Closure Plan Amendment

Edgewater I-43 Ash Disposal Facility
Phase 3 Module 1
Phase 3 Module 2
Phase 4 Module 1
Contact Water Swale Module

Prepared for:

Wisconsin Power and Light Company
Edgewater Generating Station
3739 Lakeshore Drive
Sheboygan, Wisconsin 53081-7233

SCS ENGINEERS

25222259.00 | February 18, 2026

2830 Dairy Drive
Madison, WI 53718-6751
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PE CERTIFICATION

2/18/2026

I, Phillip Gearing, hereby certify that I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of ch. A–E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A–E 8, Wis. Adm. Code; 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 chs. NR 500 to 538, Wis. Adm. Code.

Specifically,

- This Closure Plan Amendment was prepared by me or under my direct supervision and meets the requirements of 40 CFR 257.102(b) and NR 514.07(10)(c)

(signature) 2/18/2026 (date)

Phillip Gearing
(printed or typed name)

License number E-45115

My license renewal date is July 31, 2026.

Pages or sheets covered by this seal:

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1.0 INTRODUCTION AND PROJECT SUMMARY

On behalf of Wisconsin Power and Light (WPL), SCS Engineers (SCS) has prepared this Closure Plan Amendment for the I-43 Ash Disposal Facility (I-43) Phase 3, Modules 1 and 2, Phase 4, Module 1, and the Contact Water Swale Module as required by 40 Code of Federal Regulations (CFR) 257.102(b) and Wisconsin Administrative Code NR 514.07(10)(c), as stated below.

40 CFR 257.102(b) *"Written closure plan — (1) Content of the plan. The owner or operator of a CCR unit must prepare a written closure plan that describes the steps necessary to close the CCR unit at any point during the active life of the CCR unit consistent with recognized and generally accepted good engineering practices. The written closure plan must include, at a minimum, the information specified in paragraphs (b)(1)(i) through (vi) of this section."*

NR 517.07(10)(c) *"A written closure plan in accordance with the requirements under s. NR 514.06 (10) and all of the following: (1) A narrative description of how the CCR landfill will be closed, including a description of the steps necessary to close the CCR unit at any point during the active life of the CCR unit, consistent with recognized and generally accepted good engineering practices."*

The I-43 facility includes the following coal combustion residual (CCR) landfills:

- Closed Phase 1 and Phase 2 (License #2853)
- Active Phase 3 and Phase 4 (License #6078)

The two landfills are located on the same property, but are not contiguous. This plan pertains to the CCR units within the active phases that are regulated under License #6078.

The following modules are the subject of this Closure Plan:

- **Phase 3, Module 1** – This module is part of an existing CCR landfill that received final cover (2015) over completed outer sideslope areas that will no longer receive additional CCR. This module has also received some intermediate cover in areas where future overlay of CCR will occur.

- **Phase 3, Module 2** – This module is part of an existing CCR landfill that has received some intermediate cover and is currently being filled.

- **Phase 4, Module 1** – This module is part of an existing CCR landfill that received final cover (2016) over completed outer sideslope areas that will no longer receive additional CCR. This module has also received some intermediate cover in areas where future overlay of CCR will occur.

- **Contact Water Swale Module (CWS)** – This module is a new CCR landfill that has been constructed and approved for filling by the Wisconsin Department of Natural Resources (DNR). Placement of CCR is anticipated to begin in 2026.

Two future CCR modules (Phase 4, Module 2 and Phase 4, Module 3) are currently permitted with the DNR, but are not planned for development as permitted at this time.

Figure 1 shows the site location. **Figure 2** shows the closure area as currently constructed. A detail of the final cover system is also included on **Figure 2**.

2.0 CLOSURE PLAN NARRATIVE

40 CFR 257.102(b)(1)(i) *"A narrative description of how the CCR unit will be closed in accordance with this section."*

NR 517.07(10)(c)(1) "*A narrative description of how the CCR landfill will be closed, including a description of the steps necessary to close the CCR unit at any point during the active life of the CCR unit, consistent with recognized and generally accepted good engineering practices."*

When CCR placement is completed in a CCR unit, or if early closure is required, the unit will be closed by covering the CCR with the final cover system described in **Section 3.0**. Prior to final cover system construction, the CCR surfaces will be graded and compacted to establish a firm subgrade for final cover construction. In addition, all required notifications will be submitted to the DNR, and WPL will obtain all additional necessary permits (for example, general permit coverage for construction storm water management). WPL may also engage in procurement activities to secure services for installing the final cover system.

