ALLIANT ENERGY
Interstate Power and Light
Lansing Generating Station

CCR SURFACE IMPOUNDMENT

SAFETY FACTOR ASSESSMENT

Report Issued: September 2, 2016
Revision 0

HARD HAT SERVICES™
Engineering, Construction and Management Solutions

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 Lansing Generating Station in Lansing, Iowa 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 Lansing Generating Station (LAN) in Lansing, Iowa (Figure 1) has one existing CCR surface impoundment, identified as LAN Upper Ash Pond

The identified existing CCR surface impoundment meets the requirements of §257.73(b)(1) and/or §257.73(b)(2), therefore is subject to the periodic safety factor assessment requirements of §257.73(e) of the CCR Rule.

2 FACILITY DESCRIPTION

LAN is located approximately three miles southeast of Lansing, Iowa on the western shore of the Mississippi River in Allamakee County, at 2320 Power Plant Drive, Lansing, Iowa (Figure 1).

LAN is a fossil-fueled electric generating station that has used four steam turbine electric generating units throughout its history. Unit 1, Unit 2, and Unit 3 were retired by 2014 and Unit 4 is the only operating unit. Sub-bituminous coal is the primary fuel for producing steam at LAN. The CCR at LAN is categorized into three types: bottom ash, fly ash, and scrubber byproduct. Fly ash is collected by electrostatic precipitators and pneumatically conveyed to an onsite fly ash silo, which is equipped with a baghouse for dust control. The fly ash is then either transported off-site for beneficial reuse, landfilled (in the case of high loss on ignition), or sluiced to LAN Upper Ash Pond (typically during startup and shutdown). Bottom ash is sluiced to a surface impoundment identified as the LAN Upper Ash Pond, Figure 2, where it is dredged, dewatered, and transported to the onsite landfill. The LAN Upper Ash Pond is located south of the generating plant and is the only existing CCR surface impoundment. Scrubber byproduct consists of fly ash, unreacted lime, and activated carbon. Scrubber byproduct is collected in the byproduct silo prior to being landfilled.

A previous CCR surface impoundment at LAN, identified as the Lower Ash Pond, was located west of the generating plant and north of Power Plant Drive. The Lower Ash Pond was closed in September 2015 by removing the CCR from the surface impoundment via hydraulic dredge and sluicing the CCR to the south end of the LAN Upper Ash Pond. CCR was removed from the Lower Ash Pond prior to backfilling the surface impoundment.

General Facility Information:

Date of Initial Facility Operations:	1946
NPDES Permit Number:	IA0300100

Latitude / Longitude:	41°56’38.43”N 91°38’22.39”W
Nameplate Ratings:	Unit 1 (1948): 16.6 MW (Retired)
	Unit 2 (1949): 11.4 MW (Retired)
	Unit 3 (1957): 35.8 MW (Retired)
	Unit 4 (1977): 270 MW

2.1 LAN Upper Ash Pond

The LAN Upper Ash Pond is located southwest of the generating plant and south of Power Plant Drive. The LAN Upper Ash Pond receives influent flows from the Unit 4 boiler floor sumps, water treatment sumps, fly ash hydroveyor system, storm water runoff from the active dry ash landfill and hillside east of the impoundment, as well as sluiced fly ash and bottom ash. The LAN Upper Ash Pond is the only receiver of sluiced CCR at LAN. The CCR is sluiced from the generating plant to the south east corner of the LAN Upper Ash Pond, Figure 2. The sluiced CCR discharges into the southeast corner of the LAN Upper Ash Pond where the majority of the CCR settles. Ongoing maintenance dredging is conducted in the southern portion of the LAN Upper Ash Pond. The dredged CCR is temporarily stockpiled and dewatered prior to being transported to the on-site active dry ash landfill located south of the LAN Upper Ash Pond.

The sluiced water that is discharged into the LAN Upper Ash Pond flows to the west prior to flowing north through a series of five interconnected settling ponds separated by intermediate dikes. The intermediate dikes have 30-inch diameter corrugated metal pipes on the west and east sides, which hydraulically connects the five settling ponds. The water from each settling pond flows north until it enters the fifth large open settling pond area of the LAN Upper Ash Pond. The north end of the LAN Upper Ash Pond has a concrete wet well and overflow weir structure that controls the LAN Upper Ash Ponds water level, and is identified as Weir Box #1. The water in the LAN Upper Ash Pond overflows a stop log weir into Weir Box #1 and then through a 146 foot long 24 inch diameter corrugated metal pipe, under Power Plant Drive, and into Weir Box #2. The water leaves Weir Box #2 through a 225 foot long, 24-inch diameter high density polyethylene pipe, which connects Weir Box #2 to Weir Box #3. The water flows through

Weir Box #3 in the backfilled former Lower Ash Pond. The water flows through Weir Box #3 and discharges to the west through a 77 foot long, 24-inch diameter corrugated metal pipe into Unnamed Creek #1. Unnamed Creek #1 flows to the north into Unnamed Creek #2 which then discharges into the Mississippi River. The National Pollution Discharge Elimination System (NPDES) Outfall 002 monitoring location, which consists of flow monitoring instrumentation, is located at Weir Box #1 and compliance samples are collected from Weir Box #3.

The total surface area of the LAN Upper Ash Pond is approximately 11.5 acres and has an embankment height of approximately 20 feet from the crest to the toe of the downstream slope at its greatest height. The area of the entire CCR Unit inclusive of the impoundment and the dredging and dewatering areas is approximately 17 acres. The interior storage depth of the LAN Upper Ash Pond is approximately 28 feet. The volume of impounded CCR and water within the LAN Upper Ash Pond is approximately 587,000 cubic yards.

3 SAFETY FACTOR ASSESSMENT- §257.73(e)

This Report evaluates whether 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 soil. In the case of cohesionless soil (gravel, sand and silt) the values are the same. For clay the total stress value is cohesion only. At the LAN Upper Ash Pond only cohesionless soil is present in and under the embankments.

3.1.1 Soil Conditions In and Under the Impoundment

The LAN Upper Ash Pond is constructed in the valley of Unnamed Creek #1 south of the LAN Generating Station. The Unnamed Creek #1 was rerouted to the west side of the

---

[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

valley in the northern half of the LAN Upper Ash Pond when the impoundment was constructed in 1974. At the north end of the LAN Upper Ash Pond, Unnamed Creek #1 drops over a manmade riffle structure under the Power Plant road Bridge losing approximately 14 feet of elevation to reach the elevation of Pool #9 of the Mississippi River. The drop structure prevents backwater flooding of the Mississippi River from encroaching on the toe of the LAN Upper Ash Pond embankment.

In early 2015, four soil borings were installed at the locations shown on Figure 2, to determine the types of and density of soil present in the embankments and foundation of the LAN Upper Ash Pond. The soil borings logs SB-1, SB-3, SB-5 and SB-7 including the penetration resistance measured by the Standard Split Spoon (SPT) (ASTM D 1556) are enclosed in Appendix A. The results of laboratory testing on selected soil samples for grain size, water content and Atterberg limits are shown in Appendix B.

The test results indicate that the embankment is constructed of uniform fine to medium sand (SP). The sand was compacted to medium dense to dense consistency as shown by the SPT results. Below the embankment, the two northern borings SB-1 and SB-7, Figure 2, show that a very loose to loose silt is present under the embankment overlying a medium dense gravel. In borings SB-3 and SB-5, Figure 2, the silt is thin and overlies the same gravel. The silt deposit in the two northern borings is from backwater deposition by the Mississippi River prior to the installation of the LAN Upper Ash Pond and the thin silt layer to the south is natural deposition from flooding of the Unnamed Stream #1. The Iowa Bedrock Survey Map available from the Iowa Geology and Water Survey, July 2013 indicates that bedrock is at elevation 564 (depth of 90 feet below top of embankment) in the northern part of the LAN Upper Ash Pond and rises in elevation moving south up the valley of the Unnamed Stream #1.

A cement-bentonite slurry wall was installed in the West embankment of the LAN Upper Ash pond in the summer of 2015. The cement-bentonite wall prevents water from the LAN Upper Ash Pond from flowing through the embankment sand and discharging as surface seepage at the toe of the embankment. During installation of the wall it was observed that the sand below the normal water elevation in the embankment had higher strength than sand above the water table likely due to cementation of the sand particles by calcium hydroxide in the impoundment water. The observation was used along with the SPT values in the boring logs to assign soil properties to the embankment and foundation soils using NAVFACS DM-7[2]. The internal friction angles selected based on the SPT results are:

Soil Type	Internal Friction Angle	Total Unit Weight (lb/ft3)
Embankment Sand above GW	32	110
Embankment Sand below GW	36	108
River Silt	26	100
Valley Gravel	35	120

The ground water elevation in the embankment is monitored by piezometers installed on both sides of the cement-bentonite wall in 2015. The monitoring results show that the water elevation in the embankment drops 17 feet across the cement-bentonite cut off wall at the north end of the west embankment.

3.1.2 Design Water Surface in Impoundment: Maximum Normal Pool and Maximum Pool Under Design Inflow Storm

The LAN Upper Ash Pond water elevation is controlled by stop logs in the overflow structure, Weir Box #1, Figure 2. The normal pool is elevation 648.75 feet that occurs when operating with stop logs installed to elevation 648 feet and with the normal process water flow to the LAN Upper Ash Pond of 8.0 cubic feet per second.

During passage of the 1,000 year return period design storm, the impoundment elevation rises to elevation 652.5 feet according to the Inflow Flood Control Plan (a separate document developed to comply with40 CFR 257.82). The rise in pool elevation during

---

[2] Naval Facilities Engineering Command Design Manual DM-7, Figure 3-7 “Density versus Angle of Internal Friction for Cohesionless Soils”, March 1971

the storm flow is 3.75 feet with a remaining freeboard of 1.5 feet on the minimum crest elevation of 654.

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 station. The peak ground acceleration (PGA) value is selected for a 2% probability of exceedance in 50 years (2500 year return period) as required by 40 CFR 257.53. Since the site soils with the exception of the river silt layer are medium dense to dense sand and gravel and extend to bedrock at 90 feet, 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 0.044 g, Appendix C.

3.1.4 Liquefaction Assessment Method and Parameters

Certain soils may have zero effective stress (liquefaction) during an earthquake 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 embankment sand, river silt and valley gravel are measured by the SPT results shown on the borings in Appendix A.

The test results for SB-1 located on the west embankment, Figure 1, at the highest embankment height and with the lowest river silt strength measured indicate the silt is very loose (blowcounts weight of rod only).

The simplified assessment of liquefaction procedure as first proposed by Seed and most recently updated and published by Idriss and Boulanger[3] is used to assess the potential for liquefaction of the river silt. The procedure uses the strengths determined by the SPT test, adjusted to normalize for overburden pressure and for fines content, to determine

---

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

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[4]. The cyclic stress ratio caused by the design surface PGA is then used to determine the actual cyclic 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 SB-1 at the north end of the west embankment of the LAN Upper Ash Pond is shown in Appendix C. The results indicate that the river silt layer will not liquefy during the site design earthquake.

3.2 LAN Upper Ash Pond

The LAN Upper Ash Pond is incised on the east and south sides of the impoundment. The north and west sides the impoundment is created by construction of medium to fine sand embankments reported to be sand from maintenance dredging of the Mississippi River. All of the embankments have the same outer slope of 3 horizontal to 1 vertical. The southern end of the west embankment has lower embankment height and sits on more competent foundation soil and is not the critical section of the embankment.

The northern embankment and the north half of the west embankment sit on a layer of loose to very loose river silt. After closure of the former LAN Lower Ash Pond, the north embankment height was reduced and has more confinement on the river silt layer than the west embankment. In addition, the north embankment has a much wider crest to accommodate Power Plant Road.

For all of the above reasons, the west embankment in the vicinity of boring SB-1 is the critical embankment slope for the LAN Upper Ash Pond, Figure 2.

---

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

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

The critical cross-section is analyzed with the maximum storage pool under normal operations at elevation 649 feet (648.75 feet rounded up). Analysis for both a circular and block sliding surface, Appendix D, show a minimum factor of safety of 1.8 for both the circular and block slide surface.

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

The LAN Upper Ash Pond storm water flow with the design 1,000 year return flow is elevation 653 feet (652.5 feet rounded up). The increase in water elevation is considered with Unnamed Stream #1 flowing at bank full capacity under the assumption that it would be transmitting rainfall from the same storm event. Analysis for both a circular and block slide surface, Appendix D, show a minimum factor of safety of 1.7 for a block slide surface.

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

The LAN Upper Ash Pond was assigned a pseudo-static earthquake coefficient equal to 0.04 g and a vertical upward component equal to $^{2}/_{3}$ of the horizontal component (0.027 g) as recommended by Newmark[5]. Analysis for both circular and block slide surfaces, Appendix D, show a minimum factor of safety of 1.4 for a block slide surface.

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

The embankment and foundation soils of the LAN Upper Ash Pond will not liquefy during the design earthquake. No post-liquefaction slope stability assessment is required.

