	3.0-5.0	98.3	20.8				2.89
43	8.0-10.0	99.0	26.7				1.00 **
43	13.0-15.0	104.0	23.1				1.07
43	18.0-20.0	104.1	22.1	32	15	17	**
44	3.0-5.0	106.2	12.7	29	16	13	
45	3.0-5.0	98.8	20.0				
45	9.0-11.0	111.4	17.0	35	11	24	0.97 **
45	11.0-13.0	111.9	19.5				
45	18.0-19.8	105.3	21.2				
45	28.0-30.0	109.8	19.3				
46	3.0-4.8	98.6	22.0				
46	10.0-12.0	104.3	22.9				
46	18.0-19.9	102.6	23.3				1.04 **
46	28.0-30.0	102.7	23.8				

cont'd.

Ottumwa Generating Station-Unit 1
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Table C-2 SUMMARY OF LABORATORY TEST RESULTS
Undisturbed Samples

Boring No.	Depth, ft	Natural Dry Density, lbs/cu.ft	Natural Moisture Content,%	Atterberg Limits % LL	PL	PI	Unconfined Compressive Strength,tsf
48	8.0-10.0	96.5	25.4				0.81
48	16.0-17.9	82.9	37.7	53	23	30	* **
49	8.0-10.0	99.2	24.1				0.46
49	13.0-15.0	96.5	27.5	38	18	20	0.76 *
49	18.0-20.0	96.9	28.0				
50	8.0-10.0	108.7	18.1				1.32
50	19.0-21.0	86.5	34.5	49	25	24	0.62 * **
51	8.0-10.0	103.3	21.5				0.72
51	19.0-21.0	96.6	23.3				
52	3.0-5.0	94.8	24.4				.85
52	6.0-8.0	108.3	16.2				
52	8.0-10.0	111.5	15.4				

* See Appendix D for Consolidation Test Results

** See Appendix E for Triaxial Test Results

Ottumwa Generating Station-Unit 1
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Table C-3 SUMMARY OF COMPRESSION TEST RESULTS
Rock Samples

Boring No.	Depth ft	Sample Height, in.	Sample Diameter, in.	Unconfined Compressive Strength,psi	Rock Description
1	36.1	2.75	2.00	1350	Gray Sandstone
1	43.0	4.38	2.03	2460	Gray Sandstone
2A	38.6	4.67	2.06	14070	White Limestone
2A	44.3	4.25	2.06	7030	Gray Sandy Shale and Limestone
2A	51.3	4.44	2.06	5990	Gray Sandstone
2A	57.7	4.44	2.06	12720	White Limestone
4	20.0	4.88	2.00	1070	Green Sandstone
4	29.4	3.88	2.06	13170	White Limestone
4	46.3	4.53	2.06	5160	Gray Sandstone
6	25.0	4.97	2.03	2500	Dark Gray Shaly Sandstone
7	27.5	4.44	2.06	14520	Gray Limestone
19	29.5	3.44	1.88	2670	Gray Sandstone
23	29.4	4.88	1.88	9270	White Limestone
28	18.7	4.63	2.06	14790	Gray Limestone
29	36.1	3.69	2.06	19150	Gray Limestone
29	42.8	6.00	2.06	16970	Gray Sandstone
30	25.0	5.94	2.06	14540	White Limestone
31	29.5	6.00	2.00	8000	Gray Limestone
32	38.5	5.63	2.06	16490	Gray Limestone
33	28.7	5.25	2.06	15030	Gray Sandstone
33	36.0	4.38	2.06	5820	Gray Sandstone
34	15.7	5.69	2.06	6550	Gray Shaly Limesto
35	26.7	4.38	2.06	12850	Gray Limestone
35	28.2	6.00	2.06	16730	Green Shale
35	30.0	6.00	2.06	17460	White Limestone
41	31.8	6.00	2.06	14000	Green Sandstone
43	41.0	3.88	2.00	5150	Gray Sandstone
43	57.9	6.00	2.06	6788	White Limestone
47	31.0	4.69	2.00	6750	Gray Sandstone
48	22.0	4.13	2.06	5820	Gray Sandstone
50	26.2	5.38	2.06	4850	Gray Sandstone
51	30.5	5.06	2.06	5820	Gray Sandstone

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Table C-4 SUMMARY OF TESTS ON LIMESTONE

1. Test for Determining the Soundness of Coarse Aggregate by Freezing and Thawing
(ISHC Test Method No 211-Method A)

Sample: Boring No 15, 24.2 to 26.4 ft depth
Boring No 15, 29.9 to 31.9 ft depth
Boring No 15, 31.9 to 39.6 ft depth
Boring No 16, 31.0 to 32.4 ft depth
Boring No 16, 32.4 to 36.0 ft depth
Boring No 17, 24.3 to 29.3 ft depth
Boring No 22, 25.6 to 30.3 ft depth

Results: Loss - 16.8%

2. Resistance to Abrasion of Coarse Aggregate by use of the Los Angeles Machine (AASHTO T 96)

Sample: (Same as above)

Results: Loss - 27.8%

3. Analysis of Limestone (ASTM C 25)

Sample: Boring No 15, 31.9 to 40.0 ft depth

Results:

Insoluble matter	1.29%
Total neutralizing value in terms of $CaCO_3$	98.25%
Calcium Carbonate ($CaCO_3$)	97.00%
Magnesium Carbonate ($MgCO_3$)	1.25%

APPENDIX D

CONSOLIDATION TESTS

Ottumwa Generating Station-Unit 1
(E-7566)

Table D-1 SUMMARY OF CONSOLIDATION TEST RESULTS

Boring No.	Depth, ft	Existing Effective Overburden Pressure, tsf	Compression Index	Initial Moisture Content, %	Initial Void Ratio	Initial Dry Density, lbs/cu.ft
1A	8.5	0.529	0.211	27.8	0.848	94.3
8A	6.0	0.821	0.218	26.7	0.821	90.7
10A	4.0	0.246	0.258	32.1	0.962	88.7
10A	7.5	0.462	0.261	34.9	0.971	85.1
26A	13.5	0.556	0.205	30.9	0.864	91.4
27A	7.0	0.416	0.238	31.0	0.958	88.6
38A	8.5	0.501	0.282	28.2	0.888	81.9
39A	4.5	0.262	0.235	27.8	0.875	91.2
39A	14.5	0.819	0.184	32.9	0.937	89.7
48A	17.5	0.915	0.369	37.5	1.077	84.5
49A	14.0	0.795	0.257	29.1	0.861	94.0
50A	20.0	0.945	0.304	37.1	1.064	84.8

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Table D-2 COEFFICIENT OF CONSOLIDATION SUMMARY

Boring No.	Depth, ft	Load Increment, tons/sq.ft	Coefficient of Consolidation $cm^2/sec.$	Coefficient of Compressibility, cm^2/kg	Average Void Ratio	Estimated Coefficient of Permeability, cm/sec
1A	8.5	0.25 to 0.5	1.69×10^{-3}	0.024	0.839	2.2×10^{-4}
1A	8.5	0.5 to 1.0	5.18×10^{-3}	0.030	0.829	0.85×10^{-4}
1A	8.5	1.0 to 2.0	3.78×10^{-3}	0.031	0.806	0.65×10^{-4}
1A	8.5	2.0 to 4.0	3.43×10^{-3}	0.027	0.764	0.51×10^{-4}
1A	8.5	4.0 to 8.0	4.26×10^{-3}	0.016	0.706	0.40×10^{-4}
8A	6.0	0.25 to 0.5	1.05×10^{-3}	0.016	0.816	0.92×10^{-5}
8A	6.0	0.5 to 1.0	1.31×10^{-3}	0.018	0.810	1.29×10^{-5}
8A	6.0	1.0 to 2.0	1.47×10^{-3}	0.017	0.797	1.38×10^{-5}
8A	6.0	2.0 to 4.0	1.25×10^{-3}	0.017	0.772	1.16×10^{-5}
8A	6.0	4.0 to 8.0	0.98×10^{-3}	0.015	0.725	0.86×10^{-5}
10A	4.0	0.25 to 0.5	3.95×10^{-4}	0.084	0.934	1.71×10^{-5}
10A	4.0	0.5 to 1.0	4.99×10^{-4}	0.066	0.907	1.72×10^{-5}
10A	4.0	1.0 to 2.0	3.67×10^{-4}	0.050	0.875	0.97×10^{-5}
10A	4.0	2.0 to 4.0	4.48×10^{-4}	0.035	0.805	0.86×10^{-5}
10A	4.0	4.0 to 8.0	3.35×10^{-4}	0.020	0.731	0.37×10^{-5}
10A	7.5	0.25 to 0.5	1.0×10^{-4}	0.156	0.916	8.1×10^{-6}
10A	7.5	0.5 to 1.0	0.9×10^{-4}	0.110	0.869	5.2×10^{-5}
10A	7.5	1.0 to 2.0	1.0×10^{-4}	0.069	0.807	3.8×10^{-6}
10A	7.5	2.0 to 4.0	1.0×10^{-4}	0.039	0.733	2.2×10^{-6}
10A	7.5	4.0 to 8.0	0.9×10^{-4}	0.020	0.576	1.1×10^{-6}
26A	13.5	0.25 to 0.5	1.60×10^{-4}	0.120	0.807	1.06×10^{-5}
26A	13.5	0.5 to 1.0	1.84×10^{-4}	0.084	0.771	0.85×10^{-5}
26A	13.5	1.0 to 2.0	2.01×10^{-4}	0.051	0.725	0.57×10^{-5}
26A	13.5	2.0 to 4.0	2.84×10^{-4}	0.029	0.671	0.47×10^{-5}
26A	13.5	4.0 to 8.0	2.83×10^{-4}	0.015	0.602	0.26×10^{-5}

cont'd.

Ottumwa Generating Station-Unit 1
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COEFFICIENT OF CONSOLIDATION SUMMARY

Table D-2

Boring No.	Depth, ft	Load Increment, tons/sq.ft	Coefficient of Consolidation $cm^2/sec.$	Coefficient of Compressibility, cm^2/kg	Average Void Ratio	Estimated Coefficient of Permeability, cm/sec
27A	7.0	0.25 to 0.5	1.55×10^{-3}	0.060	0.931	4.81×10^{-5}
27A	7.0	0.5 to 1.0	0.84×10^{-3}	0.050	0.912	2.19×10^{-5}
27A	7.0	1.0 to 2.0	0.81×10^{-3}	0.037	0.881	1.58×10^{-5}
27A	7.0	2.0 to 4.0	1.03×10^{-3}	0.028	0.834	1.48×10^{-5}
27A	7.0	4.0 to 8.0	0.78×10^{-3}	0.018	0.771	0.79×10^{-5}
38A	8.5	0.25 to 0.5	5.73×10^{-3}	0.032	0.881	3.45×10^{-4}
38A	8.5	0.5 to 1.0	7.41×10^{-3}	0.028	0.869	1.11×10^{-4}
38A	8.5	1.0 to 2.0	3.38×10^{-3}	0.026	0.848	0.48×10^{-4}
38A	8.5	2.0 to 4.0	2.42×10^{-3}	0.031	0.805	0.42×10^{-4}
38A	8.5	4.0 to 8.0	1.91×10^{-3}	0.021	0.735	0.23×10^{-4}
39A	4.5	0.25 to 0.5	2.9×10^{-4}	0.036	0.867	0.55×10^{-5}
39A	4.5	0.5 to 1.0	7.3×10^{-4}	0.054	0.848	2.13×10^{-5}
39A	4.5	1.0 t- 2.0	7.6×10^{-4}	0.035	0.817	1.46×10^{-5}
39A	4.5	2.0 to 4.0	7.9×10^{-4}	0.027	0.772	1.20×10^{-5}
39A	4.5	4.0 to 8.0	6.0×10^{-4}	0.017	0.711	5.9×10^{-5}
39A	14.5	0.25 to 0.5	6.43×10^{-3}	0.064	0.908	2.2×10^{-4}
39A	14.5	0.5 to 1.0	6.29×10^{-3}	0.048	0.889	1.6×10^{-4}
39A	14.5	1.0 to 2.0	5.42×10^{-3}	0.033	0.861	0.9×10^{-4}
39A	14.5	2.0 to 4.0	7.78×10^{-3}	0.022	0.822	0.9×10^{-4}
39A	14.5	4.0 to 8.0	6.31×10^{-3}	0.013	0.773	0.5×10^{-4}
48A	17.5	0.25 to 0.5	0.65×10^{-3}	0.040	1.067	1.25×10^{-5}
48A	17.5	0.5 to 1.0	1.20×10^{-3}	0.042	1.052	2.45×10^{-5}
48A	17.5	1.0 to 2.0	0.63×10^{-3}	0.049	1.017	1.52×10^{-5}
48A	17.5	2.0 to 4.0	0.47×10^{-3}	0.050	0.942	1.21×10^{-5}
48A	17.5	4.0 to 8.0	0.32×10^{-3}	0.028	0.837	0.48×10^{-5}

cont'd.

Ottumwa Generating Station-Unit 1
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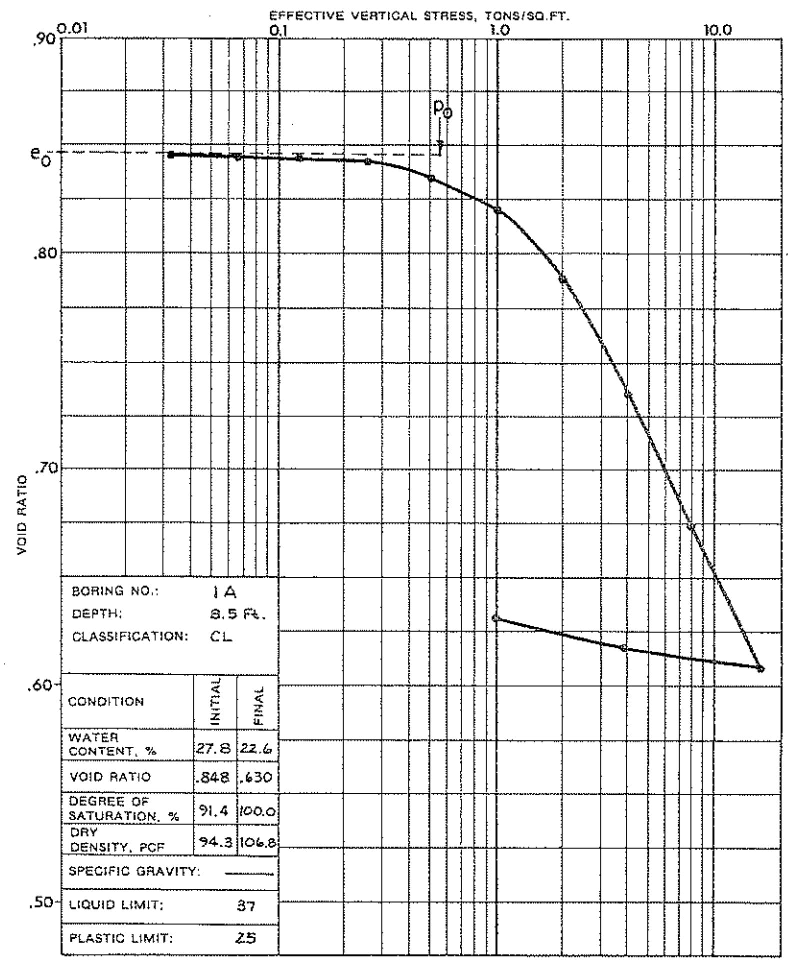
COEFFICIENT OF CONSOLIDATION SUMMARY

Table D-2

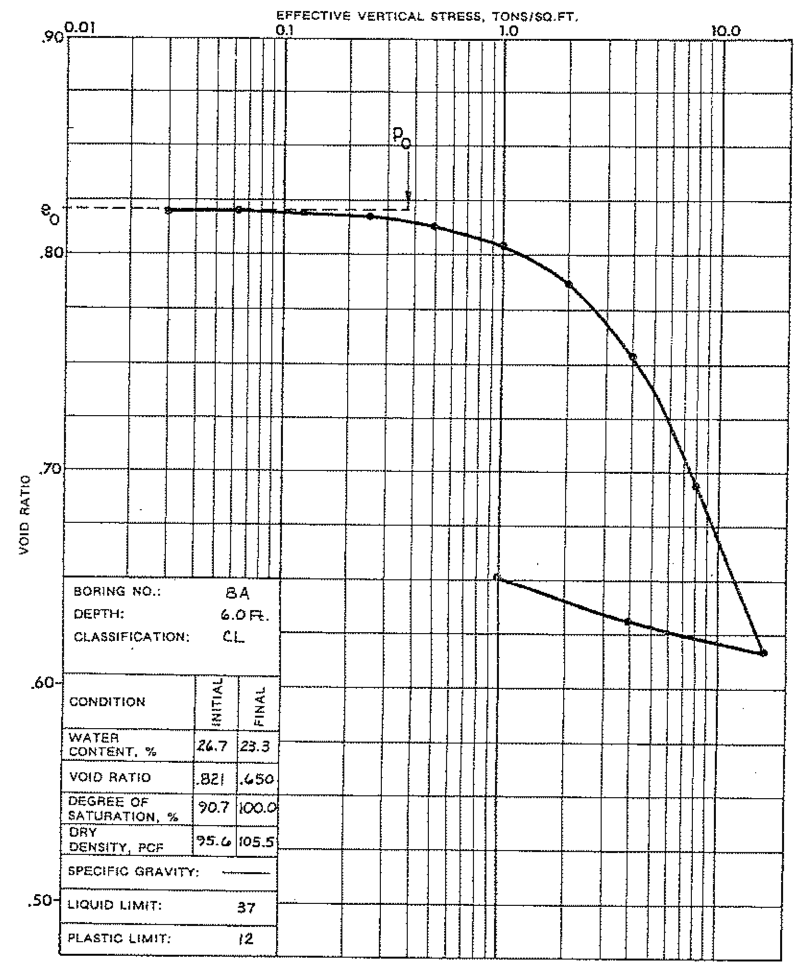
Boring No.	Depth, ft	Load Increment, tons/sq.ft	Coefficient of Consolidation $cm^2/sec.$	Coefficient of Compressibility, cm^2/kg	Average Void Ratio	Estimated Coefficient of Permeability, cm/sec
49A	14.0	0.25 to 0.5	3.30×10^{-3}	0.056	0.847	1.00×10^{-6}
49A	14.0	0.5 to 1.0	4.27×10^{-3}	0.042	0.830	0.98×10^{-6}
49A	14.0	1.0 to 2.0	4.15×10^{-3}	0.029	0.805	0.67×10^{-6}
49A	14.0	2.0 to 4.0	4.36×10^{-3}	0.029	0.767	0.72×10^{-6}
49A	14.0	4.0 to 8.0	2.36×10^{-3}	0.016	0.713	0.22×10^{-6}
50A	20.0	0.25 to 0.5	5.78×10^{-3}	0.076	1.042	2.15×10^{-4}
50A	20.0	0.5 to 1.0	7.26×10^{-3}	0.062	1.017	2.23×10^{-4}
50A	20.0	1.0 to 2.0	3.25×10^{-3}	0.055	0.945	0.92×10^{-4}
50A	20.0	2.0-4.0	1.82×10^{-3}	0.043	0.905	0.40×10^{-4}
50A	20.0	4.0 to 8.0	2.76×10^{-3}	0.023	0.816	0.35×10^{-4}



