



Unstable Areas  
Compliance Demonstration  
Phase 3 Modules 1 and 2, Phase 4  
Module 1

**Edgewater I-43 Ash Disposal Facility**

Prepared for:

**Wisconsin Power and Light Company**

Edgewater Generating Station  
3739 Lakeshore Drive  
Sheboygan, Wisconsin 53081

Prepared by:

**SCS ENGINEERS**

2830 Dairy Drive  
Madison, Wisconsin 53718-6751  
(608) 224-2830

October 2018  
File No. 25218091.00

**Offices Nationwide**  
[www.scsengineers.com](http://www.scsengineers.com)

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Phase 3 Modules 1 and 2, Phase 4 Module 1**

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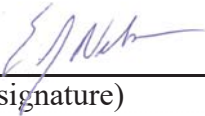
- A Site Description and Geologic Summary
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**P.E. Certification**

	<p>I, Eric J. Nelson, hereby certify that the unstable areas demonstration prepared for Phase 3 Modules 1 and 2, and Phase 4 Module 1 at the I-43 ash disposal facility meets the requirements in 40 CFR 257.64(a). This certification is based on my review of the October 2018 Unstable Areas Compliance Demonstration for Phase 3 Modules 1 and 2, and Phase 4 Module 1 prepared by SCS Engineers. I am a duly licensed Professional Engineer under the laws of the State of Wisconsin.</p>
	<p> 10/12/2018</p>
	<p>(signature) (date)</p>
	<p>Eric J. Nelson (printed or typed name)</p>
	<p>License number <u>E-37855-6</u></p> <p>My license renewal date is July 31, 2020.</p> <p>Pages or sheets covered by this seal: Unstable Areas Demonstration, I-43</p>

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## 1.0 INTRODUCTION AND PROJECT SUMMARY

On behalf of Wisconsin Power and Light Company (WPL), SCS Engineers (SCS) has prepared the enclosed Unstable Areas Restriction Compliance Demonstration for the Edgewater I-43 Ash Disposal Facility Phase 3 Modules 1 and 2, and Phase 4 Module 1 (existing coal combustion residual [CCR] landfill) as required by 40 CFR 257.64.

Future proposed CCR units (Phase 4 Modules 2 and 3) are permitted with the Wisconsin Department of Natural Resources (WDNR), but have not been developed. When developed, the units will be new CCR landfills, as defined in 40 CFR 257.53. This document addresses Phase 3 Modules 1 and 2, and Phase 4 Module 1. Future CCR units beyond Phase 4 Module 1 are not addressed and are not discussed further herein.

**Figure 1** shows the site location. **Figure 2** shows the Phase 3 Module 1 and 2, and Phase 4 Module 1 locations.

## 2.0 UNSTABLE AREAS RESTRICTION

### 257.64 “Unstable areas.”

*“(a) An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted.”*

*“(b) The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable:*

*“(1) On-site or local soil conditions that may result in significant differential settling;*

As discussed in **Appendices A and B**, and as shown by the geologic cross sections from the 1977 Preliminary Site Feasibility Report prepared by Mead & Hunt, Inc. (see **Appendix C**), the Phase 3 Modules 1 and 2, and Phase 4 Module 1 CCR units are not located in on-site or local soil conditions that may result in significant differential settling. The site soils consist of stiff to very stiff clay till that extend to depths greater than 90 feet. Because the clays are stiff to very stiff, they are not susceptible to appreciable differential settlement that would affect the performance of the landfill.

*“(2) On-site or local geologic or geomorphologic features; and*

As discussed in **Appendices A, B, and E**, and shown by the geologic cross sections in **Appendix C**, the Phase 3 Modules 1 and 2, and Phase 4 Module 1 CCR units are

not located in on-site or local geologic or geomorphologic features that are unstable. The cross sections show stiff to very stiff clay till that extend to depths greater than 90 feet. These geologic features provide a stable foundation for the CCR landfill. This assessment is confirmed by the slope stability analysis in **Appendix D** that indicates the slope stability safety factors are acceptable (i.e., safety factors against block or circular failure greater than or equal to 1.3).

(3) *On-site or local human-made features or events (both surface and subsurface)."*

As shown by the geologic cross sections in **Appendix C**, the Phase 3 Modules 1 and 2, and Phase 4 Module 1 CCR units are not located in on-site or local human-made features or events (both surface and subsurface) that are unstable. Prior to development for the landfill, the historical site use was agricultural with minimal site disturbance.

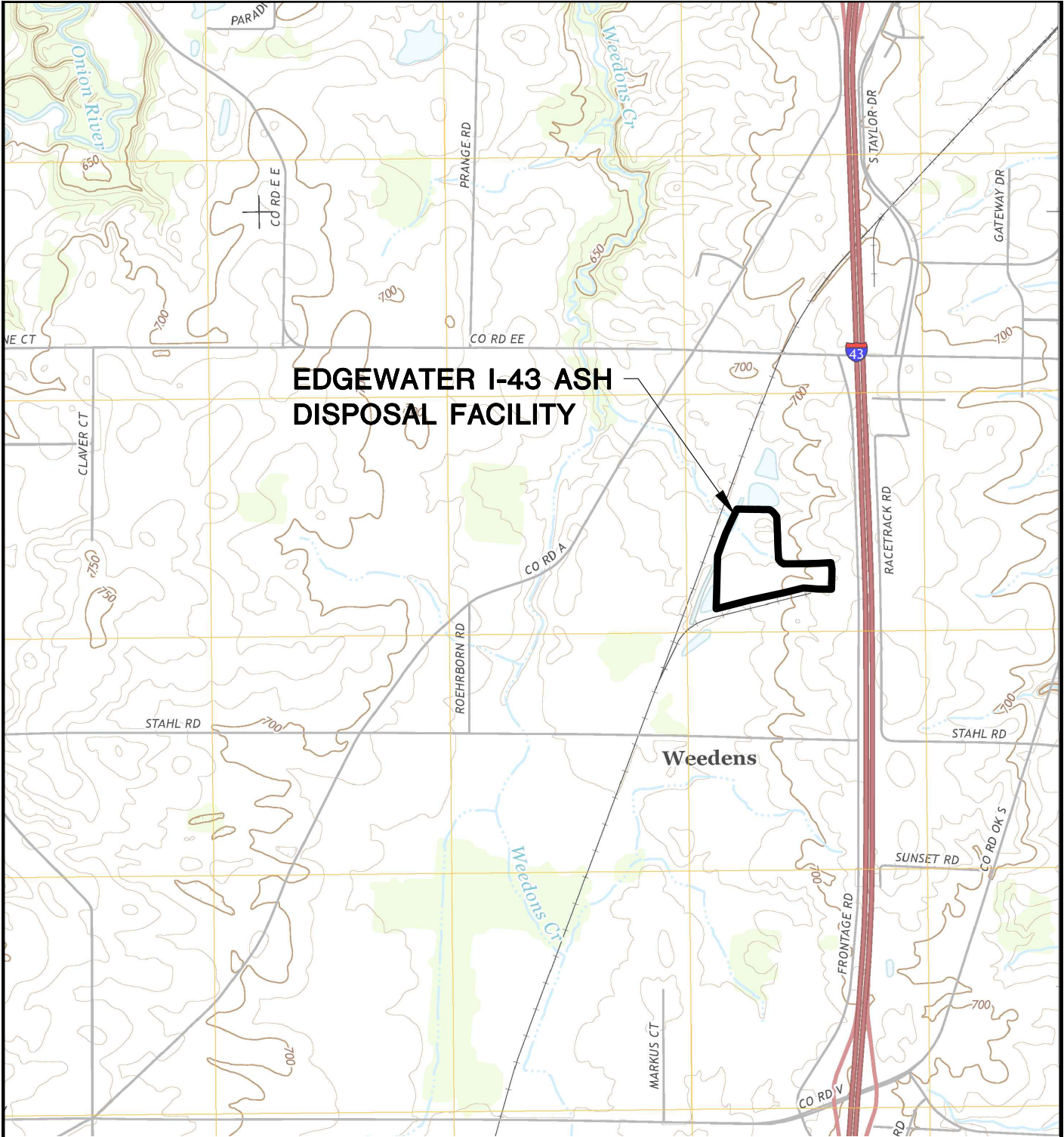
As discussed in **Appendix E**, seepage from groundwater or surface water is unlikely to cause instability. The facility is designed with adequate run-on and run-off control systems. Groundwater monitoring wells at the perimeter of the facility show that groundwater hydraulic gradients are downward and therefore groundwater is unlikely to negatively impact the performance of the facility.

### 3.0 REFERENCES

- A. Mead & Hunt, Inc., 1977, Preliminary Site Feasibility Report, Ash Disposal Site, Beck-Goebel Properties, Wilson Township, Sheboygan County, Wisconsin.

## **FIGURES**

- 1 Site Location Map
- 2 Phases 1 through 4 Location



**EDGEWATER I-43 ASH  
DISPOSAL FACILITY**

Weedens

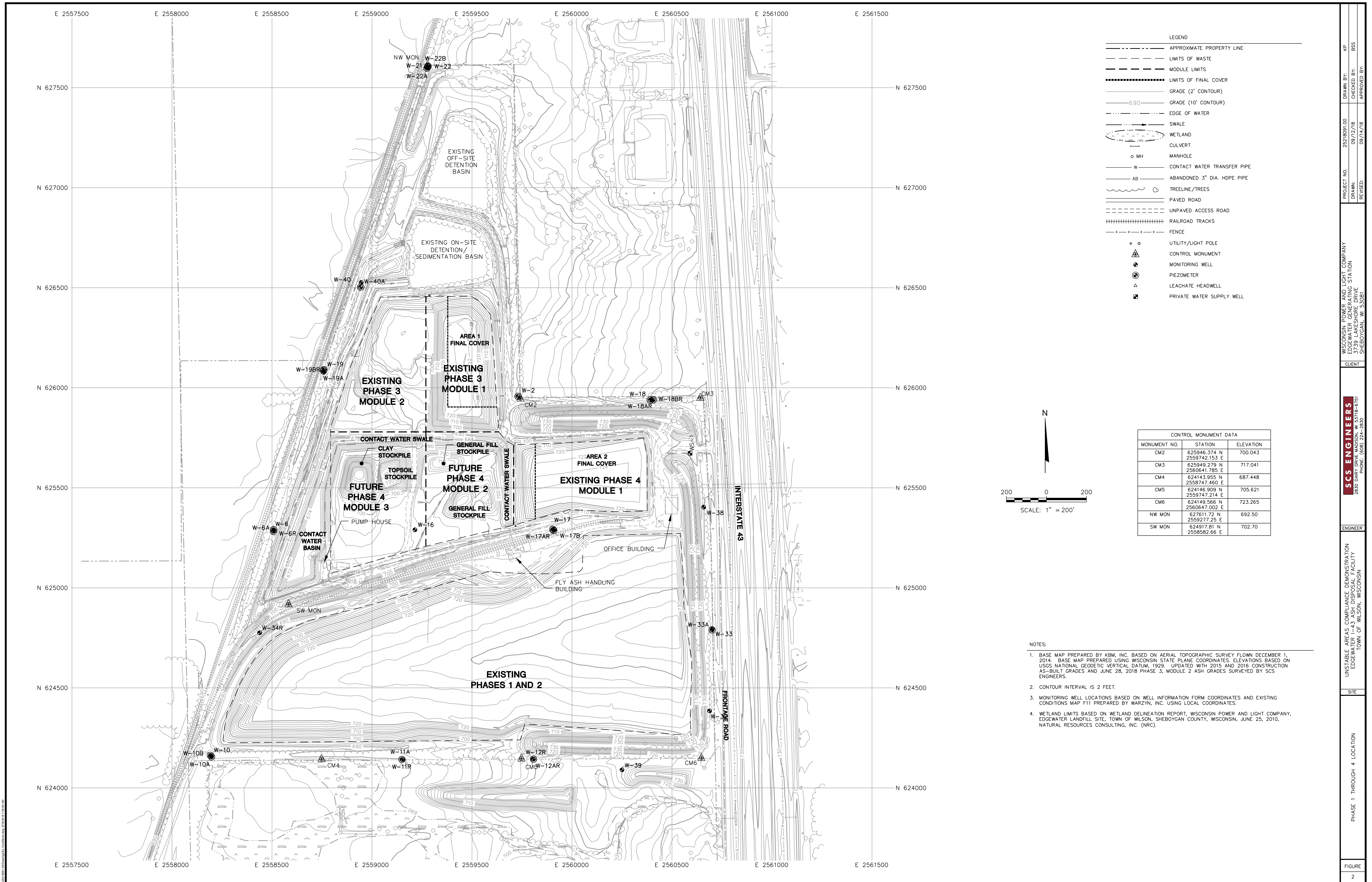


SHEBOYGAN FALLS QUADRANGLE  
WISCONSIN-SHEBOYGAN CO.  
2015  
SCALE: 1" = 2,000'



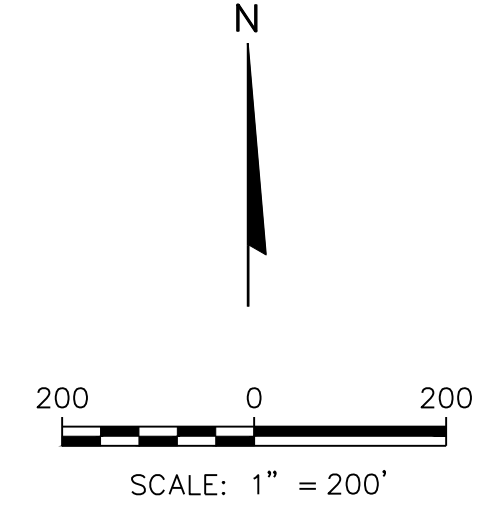
CLIENT	WISCONSIN POWER AND LIGHT COMPANY EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081		SITE	UNSTABLE AREAS COMPLIANCE DEMONSTRATION EDGEWATER I-43 ASH DISPOSAL FACILITY TOWN OF WILSON, WISCONSIN		ENGINEER	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830		FIGURE 1
	PROJECT NO.	25218091.00		DRAWN BY:	KP		APPROVED BY:		
	DRAWN:	09/17/18	CHECKED BY:	PG					
	REVISED:	09/17/18							





LEGEND

- APPROXIMATE PROPERTY LINE
- - - LIMITS OF WASTE
- - - MODULE LIMITS
- LIMITS OF FINAL COVER
- GRADE (2' CONTOUR)
- 690 --- GRADE (10' CONTOUR)
- EDGE OF WATER
- SWALE
- WETLAND
- CULVERT
- o MH MANHOLE
- W CONTACT WATER TRANSFER PIPE
- AB ABANDONED 3" DIA. HDPE PIPE
- TREELINE/TREES
- PAVED ROAD
- UNPAVED ACCESS ROAD
- RAILROAD TRACKS
- FENCE
- o U UTILITY/LIGHT POLE
- ▲ CM CONTROL MONUMENT
- MW MONITORING WELL
- ⊙ PZ PIEZOMETER
- ▲ LH LEACHATE HEADWELL
- PW PRIVATE WATER SUPPLY WELL



CONTROL MONUMENT DATA		
MONUMENT NO.	STATION	ELEVATION
CM2	625946.374 N 2559742.153 E	700.043
CM3	625949.279 N 2560641.785 E	717.041
CM4	624143.955 N 2558747.460 E	687.448
CM5	624146.909 N 2559747.214 E	705.621
CM6	624149.566 N 2560647.002 E	723.265
NW MON	627611.72 N 2559277.25 E	692.50
SW MON	624917.81 N 2558582.66 E	702.70

- NOTES:
1. BASE MAP PREPARED BY KBM, INC. BASED ON AERIAL TOPOGRAPHIC SURVEY FLOWN DECEMBER 1, 2014. BASE MAP PREPARED USING WISCONSIN STATE PLANE COORDINATES. ELEVATIONS BASED ON USGS NATIONAL GEODETIC VERTICAL DATUM, 1929. UPDATED WITH 2015 AND 2016 CONSTRUCTION AS-BUILT GRADES AND JUNE 28, 2018 PHASE 3, MODULE 2 ASH GRADES SURVEYED BY SCS ENGINEERS.
  2. CONTOUR INTERVAL IS 2 FEET.
  3. MONITORING WELL LOCATIONS BASED ON WELL INFORMATION FORM COORDINATES AND EXISTING CONDITIONS MAP F11 PREPARED BY WARZYN, INC. USING LOCAL COORDINATES.
  4. WETLAND LIMITS BASED ON WETLAND DELINEATION REPORT, WISCONSIN POWER AND LIGHT COMPANY, EDGEWATER LANDFILL SITE, TOWN OF WILSON, SHEBOYGAN COUNTY, WISCONSIN, JUNE 25, 2010, NATURAL RESOURCES CONSULTING, INC. (NRC).

PROJECT NO. 25218951.00  
 DRAWN BY: RP  
 CHECKED BY: BBS  
 APPROVED BY: [Signature]  
 WISCONSIN POWER AND LIGHT COMPANY  
 EDGEWATER GENERATING STATION  
 3739 LAKESHORE DRIVE  
 SHEBOYGAN, WI 53081  
 CLIENT  
**SCS ENGINEERS**  
 2830 DARY DRIVE MADISON, WI 53718-0797  
 PHONE: (608) 224-2830  
 ENGINEER  
 UNSTABLE AREAS COMPLIANCE DEMONSTRATION  
 EDGEWATER I-43 ASH DISPOSAL FACILITY  
 TOWN OF WILSON, WISCONSIN  
 SITE  
 PHASE 1 THROUGH 4 LOCATION  
 FIGURE 2



## **APPENDIX A**

Site Description and Geologic Summary



## Site Description and Geologic Summary

### Site Information

The I-43 ash disposal facility encompasses approximately 75 acres, and is located in an agricultural area. The site location is the East ½ of Section 8, T14N, R23E, in the Town of Wilson, located in Sheboygan County, Wisconsin. The facility is bounded by a frontage road to Interstate Highway I-43 to the east and by a rail line to the west.

### Regional Geology

The I-43 disposal facility is located in an area of thick glacial sediment overlying Silurian carbonate bedrock. The uppermost bedrock in the area is Silurian dolostone, a unit in which karst features such as closed depression, sinkholes and caves may develop by solution along fractures, joints, and bedding planes. However, in areas covered by Pleistocene ice sheets such as northeastern Wisconsin, glacial processes have eroded away or filled in most karst features.

A regional report for northeastern Wisconsin notes that the Silurian dolostone is characterized by complex fracturing and anisotropic flow, but that extensive weathering is generally absent, and caves are rare (Erb and Stiglitz, eds., 2007). In addition, most karst features in northeastern Wisconsin appear to have formed prior to Pleistocene glaciation of the area (more than about 2.4 million years ago) and sinkholes, caves, and solution-enlarged joints are filled in with a wide variety of sediments, some of which was emplaced by subglacial water under high pressure in an interconnected karst/subglacial drainage system (Luczaj and Stieglitz, 2008). If these sediment-filled features are located below the water table, they are supported by the hydrostatic pressure of groundwater, and are not expected to be zones of instability.

The I-43 area has been covered by Pleistocene ice sheets several times (Carlson and others, 2011), and borings drilled on the I-43 disposal facility penetrate up to 90 feet of predominantly clay till with some sand and sorted sediment layers. The total sequence of sediment is about 150 feet thick, as indicated by water supply records in the area of the facility. Because of the multiple glacial advances and associated erosional and depositional processes resulting in a thick sediment layer overlying the bedrock, the area is not likely to be unstable due to karstic processes.

### Previous Geologic Investigations

The disposal facility area was investigated by Mead & Hunt prior to construction by performing 9 borings within and adjacent to the facility footprint. Four of the borings were instrumented with groundwater monitoring wells. The borings extended to depths of up to 90 feet. Soil samples were collected for laboratory testing that includes Atterberg limits and permeability. The boring locations and geologic cross sections are shown in **Appendix C**. The boring

locations and geologic cross sections are also shown on drawings in **Appendix C** from the 2008 Plan of Operation prepared by BT2, Inc.

Based on the results of the subsurface investigation performed prior to disposal facility construction, the soils below the liner system within the facility footprint consist primarily of stiff to very stiff lean clays with scattered sand seams to the maximum drilling depth of 90 feet.

### **References**

BT2, Inc., 2008, Plan of Operation, Edgewater I-43 Ash Disposal Facility, Phases 3 and 4.

Carlson, A.E., Principato, S.M., Chapel, D.M., and Mickelson, D.M., 2011, Quaternary Geology of Sheboygan County, Wisconsin: Wisconsin Geological and Natural History Survey Bulletin 106, 32 p., 2 pls.

Erb, K., and Stieglitz, R., eds., 2007, Final Report of the Northeast Karst Task Force (G3836), University of Wisconsin Extension, Green Bay, Wisconsin.

Luczaj, J.A., and Stieglitz, R.D., 2008, Geologic History of New Hope Cave, Manitowoc County, Wisconsin. [https://www.uwgb.edu/luczajj/reprints/New\\_Hope\\_Cave\\_4-08.pdf](https://www.uwgb.edu/luczajj/reprints/New_Hope_Cave_4-08.pdf)

Mead & Hunt, Inc., 1977, Preliminary Site Feasibility Report, Ash Disposal Site, Beeck-Goebel Properties, Wilson Township, Sheboygan County, Wisconsin.