---

[5] 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 embankment of the LAN Upper Ash Pond meets the requirements of 40 CFR 257.73(e). The results are summarized as:

	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
LAN Upper Ash Pond	1.8	1.7	1.4	no	Not applicable

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).

MARK W. LOEROP
22197

By:

Name: MARK LOEROP

Date: 09-02-2016

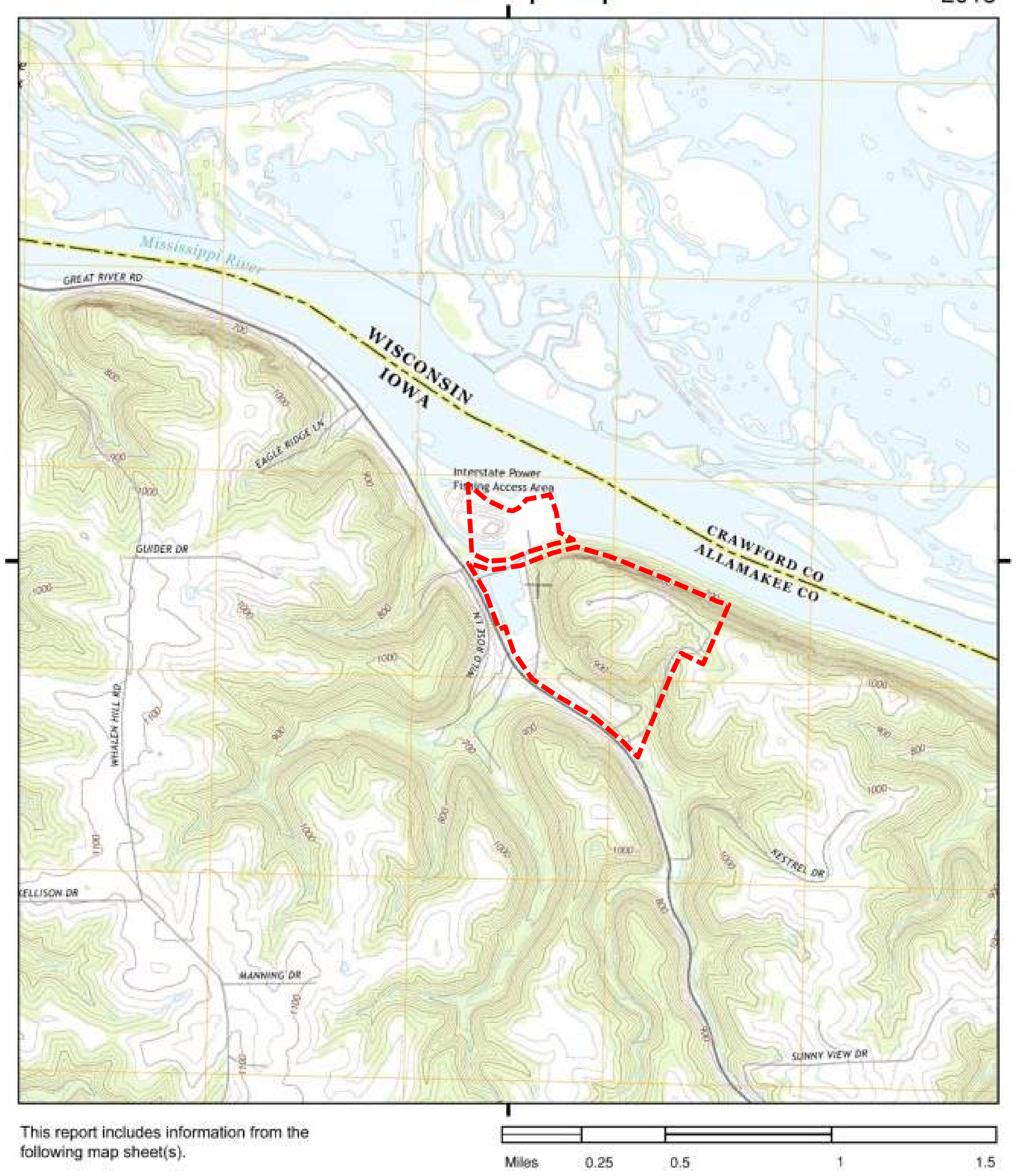
FIGURES

Alliant Energy
Interstate Power and Light
Lansing Generating Station
Lansing, 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, Lansing, 2013, 7.5-minute

SITE NAME: Lasing Generating Station
ADDRESS: 2364-2366 Power Plant Dr
Lansing, IA 52151
CLIENT: Environmental Site Assessors

N

4555570 - 1 page 5

Historical Aerial Photo

- - - - Approximate Property Boundary

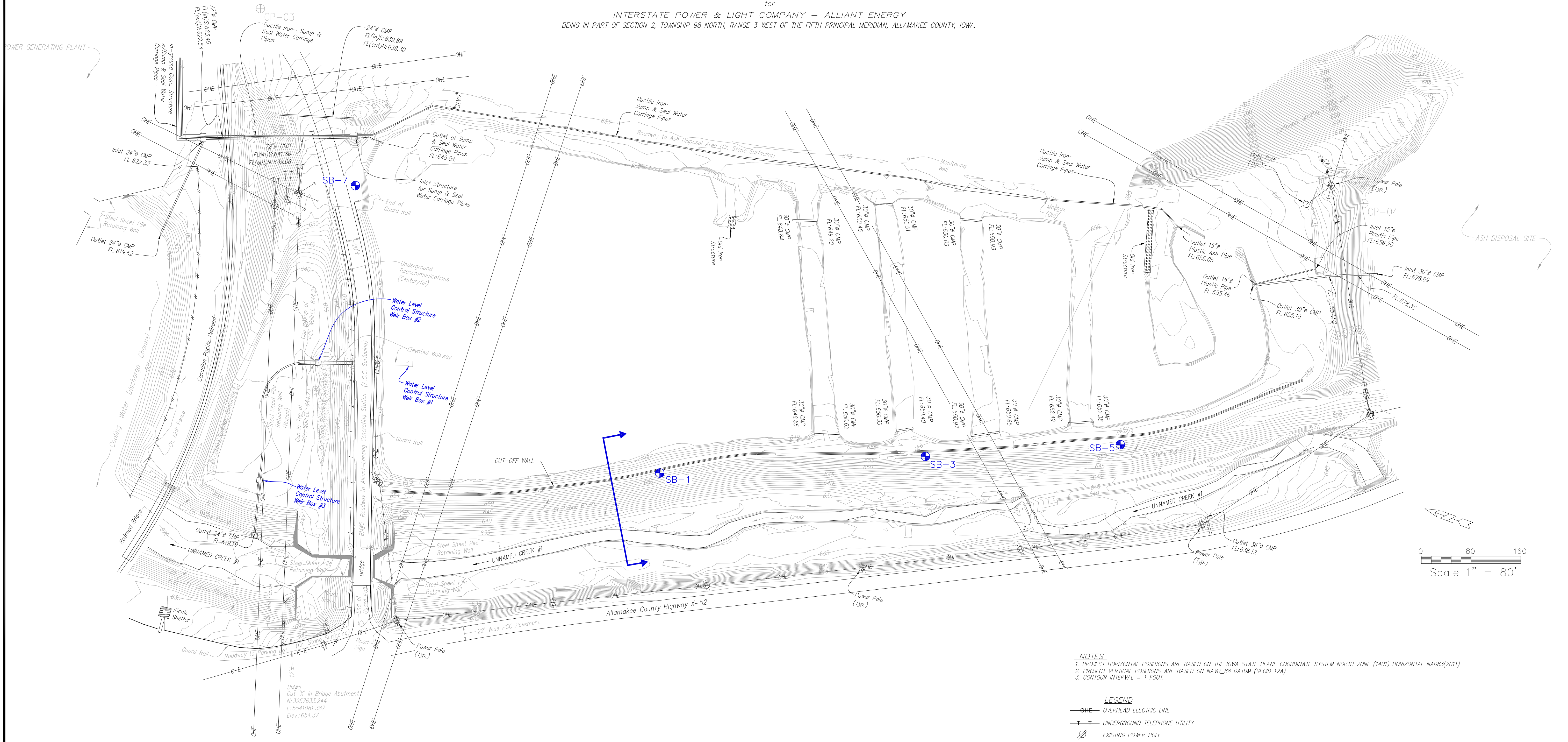
HARD HAT SERVICES™
Engineering, Construction and Management Solutions

Site Location
Lansing Generating Station
Intersate Power and Light Company

Drawing
Figure 1

Date
6/7/2016

UPPER AND LOWER CCR POND TOPOGRAPHIC SURVEY AND LOWER CCR POND BATHYMETRY
at
ALLIANT LANSING POWER GENERATING STATION
for
INTERSTATE POWER & LIGHT COMPANY – ALLIANT ENERGY
BEING IN PART OF SECTION 2, TOWNSHIP 98 NORTH, RANGE 3 WEST OF THE FIFTH PRINCIPAL MERIDIAN, ALLAMAKEE COUNTY, IOWA.



NOTES
1. PROJECT HORIZONTAL POSITIONS ARE BASED ON THE IOWA STATE PLANE COORDINATE SYSTEM NORTH ZONE (1401) HORIZONTAL NAD83(2011).
2. PROJECT VERTICAL POSITIONS ARE BASED ON NAVD_88 DATUM (GEOID 12A).
3. CONTOUR INTERVAL = 1 FOOT.

LEGEND

—OHE—	OVERHEAD ELECTRIC LINE
—T—T—	UNDERGROUND TELEPHONE UTILITY
Ø	EXISTING POWER POLE
SB ⊕	SOIL BORING LOCATION
↑_↑	ANALYSIS CROSS–SECTION

NOTE:
1. SURVEY INFORMATION PROVIDED ABOVE WAS COMPILED BY MOHN SURVEYING, INC. 1890 GREAT RIVER ROAD LANSING, IOWA 52151, APRIL 2015.
2. ALLIANT ENERGY REQUIRES 20 FEET OVERHEAD SEPARATION DISTANCE FOR EQUIPMENT OPERATING UNDER POWERLINES.

REV	DATE	BY	APP	DESCRIPTION
5				
4				
3				
2				
1				

SCALE: AS SHOWN
DATE: 5–19–16
DRAWN BY: JFD
CHECKED BY: CTS
APPROVED BY: MWL

HARD HAT SERVICES ™
Engineering, Construction and Management Solutions

CLIENT / LOCATION
INTERSTATE POWER AND LIGHT (IPL)
LANSING GENERATING STATION PROJECT
2320 POWER PLANT DR
LANSING, IA 52151

DRAWING DESCRIPTION
SOIL BORING AND
SLOPE STABILITY CROSS–SECTION LOCATION

JOB
154.018.012.002
SHT.
FIGURE 2
DWG.
154.018.012.002–D2

APPENDIX A – Soil Borings

Alliant Energy
Interstate Power and Light
Lansing Generating Station
Lansing, Iowa

Safety Factor Assessment

CABENO
Environmental Field Services, LLC
More Than Just A Probing Company

BORING LOG

CLIENT: Hard Hat

PROJECT:Lansing, IA

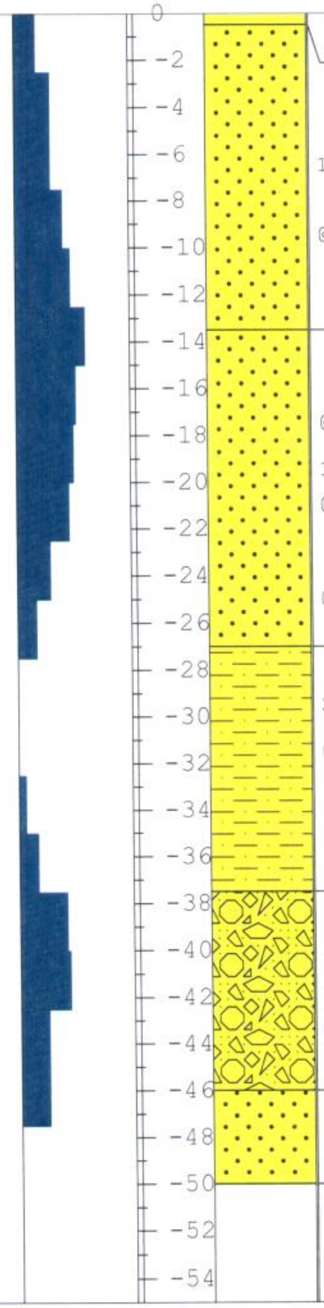
COORDINATES: *N NOT SURVEYED*
E NOT SURVEYED

BORING NO.: ***SB1***

page 1 of 1

LOGGED BY: *John Noyes*
EDITED BY: *John Noyes*
CHECKED BY: *Mark Loerop*
DATE BEGAN: *1/22/15*
DATE FINISHED: *1/2213/15*
GROUND SURFACE ELEVATION: *NOT MEASURED*