BORING NO.:	1 A
DEPTH:	8.5 Ft.
CLASSIFICATION:	CL

CONDITION	INITIAL	FINAL
WATER CONTENT, %	27.8	22.6
VOID RATIO	.848	.630
DEGREE OF SATURATION, %	91.4	100.0
DRY DENSITY, PCF	94.3	106.8
SPECIFIC GRAVITY:	——	
LIQUID LIMIT:	37	
PLASTIC LIMIT:	25	

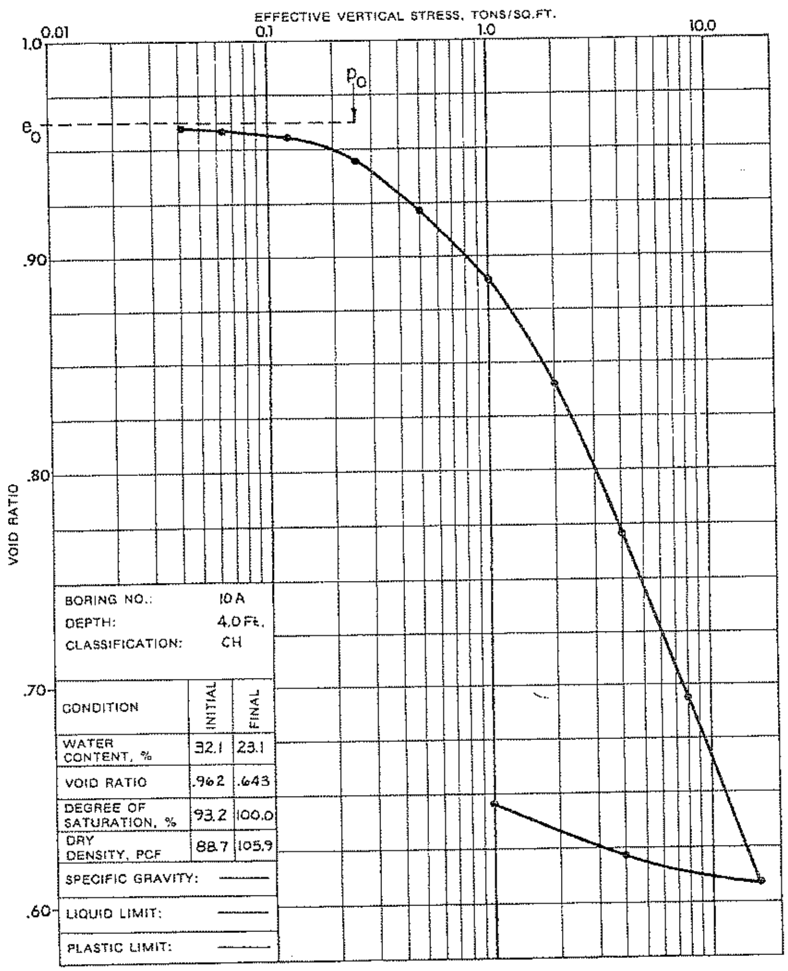
CONSOLIDATION TEST RESULTS



BORING NO.:	8A
DEPTH:	6.0 Ft.
CLASSIFICATION:	CL

CONDITION	INITIAL	FINAL
WATER CONTENT, %	26.7	23.3
VOID RATIO	.821	.650
DEGREE OF SATURATION, %	90.7	100.0
DRY DENSITY, PCF	95.6	105.5
SPECIFIC GRAVITY:	——	
LIQUID LIMIT:	37	
PLASTIC LIMIT:	12	

CONSOLIDATION TEST RESULTS



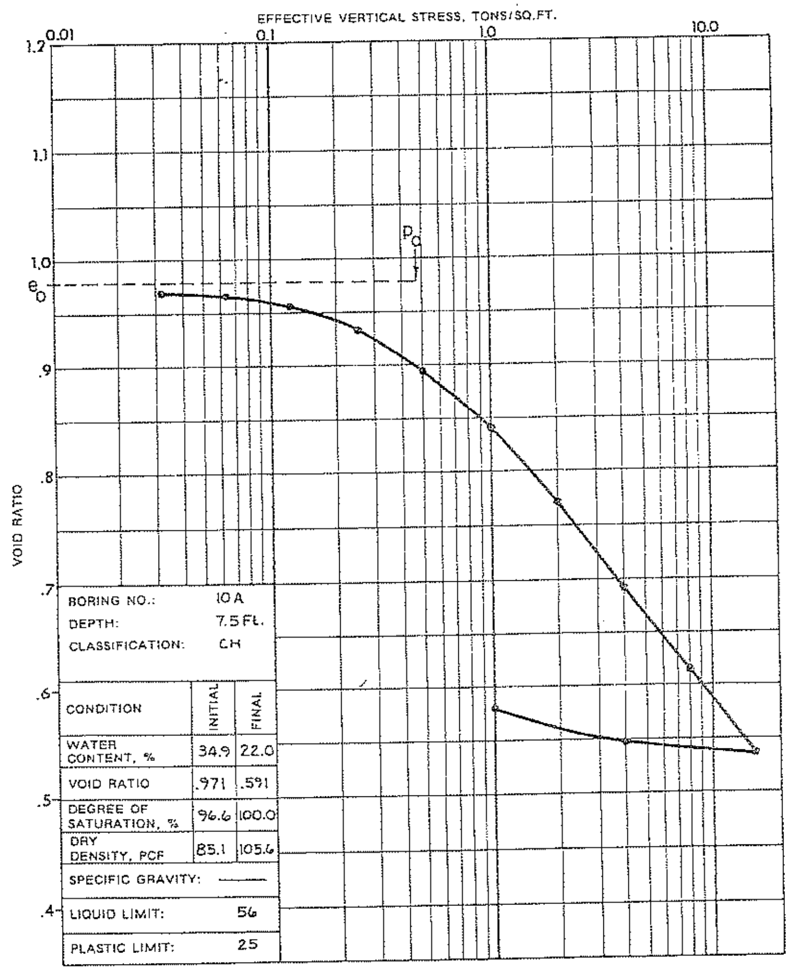
BORING NO.:	10 A
DEPTH:	4.0 Ft.
CLASSIFICATION:	CH

CONDITION	INITIAL	FINAL
WATER CONTENT, %	32.1	23.1
VOID RATIO	.962	.643
DEGREE OF SATURATION, %	93.2	100.0
DRY DENSITY, PCF	88.7	105.9
SPECIFIC GRAVITY:	——	
LIQUID LIMIT:	——	
PLASTIC LIMIT:	——	

CONSOLIDATION TEST RESULTS

ATEC ASSOCIATES

CN-1



BORING NO.:	10 A
DEPTH:	7.5 Ft.
CLASSIFICATION:	CH

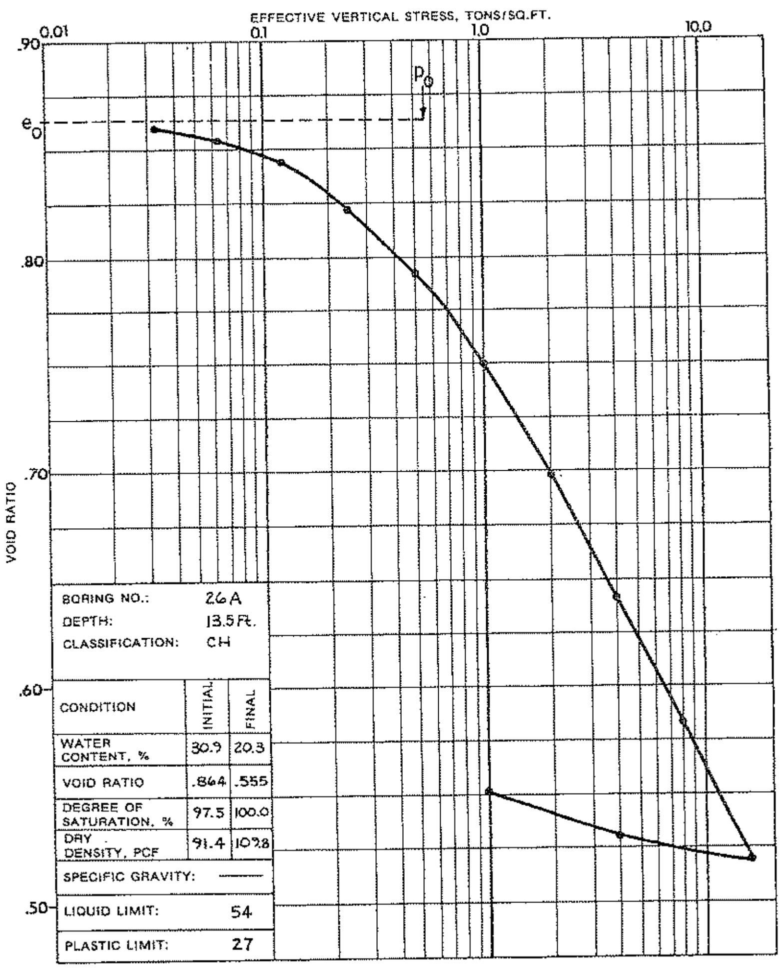
CONDITION	INITIAL	FINAL
WATER CONTENT, %	34.9	22.0
VOID RATIO	.971	.591
DEGREE OF SATURATION, %	96.6	100.0
DRY DENSITY, PCF	85.1	105.6
SPECIFIC GRAVITY:	——	
LIQUID LIMIT:	56	
PLASTIC LIMIT:	25	

CONSOLIDATION TEST RESULTS

ATEC ASSOCIATES

CN-1

CONSOLIDATION TEST RESULTS



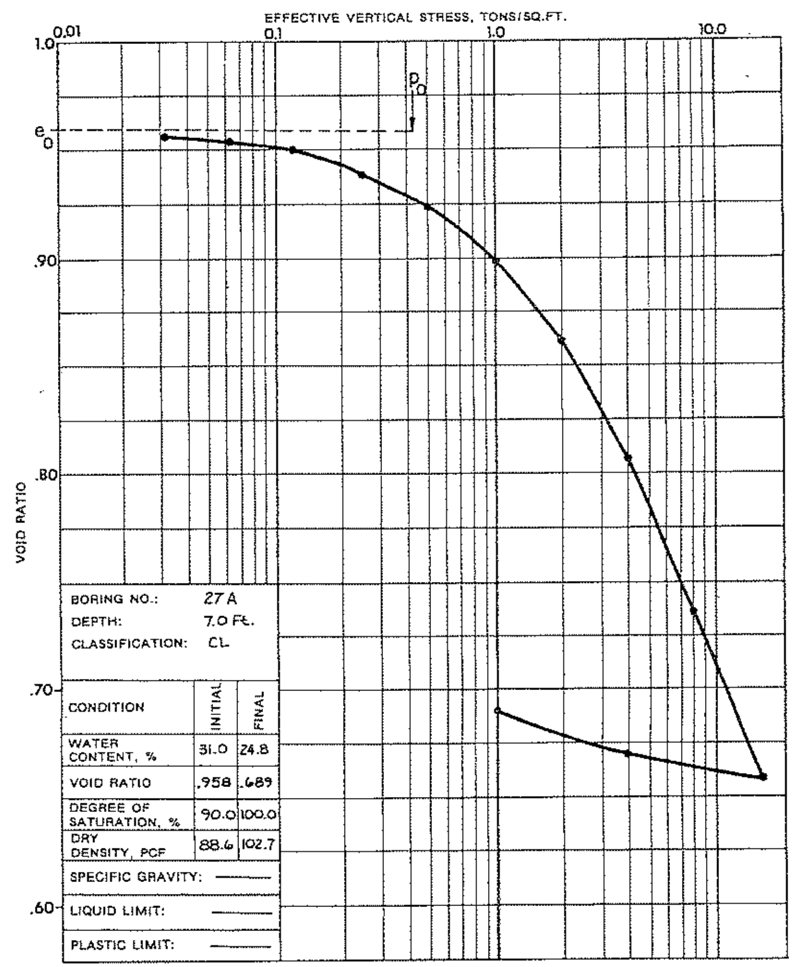
BORING NO.: 26A
DEPTH: 13.5 Ft.
CLASSIFICATION: CH

CONDITION	INITIAL	FINAL
WATER CONTENT, %	30.9	20.3
VOID RATIO	.864	.555
DEGREE OF SATURATION, %	97.5	100.0
DRY DENSITY, PCF	91.4	102.8
SPECIFIC GRAVITY:	——	
LIQUID LIMIT:	54	
PLASTIC LIMIT:	27	

ATEC ASSOCIATES

CN-1

CONSOLIDATION TEST RESULTS

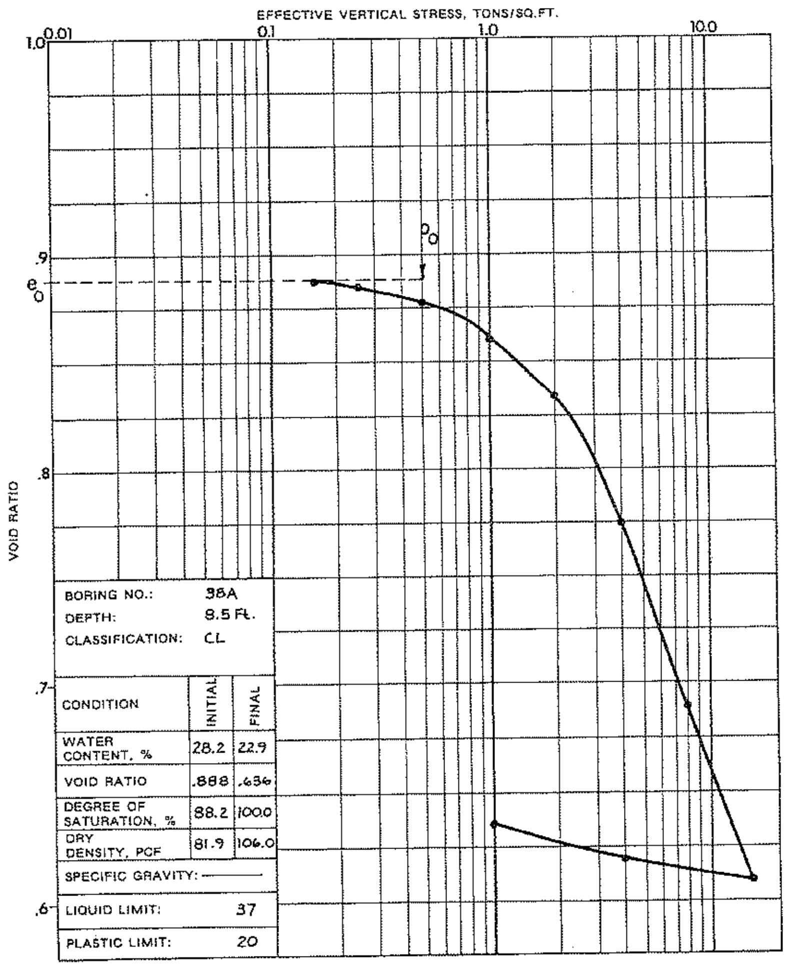


BORING NO.: 27A
DEPTH: 7.0 Ft.
CLASSIFICATION: CL

CONDITION	INITIAL	FINAL
WATER CONTENT, %	31.0	24.8
VOID RATIO	.958	.689
DEGREE OF SATURATION, %	90.0	100.0
DRY DENSITY, PCF	88.6	102.7
SPECIFIC GRAVITY:	——	
LIQUID LIMIT:	——	
PLASTIC LIMIT:	——	

ATEC ASSOCIATES

CN-1

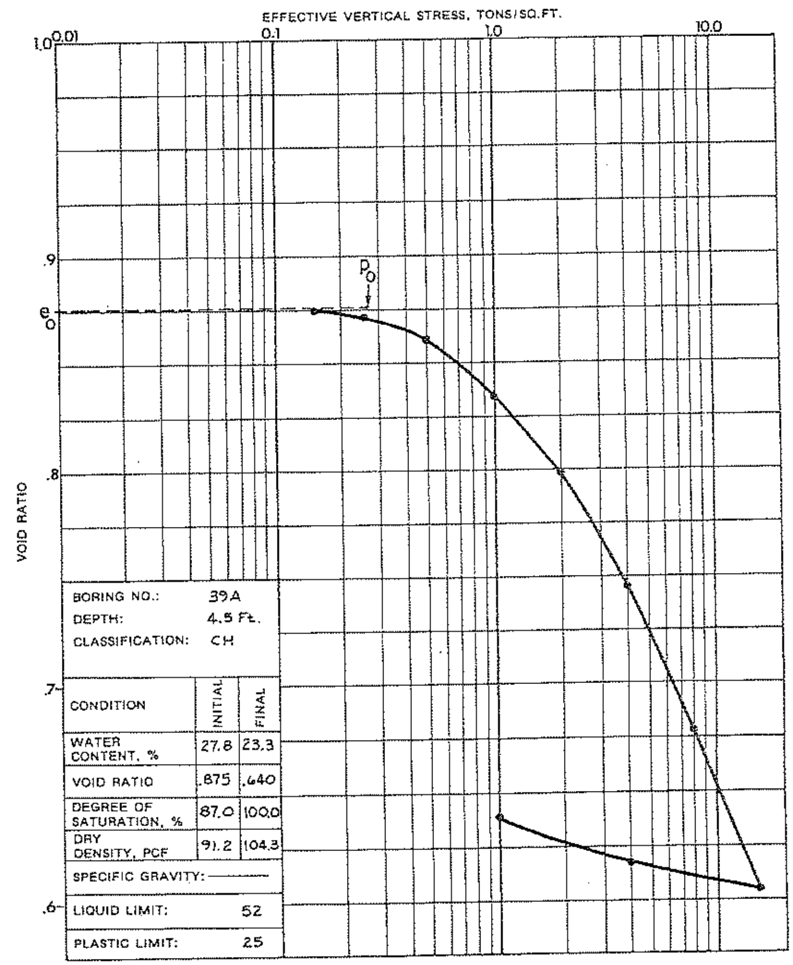


BORING NO.: 38A
DEPTH: 8.5 Ft.
CLASSIFICATION: CL

CONDITION	INITIAL	FINAL
WATER CONTENT, %	28.2	22.9
VOID RATIO	.888	.636
DEGREE OF SATURATION, %	88.2	100.0
DRY DENSITY, PCF	81.9	106.0
SPECIFIC GRAVITY: ——		
LIQUID LIMIT:	37	
PLASTIC LIMIT:	20	