BJS/DLN/AJR/EJN

I:\25218091.00\Deliverables\Unstable Area Demonstration\Appendices\Appendix A\A\_Site and Geologic Summary.docx

## **APPENDIX B**

### Liquefaction and Settlement Potential Evaluation

## Liquefaction and Settlement Potential Evaluation

Based on the results of the site investigation borings and laboratory soil test results performed by Mead & Hunt (**Appendix C**), the disposal facility soils are not subject to liquefaction or settlement concerns for the performance of the disposal facility.

Liquefaction is the process by which a saturated, loose, cohesionless soil influenced by external forces can suddenly loses its shear strength and behave as a fluid. The external forces result from ground motion from an earthquake. The disposal facility site soils in borings consist primarily of stiff to very stiff clay that is not subject to liquefaction. In addition, liquefaction is not a concern given the low magnitude (less than 0.04 g, 2 percent in 50 years) of maximum ground accelerations expected in the area; see **Attachment B1**.

Settlement below a disposal facility can be a concern if the facility is underlain by extensive soft, fine-grained soils. Soft soils are subject to consolidation settlement depending on the load over the soft soils. The disposal facility soils consist of stiff to very stiff clay till. Because the clays are stiff to very stiff rather than soft, consolidation settlement is not a concern for the performance of the disposal facility.

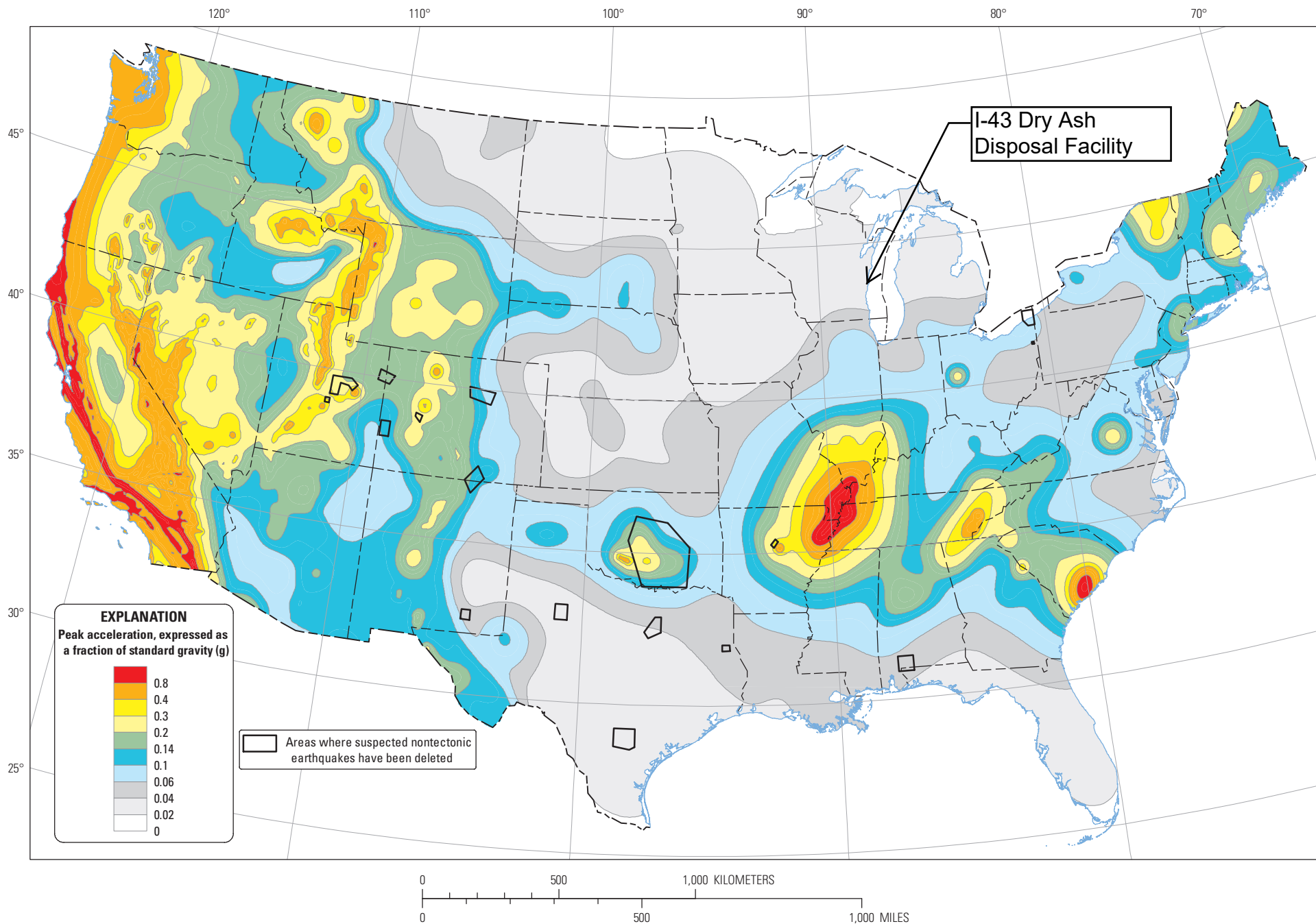
### References

USGS seismic impact zones map website:

<https://earthquake.usgs.gov/static/lfs/nshm/conterminous/2014/2014pga2pct.pdf>

DLN/AJR/EJN

I:\25218091.00\Deliverables\Unstable Area Demonstration\Appendices\B1\_Liquefaction and Settlement Potential Evaluation.docx

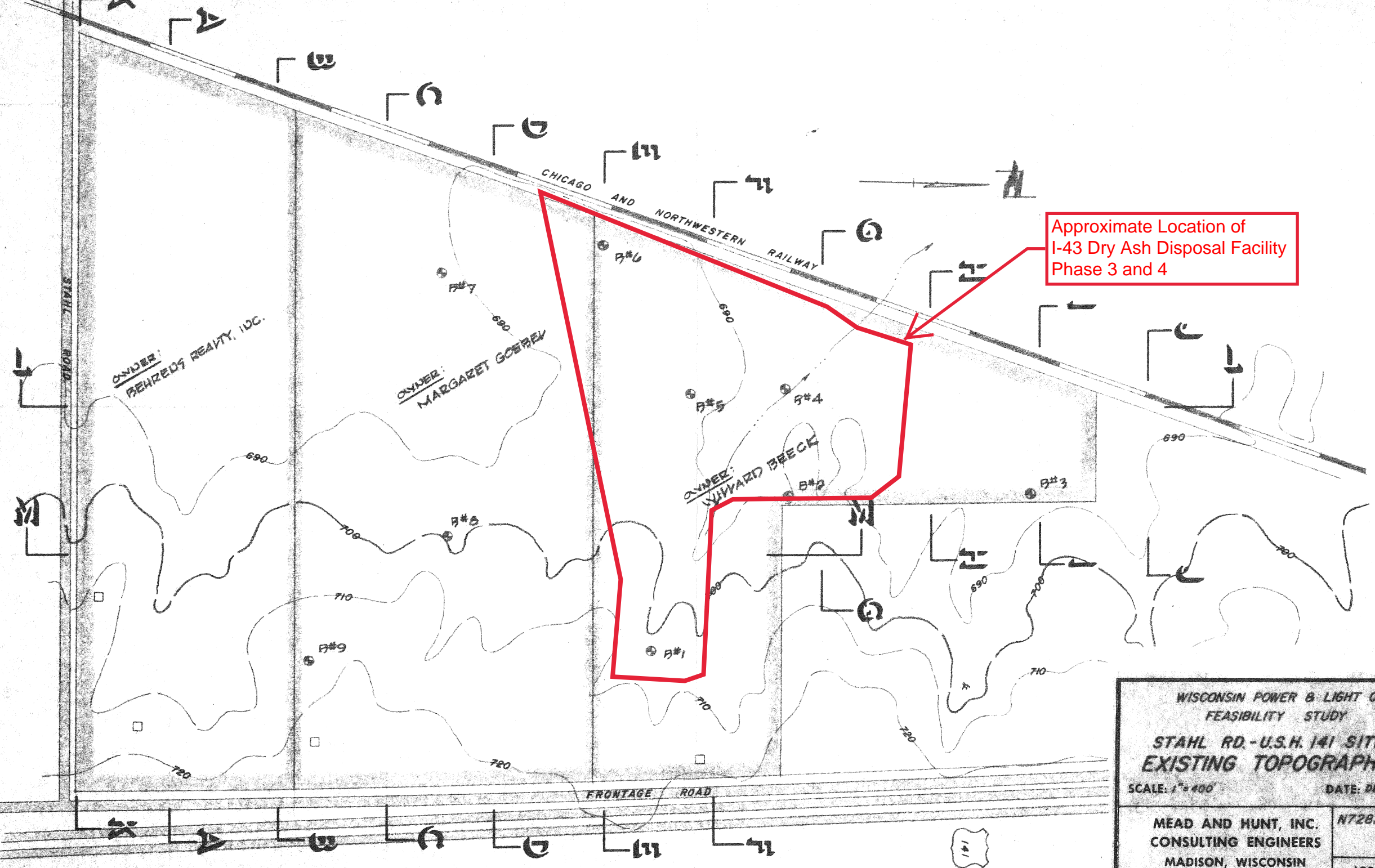


## Two-percent probability of exceedance in 50 years map of peak ground acceleration

Source: USGS seismic impact zones map - <https://earthquake.usgs.gov/static/lfs/nshmc/conterminous/2014/2014pga2pct.pdf>

## **APPENDIX C**

### Geologic Cross Sections



Approximate Location of  
I-43 Dry Ash Disposal Facility  
Phase 3 and 4





WISCONSIN POWER & LIGHT CO.  
FEASIBILITY STUDY  
**STAHL RD.-U.S.H. 141 SITE**  
**EXISTING TOPOGRAPHY**  
SCALE: 1" = 400' DATE: DEC., '77

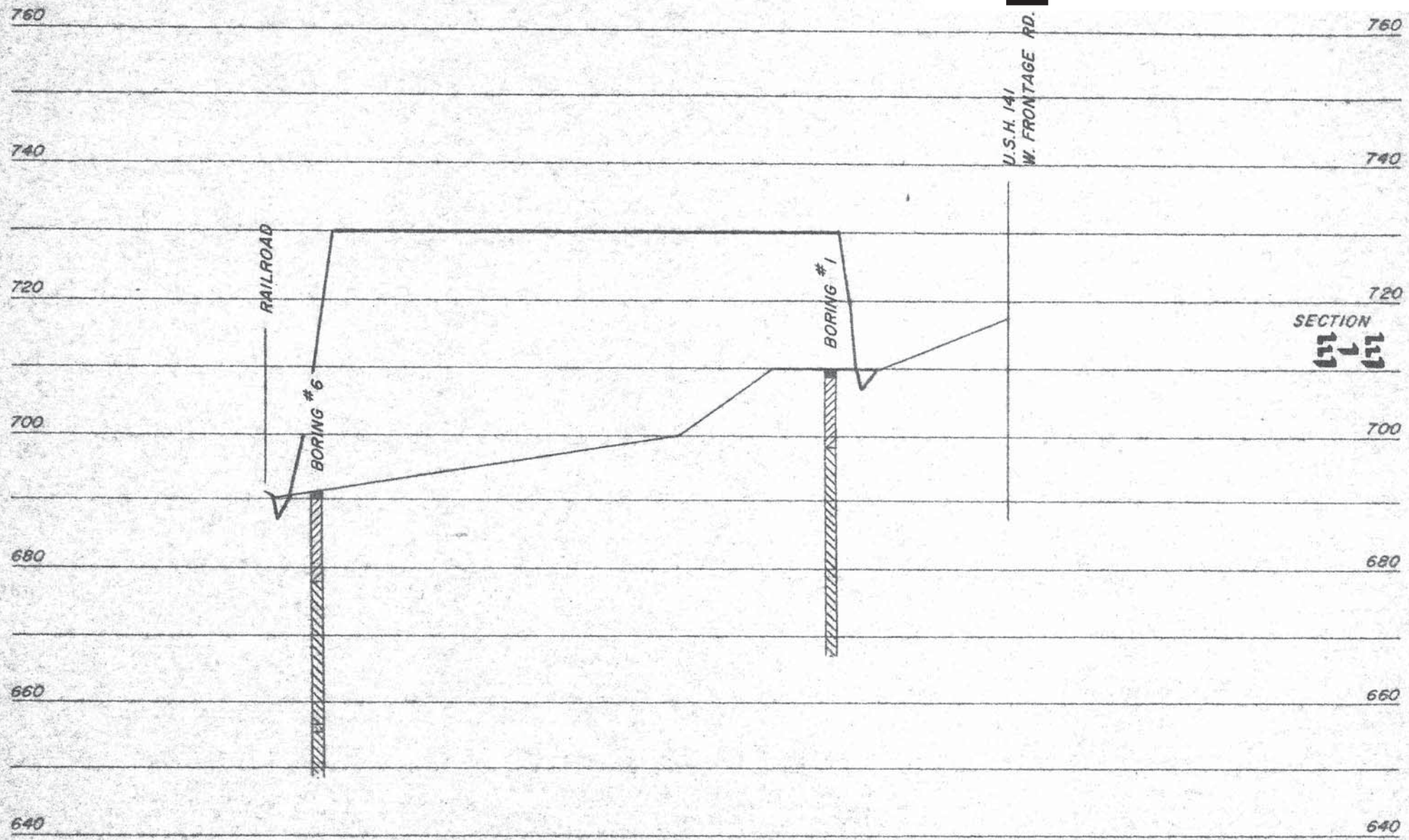
MEAD AND HUNT, INC.  
CONSULTING ENGINEERS  
MADISON, WISCONSIN

N7282B-  
JOB. W41-77



LEGEND

-  REDDISH BROWN SILTY FINE TO MEDIUM SAND  
TRACE CLAY (SM)
-  STIFF REDDISH BROWN LEAN CLAY (CL)  
TRACE FINE SAND AND GRAVEL
-  STIFF GRAYISH BROWN LEAN CLAY (CL) TRACE FINE  
SAND AND GRAVEL, OCCASIONAL THIN SEAMS OF  
CLAYEY SILT, SANDY CLAY OR GRAVEL
-  TOPSOIL



SCALE: HOR. 1" = 400'

MEAD AND HUNT, INC.  
CONSULTING ENGINEERS



LEGEND



REDDISH BROWN SILTY FINE TO MEDIUM SAND  
TRACE CLAY (SM)



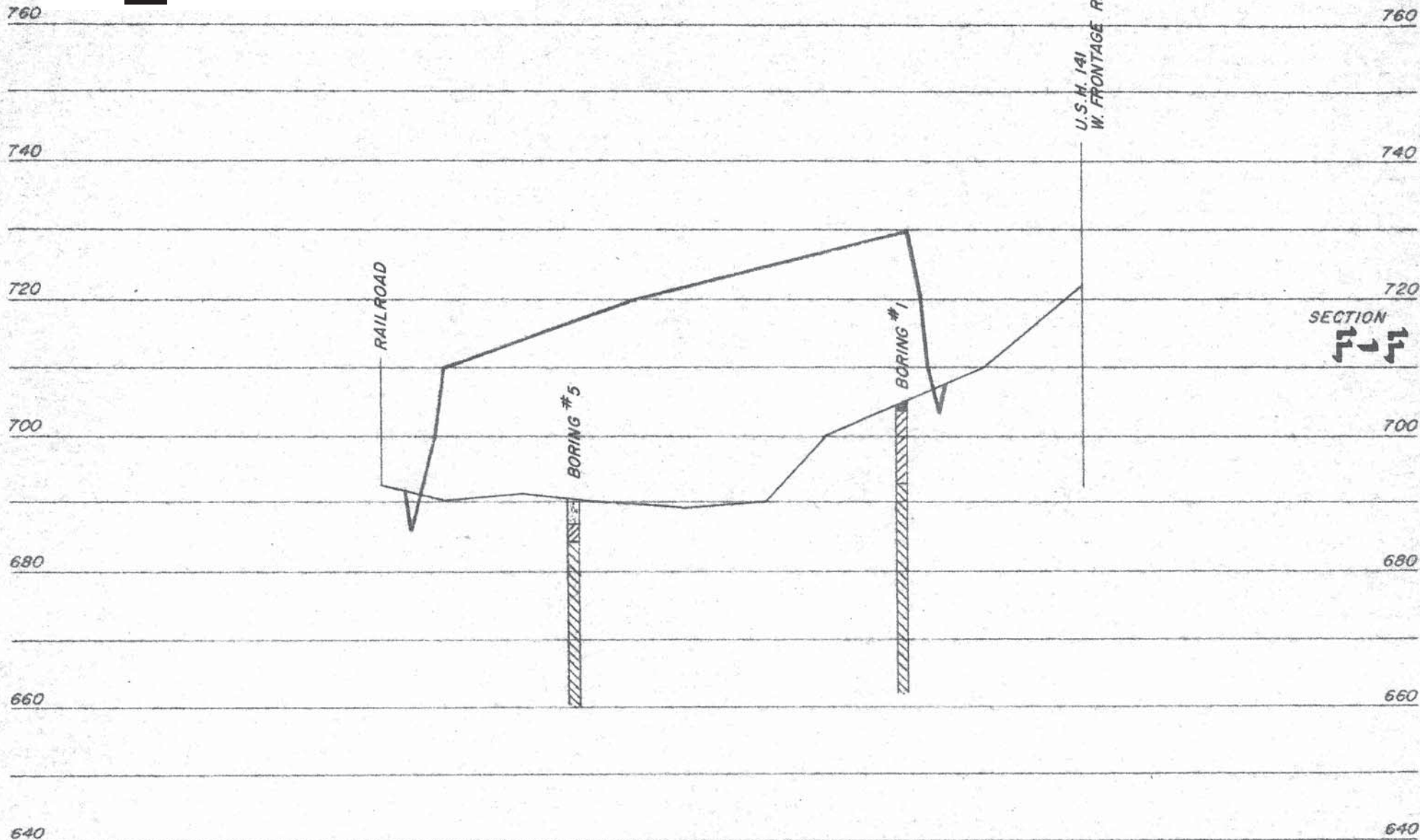
STIFF REDDISH BROWN LEAN CLAY (CL)  
TRACE FINE SAND AND GRAVEL



STIFF GRAYISH BROWN LEAN CLAY (CL) TRACE FINE  
SAND AND GRAVEL, OCCASIONAL THIN SEAMS OF  
CLAYEY SILT, SANDY CLAY OR GRAVEL



TOPSOIL



SCALE: HOR. 1" = 400'

MEAD AND HUNT, INC.  
CONSULTING ENGINEERS



LEGEND



REDDISH BROWN SILTY FINE TO MEDIUM SAND  
TRACE CLAY (SM)



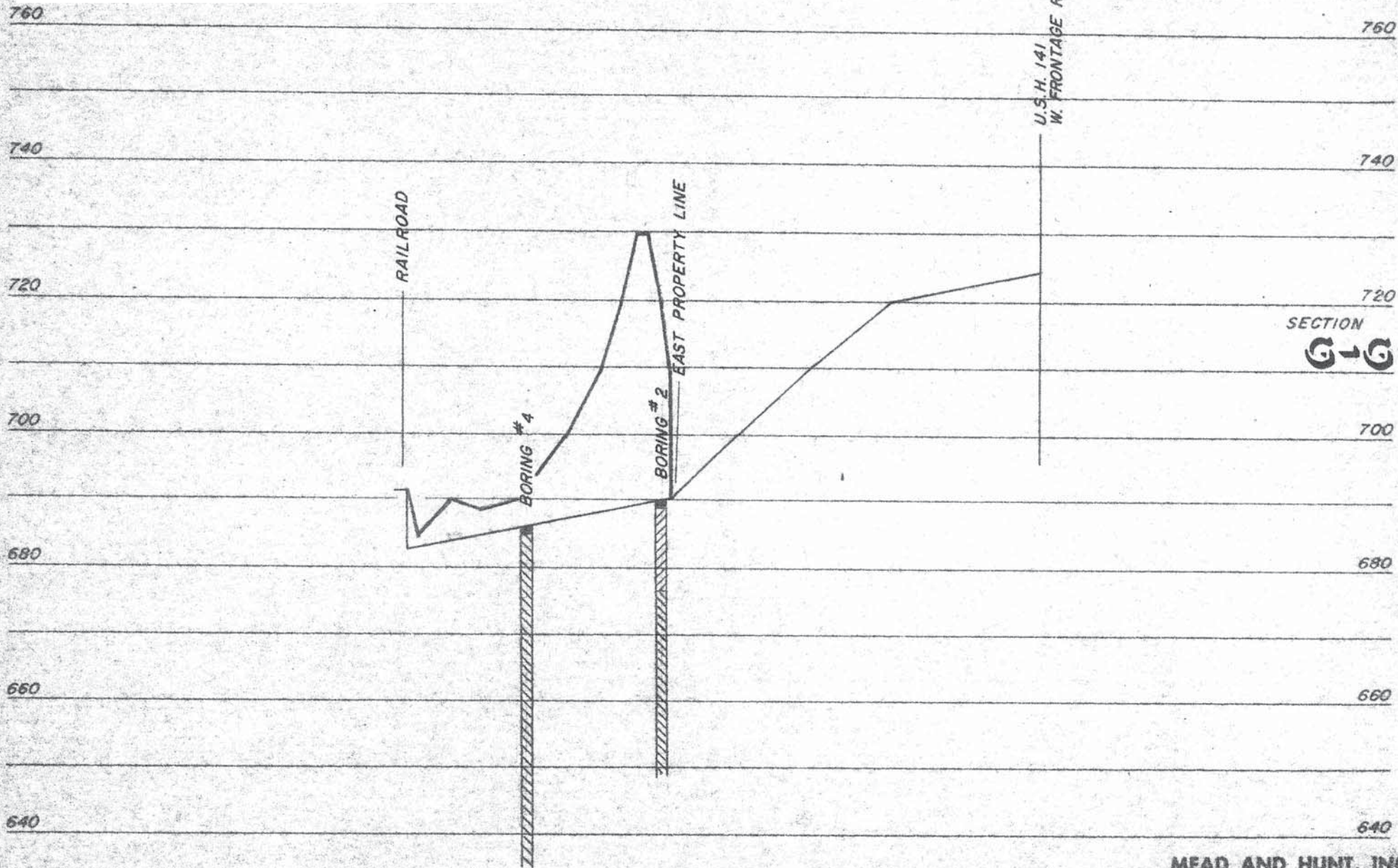
STIFF REDDISH BROWN LEAN CLAY (CL)  
TRACE FINE SAND AND GRAVEL



STIFF GRAYISH BROWN LEAN CLAY (CL) TRACE FINE  
SAND AND GRAVEL, OCCASIONAL THIN SEAMS OF  
CLAYEY SILT, SANDY CLAY OR GRAVEL