DEPTH TO WATER WHILE DRILLING	SAMPLE NO. AND TYPE	SAMPLE RECOVERY	SAMPLE INFROMATION BLOW COUNTS	N-VALUE
	SS1	18"	4 4 5	9.0
	SS2	18"	4 5 10	15.0
	SS3	18"	3 6 9	15.0
	SS4	18"	7 9 11	20.0
	SS5	18"	7 10 13	23.0
▽	SS6	18"	7 11 18	29.0
	SS7	18"	8 11 14	25.0
	SS8	18"	8 11 13	24.0
	SS9	18"	8 11 11	22.0
	SS10	18"	4 7 7	14.0
	SS11	18"	2 3 6	8.0
	SS12	18"	0 0 0	0.0
	SS13	18"	0 0 0	0.0
	SS14	18"	1 1 2	3.0
	SS15	18"	3 4 4	8.0
	SS16	18"	0 9 11	20.0
	SS17	18"	5 11 10	21.0
	SS18	18"	4 5 7	12.0
	SS19	18"	3 4 8	12.0



DESCRIPTION

SILT; brown; plastic; moist; trace clay

SAND; brown; fine grained; poorly graded; well sorted; dry to moist

1'-5' sample collected for geotech analysis

@ 9'2" black stained with plant matter

SAND; gray; fine to medium grained; moist; graded; trace gravel and snail shells

@ 15' grades wet

15'-20' sample collected for geotech analysis

@17.5' grades brown

@23.5' grades fine to coarse, well graded

SILT; gray; non plastic; wet; trace clay

28'-32' sample collected for geotech analysis

@29' grades trace plant matter and snail shells

GRAVEL; brown; coarse; poorly graded; wet; trace cobbles

40'-50' sample collected for geotech analysis

SAND; light gray; coarse grained; poorly graded; wet

Bottom of boring @ 50'
1" PVC temp well installed @ 50'.
10' screen, natural sand pack

CABENO
Environmental Field Services, LLC
More Than Just A Probing Company

BORING LOG

CLIENT: Hard Hat

PROJECT: Lansing, IA

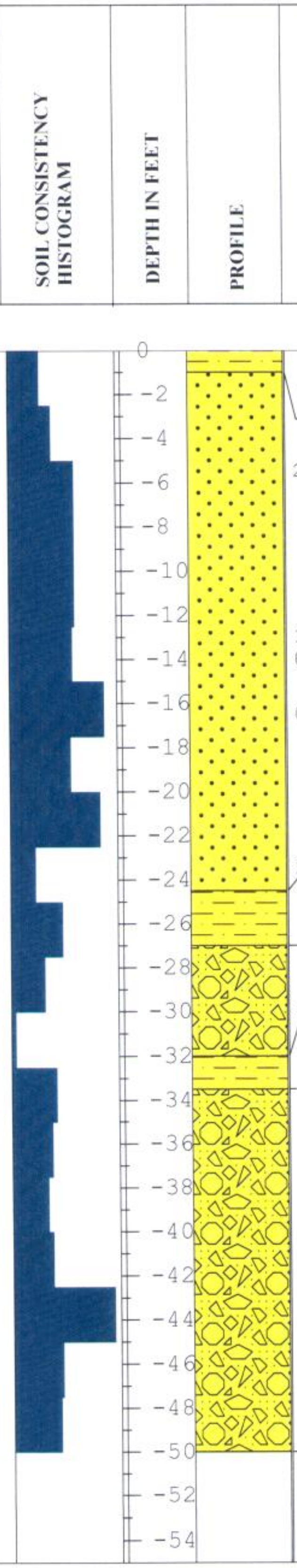
COORDINATES: *N NOT SURVEYED*
E NOT SURVEYED

BORING NO.: ***SB3***

page 1 of 1

LOGGED BY: *John Noyes*
EDITED BY: *John Noyes*
CHECKED BY: *Mark Loerop*
DATE BEGAN: *1/22/15*
DATE FINISHED: *1/22/15*
GROUND SURFACE ELEVATION: *NOT MEASURED*

DEPTH TO WATER WHILE DRILLING	SAMPLE NO. AND TYPE	SAMPLE RECOVERY	SAMPLE INFROMATION BLOW COUNTS	N-VALUE
	SS1	18"	6 7 7	14.0
	SS2	18"	4 9 10	19.0
	SS3	18"	5 10 19	29.0
	SS4	18"	7 13 16	29.0
	SS5	18"	6 12 17	29.0
▽	SS6	18"	6 12 16	28.0
	SS7	18"	12 21 21	42.0
	SS8	18"	8 12 15	27.0
	SS9	18"	8 19 21	40.0
	SS10	18"	8 5 6	11.0
	SS11	18"	6 8 15	23.0
	SS12	18"	5 5 10	15.0
	SS13	18"	3 1 1	2.0
	SS14	18"	6 10 10	20.0
	SS15	18"	4 6 12	18.0
	SS16	18"	10 9 7	16.0
	SS17	18"	6 8 10	18.0
	SS18	18"	22 24 21	45.0
	SS19	18"	10 10 12	22.0
	SS20	18"	14 9 12	21.0



DESCRIPTION

SILT; gray to black; non plastic; moist; some bottom ash

SAND; brown; fine grained; poorly graded; moist
2'-5' sample collected for geotech analysis

13'-20' sample collected for geotech analysis
@13.5' grades wet and trace snail shells

@16' grades fine to medium grained; graded

24'-27' sample collected for geotech analysis

SILT; gray; non plastic to low plasticity; wet; some clay; trace organic plant matter

GRAVEL; gray; coarse to cobbles; poorly graded; wet; trace to some sand
27'-32' sample collected for geotech analysis

SILT; gray to black; non plastic; wet; trace to some clay and organic plant matter

GRAVEL; gray; coarse to cobbles; poorly graded; wet; trace to some sand

Bottom of boring @ 50'
1" PVC temp well installed @ 50'.
10' screen, natural sand pack

CABENO
Environmental Field Services, LLC
More Than Just A Probing Company

BORING LOG

CLIENT: Hard Hat

COORDINATES: *N NOT SURVEYED*
E NOT SURVEYED

PROJECT:Lansing, IA

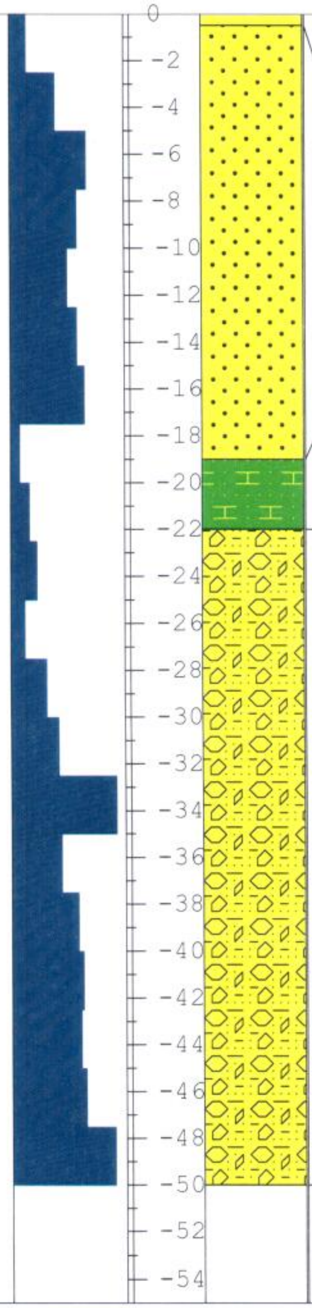
BORING NO.: ***SB5***

page 1 of 1

LOGGED BY: *John Noyes*
EDITED BY: *John Noyes*
CHECKED BY: *Mark Loerop*
DATE BEGAN: *1/23/15*
DATE FINISHED: *1/23/15*
GROUND SURFACE ELEVATION: *NOT MEASURED*

DEPTH TO WATER WHILE DRILLING	SAMPLE NO. AND TYPE	SAMPLE RECOVERY	SAMPLE INFROMATION BLOW COUNTS	N-VALUE
	SS1	18"	4 4 3	7.0
	SS2	18"	5 7 12	19.0
	SS3	18"	5 13 19	32.0
	SS4	18"	5 13 15	28.0
▽	SS5	18"	5 11 13	24.0
	SS6	18"	6 12 16	28.0
	SS7	18"	12 14 17	31.0
	SS8	18"	3 2 2	4.0
	SS9	18"	4 4 4	8.0
	SS10	18"	14 9 2	11.0
	SS11	18"	2 2 4	6.0
	SS12	18"	6 7 8	15.0
	SS13	18"	9 10 10	20.0
	SS14	18"	10 36 8	44.0
	SS15	18"	15 12 9	21.0
	SS16	18"	20 14 14	28.0
	SS17	18"	11 12 18	30.0
	SS18	18"	17 14 15	29.0
	SS19	18"	13 14 17	31.0
	SS20	18"	18 19 24	43.0

SOIL CONSISTENCY HISTOGRAM · DEPTH IN FEET · PROFILE



DESCRIPTION

SILT; black; non plastic; dry to moist

SAND; brown; fine grained; poorly graded; moist; trace to some bottom ash
5' bottom ash grades out

10'-16' sample collected for geotech analysis

@12' grades wet and trace snail shells

@ 16' grades gray to olive

Silty CLAY; black to dark gray; low plasticity; moist; trace fine sand and organic plant matter
18.5'-20' sample collected for geotech analysis

SAND & GRAVEL; black; fine to coarse; well graded; wet; trace to some silt
22'-27.5' sample collected for geotech analysis

40'-45' sample collected for geotech analysis

@43.5' grades brown

Bottom of boring @ 50'
1" PVC temp well installed @ 50'.
10' screen, natural sand pack

BORING LOG

CABENO Environmental Field Services, LLC

More Than Just A Probing Company

CLIENT: Hard Hat

PROJECT:Lansing, IA

COORDINATES: *N NOT SURVEYED* *E NOT SURVEYED*

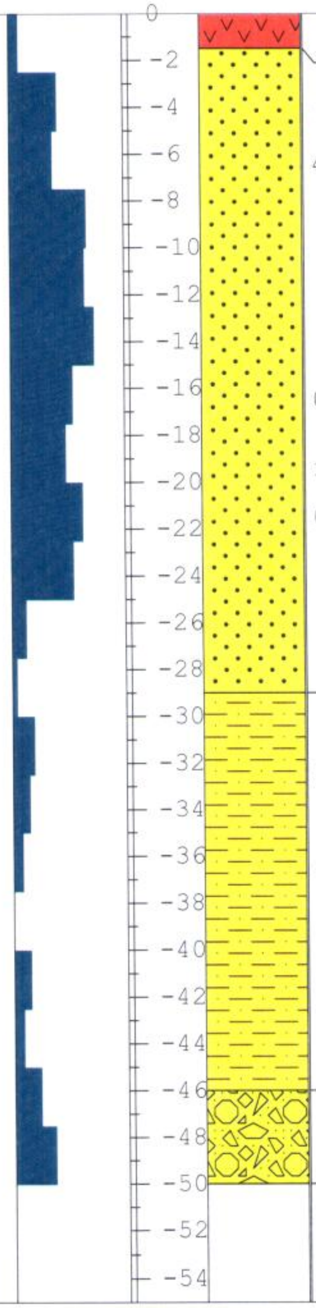
BORING NO.: ***SB7***

page 1 of 1

LOGGED BY: *John Noyes*
EDITED BY: *John Noyes*
CHECKED BY: *Mark Loerop*
DATE BEGAN: *1/23/15*
DATE FINISHED: *1/23/15*
GROUND SURFACE ELEVATION: *NOT MEASURED*

DEPTH TO WATER WHILE DRILLING	SAMPLE NO. AND TYPE	SAMPLE RECOVERY	SAMPLE INFROMATION BLOW COUNTS	N-VALUE
	SS1	18"	3 2 2	4.0
	SS2	18"	9 11 19	20.0
	SS3	18"	4 5 13	18.0
	SS4	18"	7 14 18	32.0
	SS5	18"	5 11 20	31.0
	SS6	18"	8 15 20	35.0
▽	SS7	18"	7 12 14	26.0
	SS8	18"	7 9 14	23.0
	SS9	18"	11 13 17	30.0
	SS10	18"	8 12 14	26.0
	SS11	18"	2 3 3	6.0
	SS12	18"	1 1 1	2.0
	SS13	18"	3 3 6	9.0
	SS14	18"	2 3 4	7.0
	SS15	18"	1 2 2	4.0
	SS16	18"	0 0 0	0.0
	SS17	18"	2 3 4	7.0
	SS18	18"	3 2 2	4.0
	SS19	18"	8 4 7	11.0
	SS20	18"	2 8 9	17.0

SOIL CONSISTENCY HISTOGRAM — DEPTH IN FEET — PROFILE



DESCRIPTION

Bottom ASH; black; fine grained; poorly graded

SAND; brown; fine grained; poorly graded; moist

4'-10' sample collected for geotech analysis

@16' grades wet

19'-25' sample collected for geotech analysis

@ 21' grades gray

SILT; black to gray; no plasticity; moist to wet; trace clay

29'-32.5' sample collected for geotech analysis

36'-40' sample collected for geotech analysis

@ 41' grading trace organic plant matter and trace intermittent 1/16" sand seams

@ 44' is a thin, 1" gravel seam

GRAVEL; brown; coarse; poorly graded; wet; trace to some silt and sand
46'-50' sample collected for geotech analysis
last spoon blocked with large gravel