CONSOLIDATION TEST RESULTS

ATEC ASSOCIATES CN-1

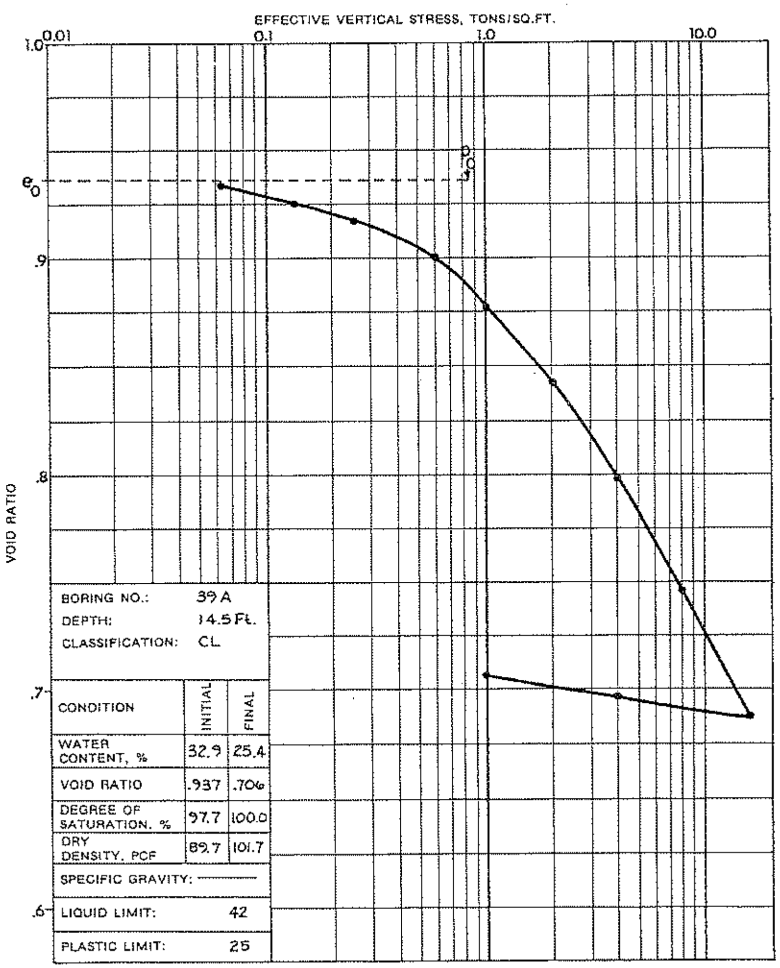


BORING NO.: 39A
DEPTH: 4.5 Ft.
CLASSIFICATION: CH

CONDITION	INITIAL	FINAL
WATER CONTENT, %	27.8	23.3
VOID RATIO	.875	.640
DEGREE OF SATURATION, %	87.0	100.0
DRY DENSITY, PCF	91.2	104.3
SPECIFIC GRAVITY: ——		
LIQUID LIMIT:	52	
PLASTIC LIMIT:	25	

CONSOLIDATION TEST RESULTS

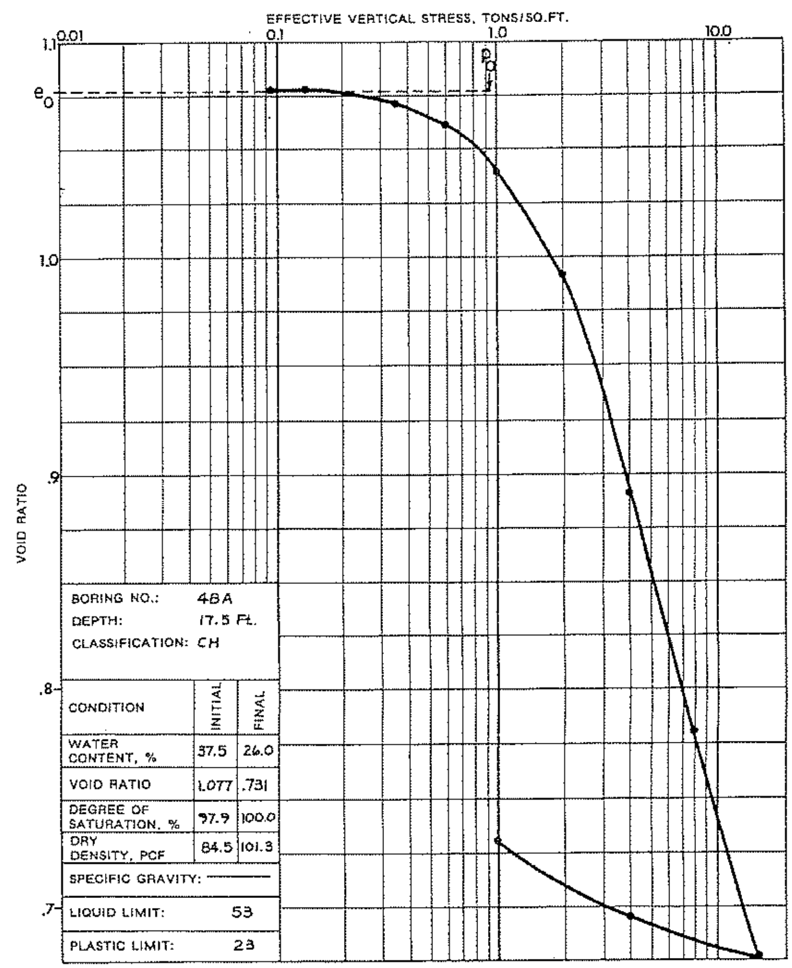
ATEC ASSOCIATES CN-1



BORING NO.: 39 A
DEPTH: 14.5 Ft.
CLASSIFICATION: CL

CONDITION	INITIAL	FINAL
WATER CONTENT, %	32.9	25.4
VOID RATIO	.937	.706
DEGREE OF SATURATION, %	97.7	100.0
DRY DENSITY, PCF	89.7	101.7
SPECIFIC GRAVITY:	———	
LIQUID LIMIT:	42	
PLASTIC LIMIT:	25	

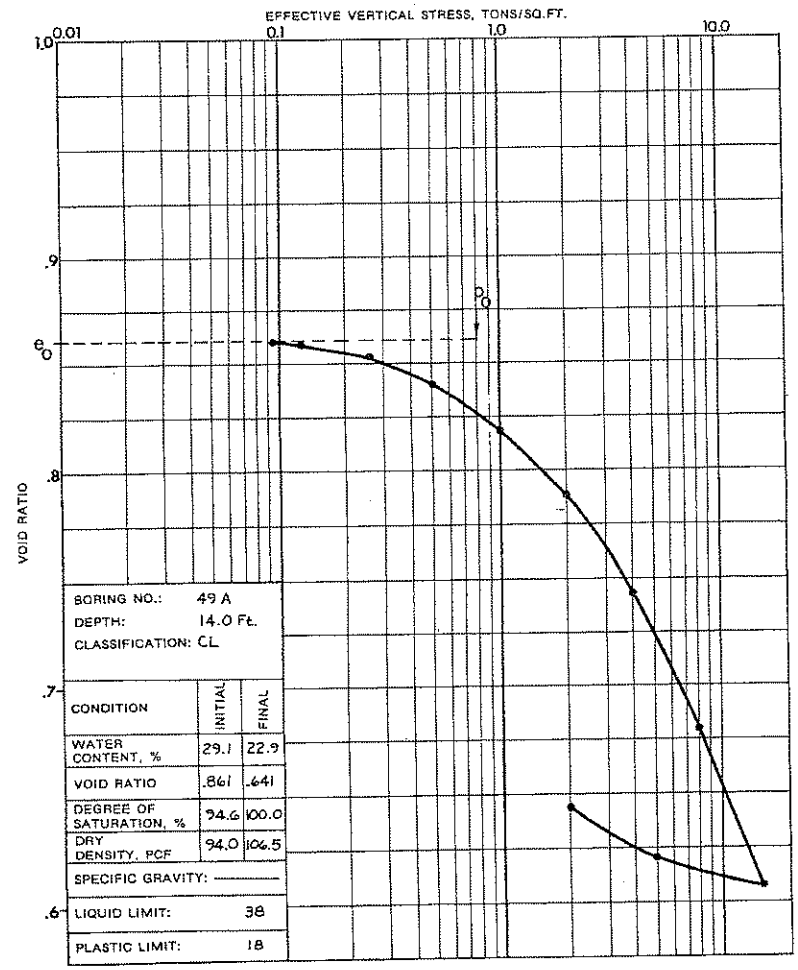
CONSOLIDATION TEST RESULTS



BORING NO.: 48A
DEPTH: 17.5 Ft.
CLASSIFICATION: CH

CONDITION	INITIAL	FINAL
WATER CONTENT, %	37.5	26.0
VOID RATIO	1.077	.731
DEGREE OF SATURATION, %	97.9	100.0
DRY DENSITY, PCF	84.5	101.3
SPECIFIC GRAVITY:	———	
LIQUID LIMIT:	53	
PLASTIC LIMIT:	23	

CONSOLIDATION TEST RESULTS



BORING NO.: 49 A
DEPTH: 14.0 Ft.
CLASSIFICATION: CL

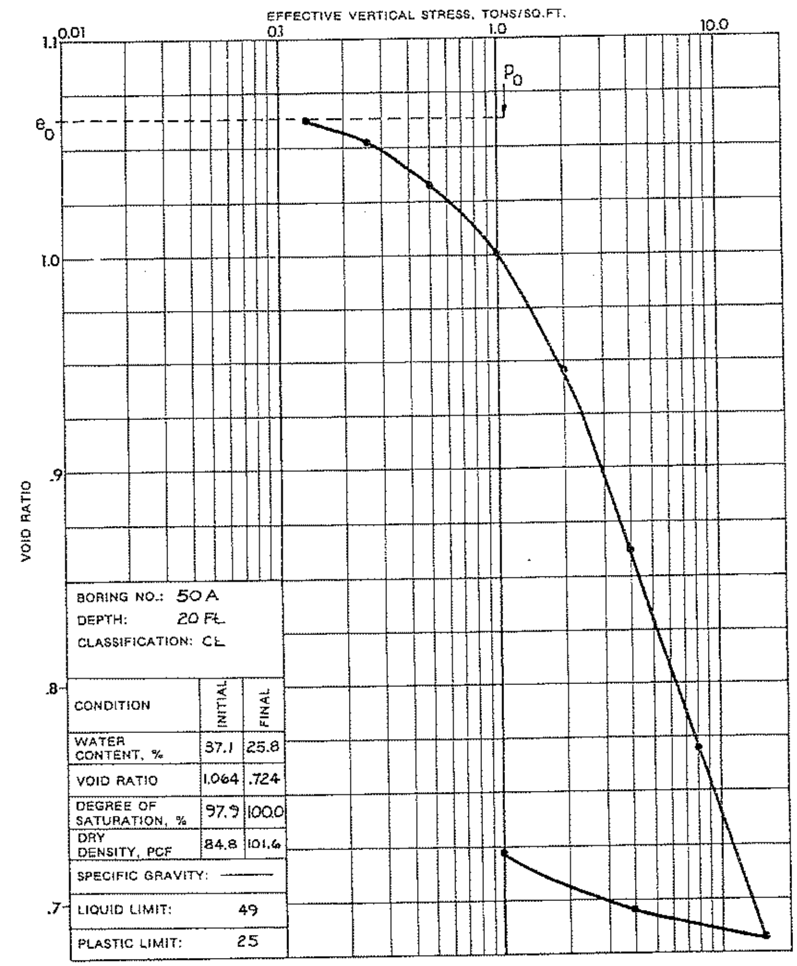
CONDITION	INITIAL	FINAL
WATER CONTENT, %	29.1	22.9
VOID RATIO	.861	.641
DEGREE OF SATURATION, %	94.6	100.0
DRY DENSITY, PCF	94.0	106.5

SPECIFIC GRAVITY:	———
LIQUID LIMIT:	38
PLASTIC LIMIT:	18

CONSOLIDATION TEST RESULTS

ATEC ASSOCIATES

CN-1



BORING NO.: 50 A
DEPTH: 20 Ft.
CLASSIFICATION: CL

CONDITION	INITIAL	FINAL
WATER CONTENT, %	37.1	25.8
VOID RATIO	1.064	.724
DEGREE OF SATURATION, %	97.9	100.0
DRY DENSITY, PCF	84.8	101.6

SPECIFIC GRAVITY:	———
LIQUID LIMIT:	49
PLASTIC LIMIT:	25

CONSOLIDATION TEST RESULTS

ATEC ASSOCIATES

CN-1

APPENDIX E

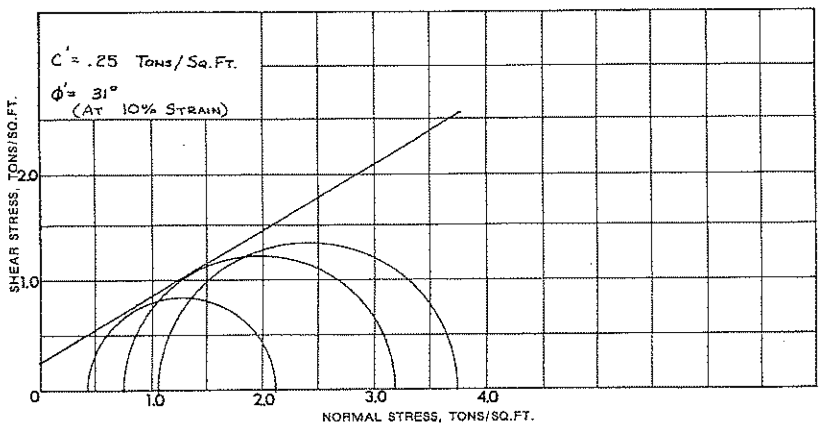
TRIAXIAL TESTS

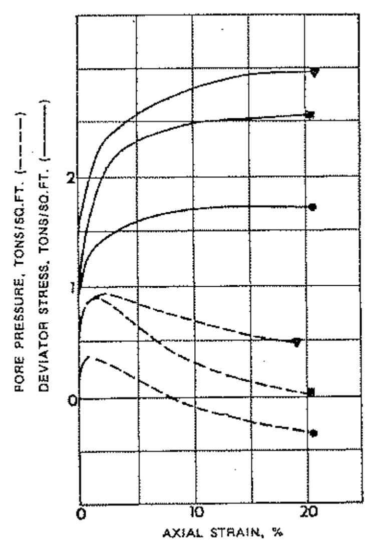
Ottumwa Generating Station-Unit 1
(E-7566)

Table E-1 SUMMARY OF CONSOLIDATED-UNDRAINED TRIAXIAL TEST RESULTS

Boring No.	Depth, ft	c' kg/cm²	ø' degrees	Effective Confining Pressures tsf	Dry Densities, lbs/cu.ft	% Final Water Contents	Strain Rate %/min
9A	13.0-14.5	0.25	31	.35	101.2	26.2	
				1.06	107.7	20.4	1.0
				1.76	101.1	23.8	
10A	5.0-7.0	0.30	34.5	1.41	94.4	25.8	1.0
				1.82	91.6	27.0	
10A	7.0-9.0	0.30	29	1.06	91.3	27.7	
				2.11	88.1	28.5	1.0
				3.17	96.3	22.8	
18A	19.0-21.0	0.20	34	0.70	107.8	22.2	
				1.41	104.5	19.9	0.5
				2.11	105.7	21.3	
39A	13.0-15.0	0	34	1.06	89.1	30.0	
				2.11	82.9	29.4	.074
				3.17	90.0	27.1	
43A	18.0-20.0	0.3	31	0.35	104.1	23.6	
				1.06	105.3	22.3	0.5
				1.76	105.0	21.6	
48A	16.0-17.9	0	31	1.06	88.3	31.0	
				2.11	88.1	28.9	.071
				3.17	85.2	30.2	
32A *	0.0-7.0	0	40	0.70	109.2	23.1	.071
				1.41	109.6	21.5	
				2.11	109.7	22.0	

* Samples recompacted from disturbed bag sample to approximately 95 percent of modified Proctor maximum dry density.