The timing for completion of CCR placement in the units that are addressed with this closure plan will depend on CCR generation and disposal rates. Future CCR unit development will also impact the timing of closure. If early closure of the units were required, final cover will be placed in the active landfill areas shown on **Figure 2**. A closure schedule is discussed in **Section 6.0** and presented in **Appendix B**.

The initiation of closure activities will commence no later than 30 days after the known final receipt of CCR as required by 40 CFR 257.102(e)(1) and NR 506.083(2)(a), or in accordance with 40 CFR 257.102(e)(2) and NR 506.083(2)(b).

3.0 FINAL COVER SYSTEM AND PERFORMANCE

40 CFR 257.102(b)(1)(iii) *"If closure of the CCR unit will be accomplished by leaving CCR in place, a description of the final cover system, designed in accordance with paragraph (d) of this section, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in paragraph (d) of this section."*

40 CFR 257.102(d) *"Closure performance standard when leaving CCR in place.*

40 CFR 257.102(d)(1) *"The owner or operator of a CCR unit must ensure that, at a minimum, the CCR unit is closed in a manner that will:"*

> 40 CFR 257.102(d)(1)(i) "*Control, minimize, or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;"*

NR 514.07(10)(c)(3) *"A demonstration, including a narrative discussion, of how final closure will meet the performance standards under s. NR 506.083(6)."*

NR 506.083(6) *"Closure performance standards when leaving CCR in place. An owner or operator of a CCR landfill shall ensure that, at a minimum the CCR landfill is closed in a manner that will achieve all of the following performance standards:"*

NR 506.083(6)(a) *"Control, minimization or elimination, to the maximum extent feasible, of post-closure infiltration of liquids into the waste and of releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere."*

The final cover system design will minimize or eliminate infiltration, as further described below.

40 CFR 257.102(d)(1)(ii) *"Preclude the probability of future impoundment of water, sediment, or slurry;"*

NR 506.083(6)(b) *"Prevention of the impoundment of water, sediment or slurry."*

The final cover system will meet these criteria, as further described below.

40 CFR 257.102(d)(1)(iii) "*Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period;"*

NR 506.083(6)(c) *"Slope stability to prevent the sloughing or movement of the final cover system during the closure and long-term care period.*

The final cover system is designed to provide slope stability and to prevent sloughing or movement during the closure and post-closure care period. Stability of the final cover system was assessed as part of the DNR landfill permitting process and is further addressed below.

40 CFR 257.102(d)(1)(iv) "*Minimize the need for further maintenance of the CCR unit; and"*

NR 506.083(6)(d) *"Minimization of the need for long-term maintenance of the CCR landfill."*

Maintenance of the final cover will be minimized by the establishment of vegetative cover and the erosion control systems, which are further described below.

40 CFR 257.102(d)(1)(v) "*Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices."*

NR 506.083(6)(e) *"Complete closure in the shortest amount of time consistent with recognized and generally accepted good engineering practices."*

All closure activities for the CCR units will be completed within 6 months, as stated in **Section 7.0** below.

40 CFR 257.102(d)(2) *"Drainage and stabilization of CCR surface impoundments."*

This does not apply to the I-43 CCR landfill units.

40 CFR 257.102(d)(3) *"Final cover system"*

NR 517.07(10)(c)(2) *"A description of the final cover system, designed in accordance with s. NR 504.07, and the methods and procedures to be used to install the final cover."*

NR 504.12(4)(b) *"The owner or operator of a new or existing CCR landfill or a lateral expansion of a CCR landfill may propose an alternative final cover system design within a written closure plan in accordance with s. NR 504.10 and all of the following:"*

The existing final cover system (see **Figure 2**) that is currently in place on portions of Phase 3, Module 1 and Phase 4, Module 1 is as follows from the bottom up:

- Two feet of clay, compacted to a permeability of $1x10^{-7}$ cm/sec.
- Forty-mil low density polyethylene geomembrane.
- Geonet geocomposite drainage layer.
- Twelve inches of rooting zone soils.
- Six inches of topsoil.

A similar final cover system will be installed in the remaining future closure areas, except that it will include a 30-inch rooting zone per NR 504.07.

The existing and future final cover systems meet and exceed the minimum requirements of 40 CFR 257.102(d)(3)(i)(A) through (D) and NR 504.12(4)(b)(1) through (4) as follows:

- Per 257.102(d)(3)(i)(A) and NR 504.12(4)(b)(1), the permeability of the final cover system is less than or equal to the permeability of the bottom liner system and is less than $1x10^{-5}$ cm/sec required by the Rules. The final cover system 2-foot-thick clay cap is compacted to $1x10^{-7}$ cm/sec permeability. The geomembrane above the 2-foot clay cap makes the cover system even less permeable.