Bottom of boring @ 50'
1" PVC temp well installed @ 50'.
10' screen, natural sand pack

APPENDIX B – Soil Laboratory Testing

Alliant Energy
Interstate Power and Light
Lansing Generating Station
Lansing, Iowa

Safety Factor Assessment

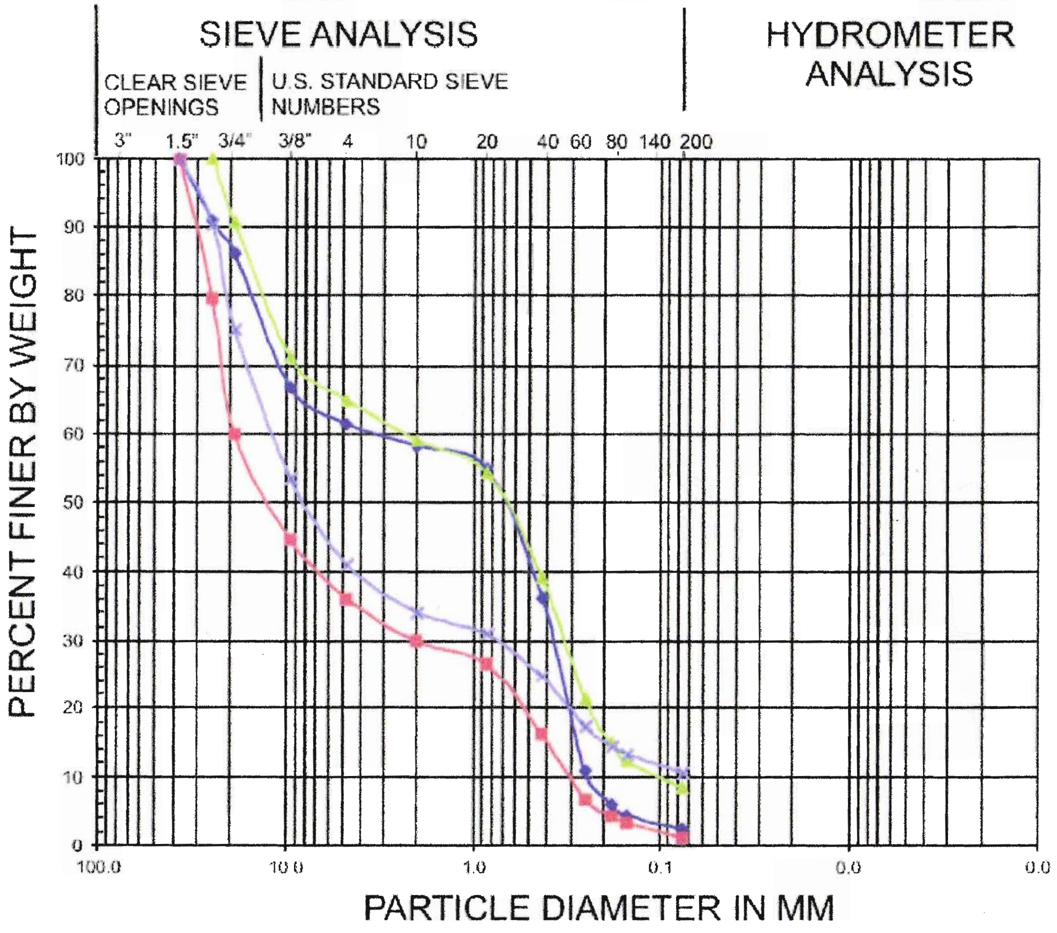
APPENDIX B

UPDATE TO ADD SB-7
· SEPARATE 8½x11

HARD HAT SERVICES
Engineering, Construction and Management Solutions

Particle Size Distribution

Project	IPL – Lansing Generating Station	Tested By	Test America	Date	2/3/2015
Boring No.	SB-1, SB-3 & SB-5 "SAND & GRAVEL"				



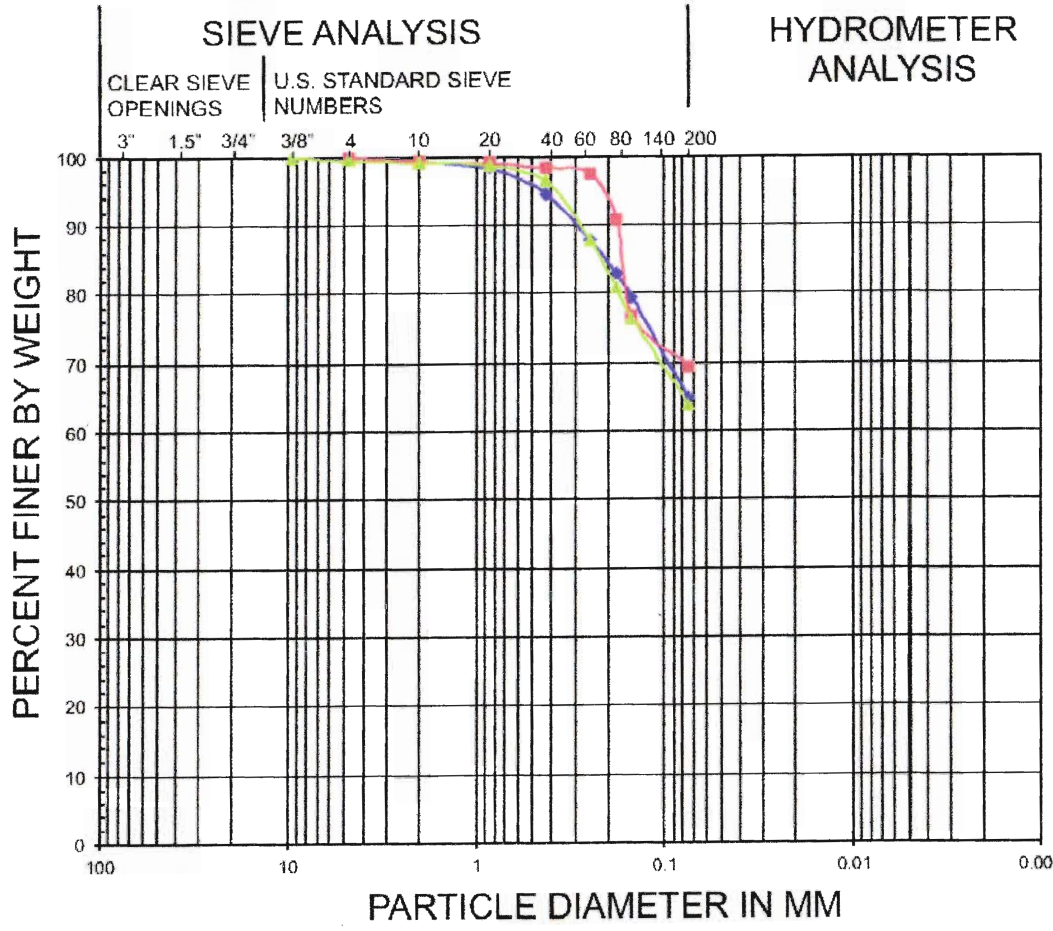
COBBLES	GRAVEL		SAND			SILT AND CLAY FRACTION
	coarse	fine	coarse	medium	fine	

SYMBOL	BORING	DEPTH (FT.)	SOIL DESCRIPTION	U.S.C.S.	W %
◆	SB-1	40 - 50	SAND & GRAVEL	SW / GW	16.5
■	SB-3	27 - 32	SAND & GRAVEL	SW / GW	13.4
▲	SB-5	22 - 27.5	SAND & GRAVEL	SW / GW	32.1
×	SB-5	44 - 45	SAND & GRAVEL	SW / GW	9.8

HARD HAT SERVICES
Engineering, Construction and Management Solutions

Particle Size Distribution

Project	IPL – Lansing Generating Station	Tested By	Test America	Date	2/3/2015
Boring No.	SB-1, SB-3 & SB-5 "SANDY SILT"				



COBBLES	GRAVEL		SAND			SILT AND CLAY FRACTION
	coarse	fine	coarse	medium	fine	

SYMBOL	BORING	DEPTH (FT.)	SOIL DESCRIPTION	U.S.C.S.	L.L.	P.L.	W %
◆	SB-1	28 - 32	Sandy Silt	ML	28	26	36.1
■	SB-3	24.5 - 27	Sandy Silt	ML	27	23	25.4
▲	SB-5	18.5 - 20	Sandy Silt	ML	24	20	21.8

NOTICE
THIS DRAWING IS THE PROPERTY OF HARD HAT SERVICES AND IS NOT TO BE REPRODUCED, CHANGED, OR COPIED IN ANY FORM OR MANNER WITHOUT PRIOR WRITTEN PERMISSION. ALL RIGHTS RESERVED.

REV	DATE	BY	APP	DESCRIPTION
5				
4				
3				
2				
1	6-15-15	TJH	MWL	INCORPORATE IPL COMMENTS

SCALE: NONE DATE: 5-14-15
DRAWN BY: JFD CHECKED BY: TJH APPROVED BY: MWL

HARD HAT SERVICES™
Engineering, Construction and Management Solutions

CLIENT / LOCATION
INTERSTATE POWER AND LIGHT (IPL)
LANSING GENERATING STATION PROJECT
2320 POWER PLANT DR
LANSING, IA 52151

DRAWING DESCRIPTION
SEEPAGE CONTROL CUT-OFF WALL
PARTICLE SIZE DISTRIBUTION
SB-1 & SB-3

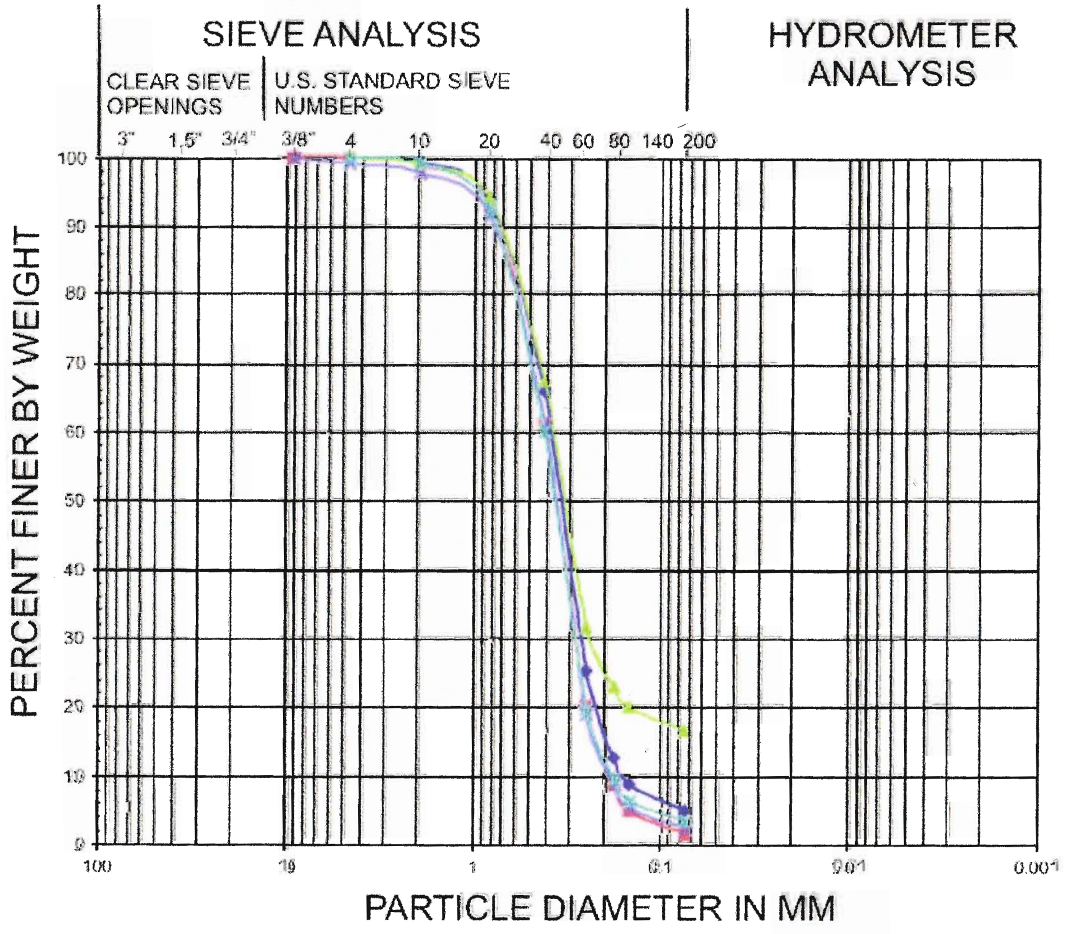
JOB 154.021.003
SHT. 8
DWG. 154021SW-08-12

APPENDIX B
UPDATE TO ADD SB-7
SEPARATE 8½ x 11

HARD HAT SERVICES
Engineering, Construction and Management Solutions

Particle Size Distribution

Project	IPL - Lansing Generating Station	Tested By	Test America	Date	2/3/2015
Boring No.	SB-1, SB-3 & SB-5 "UPPER SAND"				



COBBLES	GRAVEL		SAND			SILT AND CLAY FRACTION
	coarse	fine	coarse	medium	fine	

SYMBOL	BORING	DEPTH (FT.)	SOIL DESCRIPTION	U.S.C.S.	W %
◆	SB-1	1 - 5	Medium - Fine Sand	SP	4.1
■	SB-1	15 - 20	Medium - Fine Sand	SP	20.1
▲	SB-3	2 - 5	Silty Medium - Fine Sand	SM	3.1
✕	SB-3	13 - 20	Medium - Fine Sand	SP	19.0
✱	SB-5	10 - 16	Medium - Fine Sand	SP	13.3

NOTICE
THIS DRAWING IS THE PROPERTY OF HARD HAT SERVICES AND IS NOT TO BE REPRODUCED, CHANGED, OR COPIED IN ANY FORM OR MANNER WITHOUT PRIOR WRITTEN PERMISSION. ALL RIGHTS RESERVED.