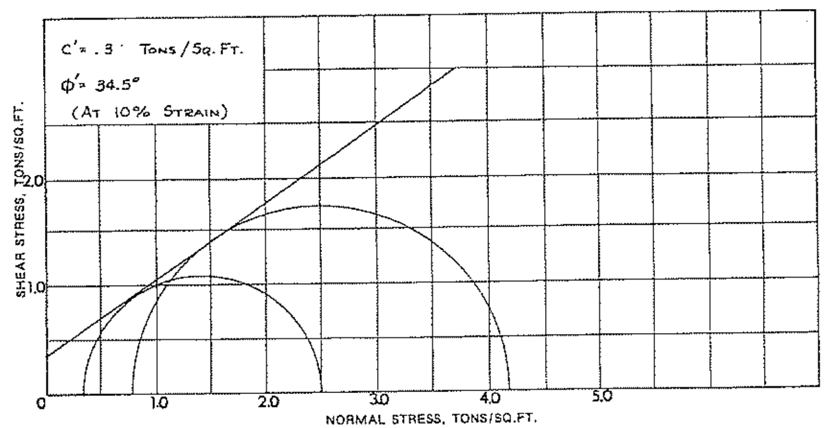


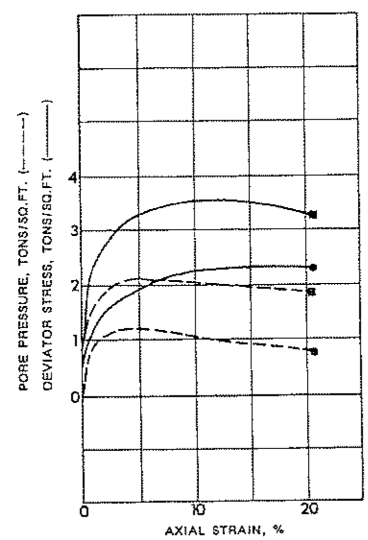
PROJECT NO.: E-7566					
BORING NO.: 9A		DEPTH: 13.0-14.5			
LIQUID LIMIT: ——		PLASTIC LIMIT: ——			
SOIL CLASSIFICATION: CH					
TYPE OF TEST: Consolidation - Undrained					
RATE OF STRAIN: 1.0%/Min.					
TEST DESIGNATION		●	■	▼	○
INITIAL	WATER CONTENT, %	24.9	21.0	24.9	
	DRY DENSITY, PCF	101.2	107.7	101.1	
	SAMPLE HEIGHT, IN.	2.80	2.80	2.80	
	SAMPLE DIAMETER, IN.	1.40	1.40	1.40	
FINAL BACK PRESSURE, TSF		1.97	4.08	1.62	
TOTAL CONSOLIDATION PRESSURE, TSF		2.32	5.14	3.38	
EFFECTIVE CONFINING PRESSURE, TSF		0.35	1.06	1.76	
FINAL WATER CONTENT, %		26.2	20.4	23.8	
REMARKS:					

TRIAXIAL TEST RESULTS

ATEC ASSOCIATES

TX-1



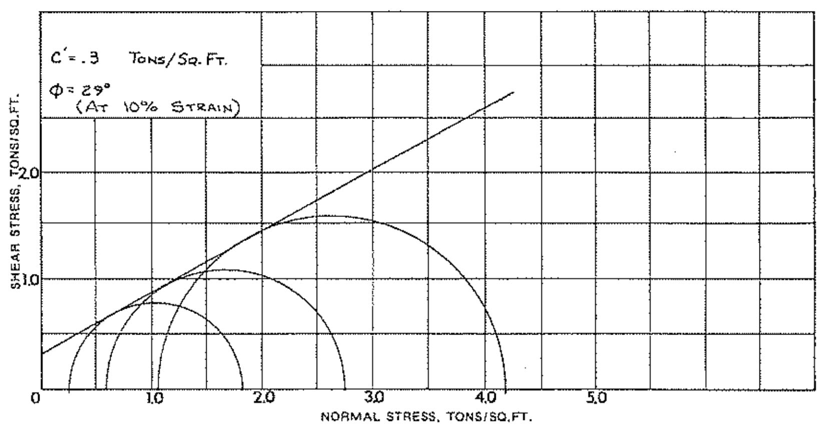


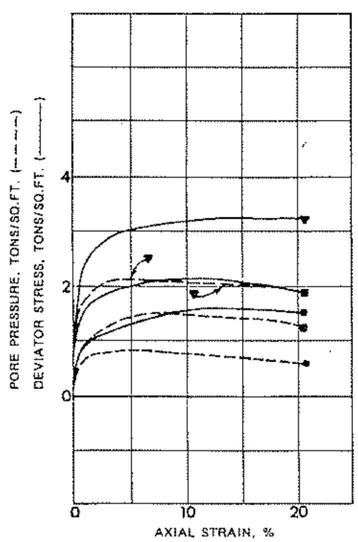
PROJECT NO.: E-7566					
BORING NO.: 10A		DEPTH: 5.0-7.0			
LIQUID LIMIT: 56		PLASTIC LIMIT: 25			
SOIL CLASSIFICATION: CH					
TYPE OF TEST: Consolidated - Undrained					
RATE OF STRAIN: 1.0%/Min.					
TEST DESIGNATION		●	■	▼	○
INITIAL	WATER CONTENT, %	28.5	30.7		
	DRY DENSITY, PCF	94.4	91.6		
	SAMPLE HEIGHT, IN.	2.80	2.80		
	SAMPLE DIAMETER, IN.	1.40	1.40		
FINAL BACK PRESSURE, TSF		1.62	1.97		
TOTAL CONSOLIDATION PRESSURE, TSF		3.03	4.79		
EFFECTIVE CONFINING PRESSURE, TSF		1.41	2.82		
FINAL WATER CONTENT, %		25.8	27.0		
REMARKS:					

TRIAXIAL TEST RESULTS

ATEC ASSOCIATES

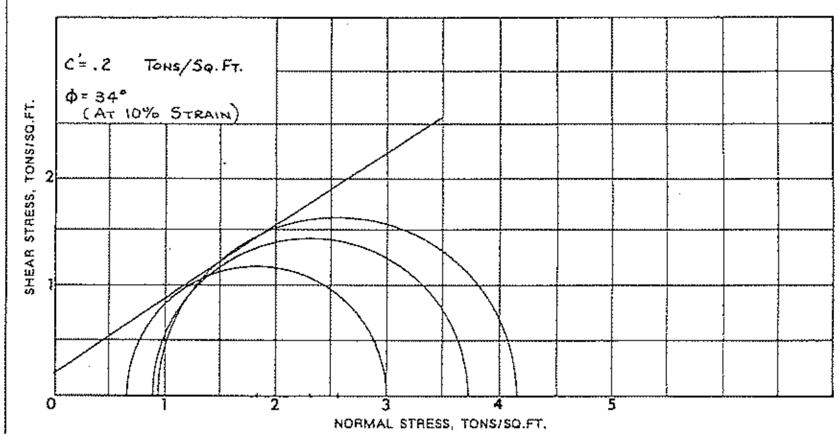
TX-1

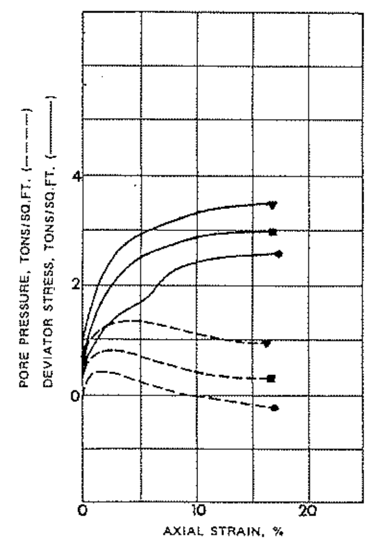




PROJECT NO.: E-7566				
BORING NO.: 10 A	DEPTH: 7.0 - 9.0			
LIQUID LIMIT: 56	PLASTIC LIMIT: 25			
SOIL CLASSIFICATION: CH				
TYPE OF TEST: Consolidated - Undrained				
RATE OF STRAIN: 1.0 %/Min.				
TEST DESIGNATION	●	■	▼	○
INITIAL WATER CONTENT, %	32.1	32.7	27.5	
INITIAL DRY DENSITY, PCF	91.3	88.1	96.3	
INITIAL SAMPLE HEIGHT, IN.	2.80	2.80	2.80	
INITIAL SAMPLE DIAMETER, IN.	1.40	1.40	1.40	
FINAL BACK PRESSURE, TSF	2.32	2.68	1.62	
TOTAL CONSOLIDATION PRESSURE, TSF	3.38	4.79	4.79	
EFFECTIVE CONFINING PRESSURE, TSF	1.06	2.11	3.17	
FINAL WATER CONTENT, %	27.7	28.5	22.8	
REMARKS:				

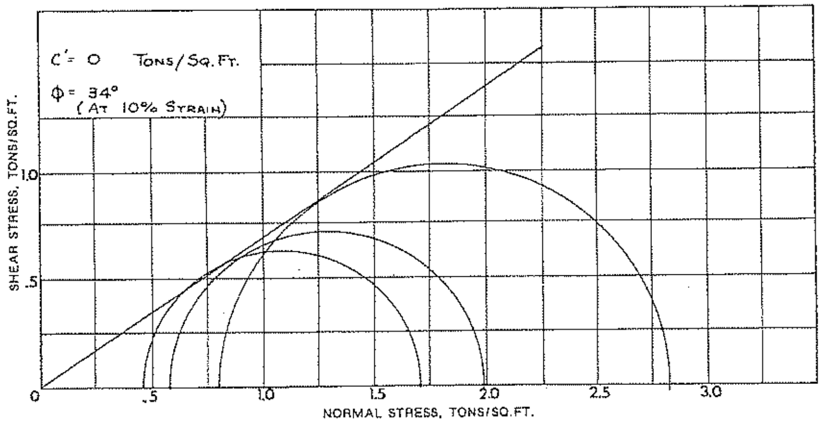
TRIAXIAL TEST RESULTS

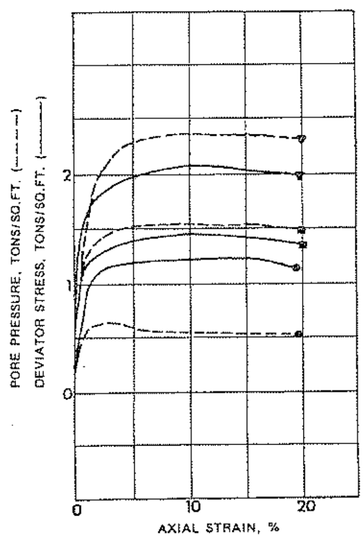




PROJECT NO.: E-7566				
BORING NO.: 18 A	DEPTH: 19.0 - 21.0			
LIQUID LIMIT: 47	PLASTIC LIMIT: 24			
SOIL CLASSIFICATION: CL				
TYPE OF TEST: Consolidated - Undrained				
RATE OF STRAIN: 0.5%/Min.				
TEST DESIGNATION	●	■	▼	○
INITIAL WATER CONTENT, %	20.6	23.0	20.9	
INITIAL DRY DENSITY, PCF	107.8	104.5	105.7	
INITIAL SAMPLE HEIGHT, IN.	5.60	5.60	5.60	
INITIAL SAMPLE DIAMETER, IN.	2.86	2.87	2.87	
FINAL BACK PRESSURE, TSF	1.62	1.62	2.68	
TOTAL CONSOLIDATION PRESSURE, TSF	2.32	3.03	4.79	
EFFECTIVE CONFINING PRESSURE, TSF	0.70	1.41	2.11	
FINAL WATER CONTENT, %	22.2	19.9	21.3	
REMARKS:				

TRIAXIAL TEST RESULTS

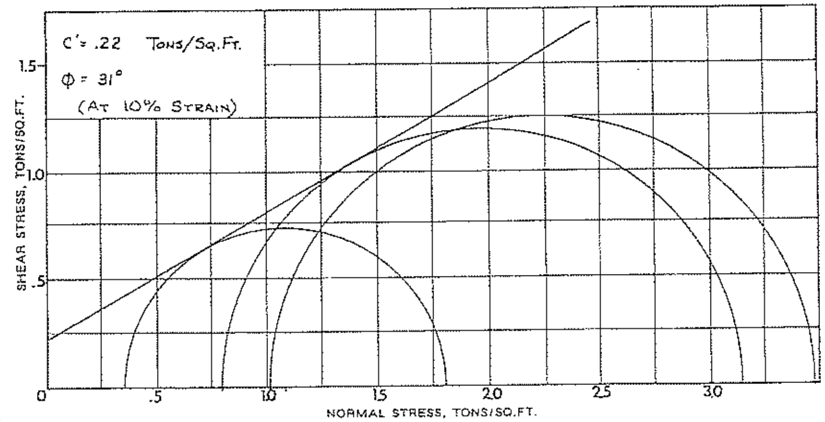


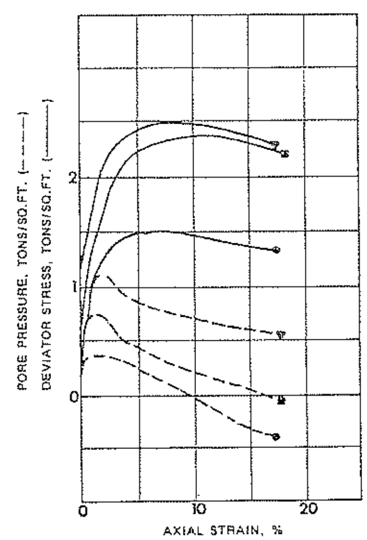


PROJECT NO.: E-7566					
BORING NO.: 39A		DEPTH: 13.0 - 15.0			
LIQUID LIMIT: 42		PLASTIC LIMIT: 25			
SOIL CLASSIFICATION: CL					
TYPE OF TEST: Consolidated - Undrained					
RATE OF STRAIN: 0.074% / Min.					
TEST DESIGNATION		●	■	▼	○
INITIAL	WATER CONTENT, %	32.8	38.4	33.9	
	DRY DENSITY, PCF	89.1	82.9	90.0	
	SAMPLE HEIGHT, IN.	2.80	2.80	2.80	
	SAMPLE DIAMETER, IN.	1.40	1.40	1.40	
FINAL BACK PRESSURE, TSF		1.97	1.27	1.62	
TOTAL CONSOLIDATION PRESSURE, TSF		3.03	3.38	4.79	
EFFECTIVE CONFINING PRESSURE, TSF		1.06	2.11	3.17	
FINAL WATER CONTENT, %		30.0	29.4	27.1	
REMARKS:					

TRIAXIAL TEST RESULTS

ATEC ASSOCIATES TX-1

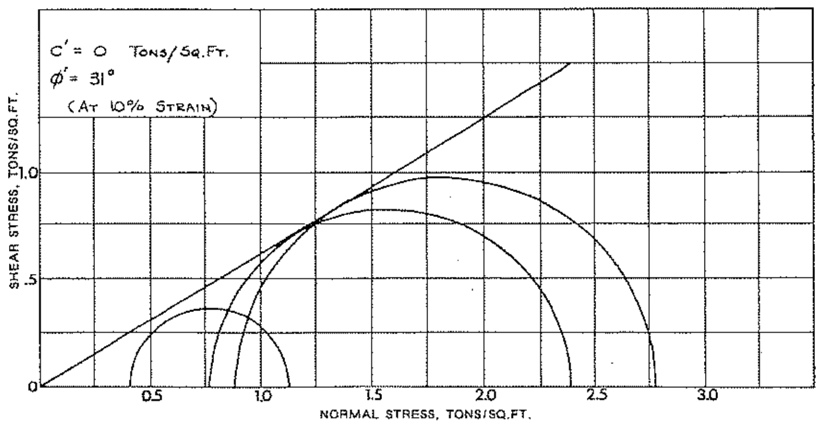


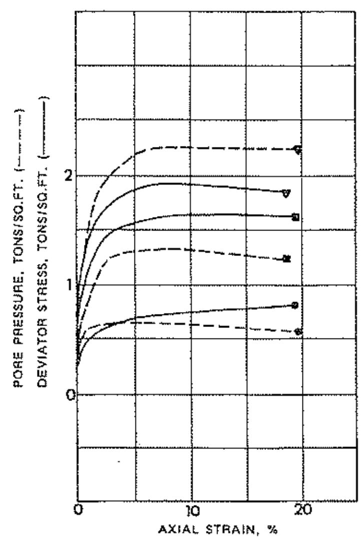


PROJECT NO.: E-7566					
BORING NO.: 43A		DEPTH: 18.0 - 20.0			
LIQUID LIMIT: 32		PLASTIC LIMIT: 15			
SOIL CLASSIFICATION: CL					
TYPE OF TEST: Consolidated - Undrained					
RATE OF STRAIN: 0.5% / Min.					
TEST DESIGNATION		●	■	▼	○
INITIAL	WATER CONTENT, %	22.2	22.2	21.1	
	DRY DENSITY, PCF	104.1	105.0	105.3	
	SAMPLE HEIGHT, IN.	5.60	5.37	5.60	
	SAMPLE DIAMETER, IN.	2.87	2.87	2.86	
FINAL BACK PRESSURE, TSF		1.27	1.97	2.32	
TOTAL CONSOLIDATION PRESSURE, TSF		1.62	3.03	4.06	
EFFECTIVE CONFINING PRESSURE, TSF		0.35	1.06	1.76	
FINAL WATER CONTENT, %		23.6	22.3	21.6	
REMARKS:					