  The bottom liner system for each of the existing modules and how it compares to the final cover system is as follows:

  – Phase 3, Module 1:

    - Five feet of clay, compacted to a permeability of $1x10^{-7}$ cm/sec.
    - The liner system does not include a geomembrane and therefore is not as impermeable as the final cover system.

  – Phase 3, Module 2:

    - Two feet of clay, compacted to a permeability of 1x10-7 cm/sec.
    - Sixty-mil High Density Polyethylene (HDPE) geomembrane.
    - Based on the design slopes and drainage system components in the liner system and future final cover system, the future final cover system is at least equivalent in permeability when compared to the liner system.

  – Phase 4, Module 1:

    - Five feet of clay, compacted to a permeability of 1x10-7 cm/sec.
    - The Phase 4, Module 1 liner system does not include a geomembrane and therefore is not as impermeable as the final cover system.

- Contact Water Swale Module
    - Four feet of clay, compacted to a permeability of 1x10-7 cm/sec.
    - Sixty-mil High Density Polyethylene (HDPE) geomembrane.
    - Based on the design slopes and drainage system components in the liner and future final cover system, the future final cover system is at least equivalent in permeability when compared to the liner system.

- Per 257.102(d)(3)(i)(B), the final cover system includes 2 feet of compacted clay, which is greater than the 18 inches of earthen material required to minimize infiltration.

- Per NR 504.12(4)(b)(2), the final cover contains an infiltration layer (2 feet of clay) that meets the requirements of s. NR 504.07(4) and achieves an equivalent reduction in infiltration as the layers specified under s. NR 504.07(4). Water infiltrating the final cover will be contained in the drainage layer (geonet geocomposite), which will limit infiltration further through the final cover system.

- Per 257.102(d)(3)(i)(C) and NR 504.12(4)(b)(3), the erosion of the existing and future final cover systems is minimized with a vegetative support layer consisting of 12 inches (existing final cover systems) or 30 inches (future final cover systems) of uncompacted rooting zone material and 6 inches of topsoil. This provides more than the required 6-inch thickness for plant growth.

The existing and future final cover systems limit infiltration while promoting surface water runoff in a controlled manner to minimize erosion and promote stability. The surface layer of 18 inches (existing final cover systems), or 36 inches (future final cover systems) of soil supports vegetation that assists with erosion control. Water that infiltrates through the vegetative support layers is collected by the lateral drainage layer (geonet geocomposite) and routed to the perimeter drainage system.

In addition, the surface has intermediate drainage swales to reduce the flow lengths down the final cover slope, also aiding in erosion control. Where needed, the intermediate drainage swales are connected to downslope flumes and energy dissipaters to control storm water runoff and prevent erosion of the final cover.

- Per 257.102(d)(3)(i)(D) and NR 504.12(4)(b)(4), the design of the existing and future final cover system minimizes disruptions to the final cover system. Stability of the final cover system was assessed as part of the DNR landfill permitting process. The stability calculations are included in **Appendix A1** and **A2**.

The design of the final cover system accommodates settling and subsidence of the CCR fill below the cover. The CCR at I-43 is placed dry and is compacted in place. CCR continues to consolidate and gain strength as filling progresses prior to final cover placement. The final cover system is designed with a maximum slope of 25 percent (4 horizontal to 1 vertical). Because the final cover has a relatively large positive slope and the CCR has been gaining strength over time, the final cover is expected to easily accommodate the remaining relatively minor settlement potential of the CCR fill when fill placement ends and the landfill is closed.

Construction of each of the final cover systems will be performed per methods and procedures described in NR 504, NR 516, and the site-specific Construction Quality Assurance/Quality Control

Plan. All final cover materials will be tested to confirm they meet the code requirements, and project documents and construction will be overseen and documented by a licensed engineer. Clay material placement will be tested for compaction, permeability, and thickness. Rooting zone and topsoil layers will be checked for thickness. All areas will be restored after final cover is placed. Vegetation will be monitored and maintained.

4.0 MAXIMUM INVENTORY OF CCR

40 CFR 257.102(b)(1)(iv) *"An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit."*

NR 514.07(10)(c)(4) *"An estimate of the maximum volume in cubic yards of CCR that will be disposed on-site over the active life of the CCR landfill."*

The following table reflects the estimated maximum volumes of CCR in each constructed CCR module at the I-43 facility.