REV	DATE	BY	APP	DESCRIPTION
5				
4				
3				
2				
1	6-15-15	TJH	MWL	INCORPORATE IPL COMMENTS

SCALE: NONE
DATE: 5-14-15
DRAWN BY: JFD
CHECKED BY: TJH
APPROVED BY: MWL

HARD HAT SERVICES™
Engineering, Construction and Management Solutions

CLIENT / LOCATION
INTERSTATE POWER AND LIGHT (IPL)
LANSING GENERATING STATION PROJECT
2320 POWER PLANT DR
LANSING, IA 52151

DRAWING DESCRIPTION
SEEPAGE CONTROL CUT-OFF WALL
PARTICLE SIZE DISTRIBUTION
SB-5

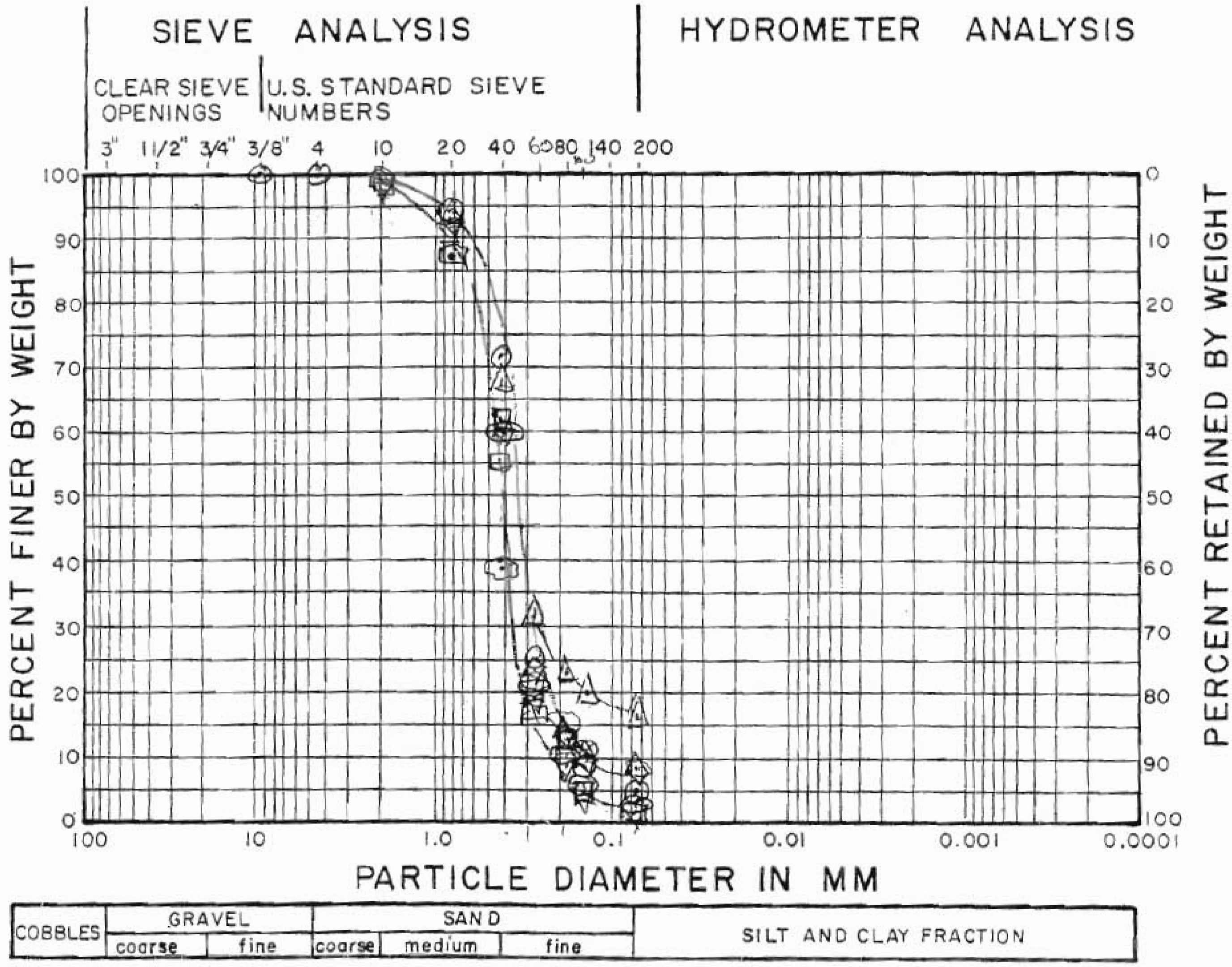
JOB 154.021.003
SHT. 9
DWG. 154021SW-08-12

HE&C
Harrington Engineering & Construction, Inc.

Particle Size Distribution

"UPPER SAND"

PROJECT ____________________ TESTED BY ____________ DATE ________
PROJECT NO. ____________________ CALC BY ____________ DATE ________
BORING NO. ____________________ CHKD BY ____________ DATE ________



SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	L.L.	P.L.	W%
⊙	SB-1		1-5	MED-FINE SAND	SP			4.1
⊡	SB-1		15-20	"	SP			20.1
△	SB-3		2-5	SILTY MED-FINE SAND	SM			3.1
▽	SB-3		13-20	MED-FINE SAND	SP			19.0
⬭	SB-5		10-16	"	SP			13.3
◇	SB-7		4-10	"	SP-SM			3.1
▭	SB-7		19-25	"	SP			17.1

HE&C
Harrington Engineering & Construction, Inc.

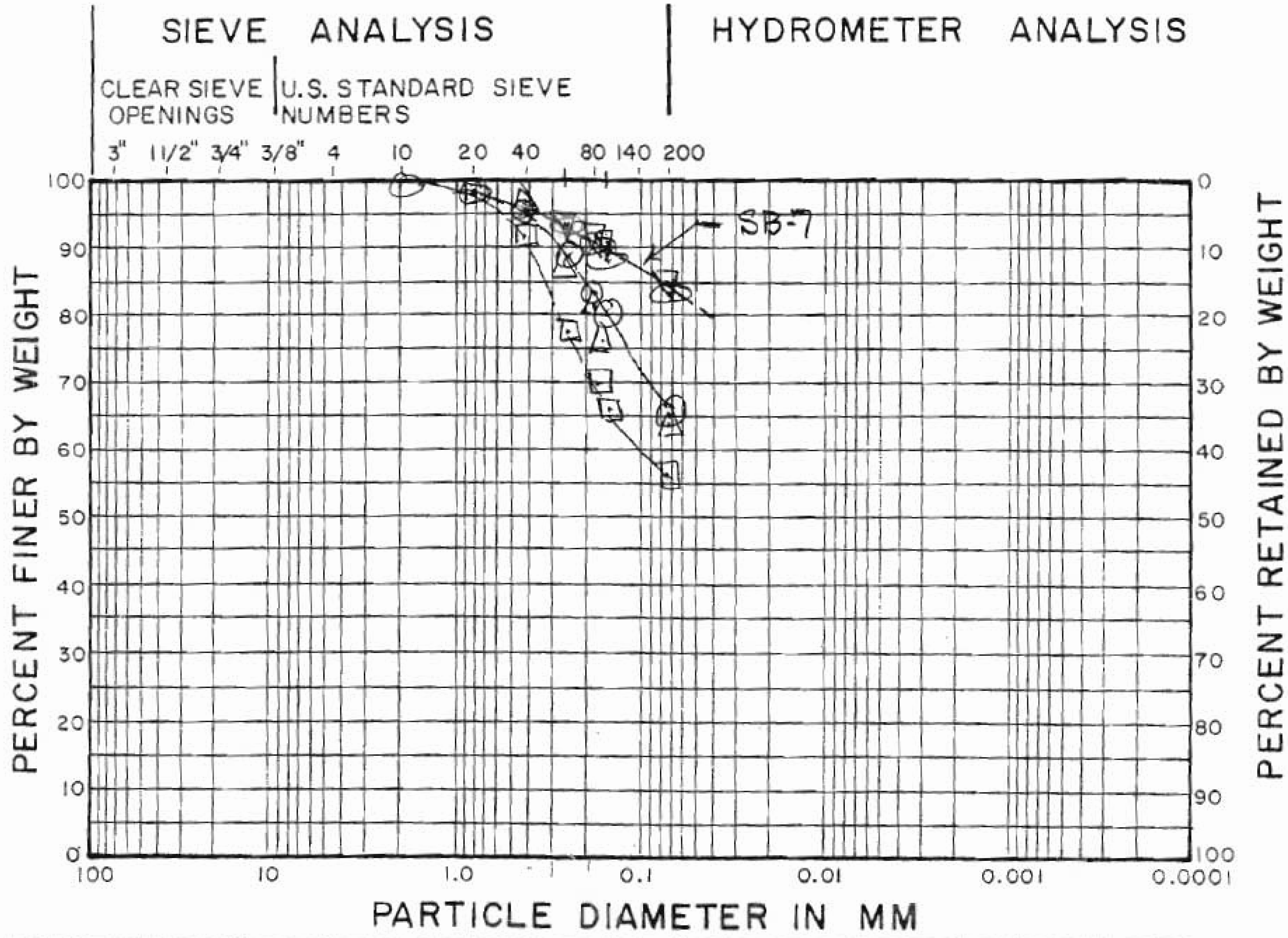
Particle Size Distribution

"SANDY SILT"

PROJECT ______________ TESTED BY ______________ DATE ______________

PROJECT NO. ______________ CALC BY ______________ DATE ______________

BORING NO. ______________ CHKD BY ______________ DATE ______________



COBBLES	GRAVEL		SAND			SILT AND CLAY FRACTION
	coarse	fine	coarse	medium	fine	

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	L.L.	P.L.	W%
○	SB-1		28-32	SANDY SILT	ML	28	26	36.1
□	SB-3		24.5-27	SANDY SILT	ML	27	23	23.4
△	SB-5		18.5-20	SANDY SILT	ML	24	20	21.8
▽	SB-7		29-32.5	SANDY SILT	ML	29	25	27.0
⬭	SB-7		36-40	SANDY SILT	ML	31	26	35.7

Harrington Engineering & Construction, Inc.