TRIAXIAL TEST RESULTS

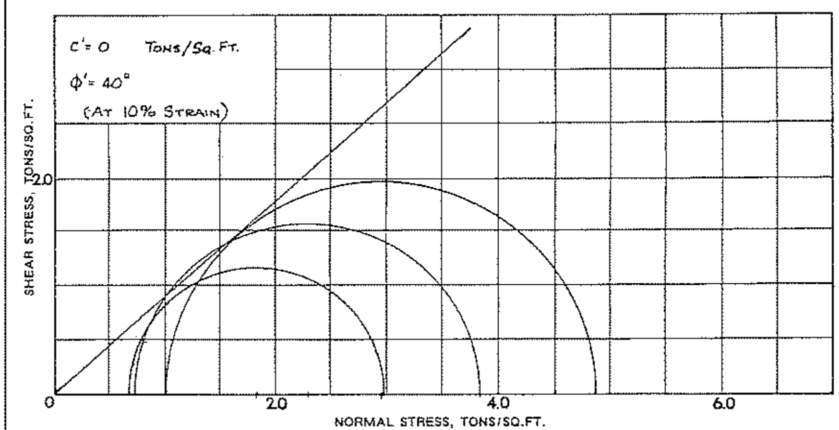
ATEC ASSOCIATES TX-1

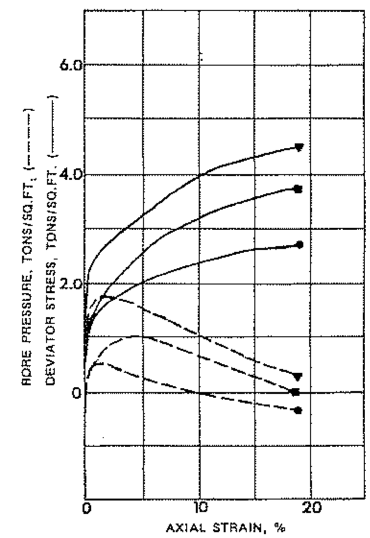




PROJECT NO.: E-7566					
BORING NO.: 48A	DEPTH: 16.0-17.9				
LIQUID LIMIT: 53	PLASTIC LIMIT: 23				
SOIL CLASSIFICATION: CH					
TYPE OF TEST: Consolidated-Undrained					
RATE OF STRAIN: 0.071%/Min.					
TEST DESIGNATION		●	■	▼	○
INITIAL	WATER CONTENT, %	33.4	33.4	36.3	
INITIAL	DRY DENSITY, PCF	88.3	88.1	85.2	
INITIAL	SAMPLE HEIGHT, IN.	2.80	2.80	2.80	
INITIAL	SAMPLE DIAMETER, IN.	1.40	1.40	1.40	
FINAL BACK PRESSURE, TSF		1.62	2.32	2.32	
TOTAL CONSOLIDATION PRESSURE, TSF		2.68	4.43	5.49	
EFFECTIVE CONFINING PRESSURE, TSF		1.06	2.11	3.17	
FINAL WATER CONTENT, %		31.0	28.9	30.2	
REMARKS:					

TRIAXIAL TEST RESULTS





PROJECT NO.: E-7566					
BORING NO.: 32	DEPTH: 0-7.0 *				
LIQUID LIMIT: —	PLASTIC LIMIT: —				
SOIL CLASSIFICATION: CL					
TYPE OF TEST: Consolidated - Undrained					
RATE OF STRAIN: 0.07%/Min.					
TEST DESIGNATION		●	■	▼	○
INITIAL	WATER CONTENT, %	19.5	19.5	19.5	
INITIAL	DRY DENSITY, PCF	109.2	109.6	109.7	
INITIAL	SAMPLE HEIGHT, IN.	2.80	2.80	2.80	
INITIAL	SAMPLE DIAMETER, IN.	1.40	1.40	1.40	
FINAL BACK PRESSURE, TSF		2.32	3.38	4.44	
TOTAL CONSOLIDATION PRESSURE, TSF		3.02	4.79	6.55	
EFFECTIVE CONFINING PRESSURE, TSF		0.70	1.41	2.11	
FINAL WATER CONTENT, %		23.1	21.5	22.0	
REMARKS: * Sample Recompacted From Disturbed Bag Sample To Approx. 95% Of Modified Proctor Maximum Dry Density.					

TRIAXIAL TEST RESULTS

Ottumwa Generating Station-Unit 1
(E-7566)

Table E-2

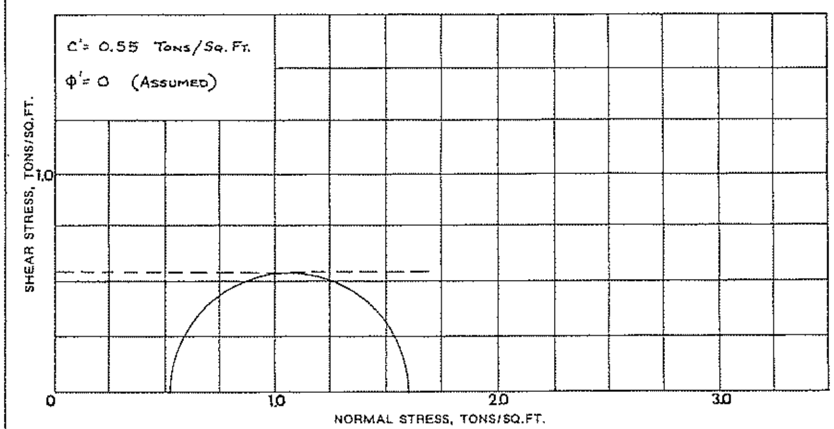
SUMMARY OF UNCONSOLIDATED-UNDRAINED TRIAXIAL TEST RESULTS

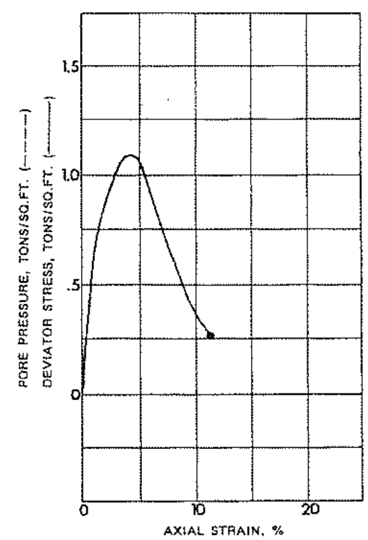
Boring No.	Depth, ft	Total Confining Pressure, tsf	Dry Density, lbs/cu.ft	Moisture Content, %	c (For Ø=0), tons/sq.ft	Remarks
41A	8.0-10.0	0.53	102.6	20.9	0.55	Small hole noted in membrane after test
43A	8.0-10.0	0.53	98.1	25.6	0.54	
45A	9.0-11.0	0.60	113.1	16.9	1.05	
46A	18.0-19.9	0.95	96.8	26.6	0.56	
50A	19.0-21.0	0.90	88.6	34.1	0.37	
32	0.0-7.0	1.41	104.6	19.3	0.85	Sample recompacted from disturbed Bag Sample at approx. 90% of modified Proctor maximum dry density
32	0.0-7.0	1.41	109.5	14.9	8.85 *	Sample recompacted from disturbed Bag Sample at approx. 95% of modified Proctor maximum dry density
32	0.0-7.0	1.41	108.5	20.1	3.38 **	Sample recompacted from disturbed Bag Sample at approx. 95% of modified Proctor maximum dry density

Note: All tests performed at a strain rate of approximately 1.0 percent per minute.

* Unconfined compressive strength for similarly recompacted sample - 10.49 tons/sq.ft

** Unconfined compressive strength for similarly recompacted sample - 5.37 tons/sq.ft





PROJECT NO.: E-7566					
BORING NO.: 41 A	DEPTH: 8.0-10.0				
LIQUID LIMIT: 41	PLASTIC LIMIT: 16				
SOIL CLASSIFICATION: CL					
TYPE OF TEST: Unconsolidated - Undrained					
RATE OF STRAIN: 1.0 % / Min.					
TEST DESIGNATION		●	■	▼	○
INITIAL	WATER CONTENT, %	20.9			
INITIAL	DRY DENSITY, PCF	102.6			
INITIAL	SAMPLE HEIGHT, IN.	5.60			
INITIAL	SAMPLE DIAMETER, IN.	2.84			
FINAL BACK PRESSURE, TSF		—			
TOTAL CONSOLIDATION PRESSURE, TSF		—			
TOTAL CONFINING PRESSURE, TSF		0.53			
FINAL WATER CONTENT, %		—			
REMARKS: Small Hole Noted In Membrane After Test.					

TRIAXIAL TEST RESULTS

ATEC ASSOCIATES

TX-1

APPENDIX C – Conversion of Blowcount to Soil Strength

Alliant Energy
Wisconsin Power and Light Company
Ottumwa Generating Station
Ottumwa, Iowa

Safety Factor Assessment

nt and procedure

ocedure of ASTM D-1586
revisions:
th 20-in.-long split bar-
g 30 blows per foot, 12-
of drive is permissible.
ch 6 in. of penetration.
ith water or drilling

s pumped from a central
d while the drawdown or
g from the well is ob-
piezometers or obser-
le 3 to 5 observation
easing intervals along
arated by 90° central

is raised or lowered
position and readings
vels at periodic inter-
equilibrium. Observa-
ead and time elapsed
n in Figure 4-3.

cased, open-end bore-
orehole with double
ch water flows out of
constant head is meas-
and procedures of

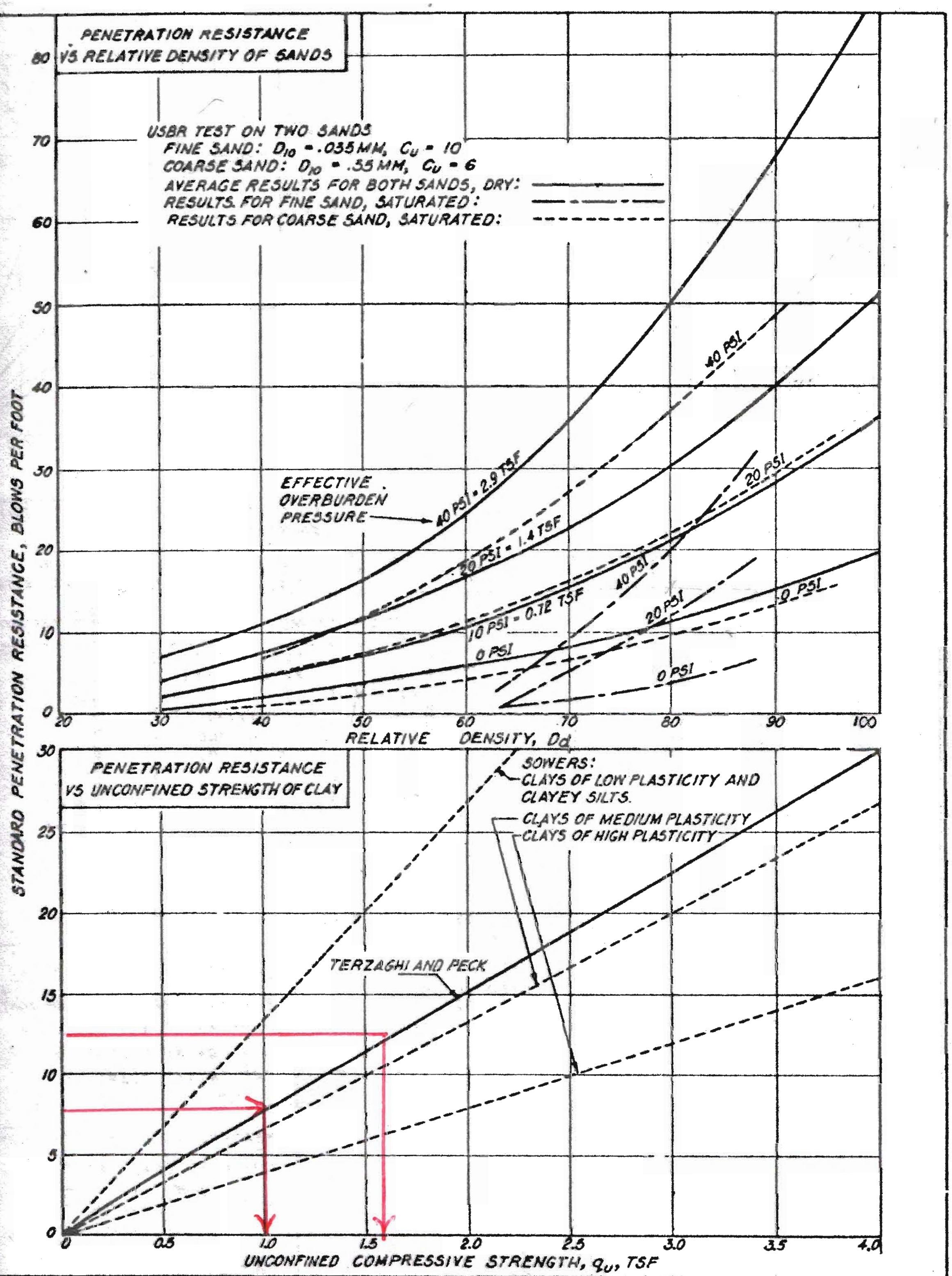
ws out of the uncased
taining a constant wa-
Use equipment and
ethod E-19.

sture content of soil
avated hole is deter-
me of hole by sand
uipment and proce-
0-45-302, Appendix

sture content is deter-
ed from a thin-wall
pressed into the
nd procedure of USCE
dix III.

ncased boreholes.

hole to determine
ctangular test pits



NATIVE CLAY SPT 8
EMBANKMENT CLAY SPT 12

FIGURE 4-2
Correlations of Standard Penetration Resistance

isticated shear tests a
satisfactorily approxi-
ication (Table 1-3 and
ction can be obtained
the laboratory. As fo
l conditions, triaxial

disturbed samples pro-
en as one-half the unc
n made between uncon
t (Section 3, Chapter
y disturbed in sampling
further useful when th

se soils are not well f
load. A practical,
cohesion is substantia
can be treated as a
shear tests. The acti
minations. Where the
rformed under drainag
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gth and its increase

nployed in determining
ohesionless soils.

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ed base course or a
ss earthwork, when
isture content that,

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han those provided b
niversally accepted.

s classified in the

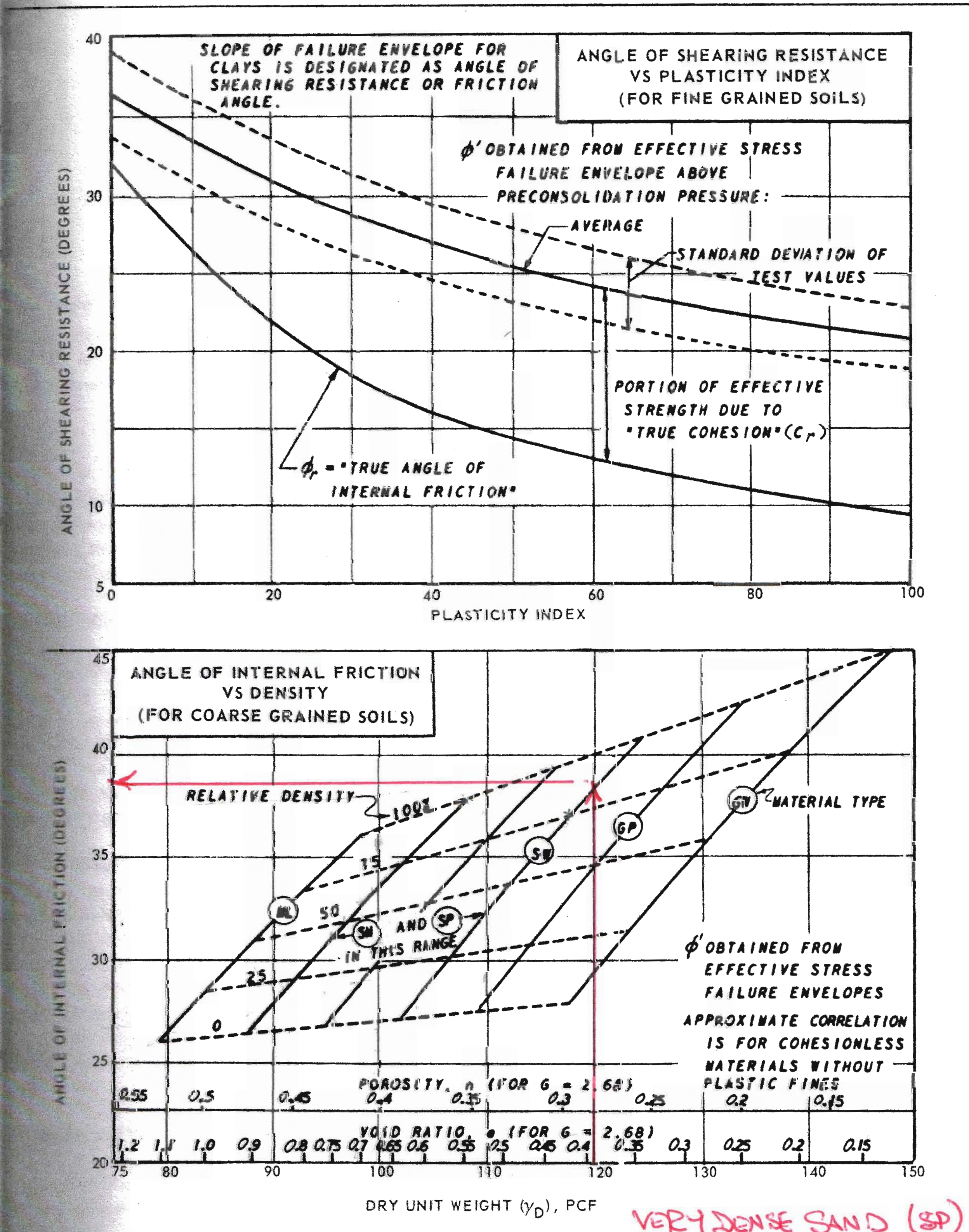


FIGURE 3-7

Correlations of Strength Characteristics

APPENDIX D – USGS Earthquake Design PGA

Alliant Energy
Wisconsin Power and Light Company
Ottumwa Generating Station
Ottumwa, Iowa