TOPSOIL



SCALE: HOR. 1" = 400'

MEAD AND HUNT, INC.  
CONSULTING ENGINEERS



LEGEND



REDDISH BROWN SILTY FINE TO MEDIUM SAND  
TRACE CLAY (SM)



STIFF REDDISH BROWN LEAN CLAY (CL)  
TRACE FINE SAND AND GRAVEL



STIFF GRAYISH BROWN LEAN CLAY (CL) TRACE FINE  
SAND AND GRAVEL, OCCASIONAL THIN SEAMS OF  
CLAYEY SILT, SANDY CLAY OR GRAVEL



TOPSOIL

760

760

740

740

720

720

700

700

680

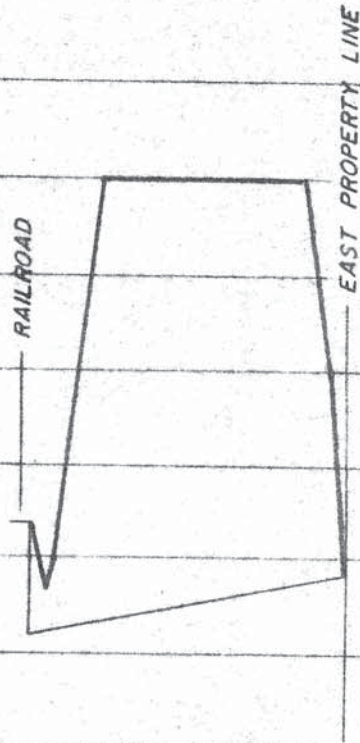
680

660

660

640

640



SECTION



SCALE: HOR. 1"=400'

MEAD AND HUNT, INC.  
CONSULTING ENGINEERS



LEGEND



REDDISH BROWN SILTY FINE TO MEDIUM SAND  
TRACE CLAY (SM)



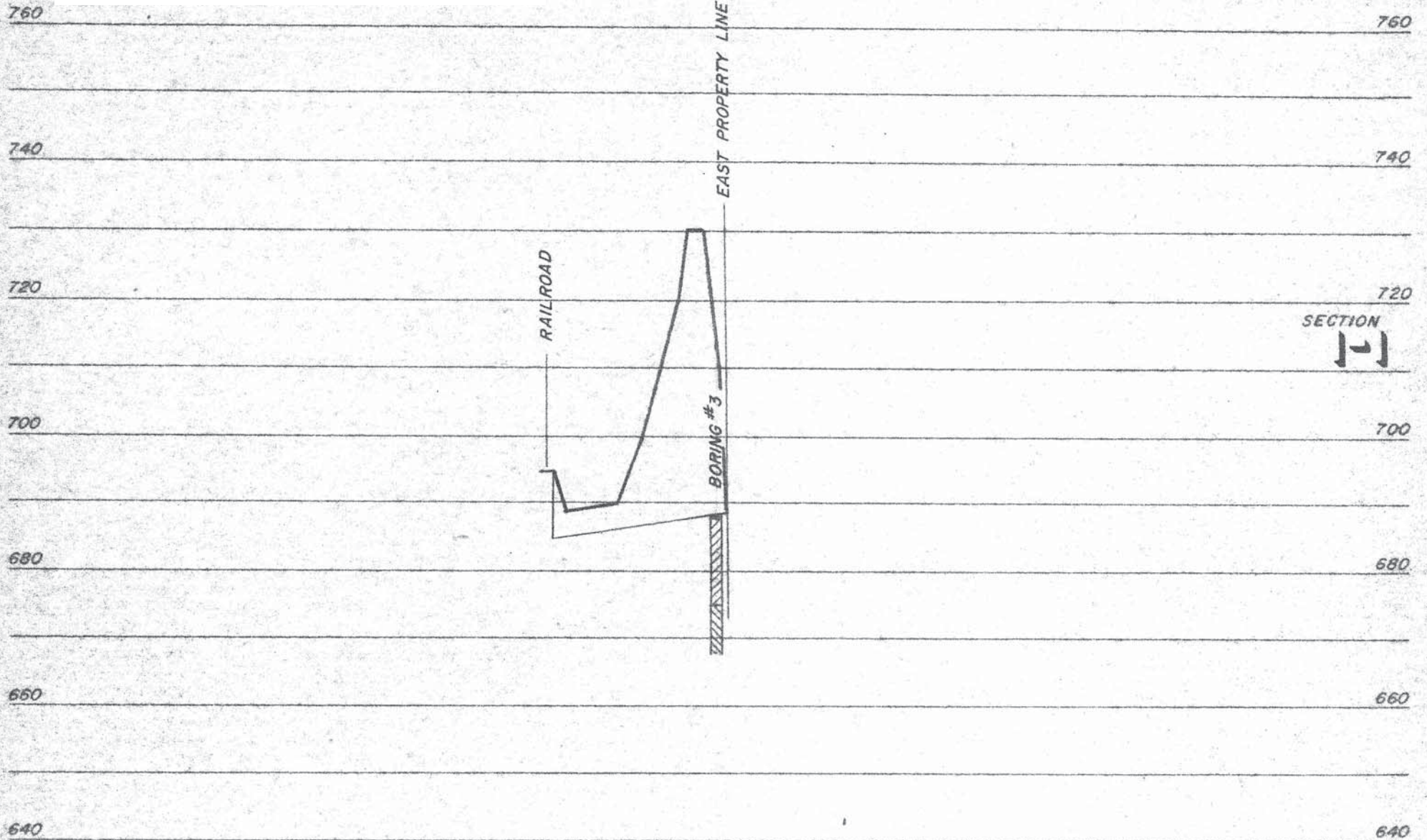
STIFF REDDISH BROWN LEAN CLAY (CL)  
TRACE FINE SAND AND GRAVEL



STIFF GRAYISH BROWN LEAN CLAY (CL) TRACE FINE  
SAND AND GRAVEL, OCCASIONAL THIN SEAMS OF  
CLAYEY SILT, SANDY CLAY OR GRAVEL



TOPSOIL



SCALE: HOR. 1"=400'

MEAD AND HUNT, INC.  
CONSULTING ENGINEERS



LEGEND



REDDISH BROWN SILTY FINE TO MEDIUM SAND  
TRACE CLAY (SM)



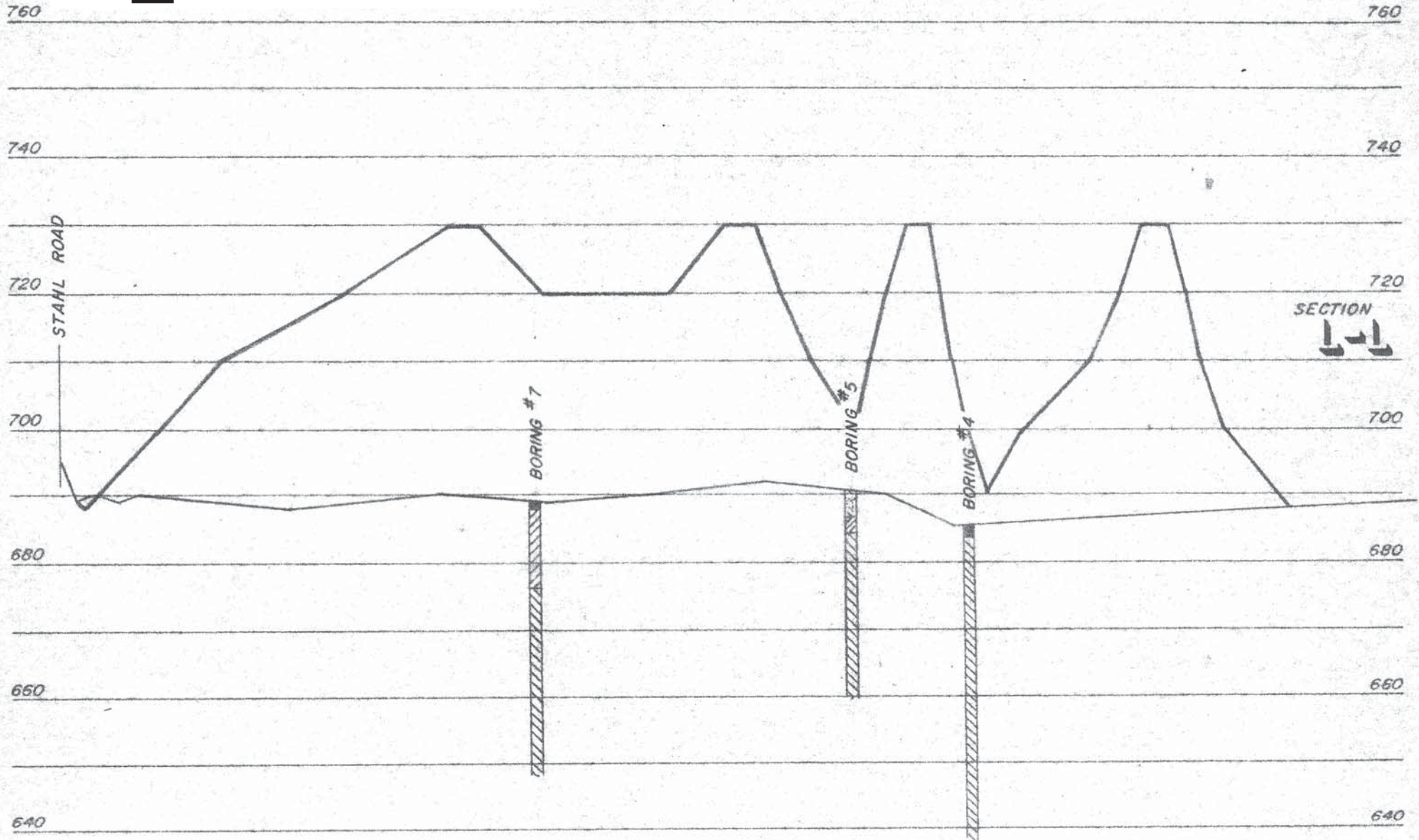
STIFF REDDISH BROWN LEAN CLAY (CL)  
TRACE FINE SAND AND GRAVEL



STIFF GRAYISH BROWN LEAN CLAY (CL) TRACE FINE  
SAND AND GRAVEL, OCCASIONAL THIN SEAMS OF  
CLAYEY SILT, SANDY CLAY OR GRAVEL



TOPSOIL



SCALE: HOR. 1" = 400'

MEAD AND HUNT, INC.  
CONSULTING ENGINEERS

LEGEND



REDDISH BROWN SILTY FINE TO MEDIUM SAND  
TRACE CLAY (SM)



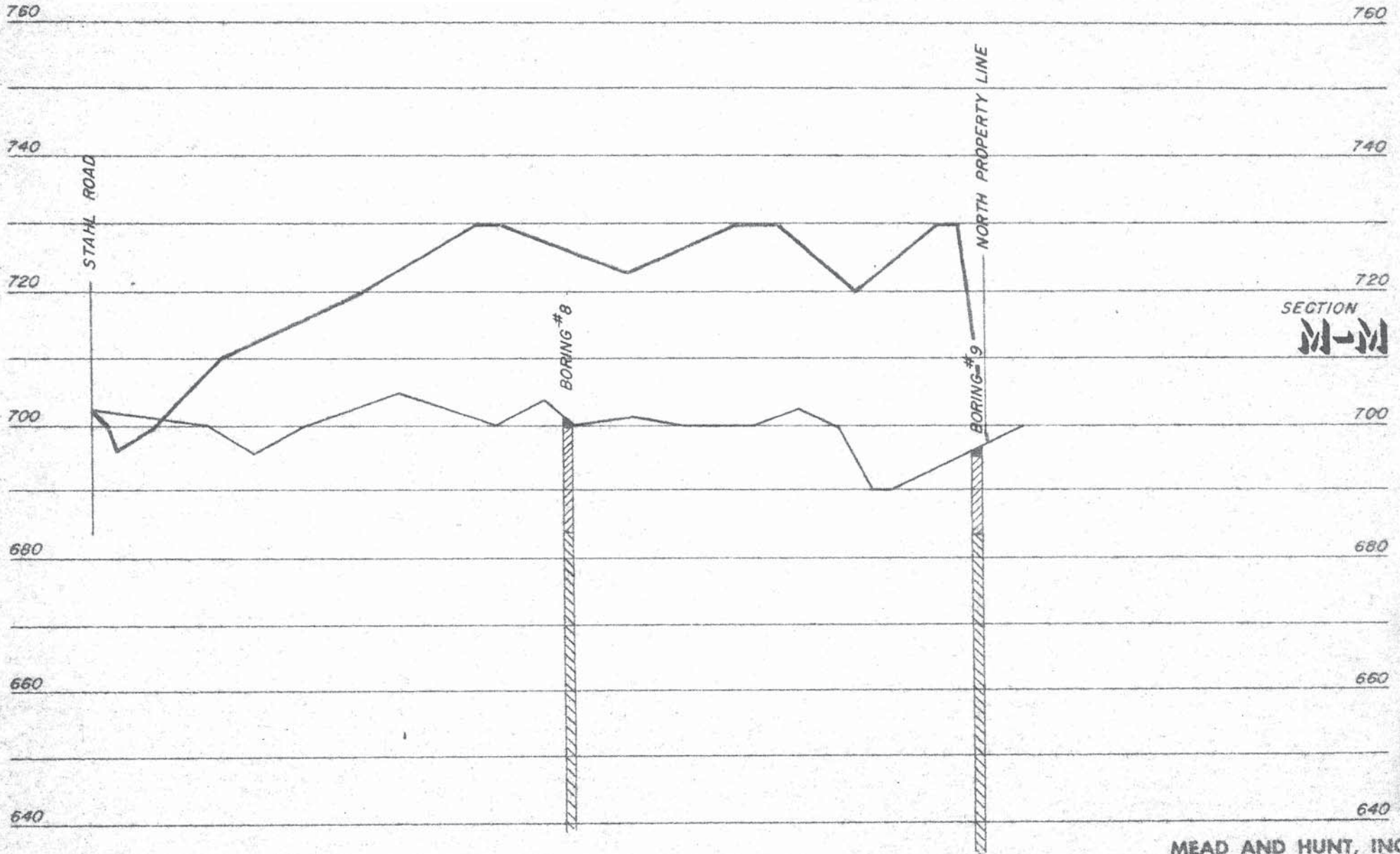
STIFF REDDISH BROWN LEAN CLAY (CL)  
TRACE FINE SAND AND GRAVEL



STIFF GRAYISH BROWN LEAN CLAY (CL) TRACE FINE  
SAND AND GRAVEL, OCCASIONAL THIN SEAMS OF  
CLAYEY SILT, SANDY CLAY OR GRAVEL



TOPSOIL



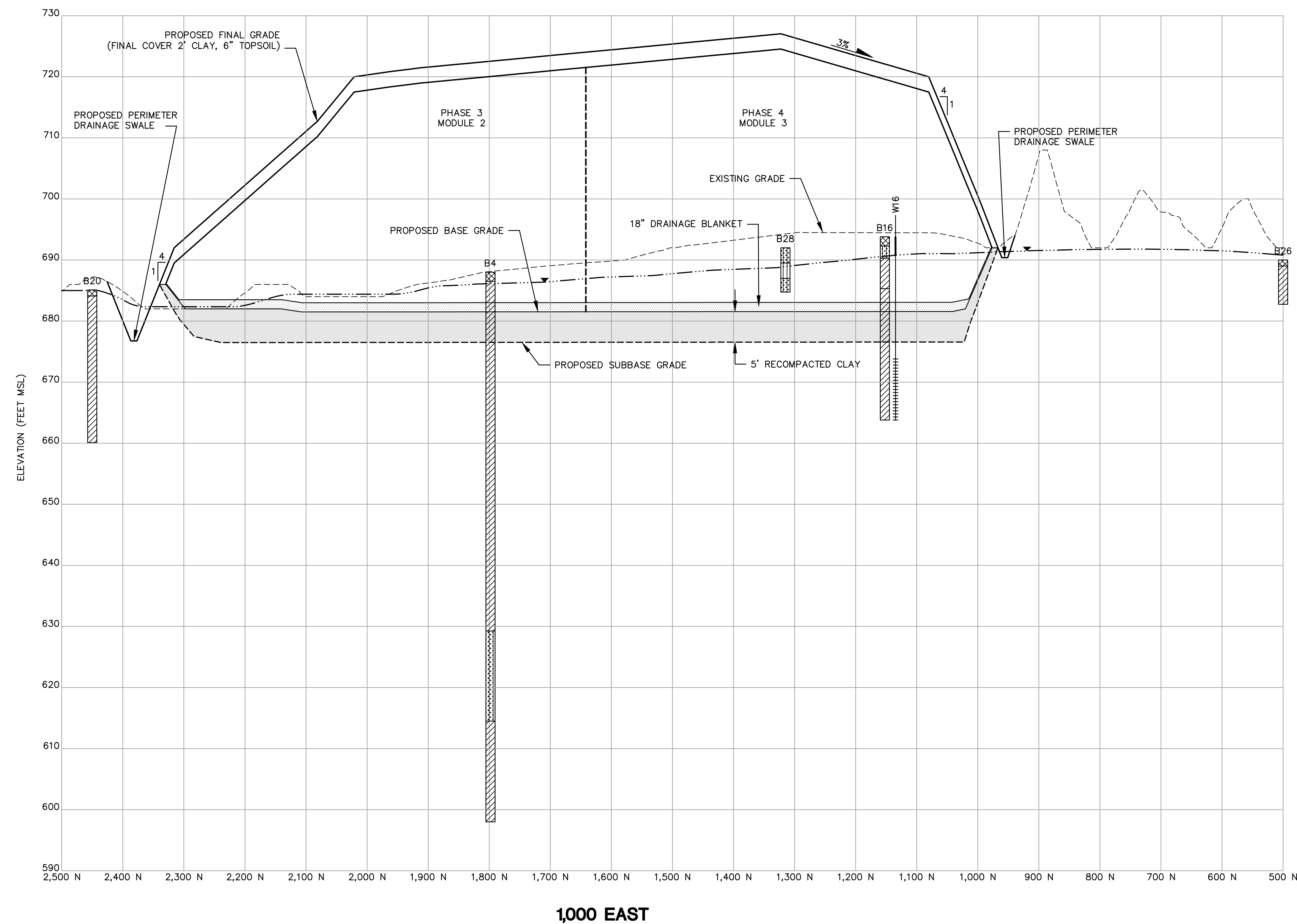
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MEAD AND HUNT, INC  
CONSULTING ENGINEER