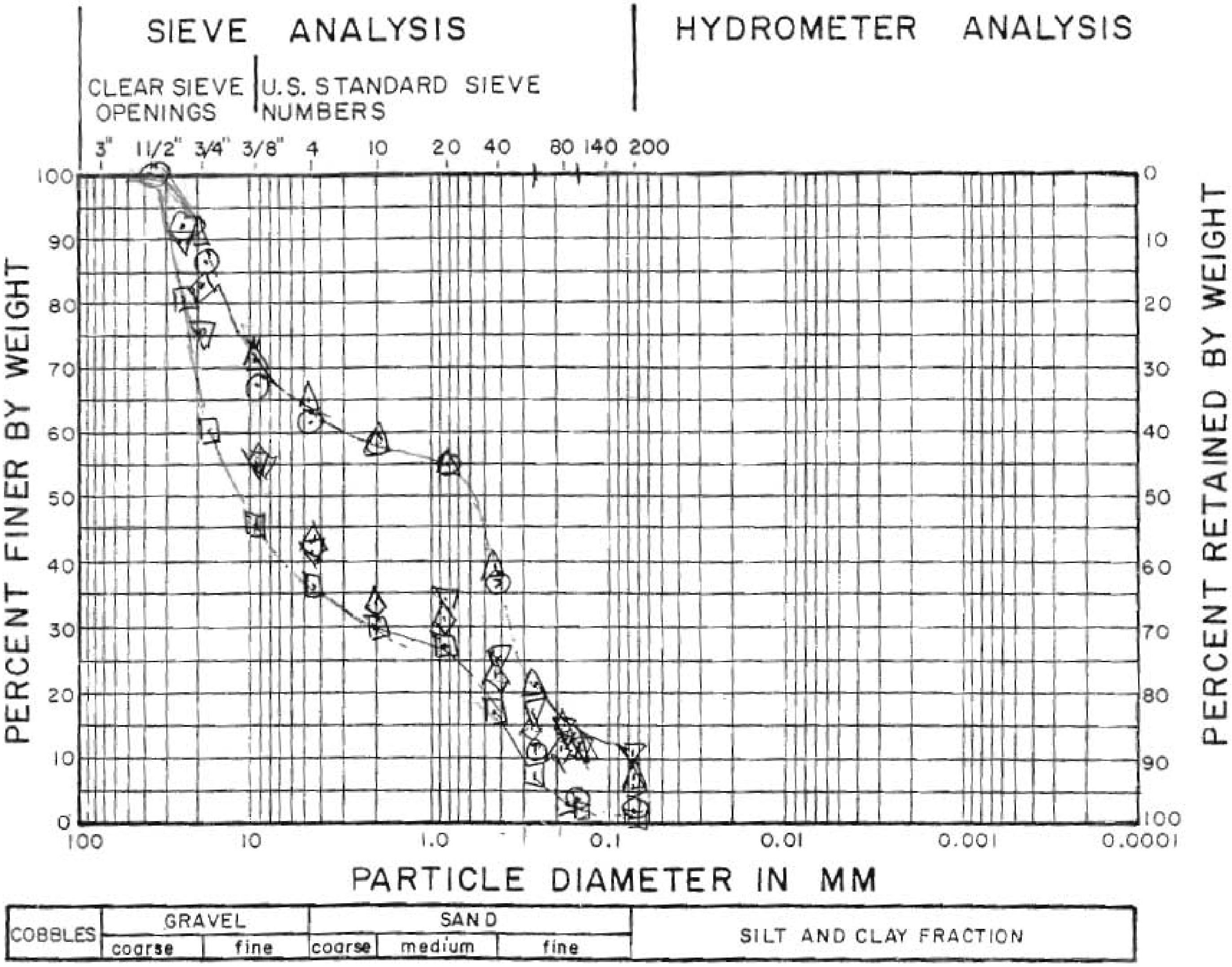
Particle Size Distribution

"SANDY GRAVEL"

PROJECT__________ TESTED BY__________ DATE__________

PROJECT NO.__________ CALC BY__________ DATE__________

BORING NO.__________ CHKD BY__________ DATE__________



SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	L.L.	P.L.	W%
○	SB-1		40-50	SAND & GRAVEL	SW/GW			16.5
□	SB-3		27-32	"	"			13.4
△	SB-5		22-27.5	"	"			32.1
▽	SB-5		44-45	"	"			9.8
◇	SB-7		46-50	"	"			35.7

APPENDIX C – Earthquake and Liquefaction Analysis

Alliant Energy
Interstate Power and Light
Lansing Generating Station
Lansing, Iowa

Safety Factor Assessment

Design Maps Detailed Report

ASCE 7-10 Standard (43.334°N, 91.168°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 = 0.059 g
From Figure 22-2 [2]	S_1 = 0.039 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	$\overline{v}_s$	$\overline{N}$ **or** $\overline{N}_{ch}$	$\overline{s}_u$
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 $\overline{s}_u$ < 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				
	$S_S \le 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \ge 1.25$
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	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 = 0.059 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				
	$S_1 \le 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \ge 0.50$
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	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 = 0.039 g, F_v = 2.400

Equation (11.4–1): $S_{MS} = F_aS_S = 1.600 \text{ x } 0.059 = 0.094$ g

Equation (11.4–2): $S_{M1} = F_vS_1 = 2.400 \text{ x } 0.039 = 0.095$ g

Section 11.4.4 — Design Spectral Acceleration Parameters

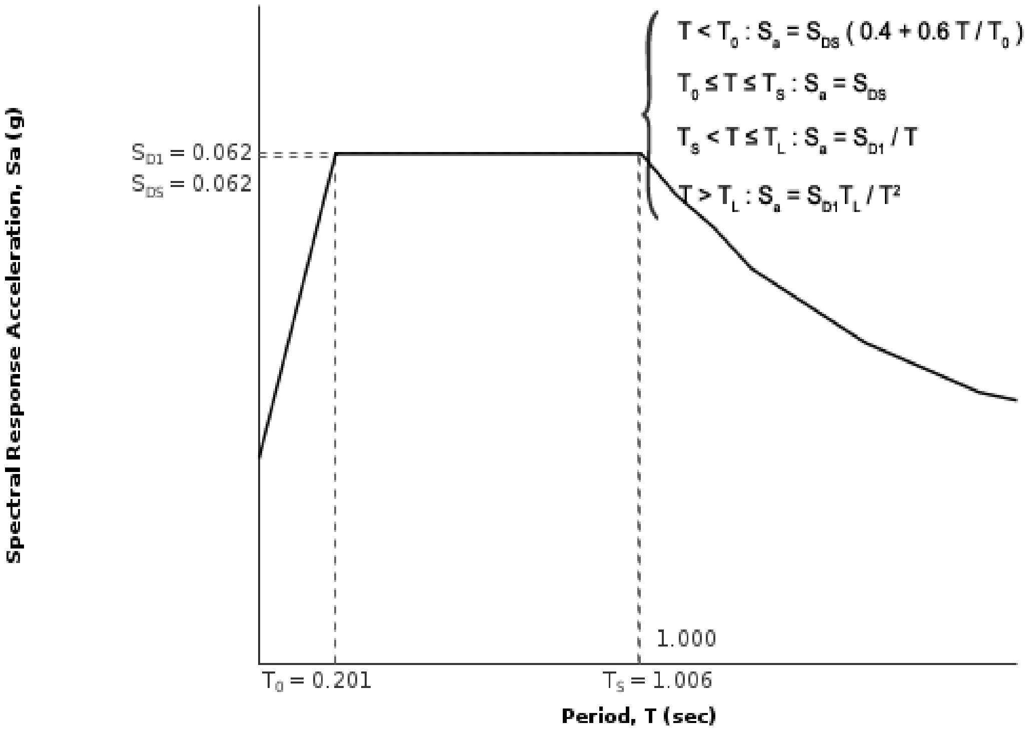
Equation (11.4–3): $S_{DS} = ⅔\, S_{MS} = ⅔ \text{ x } 0.094 = 0.062$ g

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

Section 11.4.5 — Design Response Spectrum

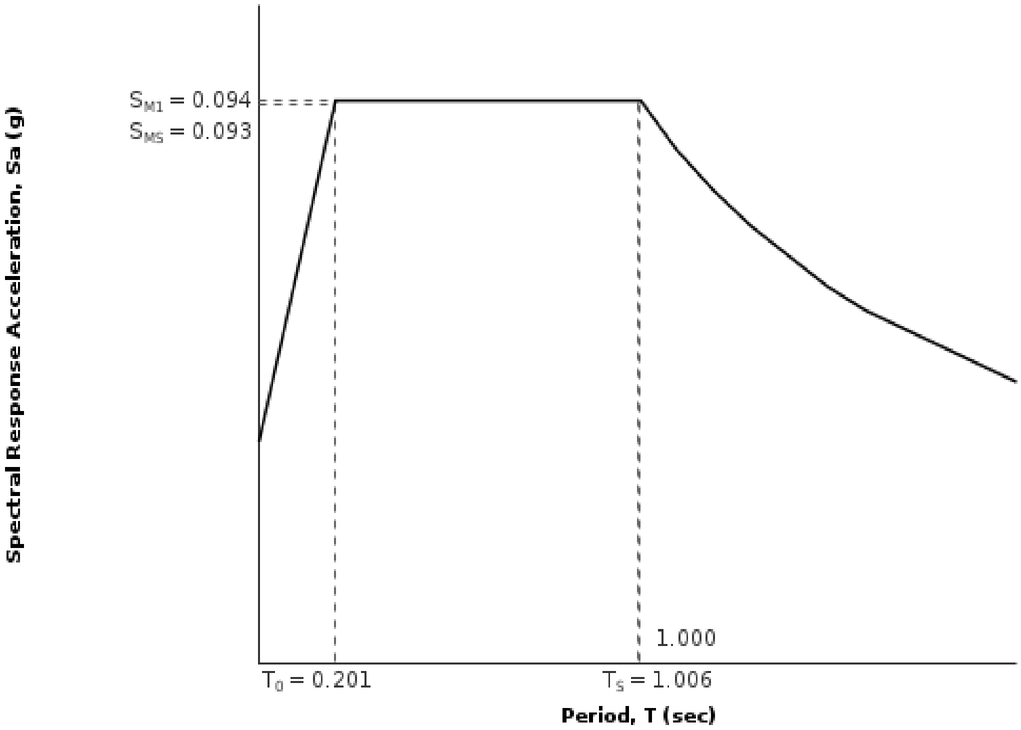
From Figure 22-12 [3] $T_L = 12$ seconds

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 = 0.028

Equation (11.8–1): $PGA_M = F_{PGA}PGA = 1.600 \times 0.028 = 0.044$ 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 = 0.028 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] $C_{RS} = 0.905$

From Figure 22-18 [6] $C_{R1} = 0.862$

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} = 0.062 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
Lansing Generating Station
Interstate Electric Power
Equations from "Soil Liquefaqction During Earthqakes" Idriss & Boulanger
Soil Conditions at Boring SB-1 "Critical Slope Stability Cross-Section

<u>Input Parameters:</u>

Peak Ground Acceleration (g) =	0.04
Earthquake Magnitude, M =	7.7
Water Table Depth (ft) =	20
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
1	2.4	9	SP	Unsaturated	5	75%	1.25	1	0.75	8.4	276	276	1.70	14.3	0.0	14.3	1.00	0.026	0.95	1.10	0.151	n.a.	n.a.
2	4.8	15	SP	Unsaturated	5	75%	1.25	1	0.75	14.1	552	552	1.70	23.9	0.0	23.9	1.00	0.026	0.95	1.10	0.266	n.a.	n.a.
3	7.2	15	SP	Unsaturated	5	75%	1.25	1	0.8	15.0	828	828	1.60	24.0	0.0	24.0	0.99	0.026	0.95	1.10	0.268	n.a.	n.a.
4	9.6	20	SP	Unsaturated	5	75%	1.25	1	0.85	21.3	1104	1104	1.38	29.4	0.0	29.4	0.99	0.026	0.95	1.10	0.451	n.a.	n.a.
5	12	23	SP	Unsaturated	5	75%	1.25	1	0.85	24.4	1380	1380	1.24	30.3	0.0	30.3	0.98	0.025	0.95	1.09	0.502	n.a.	n.a.
6	14.4	29	SP	Unsaturated	5	75%	1.25	1	0.85	30.8	1656	1656	1.13	34.8	0.0	34.8	0.97	0.025	0.95	1.06	1.072	n.a.	n.a.
7	16.8	25	SP	Unsaturated	5	75%	1.25	1	0.95	29.7	1932	1932	1.05	31.1	0.0	31.1	0.97	0.025	0.95	1.02	0.561	n.a.	n.a.
8	19.2	24	SP	Unsaturated	5	75%	1.25	1	0.95	28.5	2208	2208	0.98	27.9	0.0	27.9	0.96	0.025	0.95	0.99	0.380	n.a.	n.a.
9	21.6	22	SP		5	75%	1.25	1	0.95	26.1	2492	2392	0.94	24.6	0.0	24.6	0.95	0.026	0.95	0.98	0.280	0.261	2.00
10	24	14	SP		5	75%	1.25	1	0.95	16.6	2780	2530	0.91	15.2	0.0	15.2	0.94	0.027	0.95	0.98	0.158	0.147	2.00
11	26.4	8	SP		5	75%	1.25	1	0.95	9.5	3068	2669	0.89	8.5	0.0	8.5	0.93	0.028	0.95	0.98	0.108	0.100	2.00
12	28.8	0	ML		70	75%	1.25	1	1	0.0	3356	2807	0.87	0.0	5.6	5.6	0.92	0.029	0.95	0.98	0.089	0.083	2.00
13	31.2	0	ML		70	75%	1.25	1	1	0.0	3644	2945	0.85	0.0	5.6	5.6	0.92	0.029	0.95	0.97	0.089	0.083	2.00
14	33.6	3	ML		70	75%	1.25	1	1	3.8	3932	3083	0.83	3.1	5.6	8.7	0.91	0.030	0.95	0.97	0.109	0.100	2.00
15	36	8	GP		3	75%	1.25	1	1	10.0	4220	3222	0.81	8.1	0.0	8.1	0.90	0.031	0.95	0.96	0.105	0.096	2.00
16	38.4	20	GP		3	75%	1.25	1	1	25.0	4508	3360	0.79	19.8	0.0	19.8	0.89	0.031	0.95	0.94	0.204	0.182	2.00
17	40.8	21	GP		3	75%	1.25	1	1	26.3	4796	3498	0.78	20.4	0.0	20.4	0.88	0.031	0.95	0.93	0.211	0.187	2.00
18	43.2	12	GP		3	75%	1.25	1	1	15.0	5084	3636	0.76	11.4	0.0	11.4	0.87	0.032	0.95	0.95	0.128	0.115	2.00
19	45.6	12	SP		5	75%	1.25	1	1	15.0	5372	3775	0.75	11.2	0.0	11.2	0.86	0.032	0.95	0.94	0.127	0.114	2.00