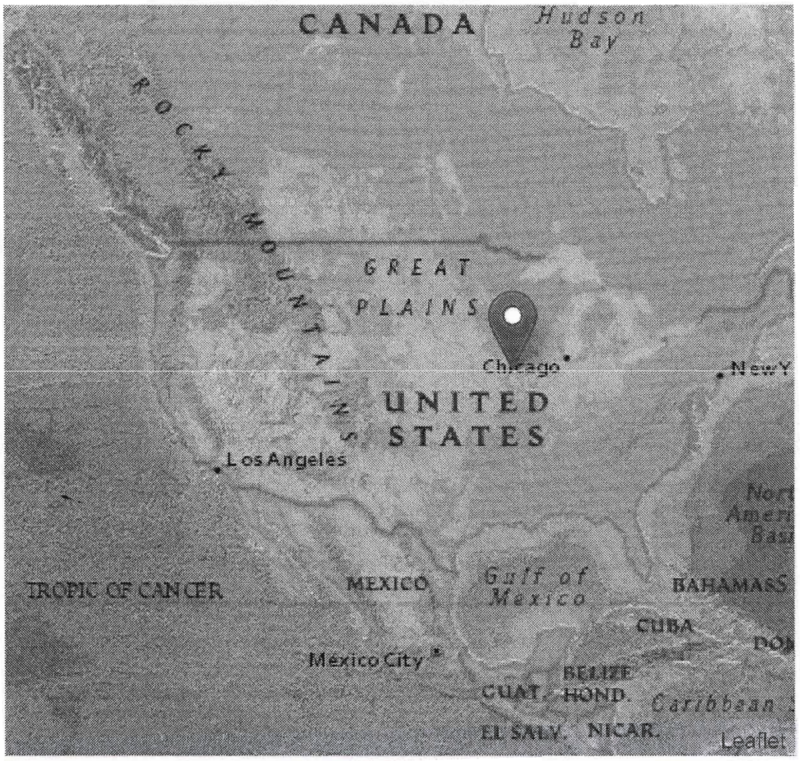
Safety Factor Assessment

U.S. Geological Survey - Earthquake Hazards Program

Ottumuwa Generating Station

Latitude = 41.000°N, Longitude = 92.543°W

Location



Reference Document

2015 NEHRP Provisions

Site Class

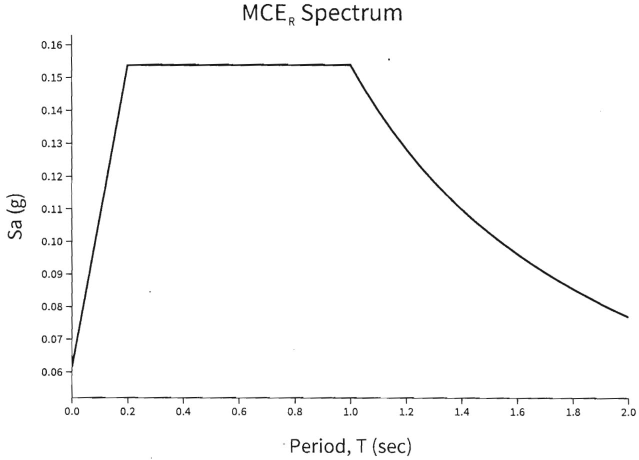
D (determined): Stiff Soil

Risk Category

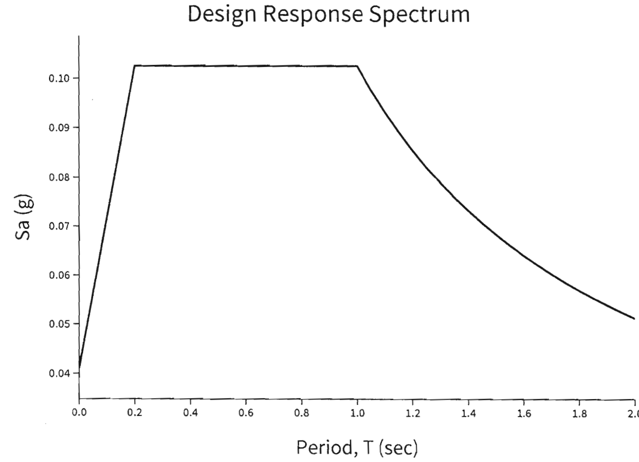
I or II or III

S_S =	0.078 g	S_{MS} =	0.124 g	S_{DS} =	0.083 g
S_1 =	0.064 g	S_{M1} =	0.154 g	S_{D1} =	0.103 g

MCE_R Spectrum



Design Response Spectrum



Since $S_{MS} < S_{M1}$, for this response spectrum S_{MS} has been set equal to S_{M1} (and hence S_{DS} has

Mapped Acceleration Parameters, Long-Period Transition Periods, and Risk Coefficients

Note: The S_S and S_1 ground motion maps provided below are for the direction of maximmum 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) 1.3 (to obtain S_1).

- FIGURE 22-1 S_S Risk-Targeted Maximum Considered Earthquake (MCE_R) Ground Motion Parameter for the Conterminous United States for 0.2 s Spectral Response Acceleration (5% of Critical Damping), Site Class B
- FIGURE 22-2 S_1 Risk-Targeted Maximum Considered Earthquake (MCE_R) Ground Motion Parameter for the Conterminous United States for 1.0 s Spectral Response Acceleration (5% of Critical Damping), Site Class B
- FIGURE 22-9 Maximum Considered Earthquake Geometric Mean (MCE_G) PGA, %g, Site Class B for the Conterminous United States
- FIGURE 22-14 Mapped Long-Period Transition Period, T_L (s), for the Conterminous United States
- FIGURE 22-18 Mapped Risk Coefficient at 0.2 s Spectral Response Period, C_{RS}
- FIGURE 22-19 Mapped Risk Coefficient at 1.0 s Spectral Response Period, C_{R1}

Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site class as Site Class , 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 $w \geq 40\%$, 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 $1 lb/ft^2 = 0.0479 kN/m^2$			

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

Table 11.8-1: Site Coefficient for F_{PGA}

Site Class	Mapped MCE Geometric Mean (MCE_G) Peak Ground Acceleration					
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA = 0.50	PGA ≥ 0.60
A	0.8	0.8	0.8	0.8	0.8	0.8
B (measured)	0.9	0.9	0.9	0.9	0.9	0.9
B (unmeasured)	1.0	1.0	1.0	1.0	1.0	1.0
C	1.3	1.2	1.2	1.2	1.2	1.2
D (determined)	1.6	1.4	1.3	1.2	1.1	1.1
D (default)	1.6	1.4	1.3	1.2	1.2	1.2
E	2.4	1.9	1.6	1.4	1.2	1.1
F	See Section 11.4.7					

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

Note: Where Site Class D is selected as the default site class per Section 11.4.2, the value of F_{pga} shall not be less than 1.2.

For Site Class = D (determined) and PGA = 0.037 g, F_{PGA} = 1.600

Mapped MCE_G

$PGA = 0.037$ g

Site-adjusted MCE_G

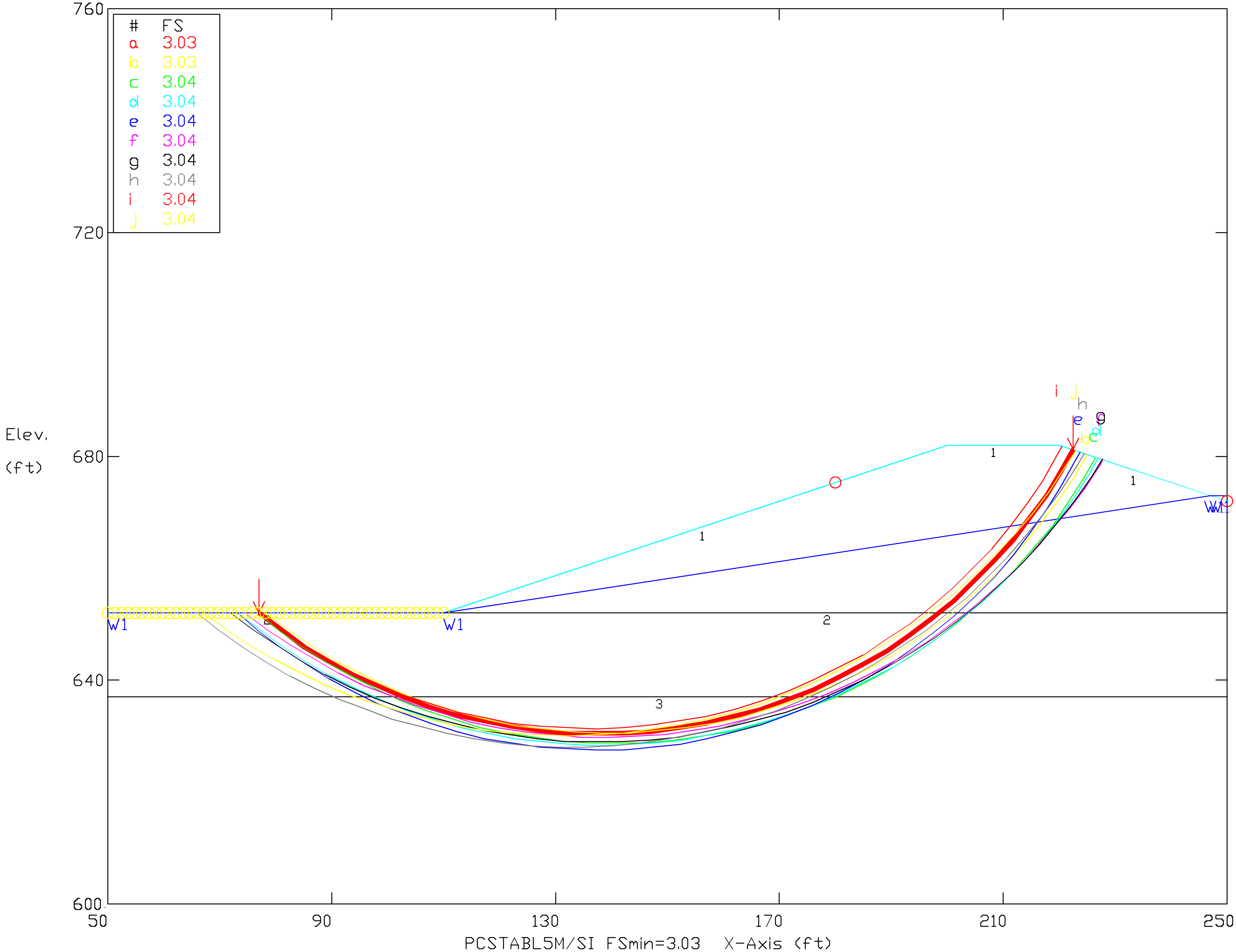
$PGA_M = F_{PGA} PGA = 1.600 \times 0.037 = 0.058$ g

APPENDIX E – Slope Stability Analysis

Alliant Energy
Wisconsin Power and Light Company
Ottumwa Generating Station
Ottumwa, Iowa

Safety Factor Assessment

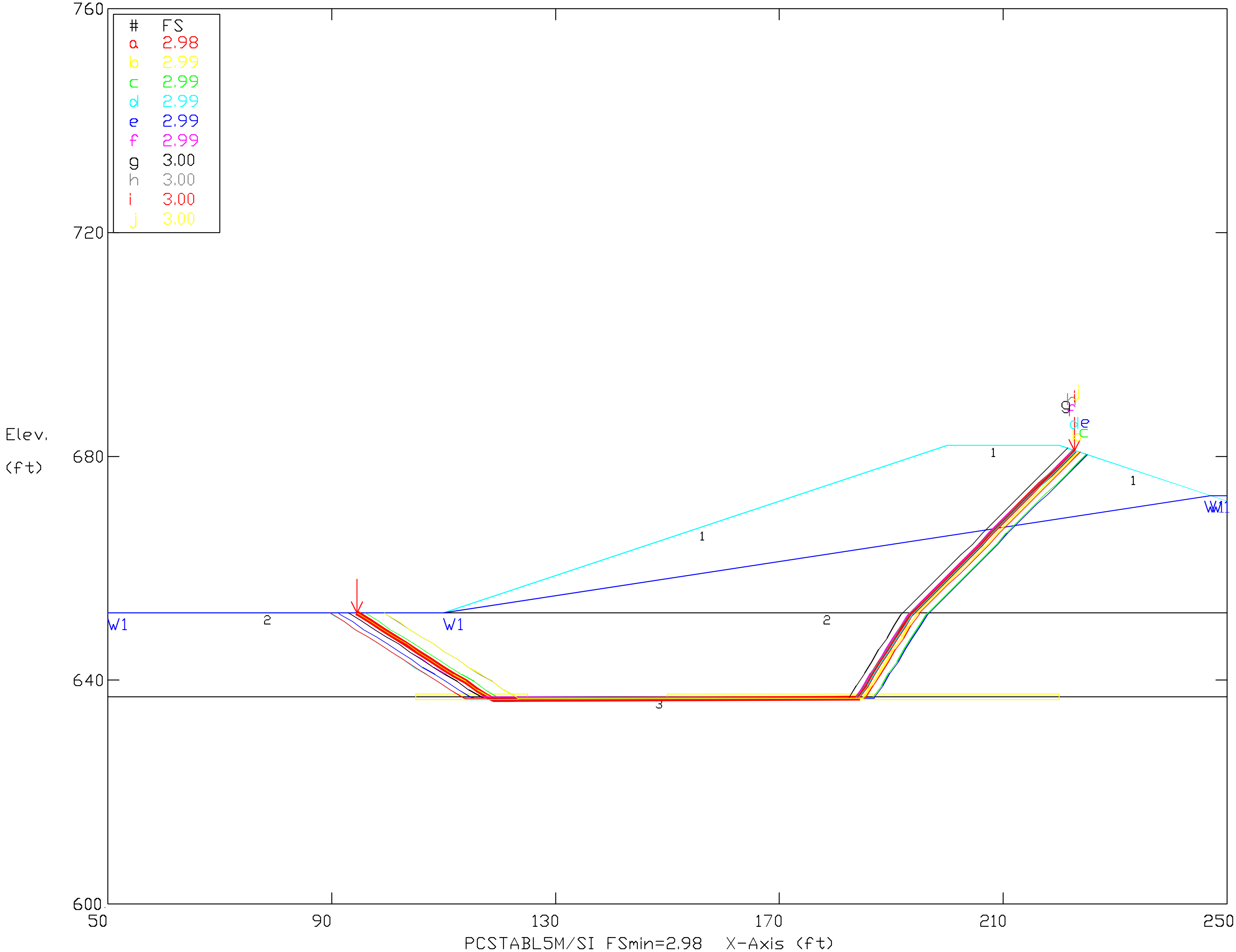
OGS ZLD Impoundment Outer Dike Static Case & Normal Water Levels
Ten Most Critical. E:OGS11C.PLT 08-24-16 4:42pm



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 Dike	125	125	1600	0	0	0	W1
2 Clay	115	115	1000	25	0	0	W1
3 Sand	125	125	0	38	0	0	W1

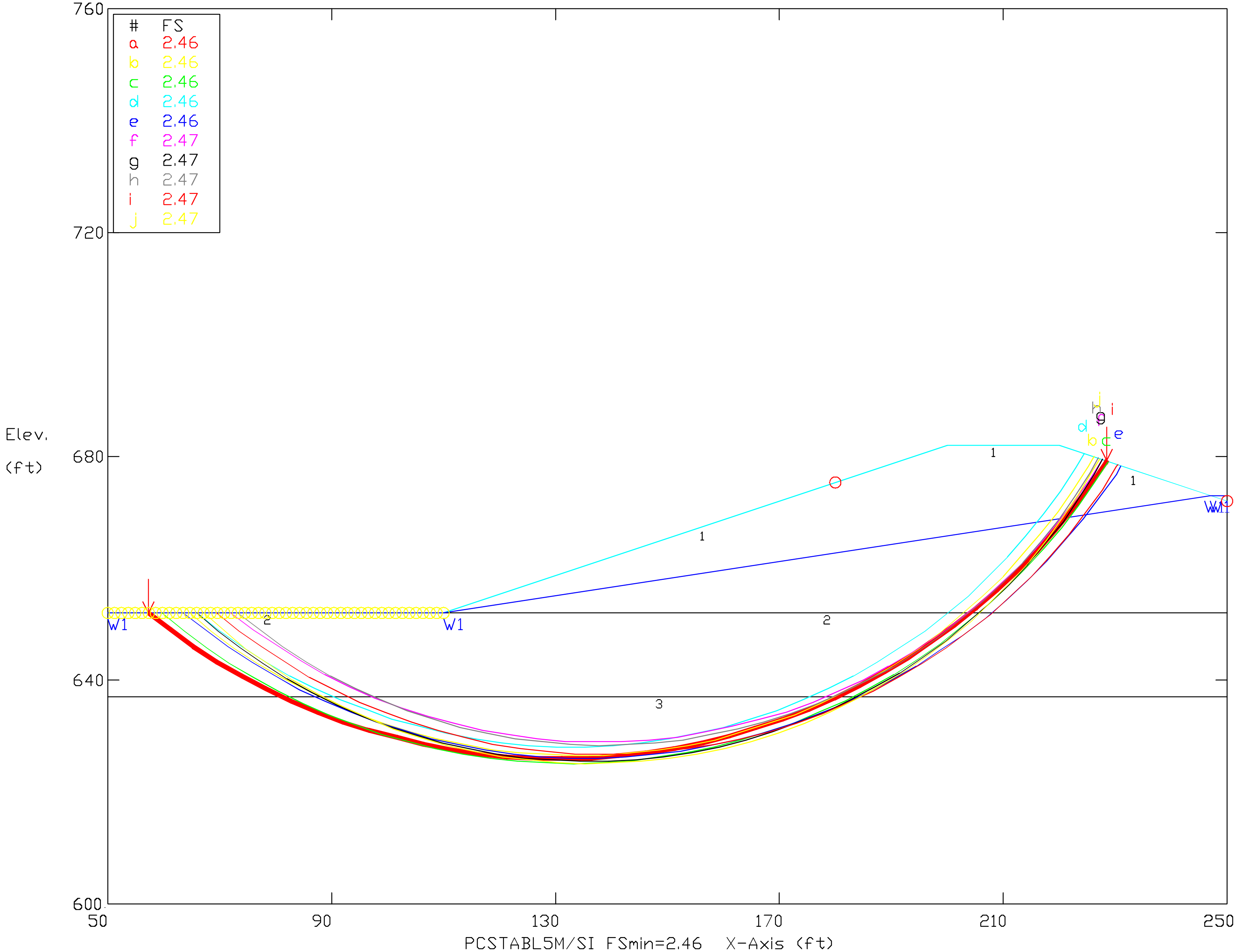
□GS ZLD Impoundment □uter Dike Static Case & Normal Water Levels