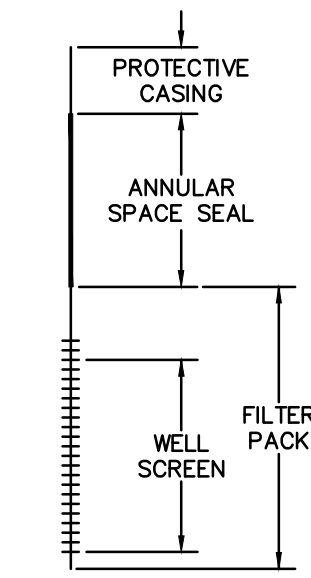




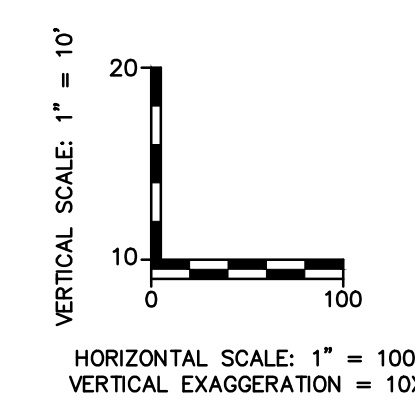


LEGEND

	FILL/TOPSOIL
	SILT (ML)
	LEAN CLAY (CL)
	SILTY SAND (SM)
	WATER TABLE ON APRIL 4, 2006

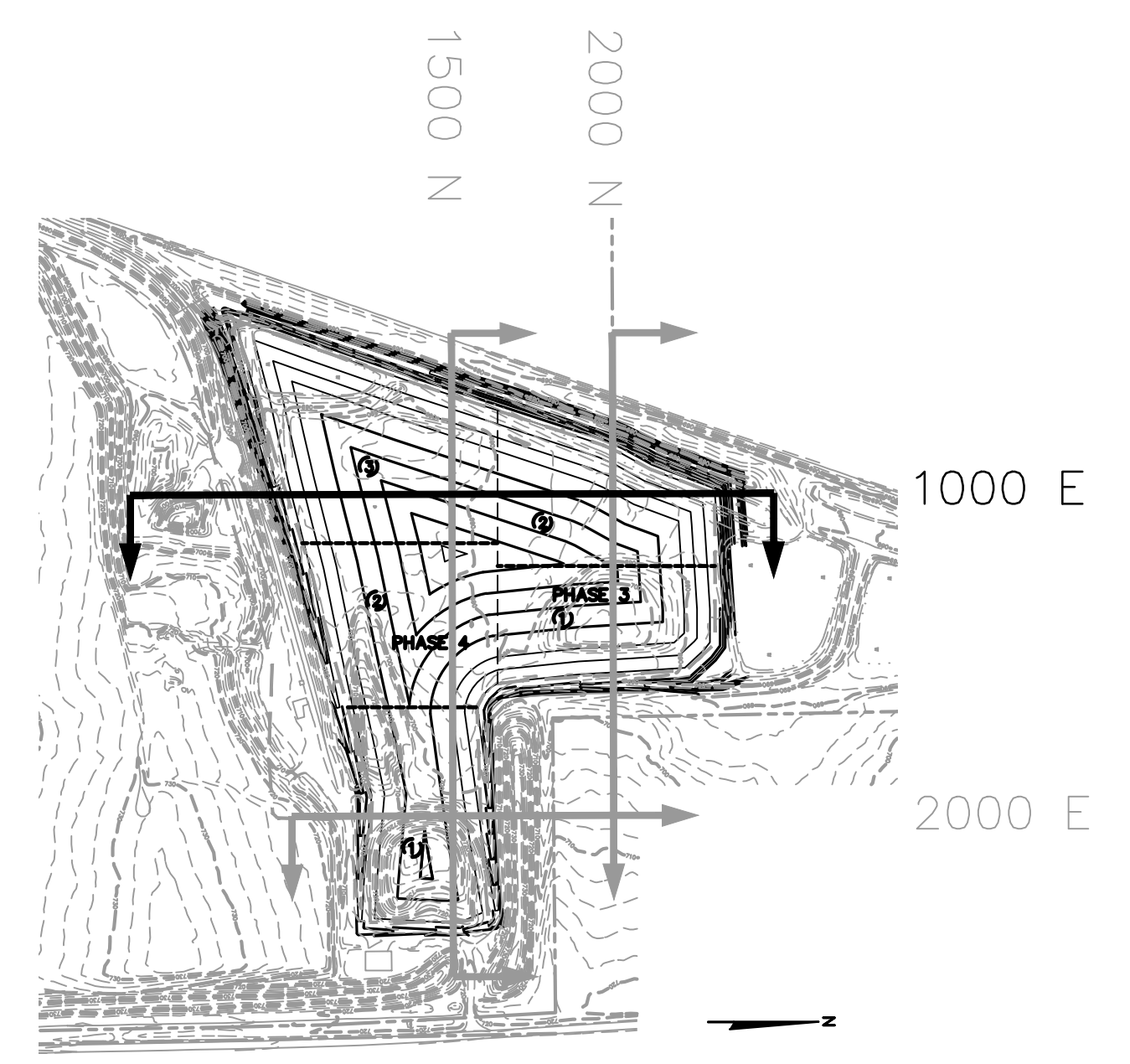


WELL DETAIL



NOTES:

- BORINGS B4, B16, AND B20 WERE INSTALLED BY SOILS & ENGINEERING SERVICES, INC. IN 1977 AND 1978.
- BORINGS B26 AND B28 WERE INSTALLED BY WARZYN ENGINEERING, INC. IN 1981.



CROSS SECTION LOCATION  
T = 600'

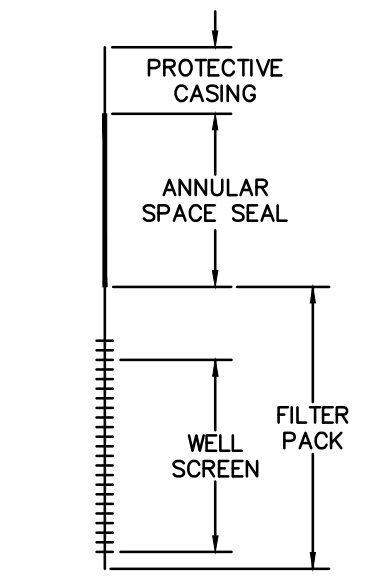
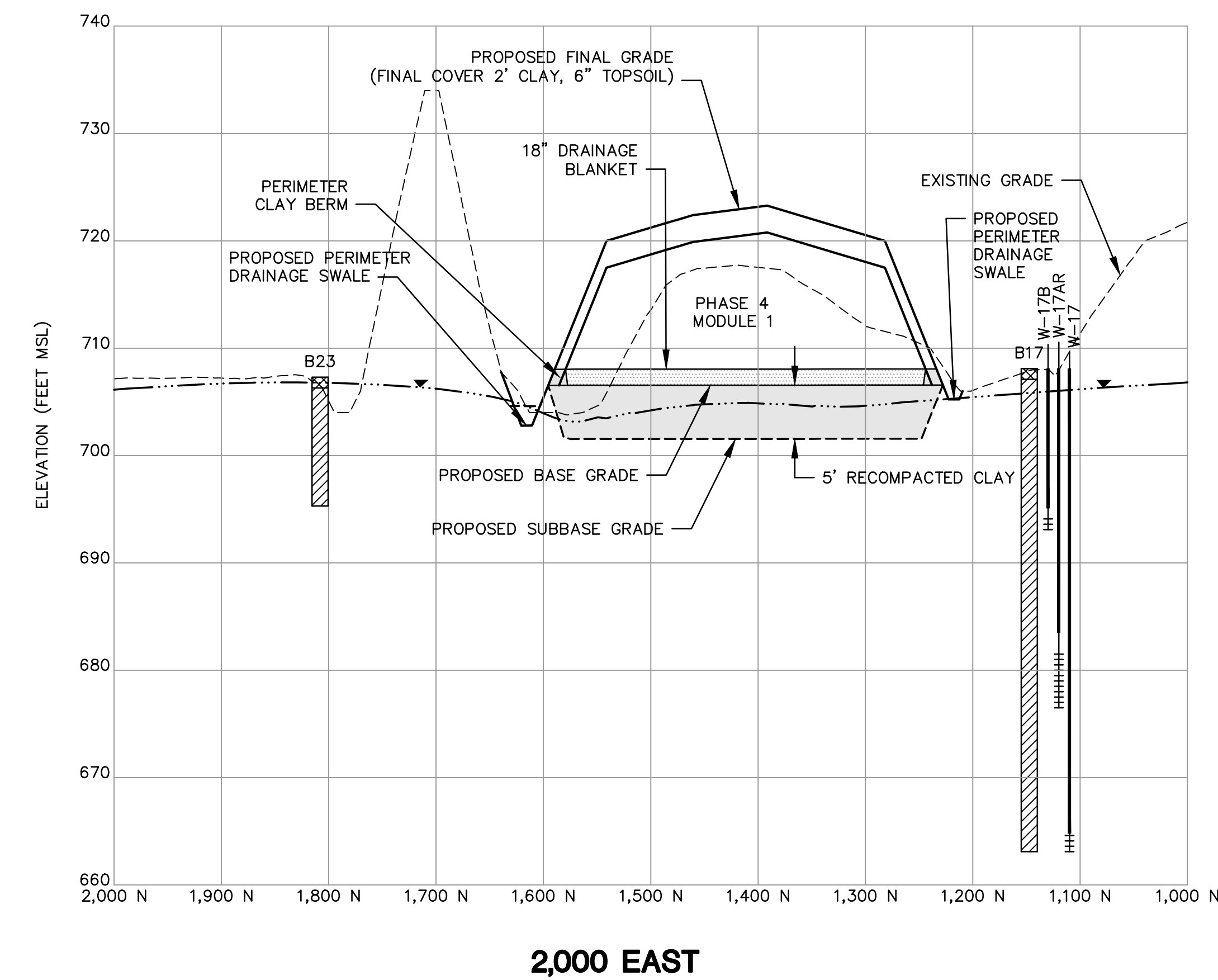
Note: Design information depicted here has been superseded by design updates in the March 2015 Plan of Operation Modification for Phases 3 and 4 prepared by SCS Engineers.

PROJECT NO. 3391	DRAWN BY: KP			2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830 FAX: (608) 224-2839	CLIENT: WISCONSIN POWER AND LIGHT EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081	SITE: PLAN OF OPERATION PHASES 3 AND 4 EDGEWATER I-43 ASH DISPOSAL FACILITY WILSON, WISCONSIN	CROSS SECTION 1,000 EAST	SHEET
DRAWN: 11/23/07	CHECKED BY: KG							12 OF 17
REVISED: 12/10/07	APPROVED BY:							

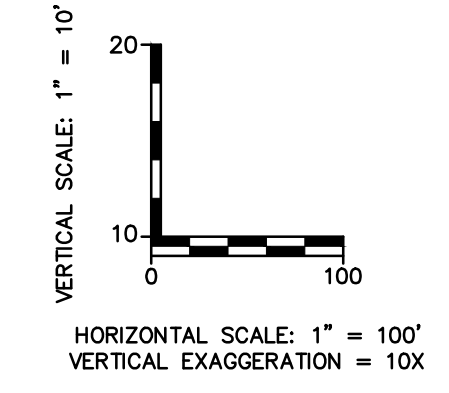
12/10/07 10:51 AM 11/23/07 10:51 AM 11/23/07 10:51 AM



LEGEND	
	FILL/TOPSOIL
	SILT (ML)
	LEAN CLAY (CL)
	SILTY SAND (SM)
	WATER TABLE ON APRIL 4, 2006

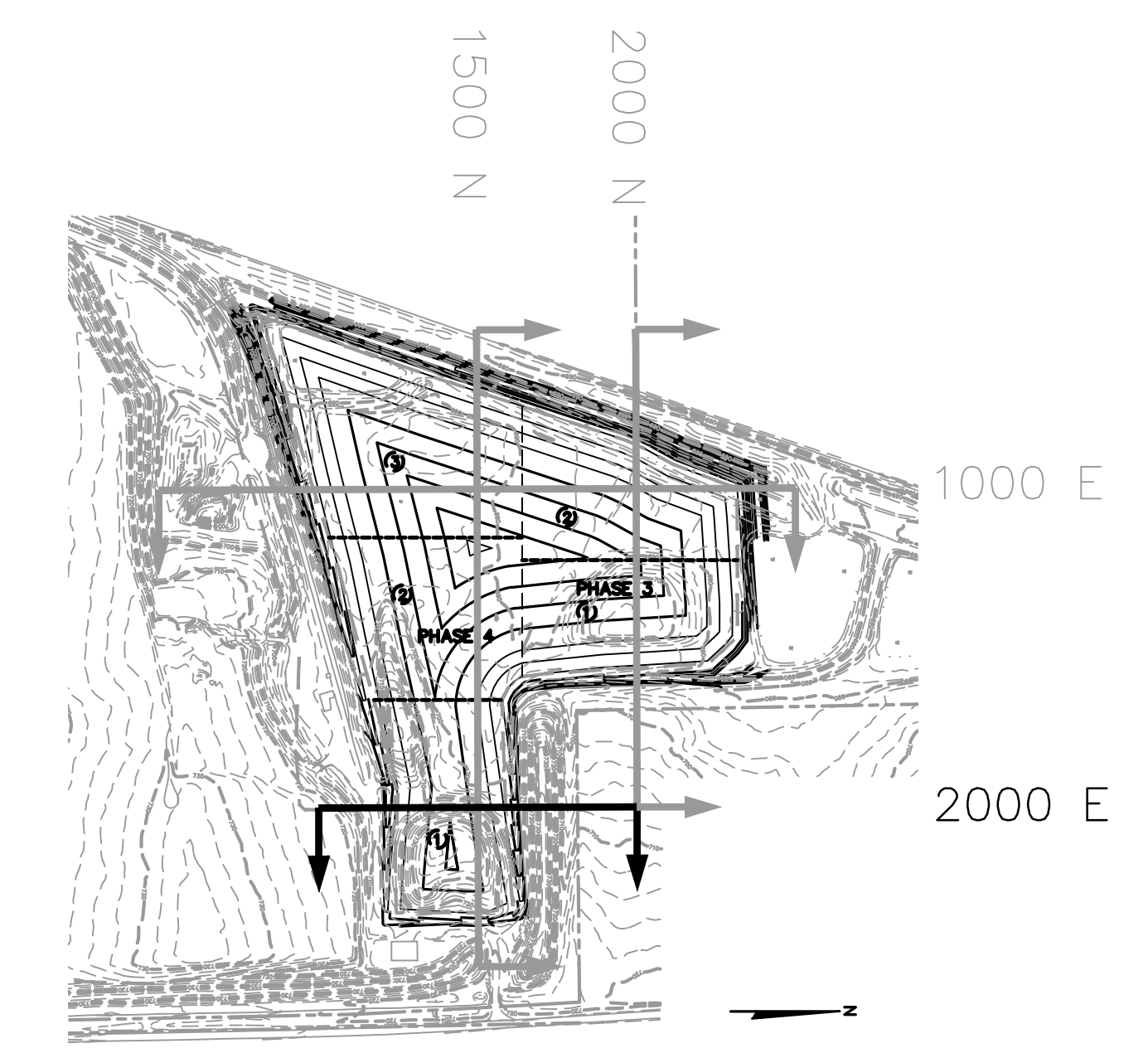


WELL DETAIL



- NOTES:
- BORINGS B17 AND B23 WERE INSTALLED BY SOILS & ENGINEERING SERVICES, INC. IN 1978.

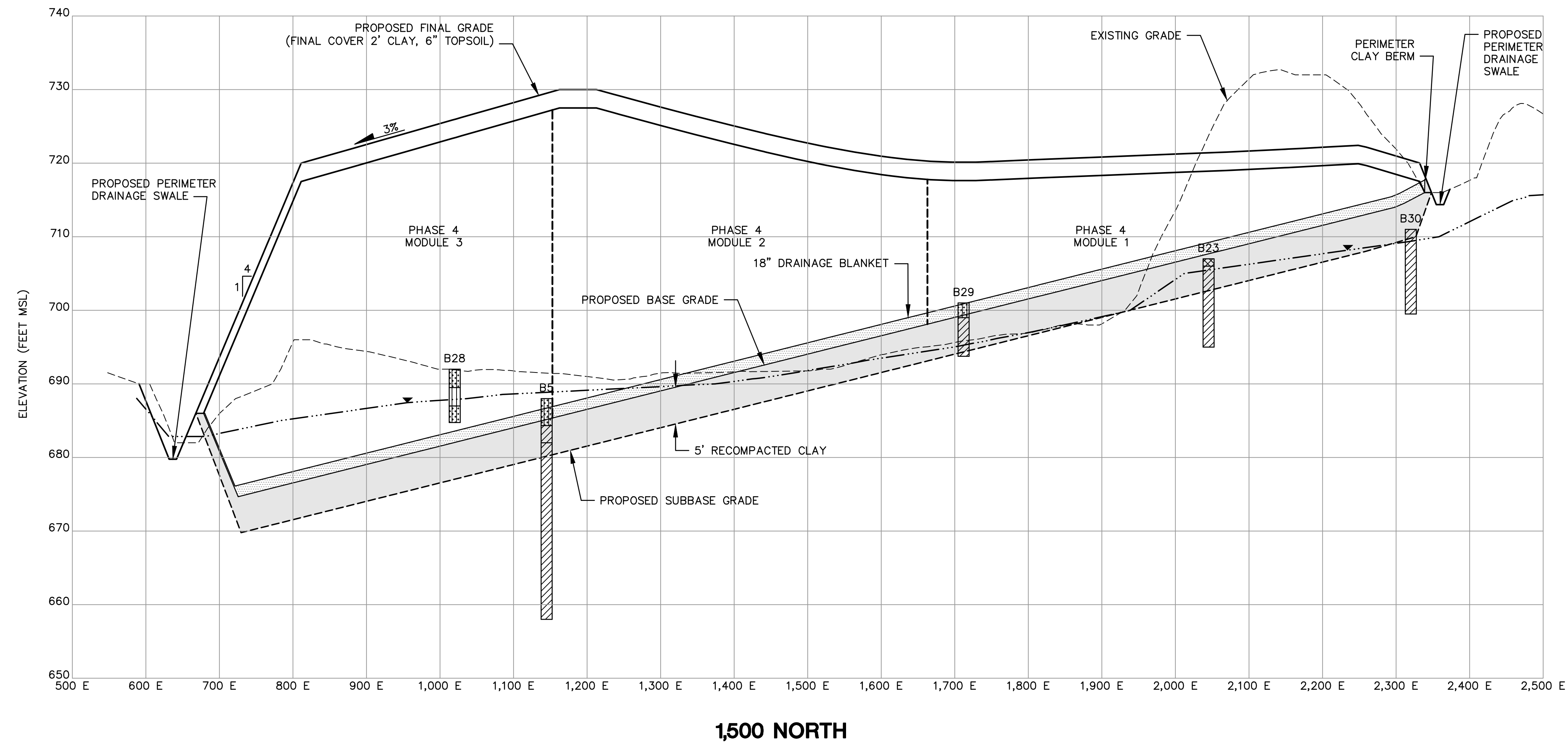
Note: Design information depicted here has been superseded by design updates in the March 2015 Plan of Operation Modification for Phases 3 and 4 prepared by SCS Engineers.