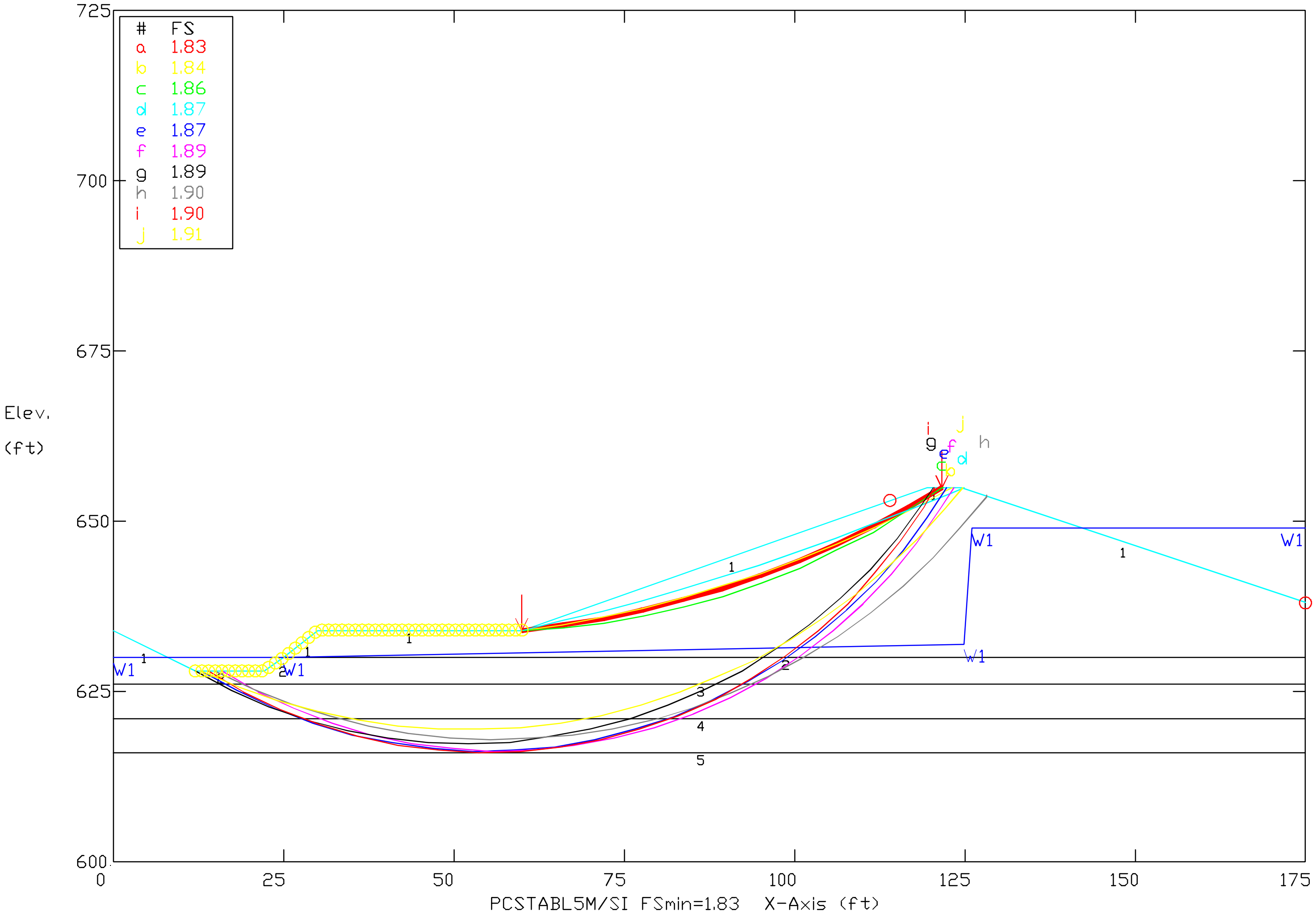
APPENDIX D – Slope Stability Analysis

Alliant Energy
Interstate Power and Light
Lansing Generating Station
Lansing, Iowa

Safety Factor Assessment

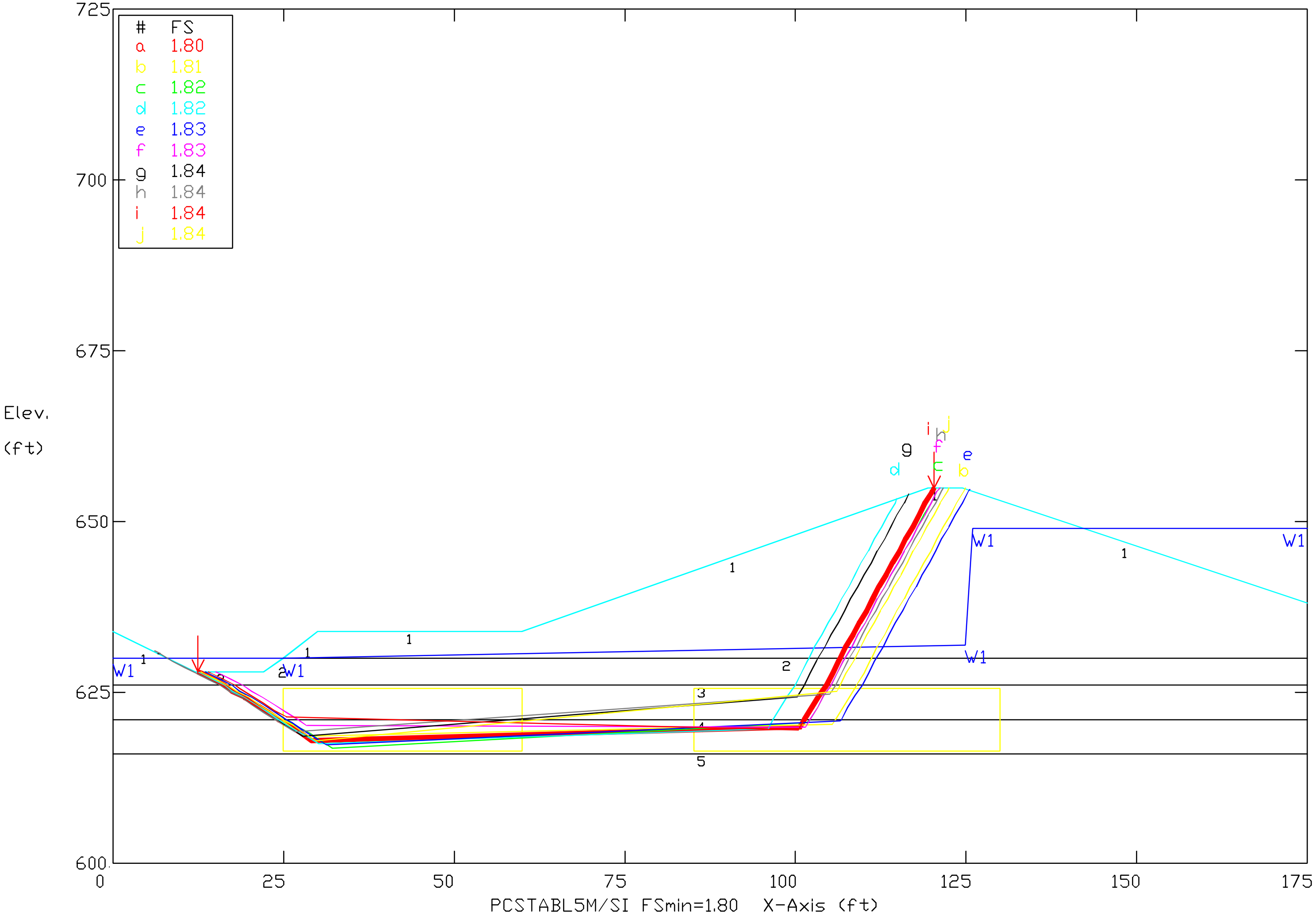
LSG - Main Ash Pond Creek Side Static Case & Normal H2O Levels (@ 649')

Ten Most Critical. E:LGS00C.PLT 05-12-16 10:04am



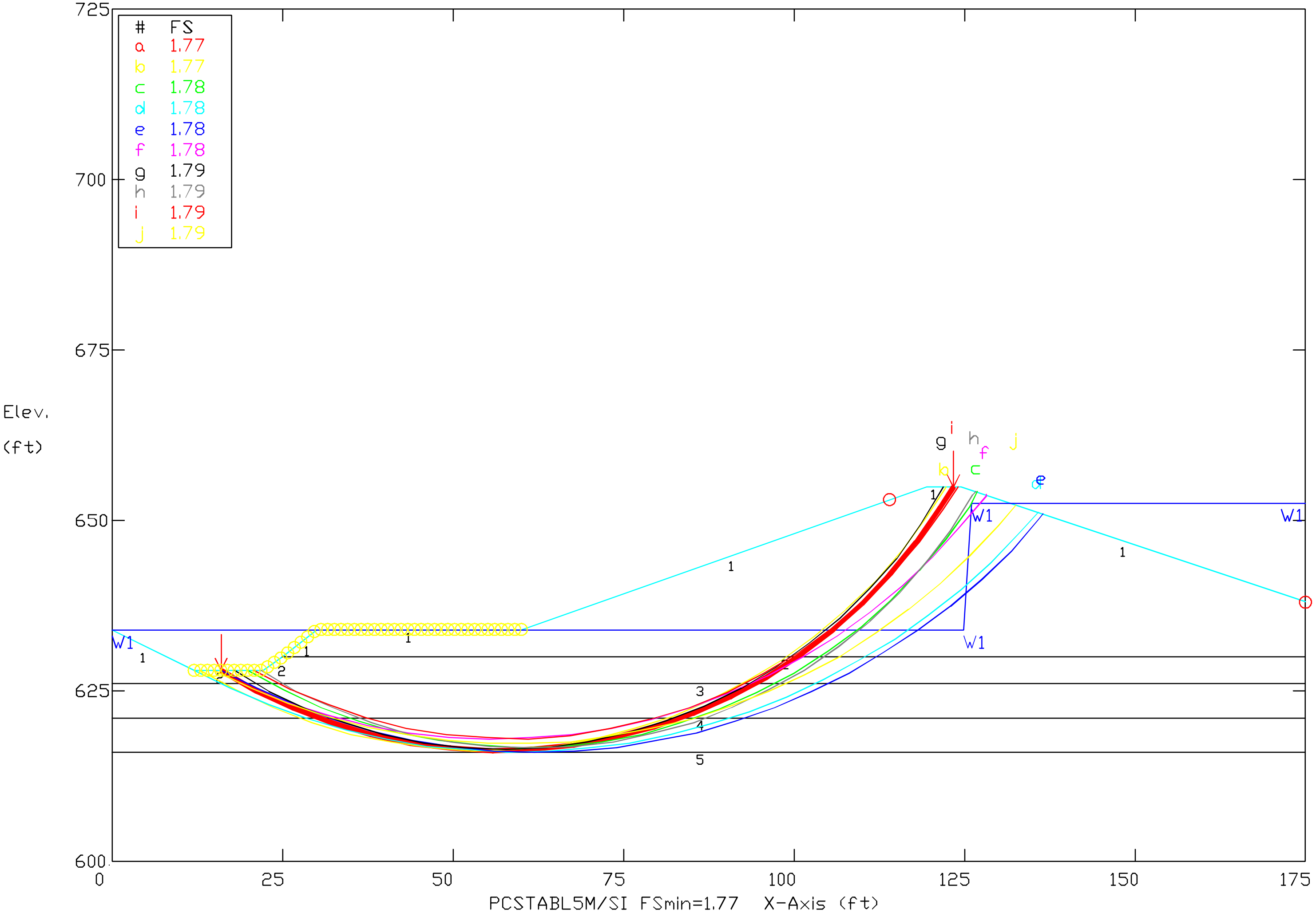
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Dike	110	115	0	32	0	0	W1
2 SP	108	108	0	36	0	0	W1
3 ML Dess.	100	100	0	26	0	0	W1
4 ML Loose	100	100	0	26	0	0	W1
5 SW/GW	120	120	0	35	0	0	W1

LSG - Main Ash Pond Creek Side Static Case & Normal H2O Levels (@ 649')
Ten Most Critical. E:LGS00B.PLT 05-12-16 10:07am