Ten Most Critical. E:□GS11B.PLT 08-24-16 4:52pm



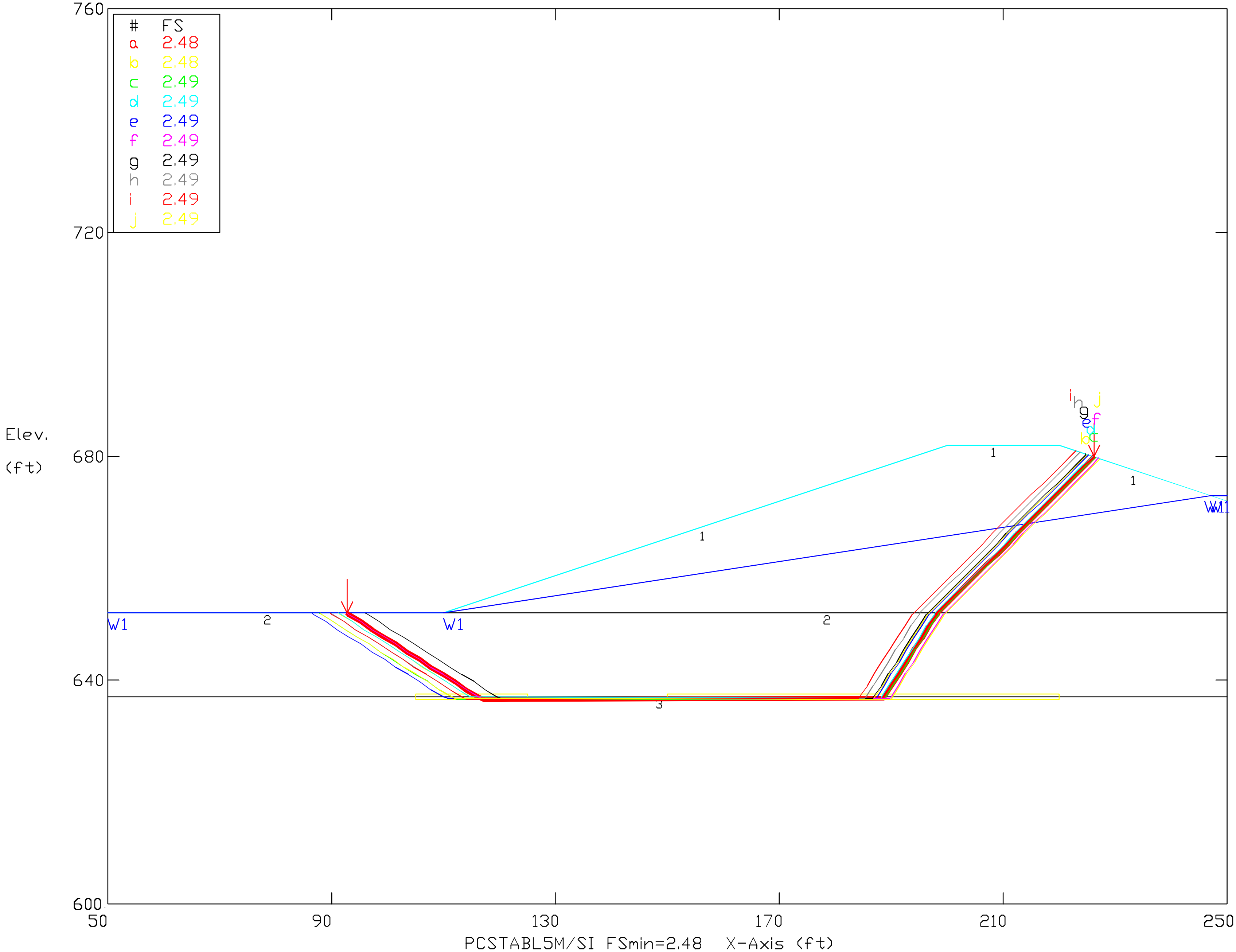
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Dike	125	125	1600	0	0	0	W1
2 Clay	115	115	1000	25	0	0	W1
3 Sand	125	125	0	38	0	0	W1

OGS ZLD Impoundment Outer Dike Earthquake Case & Normal Water Levels
Ten Most Critical. E:OGS11CEQ.PLT 08-24-16 5:14pm



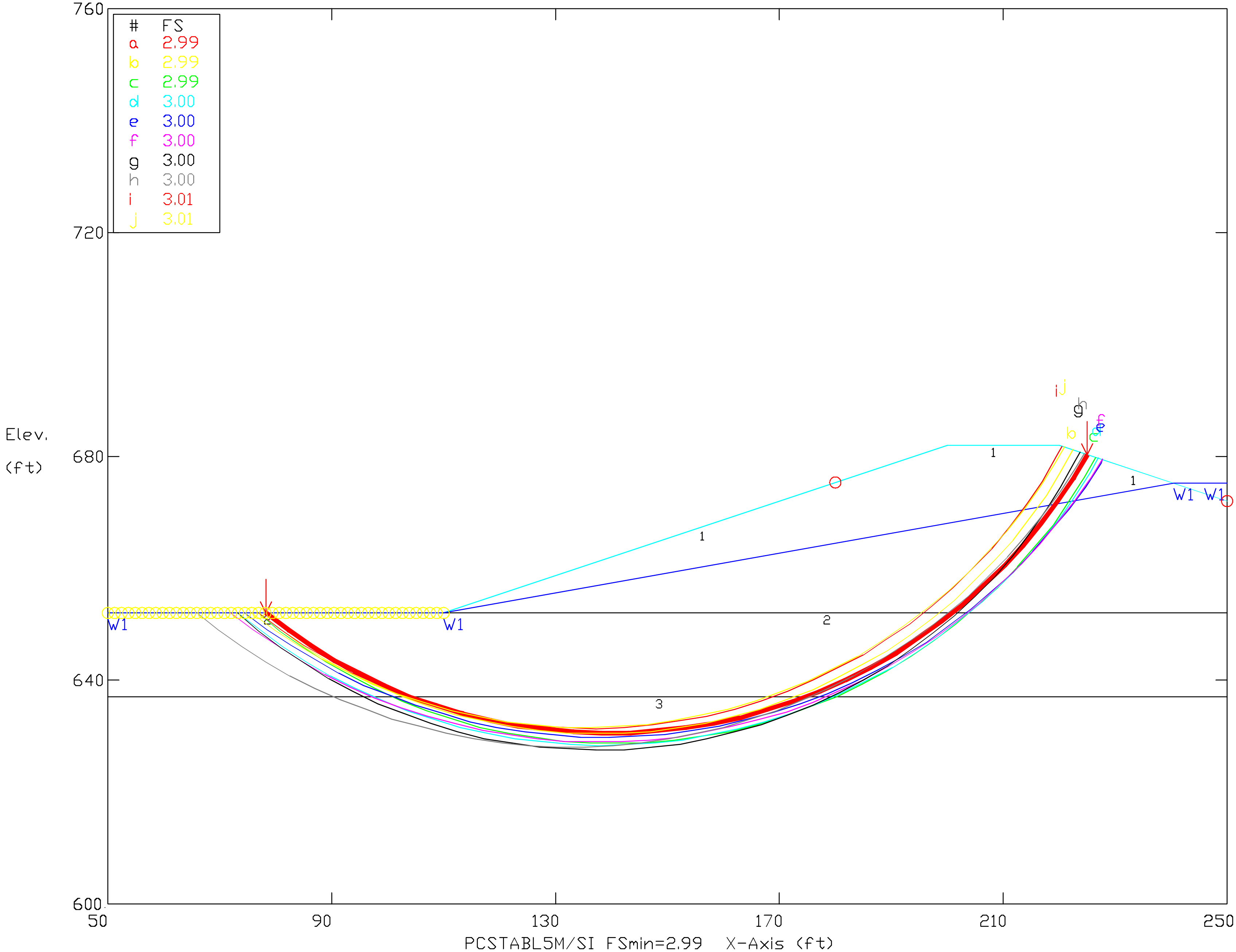
Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Dike	125	125	1600	0	0	0	W1
2	Clay	115	115	1000	25	0	0	W1
3	Sand	125	125	0	38	0	0	W1

OGS ZLD Impoundment Outer Dike Earthquake Case & Normal Water Lev
Ten Most Critical. E:OGS11BEQ.PLT 08-24-16 5:15pm



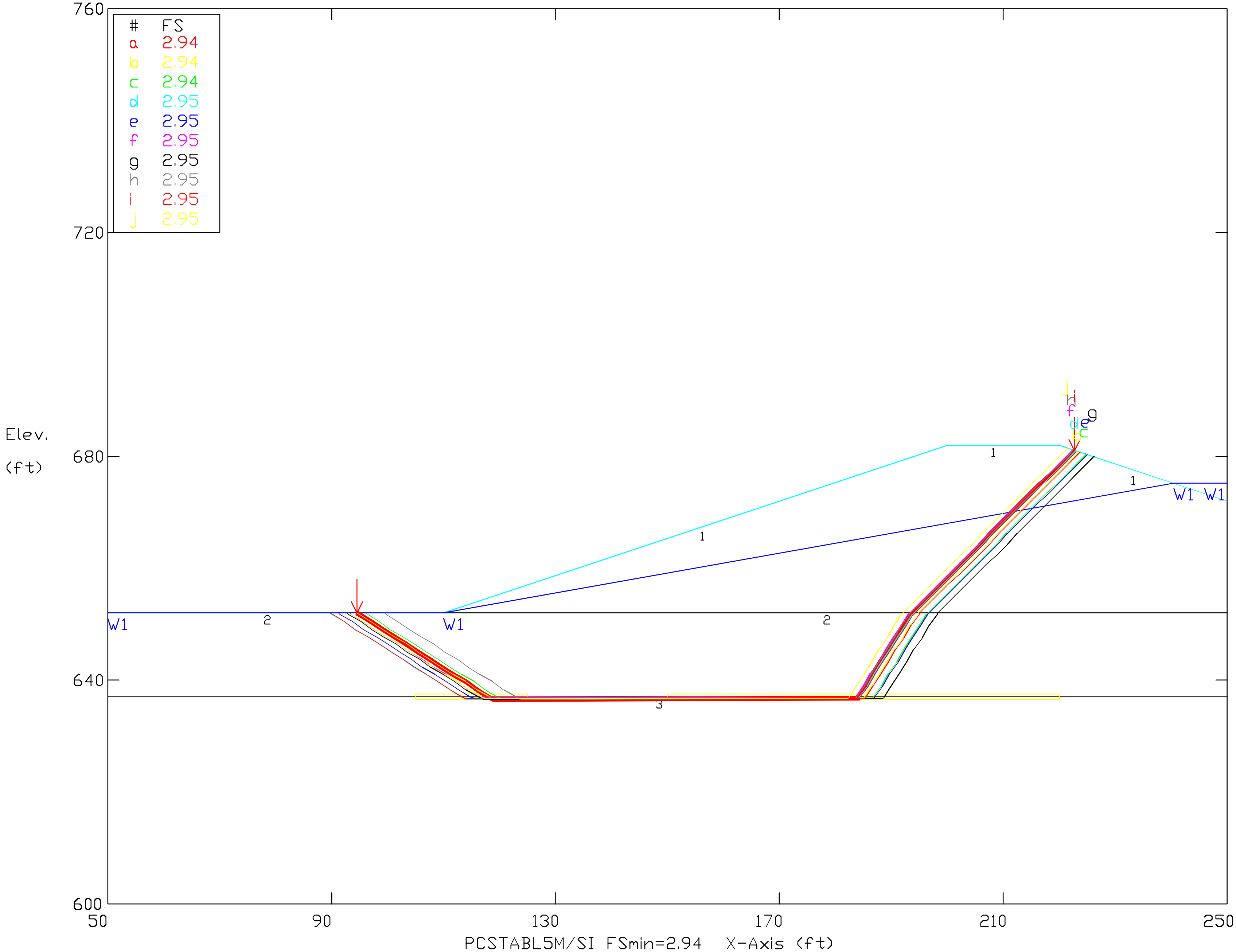
Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Dike	125	125	1600	0	0	0	W1
2	Clay	115	115	1000	25	0	0	W1
3	Sand	125	125	0	38	0	0	W1

□GS ZLD Impoundment □uter Dike Static Case & 100-Year Water Levels
Ten Most Critical. E:□GS12C.PLT 08-24-16 5:29pm



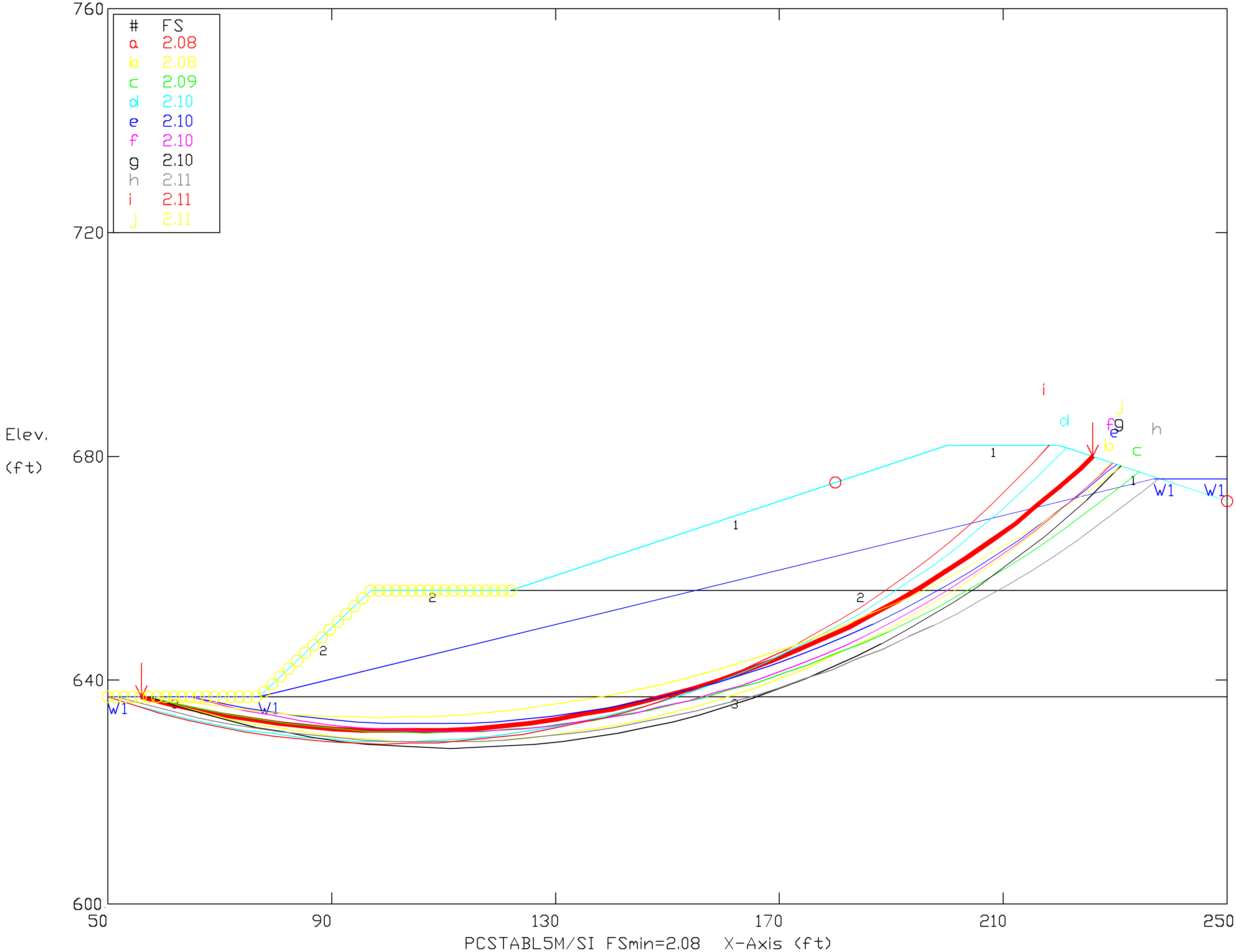
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Dike	125	125	1600	0	0	0	W1
2 Clay	115	115	1000	25	0	0	W1
3 Sand	125	125	0	38	0	0	W1

OGS ZLD Impoundment Outer Dike Static Case & 100-Year Water Levels
Ten Most Critical. E:OGS12B.PLT 08-24-16 5:33pm



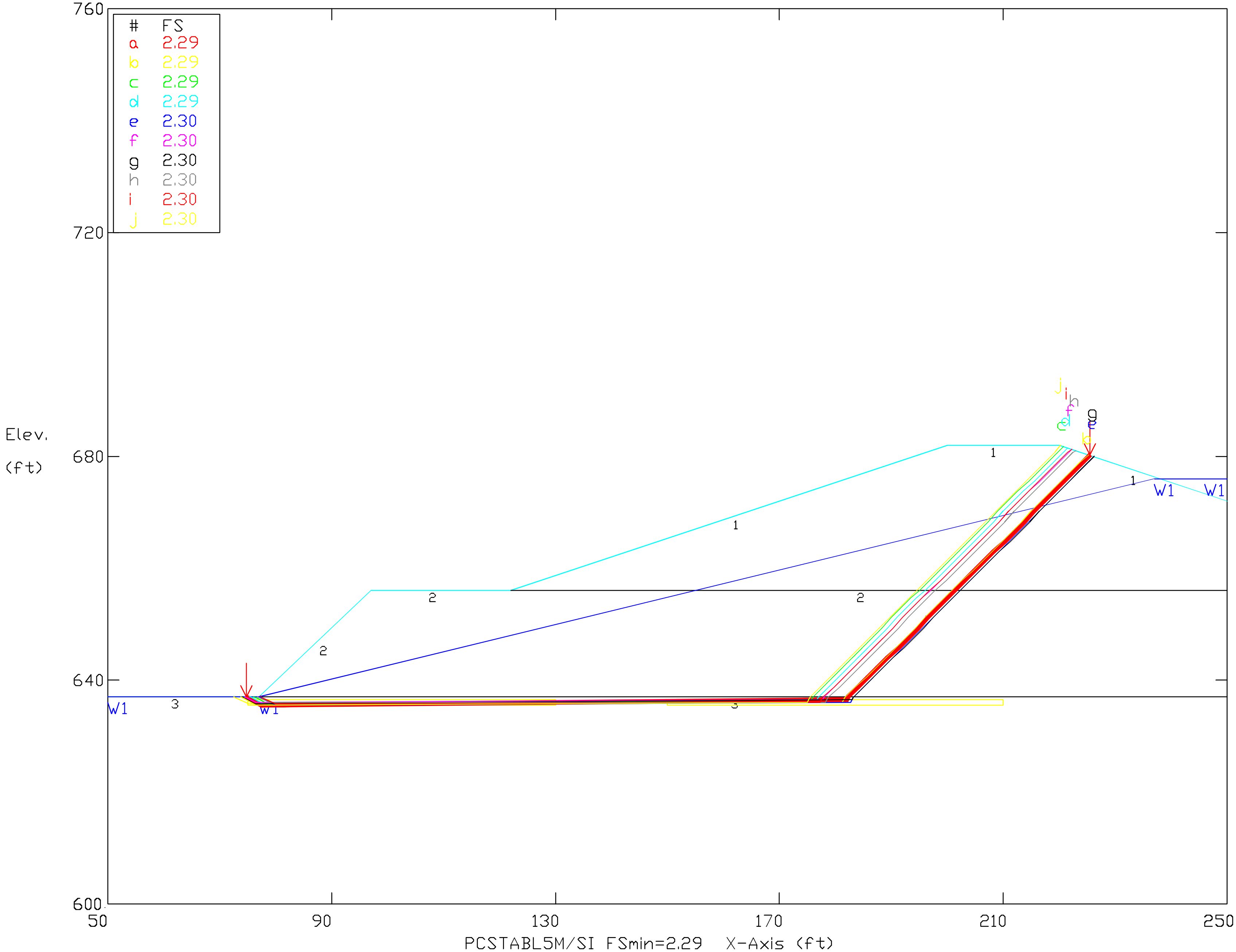
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Dike	125	125	1600	0	0	0	W1
2 Clay	115	115	1000	25	0	0	W1
3 Sand	125	125	0	38	0	0	W1