CROSS SECTION LOCATION  
T = 600'

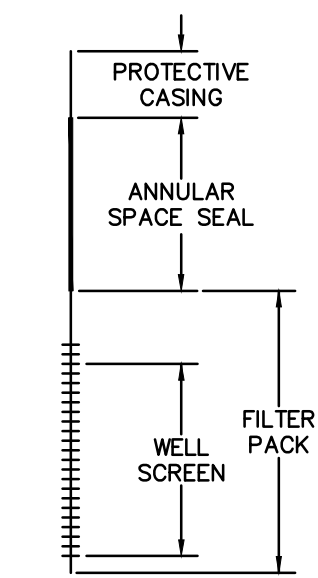
PROJECT NO. 3391	DRAWN BY: KP			2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830 FAX: (608) 224-2839	CLIENT WISCONSIN POWER AND LIGHT EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081	SITE PLAN OF OPERATION PHASES 3 AND 4 EDGEWATER I-43 ASH DISPOSAL FACILITY WILSON, WISCONSIN	CROSS SECTION 2,000 EAST	SHEET
DRAWN: 11/23/07	CHECKED BY: KG							13 OF 17
REVISED: 12/10/07	APPROVED BY:							

1/10/2008 10:52:11 AM

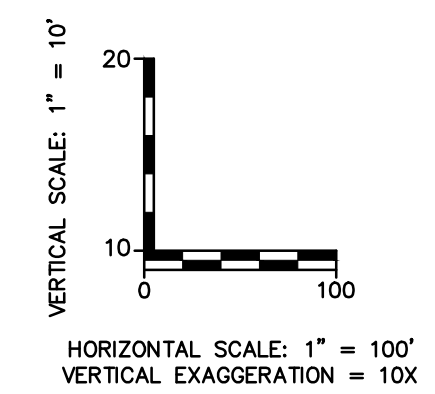


LEGEND

	FILL/TOPSOIL
	SILT (ML)
	LEAN CLAY (CL)
	SILTY SAND (SM)
	WATER TABLE ON APRIL 4, 2006

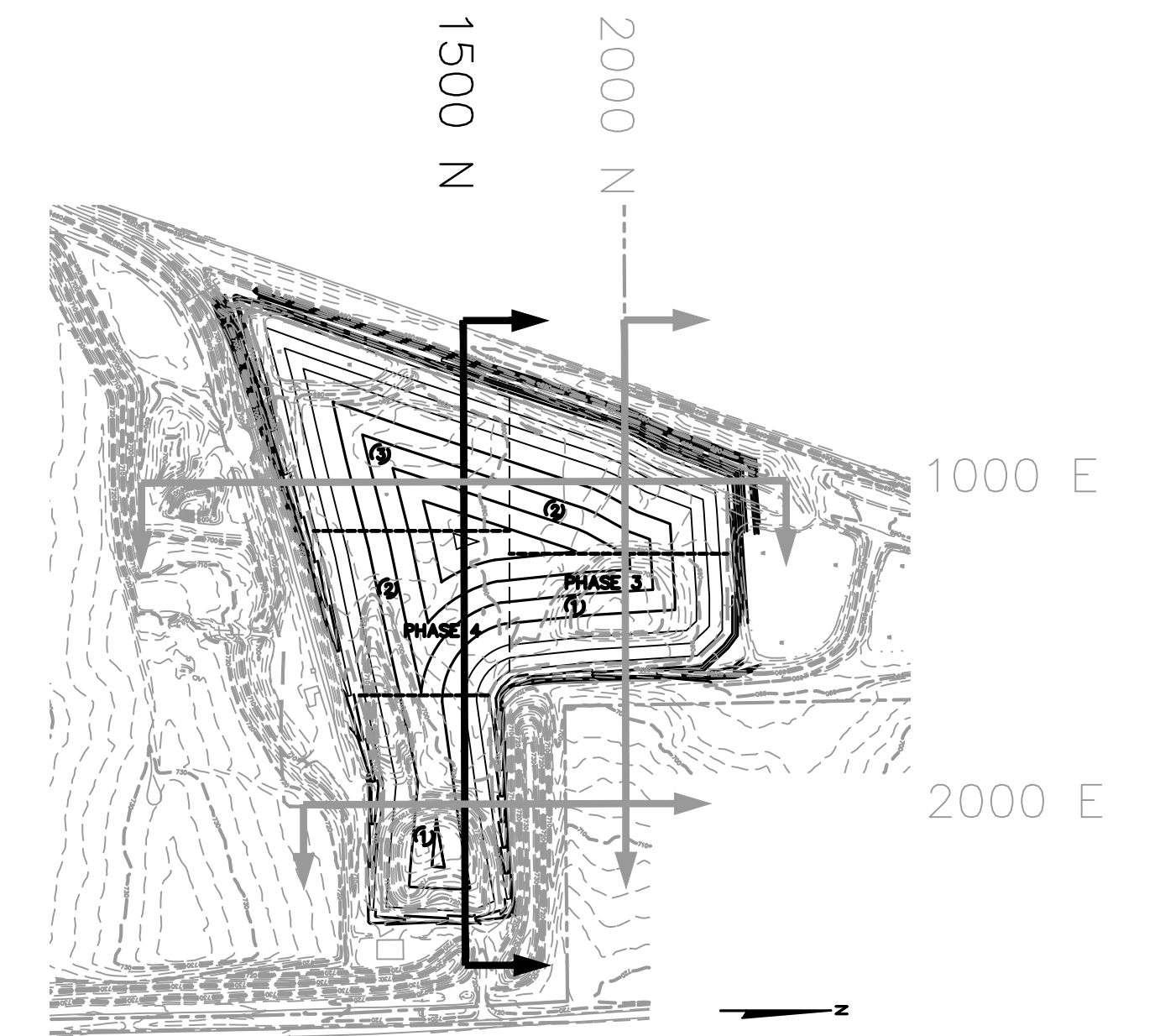


WELL DETAIL



NOTES:

- BORINGS B5 AND B23 WERE INSTALLED BY SOILS & ENGINEERING SERVICES, INC. IN 1977 AND 1978.
- BORINGS B28, B29, AND B30 WERE INSTALLED BY WARZYŃ ENGINEERING, INC. IN 1981.



CROSS SECTION LOCATION

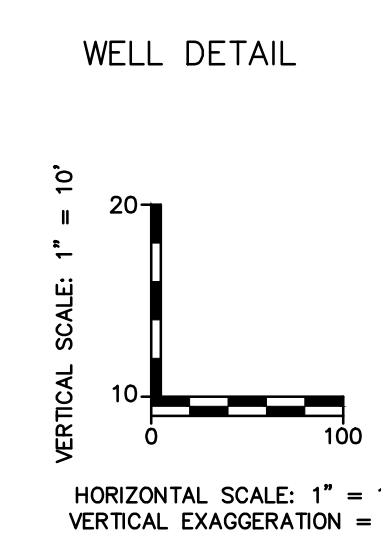
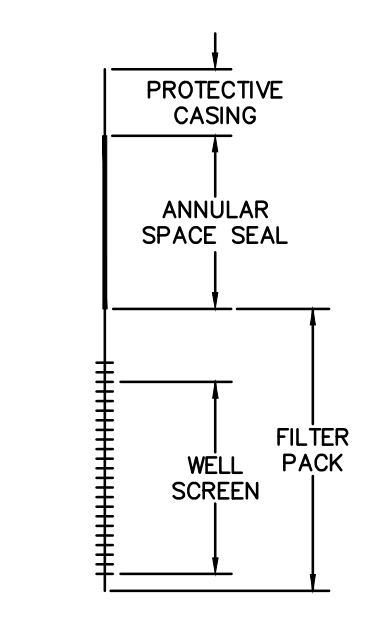
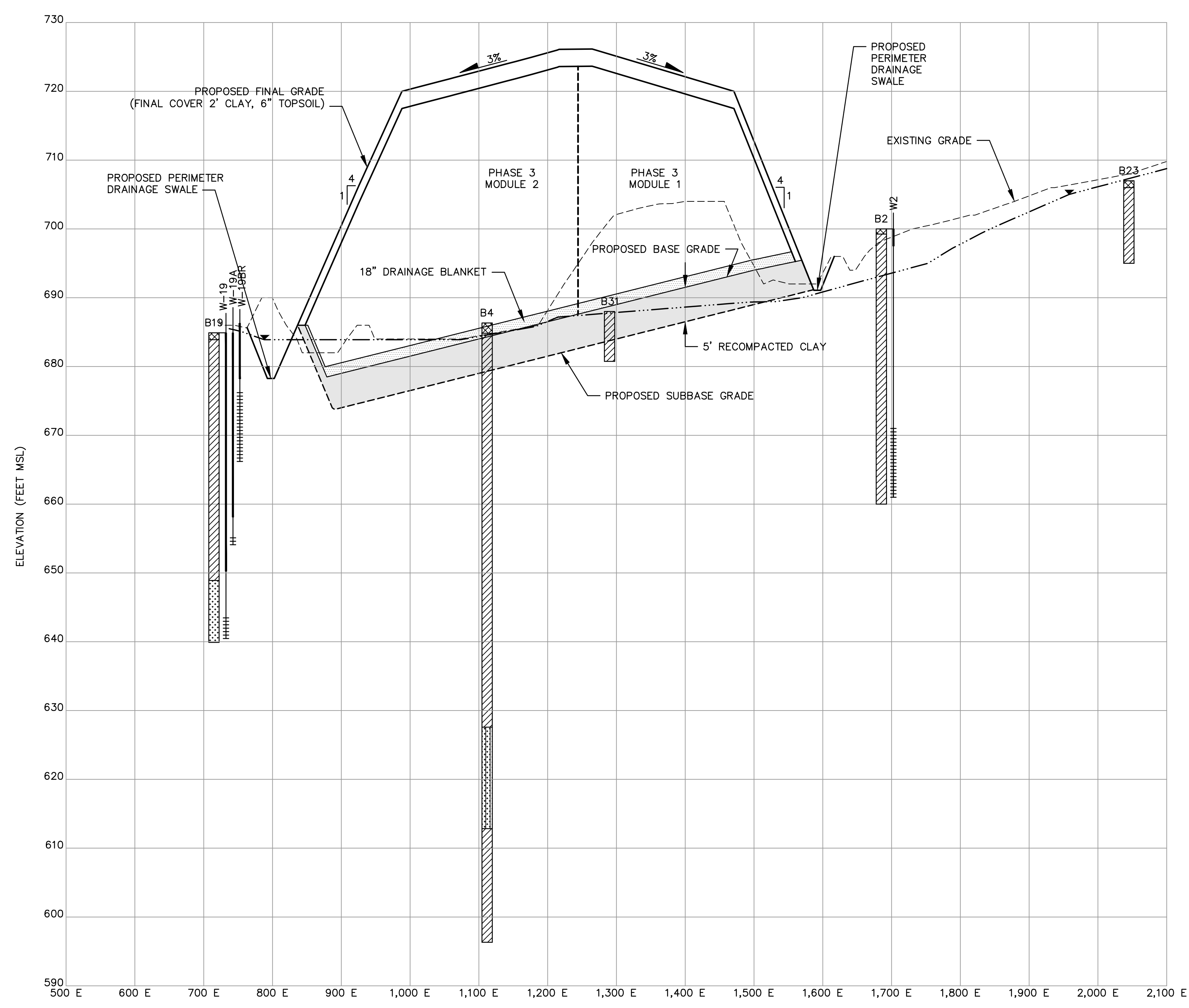
1" = 600'

Note: Design information depicted here has been superseded by design updates in the March 2015 Plan of Operation Modification for Phases 3 and 4 prepared by SCS Engineers.

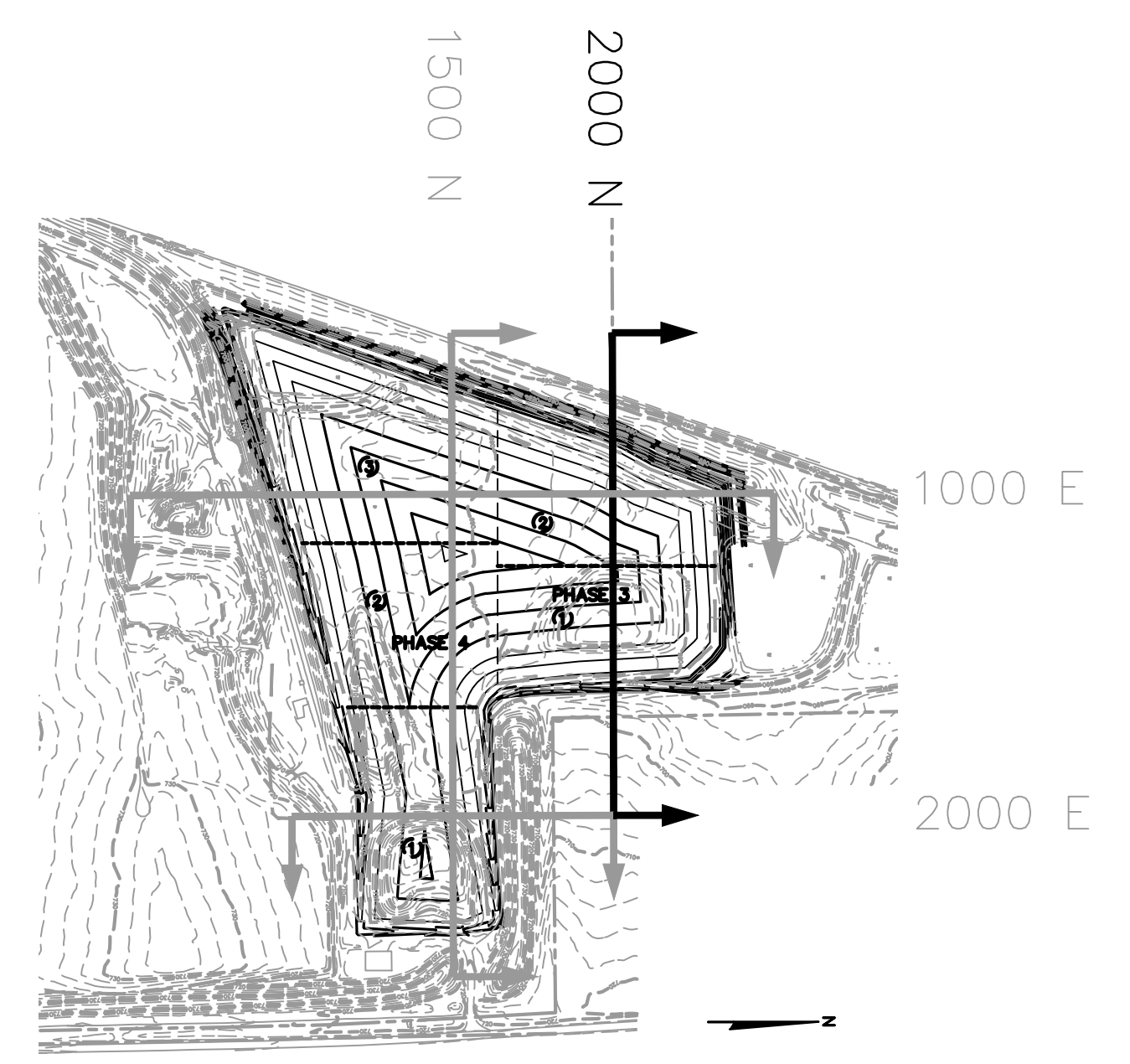
PROJECT NO. 3391	DRAWN BY: KP			2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830 FAX: (608) 224-2839	CLIENT WISCONSIN POWER AND LIGHT EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081	SITE PLAN OF OPERATION PHASES 3 AND 4 EDGEWATER 1-43 ASH DISPOSAL FACILITY WILSON, WISCONSIN	CROSS SECTION 1,500 NORTH	SHEET
DRAWN: 11/23/07	CHECKED BY: KG							14 OF 17
REVISED: 12/10/07	APPROVED BY:							



LEGEND	
	FILL/TOPSOIL
	SILT (ML)
	LEAN CLAY (CL)
	SILTY SAND (SM)
	WATER TABLE ON APRIL 4, 2006



- NOTES:
- BORINGS B2, B4, B19, AND B23 WERE INSTALLED BY SOILS & ENGINEERING SERVICES, INC. IN 1977 AND 1978.
  - BORING B31 WAS INSTALLED BY WARZYN ENGINEERING, INC. IN 1981.

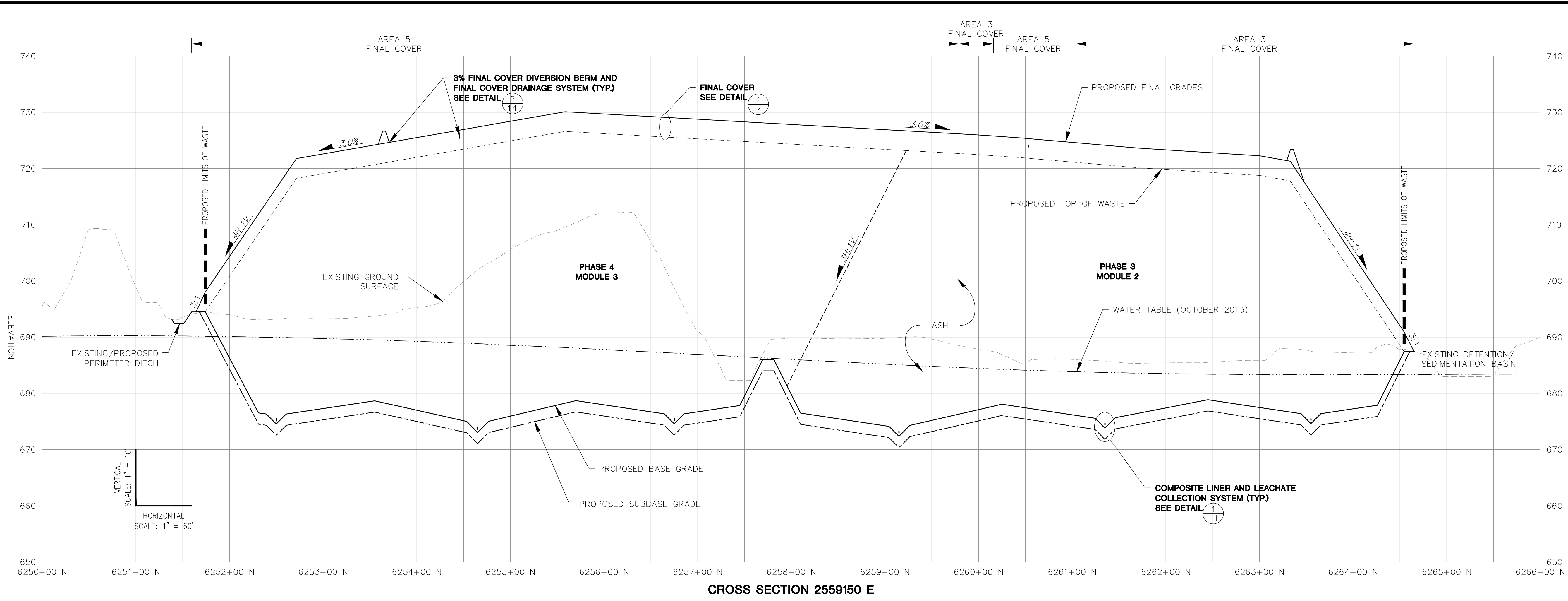


**CROSS SECTION LOCATION**  
T = 600'

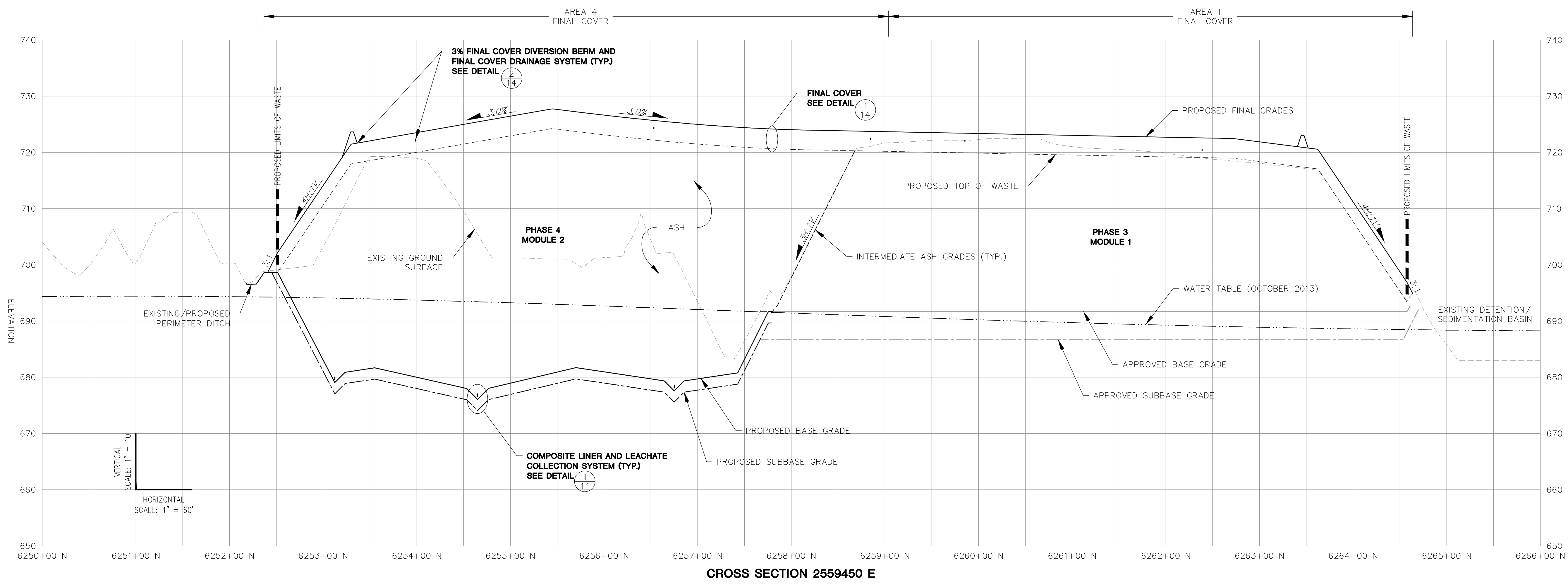
Note: Design information depicted here has been superseded by design updates in the March 2015 Plan of Operation Modification for Phases 3 and 4 prepared by SCS Engineers.