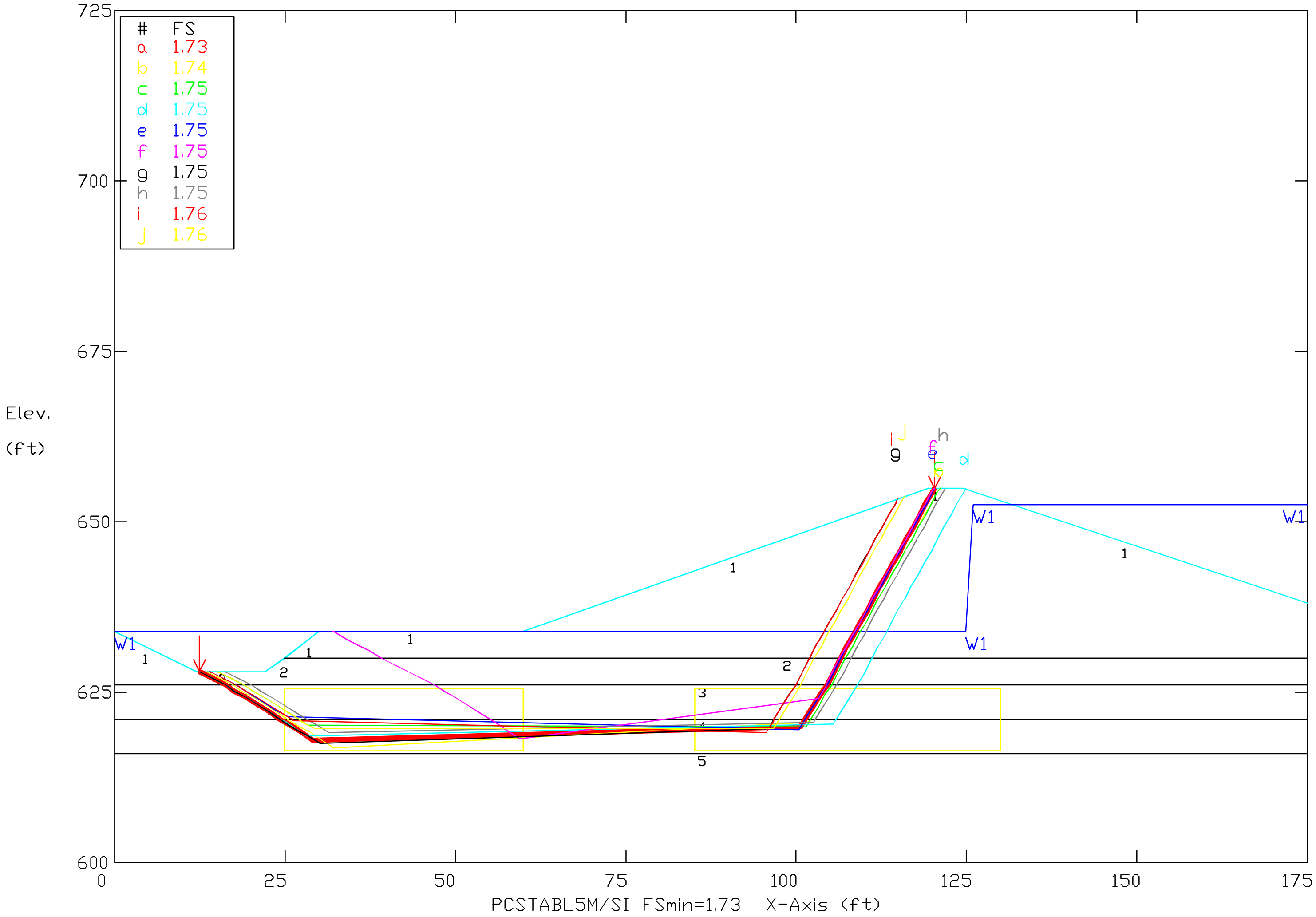
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Dike	110	115	0	32	0	0	W1
2 SP	108	108	0	36	0	0	W1
3 ML Dess.	100	100	0	26	0	0	W1
4 ML Loose	100	100	0	26	0	0	W1
5 SW/GW	120	120	0	35	0	0	W1

LSG - Main Ash Pond Creek Side Static Case & High H2O Levels (@ 652.5')
Ten Most Critical. E:LGS00CW.PLT 05-12-16 10:21am



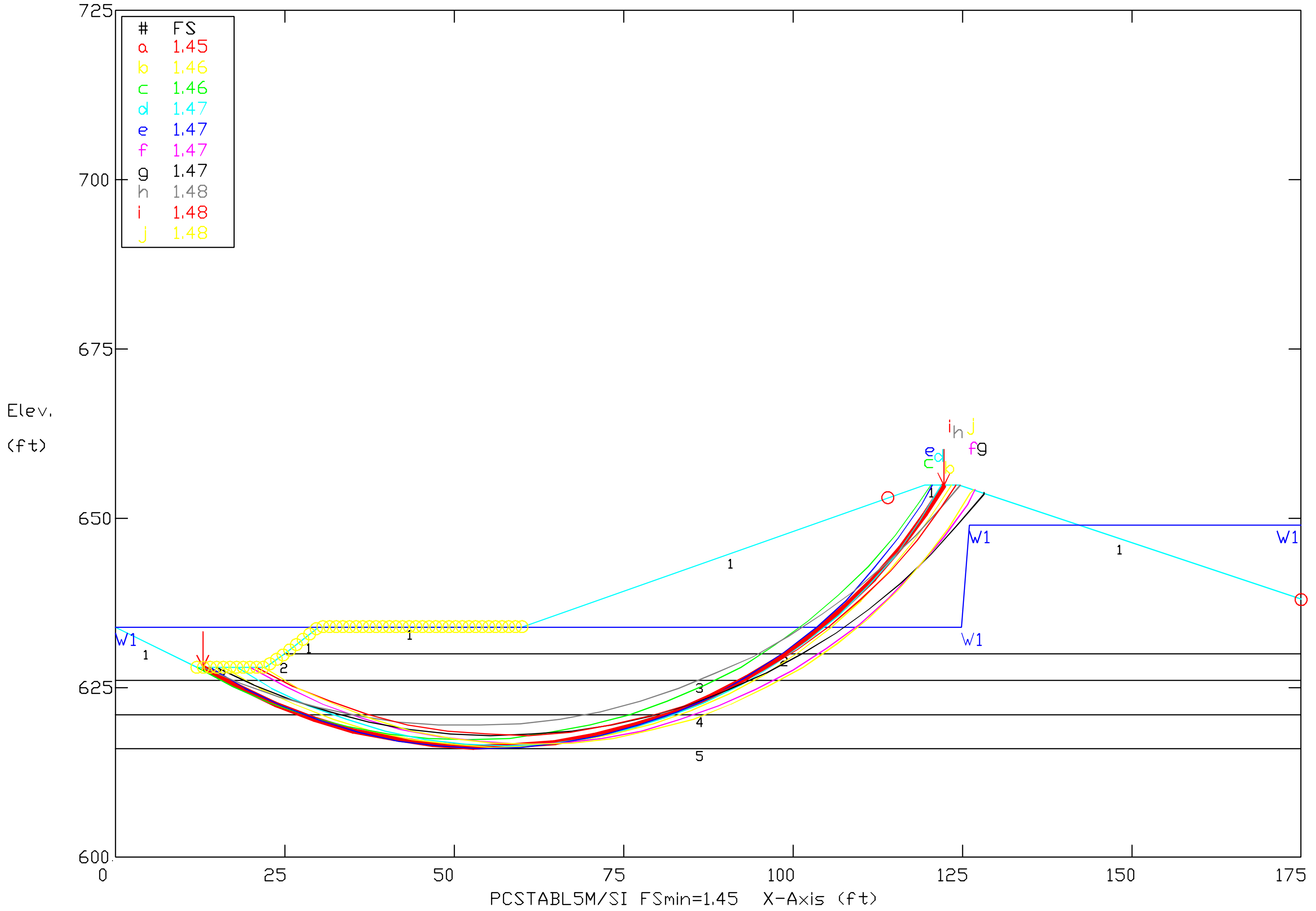
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Dike	110	115	0	32	0	0	W1
2 SP	108	108	0	36	0	0	W1
3 ML Dess.	100	100	0	26	0	0	W1
4 ML Loose	100	100	0	26	0	0	W1
5 SW/GW	120	120	0	35	0	0	W1

LSG - Main Ash Pond Creek Side Static Case & High H2O Levels (@ 652.5')
Ten Most Critical. E:LGS00BW.PLT 05-12-16 10:18am



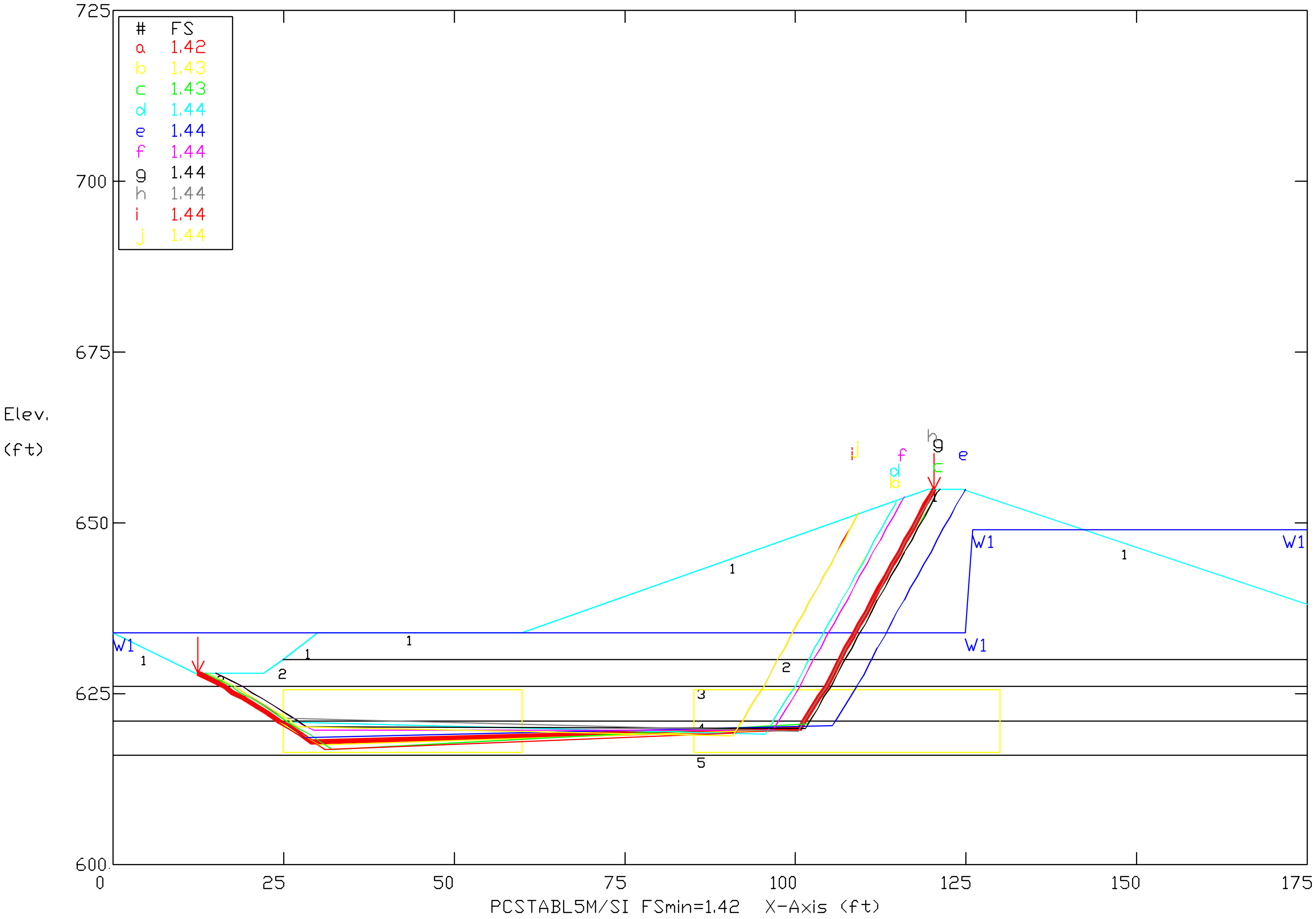
Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Dike	110	115	0	32	0	0	W1
2 SP	108	108	0	36	0	0	W1
3 ML Dess.	100	100	0	26	0	0	W1
4 ML Loose	100	100	0	26	0	0	W1
5 SW/GW	120	120	0	35	0	0	W1

LSG - Main Ash Pond Creek Side EQ Case (0.040 & 0.027) & Normal Water
Ten Most Critical. E:LGS00CEQ.PLT 05-12-16 10:56am



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	Dike	110	115	0	32	0	0	W1
2	SP	108	108	0	36	0	0	W1
3	ML Dess.	100	100	0	26	0	0	W1
4	ML Loose	100	100	0	26	0	0	W1
5	SW/GW	120	120	0	35	0	0	W1

LSG - Main Ash Pond Creek Side EQ Case (0.040 & 0.027) & Normal Water
Ten Most Critical. E:LGS00BEQ.PLT   05-12-16   10:58am



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	110	115	0	32	0	0	W1
2 SP	108	108	0	36	0	0	W1
3 ML Dess.	100	100	0	26	0	0	W1
4 ML Loose	100	100	0	26	0	0	W1
5 SW/GW	120	120	0	35	0	0	W1