OGS Settling Impoundment Outer Dike Static Case & Normal Water Levels
Ten Most Critical. E:OGS21C.PLT 08-24-16 5:35pm



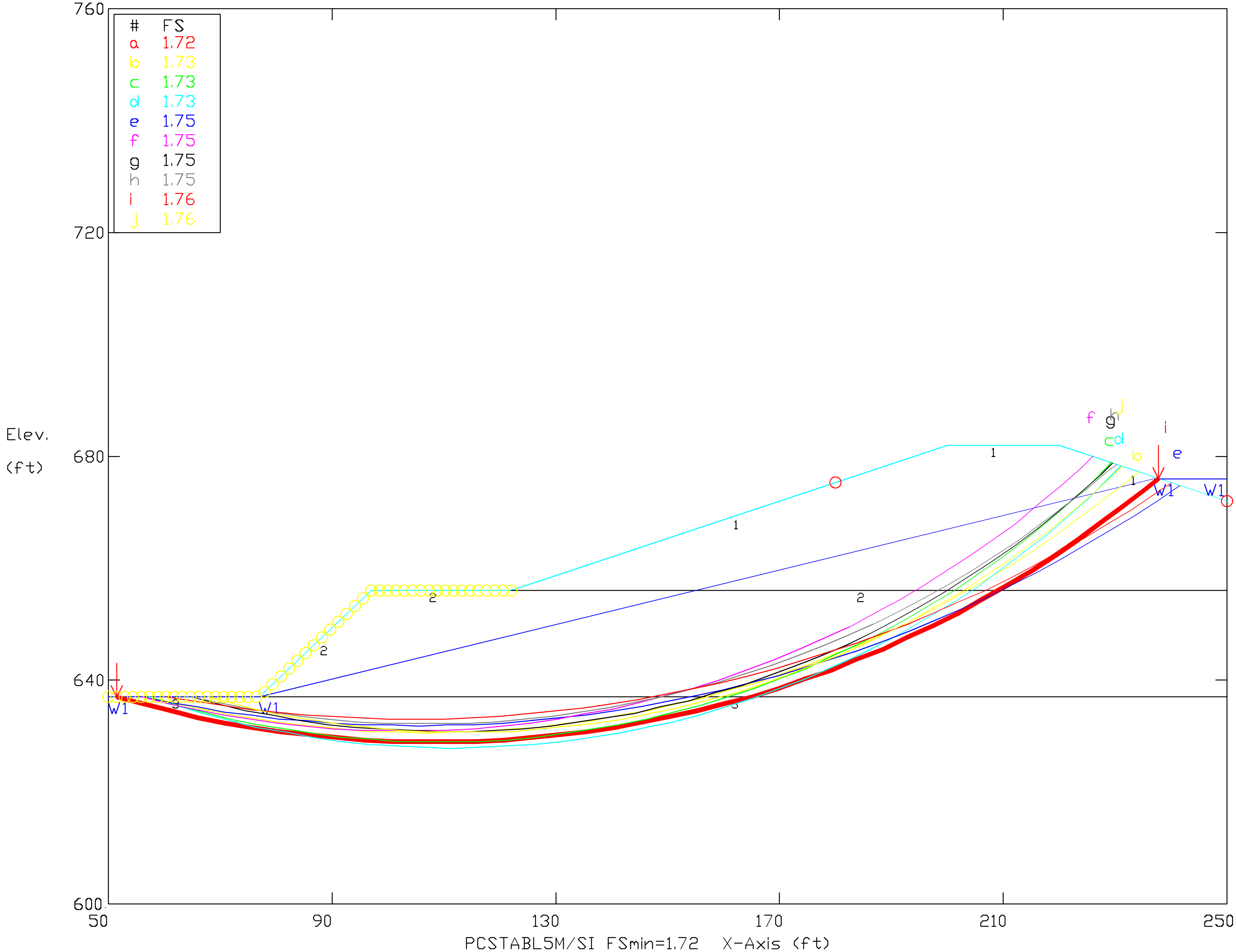
Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Clay	125	125	1600	0	0	0	W1
2	Clay	115	115	1000	0	0	0	W1
3	Sand	125	125	0	38	0	0	W1

OGS Settling Impoundment Outer Dike Static Case & Normal Water Levels
Ten Most Critical. E:OGS21B.PLT 08-24-16 7:10pm



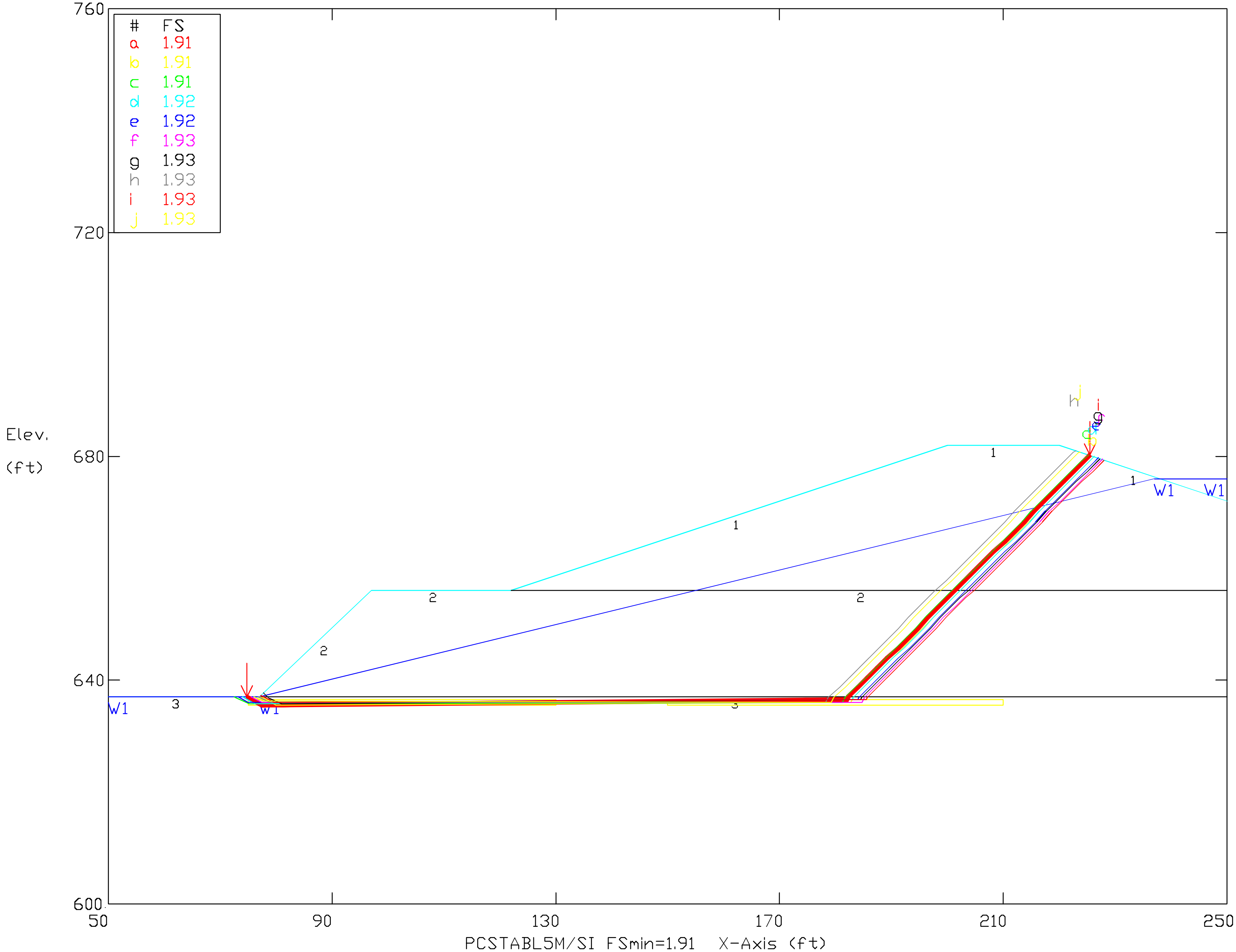
Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Clay	125	125	1600	0	0	0	W1
2	Clay	115	115	1000	0	0	0	W1
3	Sand	125	125	0	38	0	0	W1

OGS Settling Impoundment Outer Dike Earthquake Case & Normal Water Levels
Ten Most Critical. E:OGS21CEQ.PLT 08-24-16 7:19pm



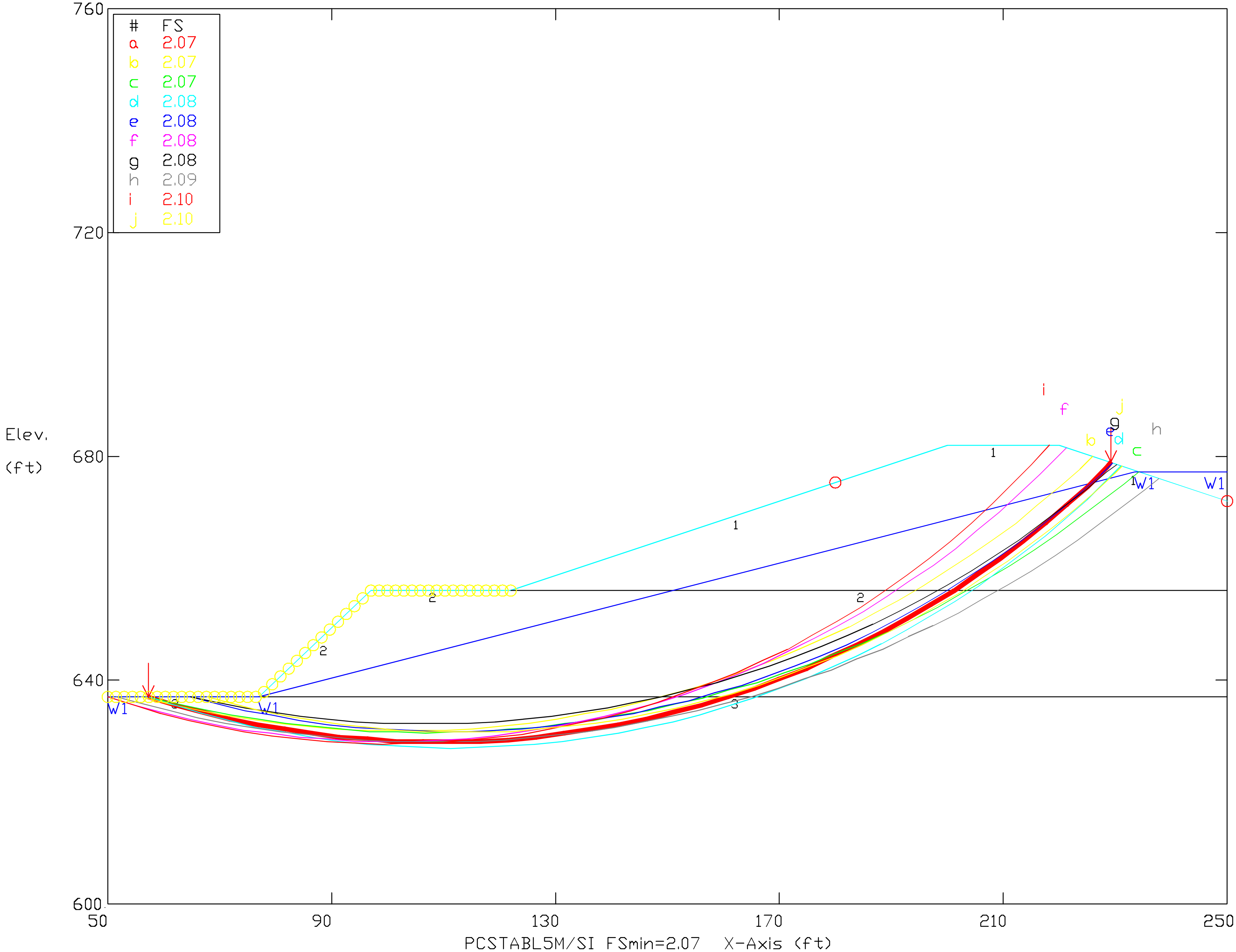
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Clay	125	125	1600	0	0	0	W1
2 Clay	115	115	1000	0	0	0	W1
3 Sand	125	125	0	38	0	0	W1

OGS Settling Impoundment Outer Dike Earthquake Case & Normal Water Levels
Ten Most Critical. E:OGS21BEQ.PLT 08-24-16 7:15pm



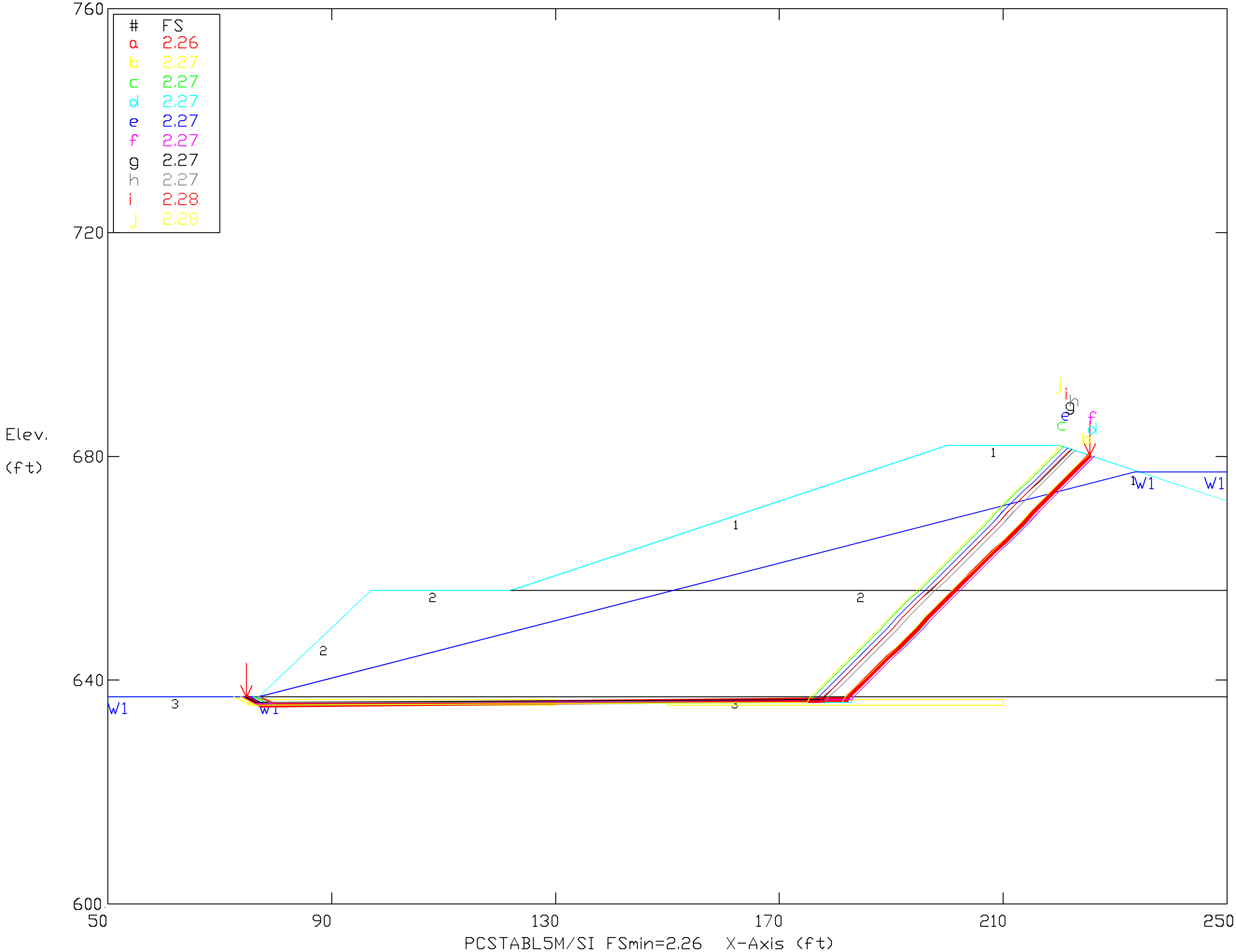
Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Clay	125	125	1600	0	0	0	W1
2	Clay	115	115	1000	0	0	0	W1
3	Sand	125	125	0	38	0	0	W1

OGS Settling Impoundment Outer Dike Static Case & 100-Year Water Levels
Ten Most Critical. E:OGS22C.PLT 08-24-16 7:23pm



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	1600	0	0	0	W1
2	Clay	115	115	1000	0	0	0	W1
3	Sand	125	125	0	38	0	0	W1

□GS Settling Impoundment □uter Dike Static Case & 100-Year Water Levels
Ten Most Critical. E:□GS22B.PLT 08-24-16 7:27pm



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	1600	0	0	0	W1
2	Clay	115	115	1000	0	0	0	W1
3	Sand	125	125	0	38	0	0	W1