PROJECT NO. 3391	DRAWN BY: KP			2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830 FAX: (608) 224-2839	CLIENT: WISCONSIN POWER AND LIGHT EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081	SITE: PLAN OF OPERATION PHASES 3 AND 4 EDGEWATER 1-43 ASH DISPOSAL FACILITY WILSON, WISCONSIN	CROSS SECTION 2,000 NORTH	SHEET
DRAWN: 11/23/07	CHECKED BY: KG							15 OF 17
REVISED: 12/10/07	APPROVED BY:							

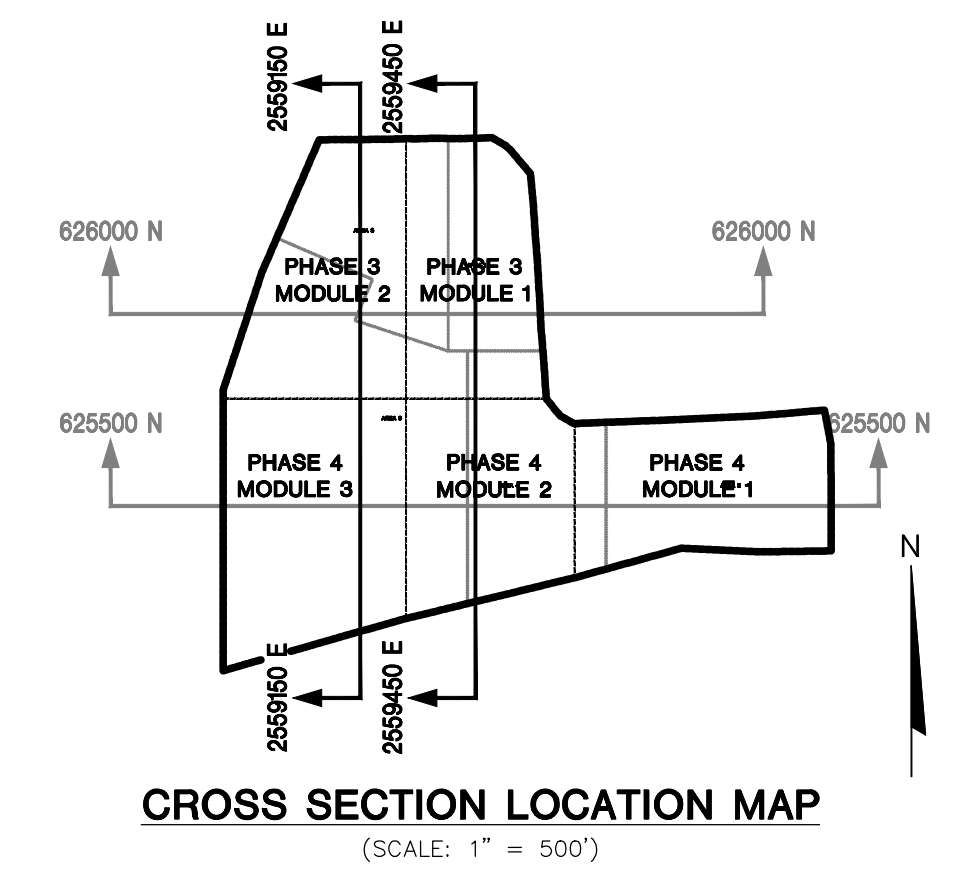
12/10/07 10:51 AM



CROSS SECTION 2559150 E



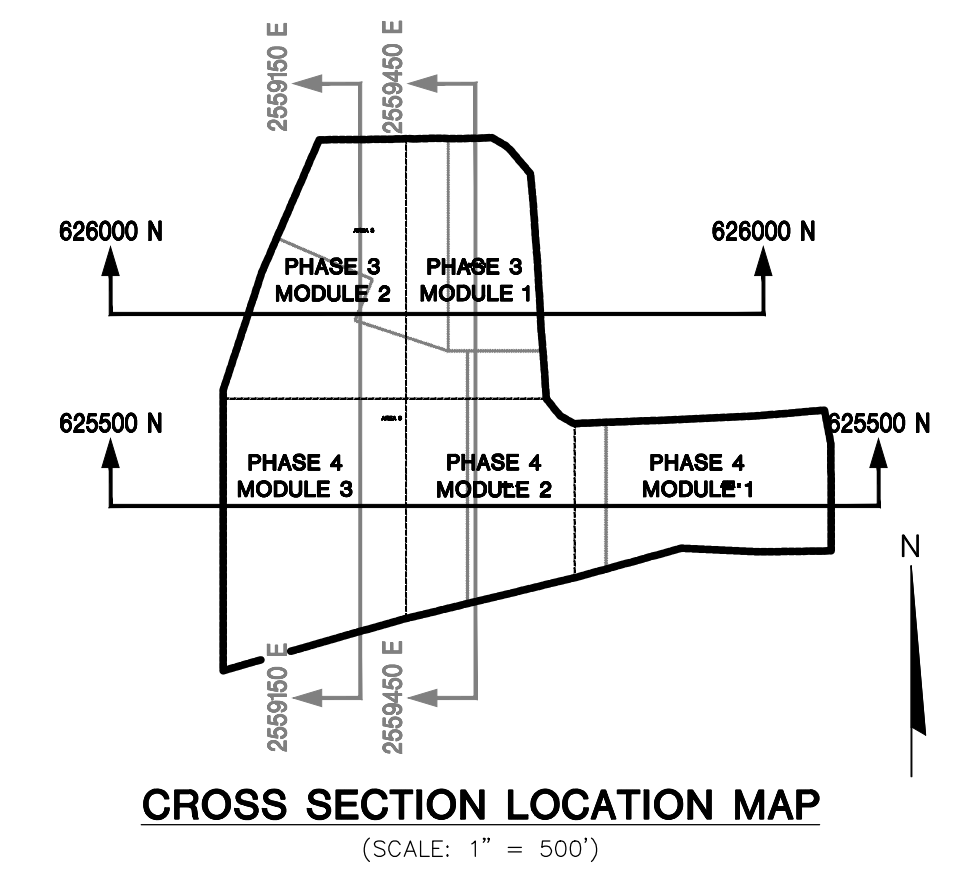
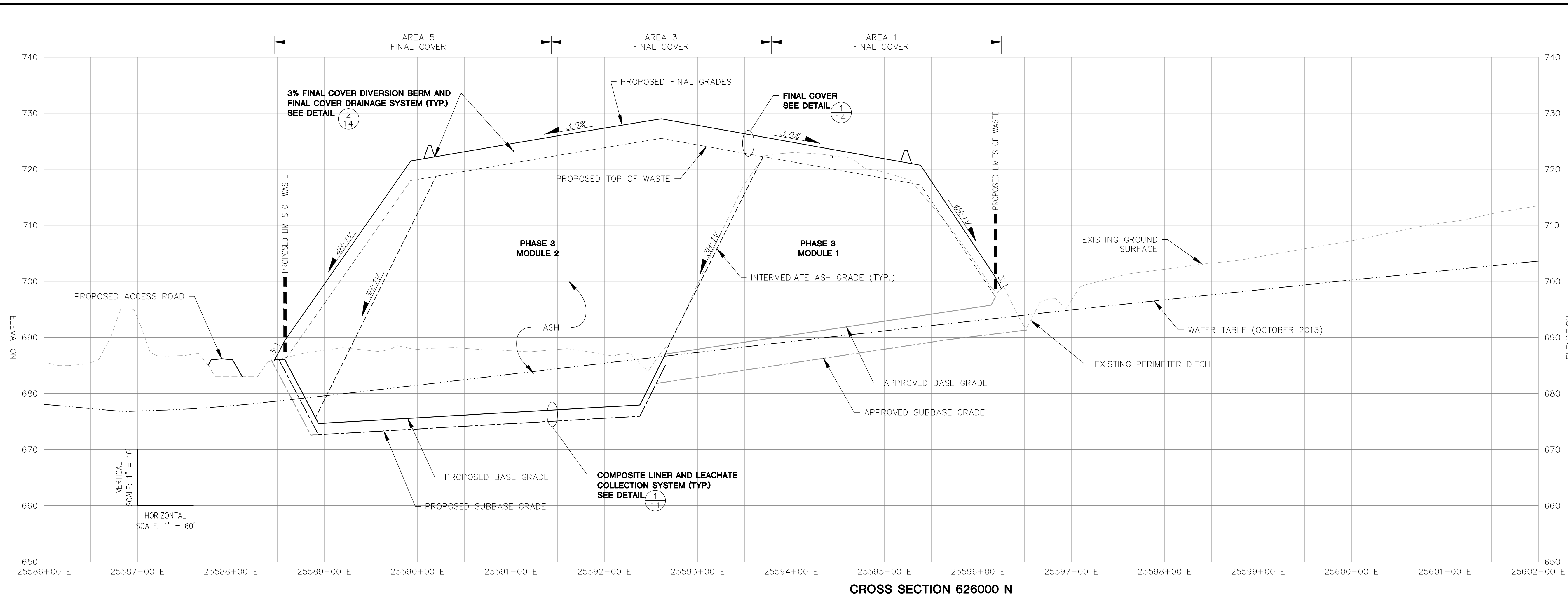
CROSS SECTION 2559450 E



**Unstable Areas Demonstration Notes:**  
 1) The "Water Table" shown on these cross sections is present in unconsolidated deposits that do not meet the definition of the "Uppermost Aquifer" as defined in 40 CFR 257.53.

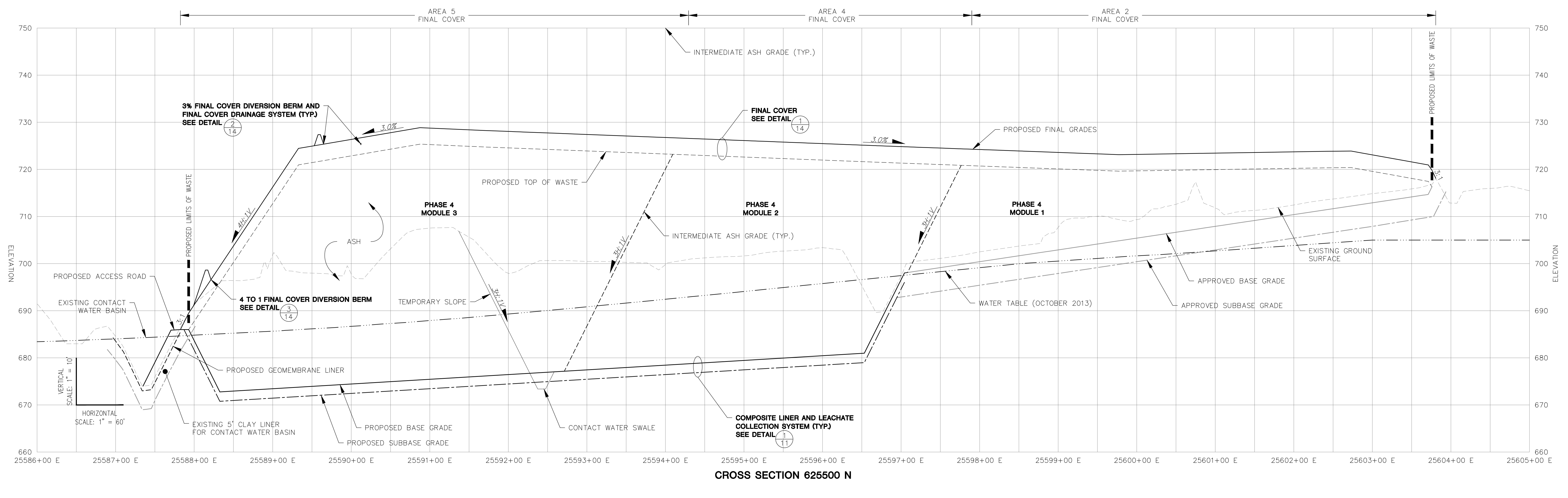
PROJECT NO.	2521400.00	DRAWN BY:	KP
DRAWN:	07/15/15	CHECKED BY:	KG/LAB
REVISION:	03/09/15	APPROVED BY:	LAB 03/09/15
CLIENT:	WISCONSIN POWER AND LIGHT COMPANY EDGEWATER GENERATING STATION 3739 LAKE SHORE DRIVE SHEBOYGAN, WI 53081		
ENGINEER:	SCS ENGINEERS 2830 DARY DRIVE MADISON, WI 53718-8797 PHONE: (608) 224-2830		
SITE:	PLAN MODIFICATION EDGEWATER 1-43 ASH DISPOSAL FACILITY TOWN OF WILSON, WISCONSIN		
SHEET:	CROSS SECTIONS - 2,559,150 EAST AND 2,559,450 EAST		
9 of 19			





**Unstable Areas Demonstration Notes:**

1) The "Water Table" shown on these cross sections is present in unconsolidated deposits that do not meet the definition of the "Uppermost Aquifer" as defined in 40 CFR 257.53.



## **APPENDIX D**

### Slope Stability Analysis

## SCS ENGINEERS

September 26, 2018  
File No. 25218091.00

### TECHNICAL MEMORANDUM

ANALYSIS BY: Brandon Suchomel

REVIEWED BY: Deb Nelson  
Phil Gearing

SUBJECT: Interim Waste Slope Stability Analyses  
Unstable Areas Restriction Compliance Demonstration Report  
Edgewater I-43 Ash Disposal Facility

### PURPOSE

The purposes of the slope stability analyses were to evaluate:

- The interim 3H:1V west waste slope in Phase 3, Module 2 at the highest waste grade

### CONCLUSION

The attached results confirm that the interim waste slope will be stable during the construction and operation of the disposal facility modules.

### APPROACH

SCS Engineers (SCS) evaluated the waste mass slope stability of the west interim slope of Module 2 at the most critical/highest waste grade cross-section (i.e. at the time of final cover placement). The Module 2 interim 3H:1V waste slope analyzed at the west filling face has a maximum waste fill height of approximately 48 feet corresponding to a peak elevation of approximately 724 feet above mean sea level. The interim waste slope was evaluated for block and circular failure.

### RESULTS

The calculated safety factors for each failure type are shown in the attached summary table.

SCS recommends a minimum safety factor of 1.3 for the interim waste slopes. The recommended safety factor of 1.3 for an interim waste slope is based on end-of-construction safety factors discussed in the U.S. Army Corps of Engineers engineer manual on slope stability (USACE 2003) and in Wisconsin Administrative Code Chapter NR 514.07(1)(b). The results



indicate that the 3H:1V waste slope for Module 2 has an acceptable minimum safety factor of approximately 1.33.

## REFERENCES

1. SCS Engineers, Edgewater I-43 Ash Disposal Facility, Plan Modification, 2015, module design interim waste grades.
2. SCS Engineers, Edgewater I-43 Ash Disposal Facility, Phase 3, Module 2 Liner and Area 1 Final Cover Construction – Construction Documentation Report, 2016, existing as-built composite liner grades, material properties for subbase, clay liner, drainage layer, and geosynthetics.
3. TRI/Environmental, Interface Friction Test Results, 2015, for 2015 Module 2 Liner Construction.
4. TRI/Environmental, Consolidated-Undrained Triaxial Compression Test Results for FGD Material, 2015, material properties for CCR.
5. U.S. Department of Transportation, Federal Highway Administration, Recycled Materials, Coal Ash User's Guide.
6. Stabilization of FGD By-Products by Using Fly Ash, Cement, and Sialite, 2009 WOCA Conference.
7. Geo-Slope International, Ltd., GeoStudio 2016, Version 8.16.2.14053, Slope/W slope stability software.
8. U.S. Army Corps of Engineers, Slope Stability Engineer Manual EM 1110-2-1902, October 2003.

## ASSUMPTIONS

- Circular and sliding block failure stability analyses are appropriate to evaluate the waste interim slope stability.
- Material properties are as shown in the table below, based on the indicated references and assumed values based on experience. Friction angles for soils are conservative assumed values based on soil type, published typical values, and SCS experience. The coal combustion residual (CCR) friction angle is a conservative assumed value based on published values and 2015 triaxial compression test results by TRI/Environmental for CCR.



<b>Material</b>	<b>Unit Weight (pcf)</b>	<b>Friction Angle (degrees)</b>	<b>Cohesion (psf)</b>	<b>Reference</b>
Subbase Soil (Clay)	135	28	0	2
Clay Liner	130	28	0	2
Geosynthetics	58	19.5	0	3
Drainage Layer (Sand)	115	30	0	2
CCR	86	20	0	4, 5, 6

Attachments: Calculations organized as follows:

- Factor of Safety Summary Table
- Cross Section Location Figure
- Slope/W Outputs

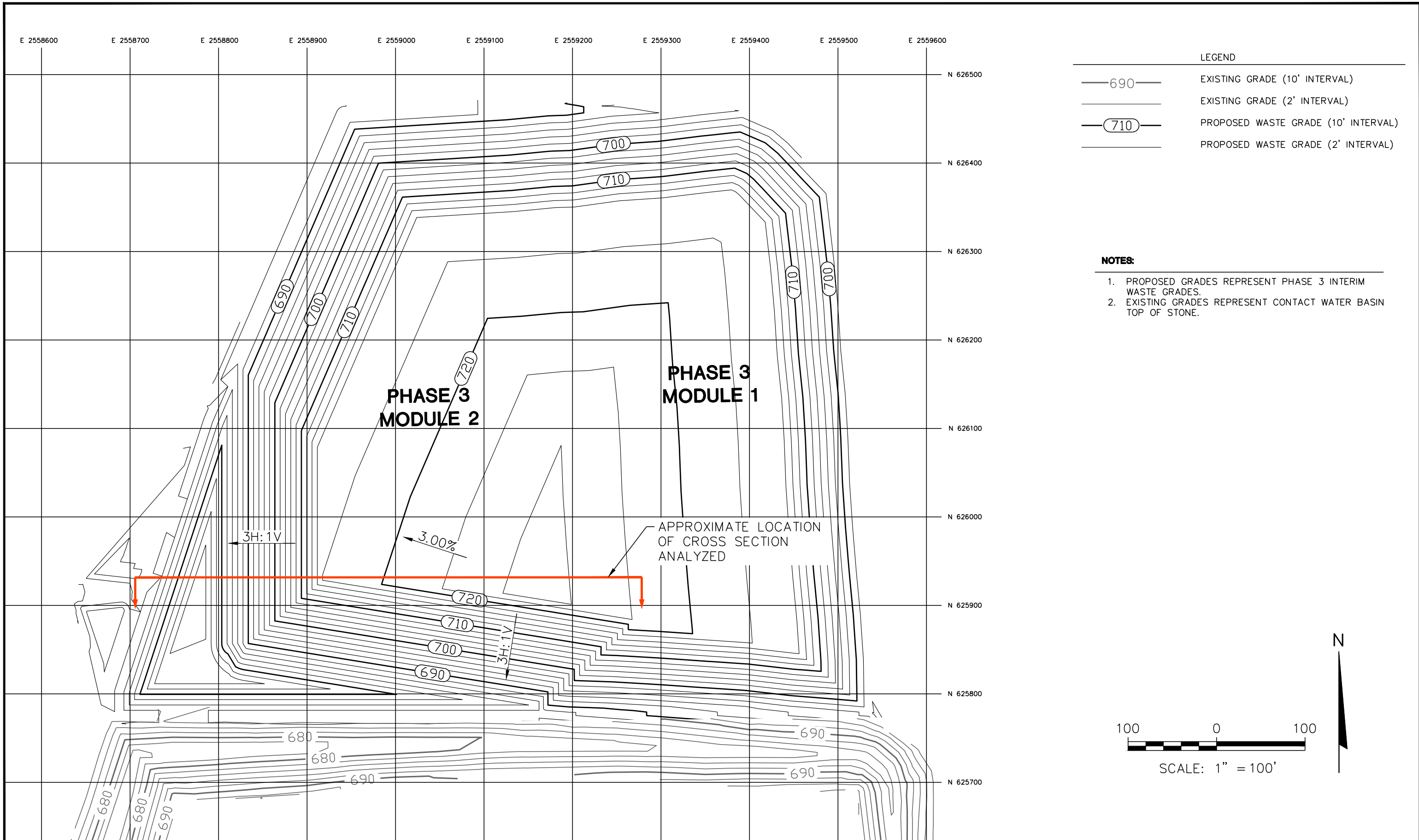
BSS/AJR/DLN/PEG  
Coordinates checked by BJM

I:\25218091.00\Data and Calculations\Slope Stability\\_Deliverable Memo\Tech Memo\_Unstable Areas Analysis\_180926.docx

**Slope Stability Analyses  
Factors of Safety Results Summary  
Edgewater I-43 Ash Disposal Facility - Location Restriction Compliance Demonstration**

<b>Phase 3, Module 2 Western Interim Waste Slope</b>		
<b>Failure Type</b>	<b>Calculated Safety Factor</b>	<b>Recommended Min. Safety Factor</b>
Block	1.33	1.3
Circular	1.37	1.3

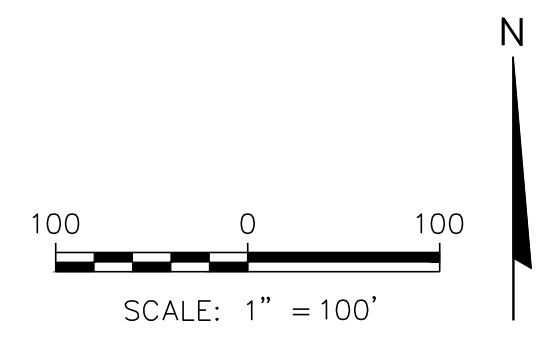
Created by: BSS, 8/28/18  
Last Revision by: BSS, 9/5/18  
Checked by:DLN, 9/5/18



**LEGEND**

	EXISTING GRADE (10' INTERVAL)
	EXISTING GRADE (2' INTERVAL)
	PROPOSED WASTE GRADE (10' INTERVAL)
	PROPOSED WASTE GRADE (2' INTERVAL)

- NOTES:**
1. PROPOSED GRADES REPRESENT PHASE 3 INTERIM WASTE GRADES.
  2. EXISTING GRADES REPRESENT CONTACT WATER BASIN TOP OF STONE.



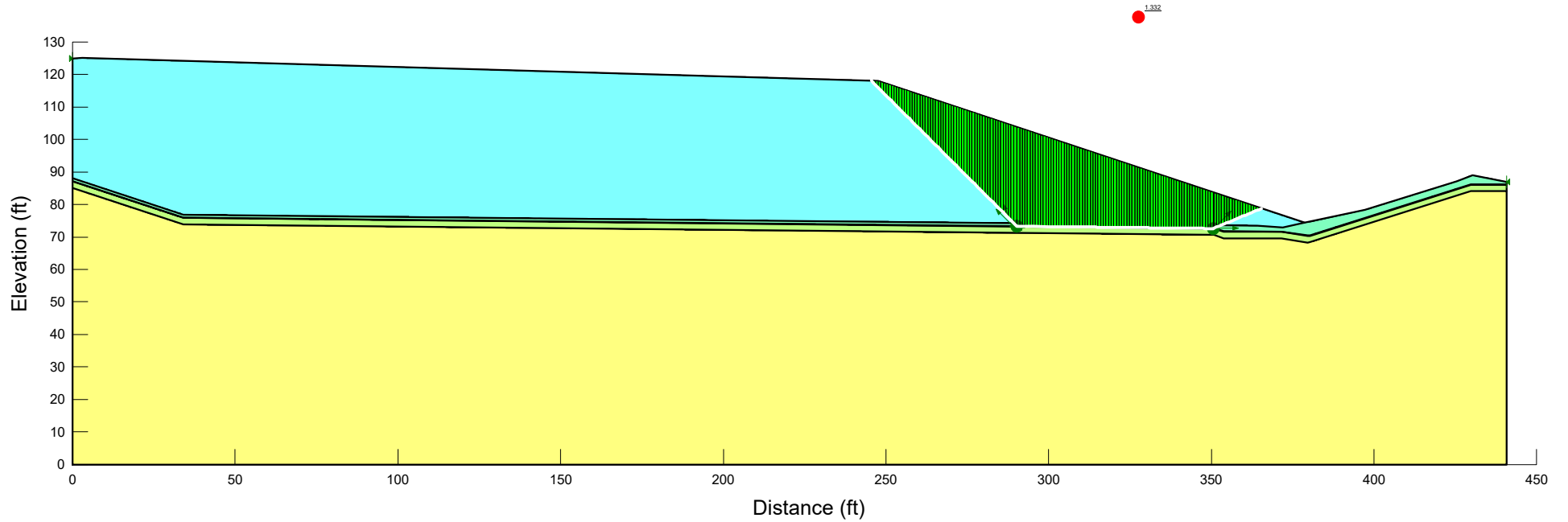
PROJECT NO. 25218091.00	DRAWN BY: BSS	 <b>SCS ENGINEERS</b> 2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830	 Wisconsin Power and Light Company EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081	LOCATION RESTRICTION COMPLIANCE DEMONSTRATION REPORT EDGEWATER 1-43 ASH DISPOSAL FACILITY TOWN OF WILSON, WISCONSIN	FIGURE
DRAWN: 08/24/18	CHECKED BY: PEG				1 OF 1
REVISD: 09/10/18	APPROVED BY:				

I:\25218091.00\Drawings\Locations or Cross Section Locations.dwg, 9/10/2018 1:19:32 PM

# Edgewater Unstable Areas Analysis 2018 - West Slope

Name: Block

F of S: 1.332



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
<span style="color: cyan;">■</span>	CCR	Mohr-Coulomb	86	0	20
<span style="color: lightgreen;">■</span>	Clay Liner	Mohr-Coulomb	130	0	28
<span style="color: green;">■</span>	Drainage Layer	Mohr-Coulomb	115	0	30
<span style="color: darkgreen;">■</span>	Geosynthetics	Mohr-Coulomb	58	0	19.5
<span style="color: yellow;">■</span>	Subbase	Mohr-Coulomb	135	0	28

# Block

Report generated using GeoStudio 2016. Copyright © 1991-2017 GEO-SLOPE International Ltd.

---

## File Information

File Version: 8.16

Title: Edgewater Unstable Areas Analysis 2018 - West Slope

Comments: Running slope stability analysis on the west waste slope of Phase 3, Module 2 of the Edgewater I-43 Ash Disposal Facility. Location of analysis was selected based on longest and steepest slope at the time of peak waste placement within Module 2.

Created By: Suchomel, Brandon

Last Edited By: Suchomel, Brandon

Revision Number: 45

Date: 9/5/2018

Time: 1:09:20 PM

Tool Version: 8.16.3.14580

File Name: Western Slope of Module 2 Phase 3.gsz

Directory: I:\25218091.00\Data and Calculations\Slope Stability\

Last Solved Date: 9/5/2018

Last Solved Time: 1:13:42 PM

## Project Settings

Length(L) Units: Feet

Time(t) Units: Seconds

Force(F) Units: Pounds

Pressure(p) Units: psf

Strength Units: psf

Unit Weight of Water: 62.4 pcf

View: 2D

Element Thickness: 1

## Analysis Settings

### Block

Kind: SLOPE/W

Method: Janbu

Settings

PWP Conditions Source: (none)

Slip Surface

Direction of movement: Left to Right

Use Passive Mode: No

Slip Surface Option: Block

Critical slip surfaces saved: 10

Resisting Side Maximum Convex Angle: 1 °

Driving Side Maximum Convex Angle: 5 °

Restrict Block Crossing: No  
Optimize Critical Slip Surface Location: No  
Tension Crack

Tension Crack Option: (none)

F of S Distribution

F of S Calculation Option: Constant

Advanced

Number of Slices: 150

F of S Tolerance: 0.001

Minimum Slip Surface Depth: 0.1 ft

## Materials

### Subbase

Model: Mohr-Coulomb

Unit Weight: 135 pcf

Cohesion': 0 psf

Phi': 28 °

Phi-B: 0 °

### Clay Liner

Model: Mohr-Coulomb

Unit Weight: 130 pcf

Cohesion': 0 psf

Phi': 28 °

Phi-B: 0 °

### Geosynthetics

Model: Mohr-Coulomb

Unit Weight: 58 pcf

Cohesion': 0 psf

Phi': 19.5 °

Phi-B: 0 °

### Drainage Layer

Model: Mohr-Coulomb

Unit Weight: 115 pcf

Cohesion': 0 psf

Phi': 30 °

Phi-B: 0 °

### CCR

Model: Mohr-Coulomb

Unit Weight: 86 pcf

Cohesion': 0 psf

Phi': 20 °

Phi-B: 0 °



## Slip Surface Limits

Left Coordinate: (0, 124.95) ft

Right Coordinate: (440.79, 86.91) ft

## Slip Surface Block

### Left Grid

Upper Left: (289.08, 73.32) ft

Lower Left: (289.08, 73.22) ft

Lower Right: (292.05, 73.19) ft

X Increments: 10

Y Increments: 5

Starting Angle: 115 °

Ending Angle: 135 °

Angle Increments: 2

### Right Grid

Upper Left: (350, 72.7) ft

Lower Left: (349.99, 72.6) ft

Lower Right: (350.8, 72.59) ft

X Increments: 10

Y Increments: 5

Starting Angle: 0 °

Ending Angle: 45 °

Angle Increments: 2

## Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	87.05
Point 3	0	85.05
Point 4	0	87.15
Point 5	34.01	75.82
Point 6	34.01	73.82
Point 7	34.01	75.92
Point 8	350.8	72.59
Point 9	350.8	70.59
Point 10	350.8	72.69
Point 11	353.74	71.61
Point 12	353.74	69.61
Point 13	353.74	71.71
Point 14	371.54	71.58
Point 15	371.54	69.58
Point 16	371.54	71.68
Point 17	379.67	70.31
Point 18	379.67	68.31

Point 19	379.67	70.41
Point 20	380.33	70.37
Point 21	380.33	68.37
Point 22	380.33	70.47
Point 23	429.74	86.05
Point 24	429.74	84.05
Point 25	429.74	86.15
Point 26	440.79	86.05
Point 27	440.79	84.05
Point 28	440.79	86.15
Point 29	440.79	0
Point 30	0	88.06
Point 31	34.01	76.88
Point 32	364.01	73.53
Point 33	371.98	72.92
Point 34	378.75	74.32
Point 35	397.24	78.26
Point 36	425.51	87.13
Point 37	430.24	89.04
Point 38	440.79	86.91
Point 39	0	124.95
Point 40	2.89	125.01
Point 41	247.62	118.03

## Regions

	Material	Points	Area (ft <sup>2</sup> )
Region 1	Subbase	1,3,6,9,12,15,18,21,24,27,29	32,320
Region 2	Clay Liner	3,2,5,8,11,14,17,20,23,26,27,24,21,18,15,12,9,6	881.58
Region 3	Geosynthetics	2,4,7,10,13,16,19,22,25,28,26,23,20,17,14,11,8,5	44.079
Region 4	Drainage Layer	4,30,31,32,33,34,35,36,37,38,28,25,22,19,16,13,10,7	551.77
Region 5	CCR	30,39,40,41,34,33,32,31	14,008

## Current Slip Surface

Slip Surface: 22,397

F of S: 1.332

Volume: 2,037.6438 ft<sup>3</sup>

Weight: 176,875.14 lbs

Resisting Force: 59,709.489 lbs

Activating Force: 44,812.944 lbs

F of S Rank (Analysis): 1 of 39,204 slip surfaces

F of S Rank (Query): 1 of 39,204 slip surfaces

Exit: (365.43856, 78.757145) ft

Entry: (245.44394, 118.09206) ft

Radius: 65.463717 ft

Center: (315.11191, 127.92579) ft

## Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	245.80661	117.72939	0	23.800692	8.6627436	0
Slice 2	246.53197	117.00403	0	71.402077	25.988231	0
Slice 3	247.25732	116.27868	0	119.00346	43.313718	0
Slice 4	248.02026	115.51574	0	160.82963	58.537199	0
Slice 5	248.82078	114.71522	0	196.88059	71.658675	0
Slice 6	249.6213	113.9147	0	232.93155	84.780151	0
Slice 7	250.42182	113.11418	0	268.98251	97.901626	0
Slice 8	251.22234	112.31366	0	305.03347	111.0231	0
Slice 9	252.02286	111.51314	0	341.08442	124.14458	0
Slice 10	252.82338	110.71262	0	377.13538	137.26605	0
Slice 11	253.6239	109.9121	0	413.18634	150.38753	0
Slice 12	254.42442	109.11158	0	449.2373	163.50901	0
Slice 13	255.22494	108.31106	0	485.28826	176.63048	0
Slice 14	256.02546	107.51054	0	521.33922	189.75196	0
	256.82598	106.71002	0	557.39017	202.87343	0

Slice 15						
Slice 16	257.6265	105.9095	0	593.44113	215.99491	0
Slice 17	258.42702	105.10898	0	629.49209	229.11638	0
Slice 18	259.22754	104.30846	0	665.54305	242.23786	0
Slice 19	260.02806	103.50794	0	701.59401	255.35934	0
Slice 20	260.82858	102.70742	0	737.64497	268.48081	0
Slice 21	261.6291	101.9069	0	773.69592	281.60229	0
Slice 22	262.42962	101.10638	0	809.74688	294.72376	0
Slice 23	263.23014	100.30586	0	845.79784	307.84524	0
Slice 24	264.03066	99.505339	0	881.8488	320.96671	0
Slice 25	264.83118	98.704819	0	917.89976	334.08819	0
Slice 26	265.6317	97.904299	0	953.95072	347.20967	0
Slice 27	266.43222	97.103779	0	990.00167	360.33114	0
Slice 28	267.23274	96.303259	0	1,026.0526	373.45262	0
Slice 29	268.03326	95.502739	0	1,062.1036	386.57409	0
Slice 30	268.83378	94.702219	0	1,098.1545	399.69557	0
Slice 31	269.6343	93.901699	0	1,134.2055	412.81704	0
Slice 32	270.43482	93.101179	0	1,170.2565	425.93852	0
Slice 33	271.23534	92.300658	0	1,206.3074	439.06	0
Slice 34	272.03586	91.500138	0	1,242.3584	452.18147	0
Slice 35	272.83638	90.699618	0	1,278.4093	465.30295	0
Slice 36	273.6369	89.899098	0	1,314.4603	478.42442	0
Slice 37	274.43742	89.098578	0	1,350.5113	491.5459	0
Slice 38	275.23794	88.298058	0	1,386.5622	504.66737	0

Slice 39	276.03846	87.497538	0	1,422.6132	517.78885	0
Slice 40	276.83898	86.697018	0	1,458.6641	530.91033	0
Slice 41	277.6395	85.896498	0	1,494.7151	544.0318	0
Slice 42	278.44002	85.095978	0	1,530.766	557.15328	0
Slice 43	279.24054	84.295458	0	1,566.817	570.27475	0
Slice 44	280.04106	83.494938	0	1,602.868	583.39623	0
Slice 45	280.84158	82.694418	0	1,638.9189	596.5177	0
Slice 46	281.6421	81.893898	0	1,674.9699	609.63918	0
Slice 47	282.44262	81.093378	0	1,711.0208	622.76066	0
Slice 48	283.24314	80.292858	0	1,747.0718	635.88213	0
Slice 49	284.04366	79.492338	0	1,783.1228	649.00361	0
Slice 50	284.84418	78.691818	0	1,819.1737	662.12508	0
Slice 51	285.6447	77.891298	0	1,855.2247	675.24656	0
Slice 52	286.44522	77.090777	0	1,891.2756	688.36803	0
Slice 53	287.24574	76.290257	0	1,927.3266	701.48951	0
Slice 54	288.04626	75.489737	0	1,963.3775	714.61099	0
Slice 55	288.84678	74.689217	0	1,999.4285	727.73246	0
Slice 56	289.73773	73.798273	0	1,821.5365	1,051.6646	0
Slice 57	290.65013	73.283295	0	2,602.4557	921.57791	0
Slice 58	291.47378	73.2545	0	2,612.8198	925.24804	0
Slice 59	292.27763	73.2455	0	2,590.5947	917.3777	0
Slice 60	293.08149	73.2365	0	2,568.3695	909.50736	0
Slice 61	293.88534	73.2275	0	2,546.1444	901.63702	0
Slice 62	294.68919	73.2185	0	2,523.9193	893.76668	0



Slice 63	295.49305	73.2095	0	2,501.6941	885.89634	0
Slice 64	296.2969	73.2005	0	2,479.469	878.02601	0
Slice 65	297.10075	73.1915	0	2,457.2438	870.15567	0
Slice 66	297.90461	73.1825	0	2,435.0187	862.28533	0
Slice 67	298.70846	73.1735	0	2,412.7935	854.41499	0
Slice 68	299.51231	73.1645	0	2,390.5684	846.54465	0
Slice 69	300.31617	73.1555	0	2,368.3432	838.67432	0
Slice 70	301.12002	73.1465	0	2,346.1181	830.80398	0
Slice 71	301.92387	73.1375	0	2,323.8929	822.93364	0
Slice 72	302.72773	73.1285	0	2,301.6678	815.0633	0
Slice 73	303.53158	73.1195	0	2,279.4426	807.19296	0
Slice 74	304.33543	73.1105	0	2,257.2175	799.32262	0
Slice 75	305.13929	73.1015	0	2,234.9923	791.45229	0
Slice 76	305.94314	73.0925	0	2,212.7672	783.58195	0
Slice 77	306.74699	73.0835	0	2,190.542	775.71161	0
Slice 78	307.55085	73.0745	0	2,168.3169	767.84127	0
Slice 79	308.3547	73.0655	0	2,146.0917	759.97093	0
Slice 80	309.15855	73.0565	0	2,123.8666	752.1006	0
Slice 81	309.96241	73.0475	0	2,101.6414	744.23026	0
Slice 82	310.76626	73.0385	0	2,079.4163	736.35992	0
Slice 83	311.57011	73.0295	0	2,057.1911	728.48958	0
Slice 84	312.37397	73.0205	0	2,034.966	720.61924	0
Slice 85	313.17782	73.0115	0	2,012.7408	712.7489	0
Slice 86	313.98167	73.0025	0	1,990.5157	704.87857	0

Slice 87	314.78553	72.9935	0	1,968.2905	697.00823	0
Slice 88	315.58938	72.9845	0	1,946.0654	689.13789	0
Slice 89	316.39323	72.9755	0	1,923.8402	681.26755	0
Slice 90	317.19709	72.9665	0	1,901.6151	673.39721	0
Slice 91	318.00094	72.9575	0	1,879.3899	665.52688	0
Slice 92	318.80479	72.9485	0	1,857.1648	657.65654	0
Slice 93	319.60865	72.9395	0	1,834.9396	649.7862	0
Slice 94	320.4125	72.9305	0	1,812.7145	641.91586	0
Slice 95	321.21635	72.9215	0	1,790.4893	634.04552	0
Slice 96	322.02021	72.9125	0	1,768.2642	626.17518	0
Slice 97	322.82406	72.9035	0	1,746.039	618.30485	0
Slice 98	323.62791	72.8945	0	1,723.8139	610.43451	0
Slice 99	324.43177	72.8855	0	1,701.5887	602.56417	0
Slice 100	325.23562	72.8765	0	1,679.3636	594.69383	0
Slice 101	326.03947	72.8675	0	1,657.1384	586.82349	0
Slice 102	326.84333	72.8585	0	1,634.9133	578.95316	0
Slice 103	327.64718	72.8495	0	1,612.6881	571.08282	0
Slice 104	328.45103	72.8405	0	1,590.463	563.21248	0
Slice 105	329.25489	72.8315	0	1,568.2378	555.34214	0
Slice 106	330.05874	72.8225	0	1,546.0127	547.4718	0
Slice 107	330.86259	72.8135	0	1,523.7875	539.60146	0
Slice 108	331.66645	72.8045	0	1,501.5624	531.73113	0
Slice 109	332.4703	72.7955	0	1,479.3372	523.86079	0
Slice 110	333.27415	72.7865	0	1,457.1121	515.99045	0

Slice 111	334.07801	72.7775	0	1,434.8869	508.12011	0
Slice 112	334.88186	72.7685	0	1,412.6618	500.24977	0
Slice 113	335.68571	72.7595	0	1,390.4366	492.37944	0
Slice 114	336.48957	72.7505	0	1,368.2115	484.5091	0
Slice 115	337.29342	72.7415	0	1,345.9863	476.63876	0
Slice 116	338.09727	72.7325	0	1,323.7612	468.76842	0
Slice 117	338.90113	72.7235	0	1,301.536	460.89808	0
Slice 118	339.70498	72.7145	0	1,279.3109	453.02774	0
Slice 119	340.50883	72.7055	0	1,257.0857	445.15741	0
Slice 120	341.31269	72.6965	0	1,234.8606	437.28707	0
Slice 121	342.11654	72.6875	0	1,212.6354	429.41673	0
Slice 122	342.92039	72.6785	0	1,190.4103	421.54639	0
Slice 123	343.72425	72.6695	0	1,168.1851	413.67605	0
Slice 124	344.5281	72.6605	0	1,145.96	405.80572	0
Slice 125	345.33195	72.6515	0	1,123.7348	397.93538	0
Slice 126	346.13581	72.6425	0	1,101.5097	390.06504	0
Slice 127	346.93966	72.6335	0	1,079.2845	382.1947	0
Slice 128	347.74351	72.6245	0	1,057.0594	374.32436	0
Slice 129	348.54737	72.6155	0	1,034.8342	366.45402	0
Slice 130	349.35122	72.6065	0	1,012.6091	358.58369	0
Slice 131	350.15507	72.5975	0	990.38394	350.71335	0
Slice 132	350.6742	72.641544	0	1,096.7514	388.38005	0
Slice 133	351.17396	72.848554	0	1,146.2885	661.80996	0
Slice 134	351.93911	73.165487	0	1,074.8657	620.57398	0

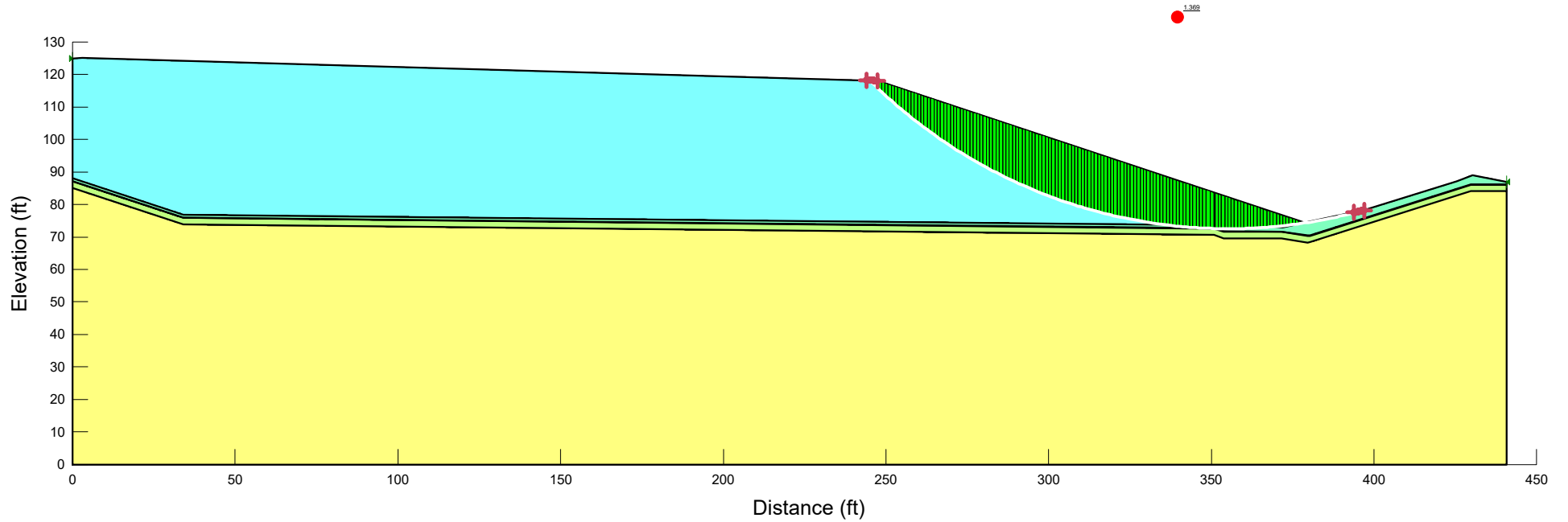
Slice 135	352.70425	73.48242	0	1,003.4429	579.33801	0
Slice 136	353.49855	73.811429	0	865.52147	315.02405	0
Slice 137	354.322	74.152513	0	805.83033	293.29825	0
Slice 138	355.14545	74.493597	0	746.13919	271.57246	0
Slice 139	355.9689	74.83468	0	686.44806	249.84666	0
Slice 140	356.79234	75.175764	0	626.75692	228.12086	0
Slice 141	357.61579	75.516848	0	567.06579	206.39507	0
Slice 142	358.43924	75.857932	0	507.37465	184.66927	0
Slice 143	359.26269	76.199016	0	447.68352	162.94347	0
Slice 144	360.08614	76.5401	0	387.99238	141.21768	0
Slice 145	360.90959	76.881184	0	328.30125	119.49188	0
Slice 146	361.73304	77.222268	0	268.61011	97.766085	0
Slice 147	362.55649	77.563352	0	208.91897	76.040288	0
Slice 148	363.37994	77.904436	0	149.22784	54.314492	0
Slice 149	364.20339	78.24552	0	89.536703	32.588695	0
Slice 150	365.02684	78.586604	0	29.845568	10.862898	0



# Edgewater Unstable Areas Analysis 2018 - West Slope

Name: Circular

F of S: 1.369



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Cyan	CCR	Mohr-Coulomb	86	0	20
Light Green	Clay Liner	Mohr-Coulomb	130	0	28
Light Green	Drainage Layer	Mohr-Coulomb	115	0	30
Green	Geosynthetics	Mohr-Coulomb	58	0	19.5
Yellow	Subbase	Mohr-Coulomb	135	0	28

# Circular

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## File Information

File Version: 8.16

Title: Edgewater Unstable Areas Analysis 2018 - West Slope

Comments: Running slope stability analysis on the west waste slope of Phase 3, Module 2 of the Edgewater I-43 Ash Disposal Facility. Location of analysis was selected based on longest and steepest slope at the time of peak waste placement within Module 2.

Created By: Suchomel, Brandon

Last Edited By: Suchomel, Brandon

Revision Number: 45

Date: 9/5/2018

Time: 1:09:20 PM

Tool Version: 8.16.3.14580

File Name: Western Slope of Module 2 Phase 3.gsz

Directory: I:\25218091.00\Data and Calculations\Slope Stability\

Last Solved Date: 9/5/2018

Last Solved Time: 1:17:09 PM

## Project Settings

Length(L) Units: Feet

Time(t) Units: Seconds

Force(F) Units: Pounds

Pressure(p) Units: psf

Strength Units: psf

Unit Weight of Water: 62.4 pcf

View: 2D

Element Thickness: 1

## Analysis Settings

### Circular

Kind: SLOPE/W

Method: Bishop

Settings

PWP Conditions Source: (none)

Slip Surface

Direction of movement: Left to Right

Use Passive Mode: No

Slip Surface Option: Entry and Exit

Critical slip surfaces saved: 10

Resisting Side Maximum Convex Angle: 1 °

Driving Side Maximum Convex Angle: 5 °

Optimize Critical Slip Surface Location: **No**  
Tension Crack  
Tension Crack Option: **(none)**  
F of S Distribution  
F of S Calculation Option: **Constant**  
Advanced  
Number of Slices: **150**  
F of S Tolerance: **0.001**  
Minimum Slip Surface Depth: **0.1 ft**

## Materials

### Subbase

Model: **Mohr-Coulomb**  
Unit Weight: **135 pcf**  
Cohesion': **0 psf**  
Phi': **28 °**  
Phi-B: **0 °**

### Clay Liner

Model: **Mohr-Coulomb**  
Unit Weight: **130 pcf**  
Cohesion': **0 psf**  
Phi': **28 °**  
Phi-B: **0 °**

### Geosynthetics

Model: **Mohr-Coulomb**  
Unit Weight: **58 pcf**  
Cohesion': **0 psf**  
Phi': **19.5 °**  
Phi-B: **0 °**

### Drainage Layer

Model: **Mohr-Coulomb**  
Unit Weight: **115 pcf**  
Cohesion': **0 psf**  
Phi': **30 °**  
Phi-B: **0 °**

### CCR

Model: **Mohr-Coulomb**  
Unit Weight: **86 pcf**  
Cohesion': **0 psf**  
Phi': **20 °**  
Phi-B: **0 °**

## Slip Surface Entry and Exit

Left Projection: [Range](#)

Left-Zone Left Coordinate: (243.97, 118.1341) ft

Left-Zone Right Coordinate: (247.34, 118.03799) ft

Left-Zone Increment: 100

Right Projection: [Range](#)

Right-Zone Left Coordinate: (393.76, 77.51845) ft

Right-Zone Right Coordinate: (396.92, 78.19181) ft

Right-Zone Increment: 100

Radius Increments: 30

## Slip Surface Limits

Left Coordinate: (0, 124.95) ft

Right Coordinate: (440.79, 86.91) ft

## Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	87.05
Point 3	0	85.05
Point 4	0	87.15
Point 5	34.01	75.82
Point 6	34.01	73.82
Point 7	34.01	75.92
Point 8	350.8	72.59
Point 9	350.8	70.59
Point 10	350.8	72.69
Point 11	353.74	71.61
Point 12	353.74	69.61
Point 13	353.74	71.71
Point 14	371.54	71.58
Point 15	371.54	69.58
Point 16	371.54	71.68
Point 17	379.67	70.31
Point 18	379.67	68.31
Point 19	379.67	70.41
Point 20	380.33	70.37
Point 21	380.33	68.37
Point 22	380.33	70.47
Point 23	429.74	86.05
Point 24	429.74	84.05
Point 25	429.74	86.15
Point 26	440.79	86.05



Point 27	440.79	84.05
Point 28	440.79	86.15
Point 29	440.79	0
Point 30	0	88.06
Point 31	34.01	76.88
Point 32	364.01	73.53
Point 33	371.98	72.92
Point 34	378.75	74.32
Point 35	397.24	78.26
Point 36	425.51	87.13
Point 37	430.24	89.04
Point 38	440.79	86.91
Point 39	0	124.95
Point 40	2.89	125.01
Point 41	247.62	118.03

## Regions

	Material	Points	Area (ft <sup>2</sup> )
Region 1	Subbase	1,3,6,9,12,15,18,21,24,27,29	32,320
Region 2	Clay Liner	3,2,5,8,11,14,17,20,23,26,27,24,21,18,15,12,9,6	881.58
Region 3	Geosynthetics	2,4,7,10,13,16,19,22,25,28,26,23,20,17,14,11,8,5	44.079
Region 4	Drainage Layer	4,30,31,32,33,34,35,36,37,38,28,25,22,19,16,13,10,7	551.77
Region 5	CCR	30,39,40,41,34,33,32,31	14,008

## Current Slip Surface

Slip Surface: 106,000

F of S: 1.369

Volume: 1,644.7877 ft<sup>3</sup>

Weight: 142,278.76 lbs

Resisting Moment: 8,872,216.2 lbs-ft

Activating Moment: 6,479,605.3 lbs-ft  
 F of S Rank (Analysis): 1 of 316,231 slip surfaces  
 F of S Rank (Query): 1 of 316,231 slip surfaces  
 Exit: (396.4776, 78.097542) ft  
 Entry: (245.0821, 118.10238) ft  
 Radius: 155.79743 ft  
 Center: (355.19053, 228.32476) ft

## Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	245.50508	117.68306	0	27.722323	10.0901	0
Slice 2	246.35105	116.85074	0	82.997012	30.208442	0
Slice 3	247.19702	116.03097	0	137.75366	50.138233	0
Slice 4	248.12298	115.14835	0	186.51865	67.887238	0
Slice 5	249.12894	114.20505	0	229.11109	83.389617	0
Slice 6	250.13491	113.27829	0	270.839	98.577333	0
Slice 7	251.14087	112.36765	0	311.71134	113.45365	0
Slice 8	252.14683	111.47278	0	351.73691	128.02177	0
Slice 9	253.1528	110.5933	0	390.92429	142.28481	0
Slice 10	254.15876	109.72888	0	429.28189	156.24583	0
Slice 11	255.16472	108.87918	0	466.8179	169.90782	0
Slice 12	256.17069	108.0439	0	503.54035	183.2737	0
Slice 13	257.17665	107.22274	0	539.45704	196.3463	0
Slice 14	258.18261	106.41541	0	574.5756	209.12842	0
Slice 15	259.18858	105.62164	0	608.90346	221.62273	0
Slice 16	260.19454	104.84117	0	642.44785	233.83189	0
Slice 17	261.2005	104.07374	0	675.21582	245.75846	0
Slice 18	262.20647	103.31912	0	707.21423	257.40493	0
Slice 19	263.21243	102.57708	0	738.44975	268.77373	0
Slice 20	264.21839	101.84739	0	768.92888	279.86723	0
Slice 21	265.22436	101.12984	0	798.65794	290.68772	0
Slice 22	266.23032	100.42424	0	827.64305	301.23744	0
	267.23628	99.730368	0	855.89019	311.51855	0

Slice 23						
Slice 24	268.24225	99.048052	0	883.40516	321.53318	0
Slice 25	269.24821	98.377107	0	910.19358	331.28337	0
Slice 26	270.25417	97.717356	0	936.26092	340.77111	0
Slice 27	271.26014	97.068632	0	961.61249	349.99832	0
Slice 28	272.2661	96.43077	0	986.25345	358.9669	0
Slice 29	273.27206	95.803616	0	1,010.1888	367.67865	0
Slice 30	274.27803	95.187016	0	1,033.4234	376.13535	0
Slice 31	275.28399	94.580825	0	1,055.9619	384.33869	0
Slice 32	276.28995	93.984903	0	1,077.8089	392.29035	0
Slice 33	277.29592	93.399112	0	1,098.9688	399.99193	0
Slice 34	278.30188	92.823322	0	1,119.4459	407.44499	0
Slice 35	279.30784	92.257406	0	1,139.2443	414.65103	0
Slice 36	280.31381	91.701241	0	1,158.3681	421.61152	0
Slice 37	281.31977	91.154709	0	1,176.8211	428.32787	0
Slice 38	282.32573	90.617694	0	1,194.6071	434.80144	0
Slice 39	283.3317	90.090086	0	1,211.7297	441.03356	0
Slice 40	284.33766	89.571777	0	1,228.1925	447.0255	0
Slice 41	285.34362	89.062664	0	1,243.9987	452.77849	0
Slice 42	286.34959	88.562646	0	1,259.1517	458.29373	0
Slice 43	287.35555	88.071625	0	1,273.6546	463.57237	0
Slice 44	288.36151	87.589509	0	1,287.5105	468.6155	0
Slice 45	289.36748	87.116204	0	1,300.7223	473.42419	0
Slice 46	290.37344	86.651624	0	1,313.2928	477.99948	0

Slice 47	291.3794	86.195683	0	1,325.2247	482.34234	0
Slice 48	292.38537	85.748297	0	1,336.5206	486.45373	0
Slice 49	293.39133	85.309386	0	1,347.1831	490.33455	0
Slice 50	294.39729	84.878873	0	1,357.2145	493.98568	0
Slice 51	295.40326	84.456682	0	1,366.6171	497.40795	0
Slice 52	296.40922	84.042741	0	1,375.3932	500.60217	0
Slice 53	297.41518	83.636977	0	1,383.5447	503.5691	0
Slice 54	298.42115	83.239324	0	1,391.0738	506.30946	0
Slice 55	299.42711	82.849713	0	1,397.9823	508.82395	0
Slice 56	300.43307	82.468081	0	1,404.2721	511.11323	0
Slice 57	301.43903	82.094366	0	1,409.9448	513.17793	0
Slice 58	302.445	81.728506	0	1,415.0021	515.01863	0
Slice 59	303.45096	81.370443	0	1,419.4455	516.63591	0
Slice 60	304.45692	81.02012	0	1,423.2765	518.03028	0
Slice 61	305.46289	80.677482	0	1,426.4964	519.20225	0
Slice 62	306.46885	80.342476	0	1,429.1066	520.15226	0
Slice 63	307.47481	80.01505	0	1,431.1081	520.88076	0
Slice 64	308.48078	79.695154	0	1,432.5022	521.38815	0
Slice 65	309.48674	79.382739	0	1,433.2897	521.67479	0
Slice 66	310.4927	79.077759	0	1,433.4717	521.74101	0
Slice 67	311.49867	78.780167	0	1,433.0489	521.58714	0
Slice 68	312.50463	78.48992	0	1,432.0221	521.21343	0
Slice 69	313.51059	78.206976	0	1,430.3921	520.62015	0
Slice 70	314.51656	77.931292	0	1,428.1594	519.80749	0



Slice 71	315.52252	77.66283	0	1,425.3244	518.77566	0
Slice 72	316.52848	77.40155	0	1,421.8877	517.52481	0
Slice 73	317.53445	77.147415	0	1,417.8496	516.05505	0
Slice 74	318.54041	76.90039	0	1,413.2103	514.3665	0
Slice 75	319.54637	76.66044	0	1,407.9701	512.45921	0
Slice 76	320.55234	76.427531	0	1,402.129	510.33322	0
Slice 77	321.5583	76.20163	0	1,395.687	507.98854	0
Slice 78	322.56426	75.982708	0	1,388.6442	505.42515	0
Slice 79	323.57023	75.770732	0	1,381.0003	502.643	0
Slice 80	324.57619	75.565676	0	1,372.7551	499.642	0
Slice 81	325.58215	75.36751	0	1,363.9084	496.42204	0
Slice 82	326.58812	75.176208	0	1,354.4596	492.98299	0
Slice 83	327.59408	74.991745	0	1,344.4085	489.32468	0
Slice 84	328.60004	74.814095	0	1,333.7544	485.44689	0
Slice 85	329.60601	74.643236	0	1,322.4966	481.34941	0
Slice 86	330.61197	74.479143	0	1,310.6346	477.03198	0
Slice 87	331.61793	74.321797	0	1,298.1674	472.4943	0
Slice 88	332.6239	74.171176	0	1,285.0942	467.73605	0
Slice 89	333.62986	74.02726	0	1,271.4141	462.75689	0
Slice 90	334.63582	73.890031	0	1,257.1259	457.55643	0
Slice 91	335.64716	73.75881	0	1,220.5462	704.68269	0
Slice 92	336.66386	73.633651	0	1,209.4867	698.29749	0
Slice 93	337.68056	73.51527	0	1,197.6162	691.44404	0
Slice 94	338.69727	73.403652	0	1,184.9305	684.11996	0

Slice 95	339.71397	73.298781	0	1,171.4254	676.32274	0
Slice 96	340.73068	73.200646	0	1,157.0963	668.04984	0
Slice 97	341.74738	73.109232	0	1,141.9387	659.29859	0
Slice 98	342.76408	73.024527	0	1,125.9478	650.06627	0
Slice 99	343.78079	72.946522	0	1,109.1188	640.35003	0
Slice 100	344.79749	72.875205	0	1,091.4466	630.14698	0
Slice 101	345.81419	72.810568	0	1,072.9259	619.45408	0
Slice 102	346.8309	72.752602	0	1,053.5515	608.26825	0
Slice 103	347.90876	72.698638	0	1,038.6508	367.80553	0
Slice 104	349.04779	72.649519	0	1,011.4207	358.16284	0
Slice 105	350.20865	72.608127	0	983.05651	348.11857	0
Slice 106	350.96459	72.584742	0	967.36629	342.56237	0
Slice 107	351.62459	72.568934	0	950.53176	548.78977	0
Slice 108	352.61542	72.549402	0	926.79715	535.08658	0
Slice 109	353.60625	72.536174	0	902.21312	520.89299	0
Slice 110	354.59709	72.529249	0	876.77337	506.20534	0
Slice 111	355.58792	72.528625	0	850.47144	491.01991	0
Slice 112	356.57875	72.534303	0	823.30065	475.33285	0
Slice 113	357.56959	72.546284	0	795.25415	459.1402	0
Slice 114	358.56042	72.564568	0	766.32486	442.43787	0
Slice 115	359.55125	72.589159	0	736.50553	425.22166	0
Slice 116	360.54208	72.620058	0	705.78865	407.48727	0
Slice 117	361.53292	72.65727	0	674.16654	389.23023	0
Slice 118	362.52375	72.7008	0	641.63126	370.44598	0

Slice 119	363.51458	72.750652	0	608.17464	351.12979	0
Slice 120	364.51354	72.807346	0	572.50478	330.53579	0
Slice 121	365.52063	72.870994	0	534.5874	308.64418	0
Slice 122	366.52771	72.941194	0	495.67986	286.1809	0
Slice 123	367.5348	73.017957	0	455.77241	263.14032	0
Slice 124	368.54188	73.101292	0	414.85499	239.51664	0
Slice 125	369.52968	73.189363	0	370.6537	134.90691	0
Slice 126	370.49818	73.281933	0	334.60383	121.78583	0
Slice 127	371.46668	73.380612	0	297.89026	108.42319	0
Slice 128	372.43518	73.485412	0	260.50822	94.817238	0
Slice 129	373.40369	73.596345	0	222.45278	80.966192	0
Slice 130	374.37219	73.713425	0	183.71888	66.868205	0
Slice 131	375.34069	73.836665	0	144.3013	52.521378	0
Slice 132	376.3092	73.96608	0	104.19466	37.923753	0
Slice 133	377.2777	74.101685	0	63.393407	23.073313	0
Slice 134	378.25597	74.244992	0	21.46659	7.8131999	0
Slice 135	379.24243	74.395891	0	3.5751225	2.0640979	0
Slice 136	380.2273	74.553012	0	10.097993	5.8300792	0
Slice 137	381.21217	74.716609	0	15.857989	9.1556139	0
Slice 138	382.19703	74.886701	0	20.845845	12.035354	0
Slice 139	383.1819	75.063311	0	25.052037	14.4638	0
Slice 140	384.16677	75.246461	0	28.466768	16.435296	0
Slice 141	385.15163	75.436174	0	31.079959	17.944023	0
Slice 142	386.1365	75.632476	0	32.881238	18.983992	0

Slice 143	387.12137	75.835391	0	33.859928	19.549038	0
Slice 144	388.10623	76.044946	0	34.005036	19.632817	0
Slice 145	389.0911	76.261168	0	33.30524	19.228789	0
Slice 146	390.07597	76.484086	0	31.748877	18.330223	0
Slice 147	391.06083	76.71373	0	29.323927	16.930177	0
Slice 148	392.0457	76.950129	0	26.018001	15.0215	0
Slice 149	393.03057	77.193316	0	21.818323	12.596815	0
Slice 150	394.01543	77.443324	0	16.711717	9.6485145	0
Slice 151	395.0003	77.700187	0	10.684588	6.1687499	0
Slice 152	395.98517	77.963939	0	3.7229049	2.1494202	0



## **APPENDIX E**

### Seepage Potential and Karst Condition Assessment

## **Seepage Potential and Karst Condition Assessment**

The disposal facility is designed and constructed to include storm water run-on and run-off management and leachate collection systems. The clay soils below the facility have a low permeability on the order of  $5 \times 10^{-8}$  cm/sec resulting in groundwater levels that are typically within 10 feet of the ground surface. Groundwater monitoring in 2016 and 2017 at monitoring wells adjacent to the facility show downward hydraulic gradients, confirming that groundwater movement resulting in unstable areas is not a concern. There are currently no concerns that storm water, leachate, or groundwater movement will impact the stability of the landfill.

As noted in **Appendix A**, karst features were not observed in the borings within and adjacent to the disposal facility. The borings encountered up to 90 feet of predominantly clay till. The total sequence of sediment is about 150 feet thick as indicated by water supply records in the area of the facility. Because of the multiple glacial advances and associated erosional and depositional processes resulting in a thick sediment layer overlying the bedrock, the area is not likely to be unstable due to karstic processes.

### **References**

BT2, Inc., 2008, Plan of Operation, Edgewater I-43 Ash Disposal Facility, Phases 3 and 4.  
SCS Engineers, 2018, Biennial Groundwater Monitoring Report for 2016-2017, Wisconsin Power and Light Company, Edgewater I-43 Ash Disposal Facility, Sheboygan, Wisconsin.

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