Area	Capacity (cy)
Phase 3, Module 1	127,400
Phase 3, Module 2	276,750
Phase 4, Module 1	73,300
Contact Water Swale	127,400
Total Maximum CCR Quantity	**604,850**

The estimated maximum inventory of CCR ever on site over the active life of the CCR Unit is based on the design capacity of each constructed module. The design capacity of each module is defined in the DNR-approved 2008 Plan of Operation and as revised by the March 2015 Plan of Operation Modification, the June 2024 Plan of Operation Modification request, and the approved April 2025 Plan of Operation Modification for the CWS Module.

5.0 LARGEST AREA OF CCR UNIT REQUIRING FINAL COVER

40 CFR 257.102(b)(1)(v) *"An estimate of the largest area of the CCR unit ever requiring a final cover as required by paragraph (d) of this section at any time during the CCR unit's active life."*

NR 514.07(10)(c)(5) *"An estimate of the largest area of the CCR landfill that will require a final cover at any time during the CCR landfill's active life."*

The largest area of each module requiring final cover is the open area shown on **Figure 2**, with areas as follows:

Area	Acres
Phase 3, Module 1	2.4
Phase 3, Module 2	5.6
Phase 4, Module 1	1.0
Contact Water Swale	2.1
Total	**11.1**

6.0 SCHEDULE OF SEQUENTIAL CLOSURE ACTIVITIES

40 CFR 257.102(b)(1)(vi) *"A schedule for completing all activities necessary to satisfy the closure criteria in this section, including an estimate of the year in which all closure activities for the CCR unit will be completed."*

NR 514.07(10)(c)(6) *"A schedule for completion of all closure activities, including an estimate of the year in which all closure activities for the CCR landfill will be completed."*

The potential schedule for closure of the existing CCR modules is provided in **Appendix B**. CCR placement is currently assumed to cease on June 30, 2030. This date is only an estimate and is subject to change. If the estimated date of cessation of CCR placement changes, the potential schedule for closure will be updated accordingly.

7.0 COMPLETION OF CLOSURE ACTIVITIES

40 CFR 257.102(f)(1)(i) *"For existing and new CCR landfills and any lateral expansion of a CCR landfill, within six months of commencing closure activities."*

NR 506.083(3)(a) *"The owner or operator shall complete closure of the CCR landfill within 6 months of commencing closure activities."*

As shown on the enclosed schedule, closure of the CCR unit will be completed within 6 months of commencement of closure activities.

40 CFR 257.102(f)(3) *"Upon completion, the owner or operator of the CCR unit must obtain a certification from a qualified professional engineer verifying that closure has been completed in accordance with the closure plan specified in paragraph (b) of this section and the requirements of this section."*

NR 506.083(1)(b) *"Within 30 days following completion of closure of a CCR landfill under sub. (3), the owner or operator shall prepare and submit a notification of closure to the department and place a copy in the facility's operating record. The notification shall include the certification required under s. NR 516.04(3)(d)."*

A qualified licensed engineer will oversee final cover construction. The engineer will verify final cover materials and methods and oversee material testing. At the end of construction, the engineer will provide a report summarizing and documenting construction and will certify compliance with the requirements.

8.0 CERTIFICATION

40 CFR 257.102(b)(4) *"The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer that the initial and any amendment of the written closure plan meets the requirement of this section."*

NR 500.05 *"Unless otherwise specified, all submittals for review and approval of any initial site report, feasibility report, plan of operation site investigation report, remedial action options report, construction documentation report, or closure plan, or any modifications to those plans, shall include all of the following:*

(4) CERTIFICATION. (a) The reports and plan sheets shall be under the seal of a licensed professional engineer."

Phillip Gearing, PE, a licensed professional engineer in the State of Wisconsin, has overseen the preparation of this Closure Plan. A certification statement is provided on **page iii** of this plan.

40 CFR 257.102(d)(3)(iii) *"The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer that the design of the final cover system meets the requirement of this section."*

Phillip Gearing, PE, a licensed professional engineer in the State of Wisconsin has reviewed the final cover design and certifies that the design meets the requirements of 40 CFR 257.102(d). The certification statement is provided on **page iii** of this plan.

9.0 RECORDKEEPING AND REPORTING

40 CFR 257.102(b)(2)(iv) "*The owner or operator has completed the written closure plan when the plan including the certification required by paragraph (b)(4) of this section, has been placed in the facility's operating record as required by Section 257.105(i)(4)."*

NR 506.17(2)(e) *"The written operating record shall contain the plan of operation, plan modifications, construction documentation, department approvals, annual reports, inspection records, monitoring and corrective action records, notifications to the department, and records of public comments received during any public comment period."*

The Closure Plan will be placed in the facility's operating record and on Alliant Energy's CCR Rule Compliance Data and Information website, as required by 40 CFR 257.105(i) and 257.107(i).

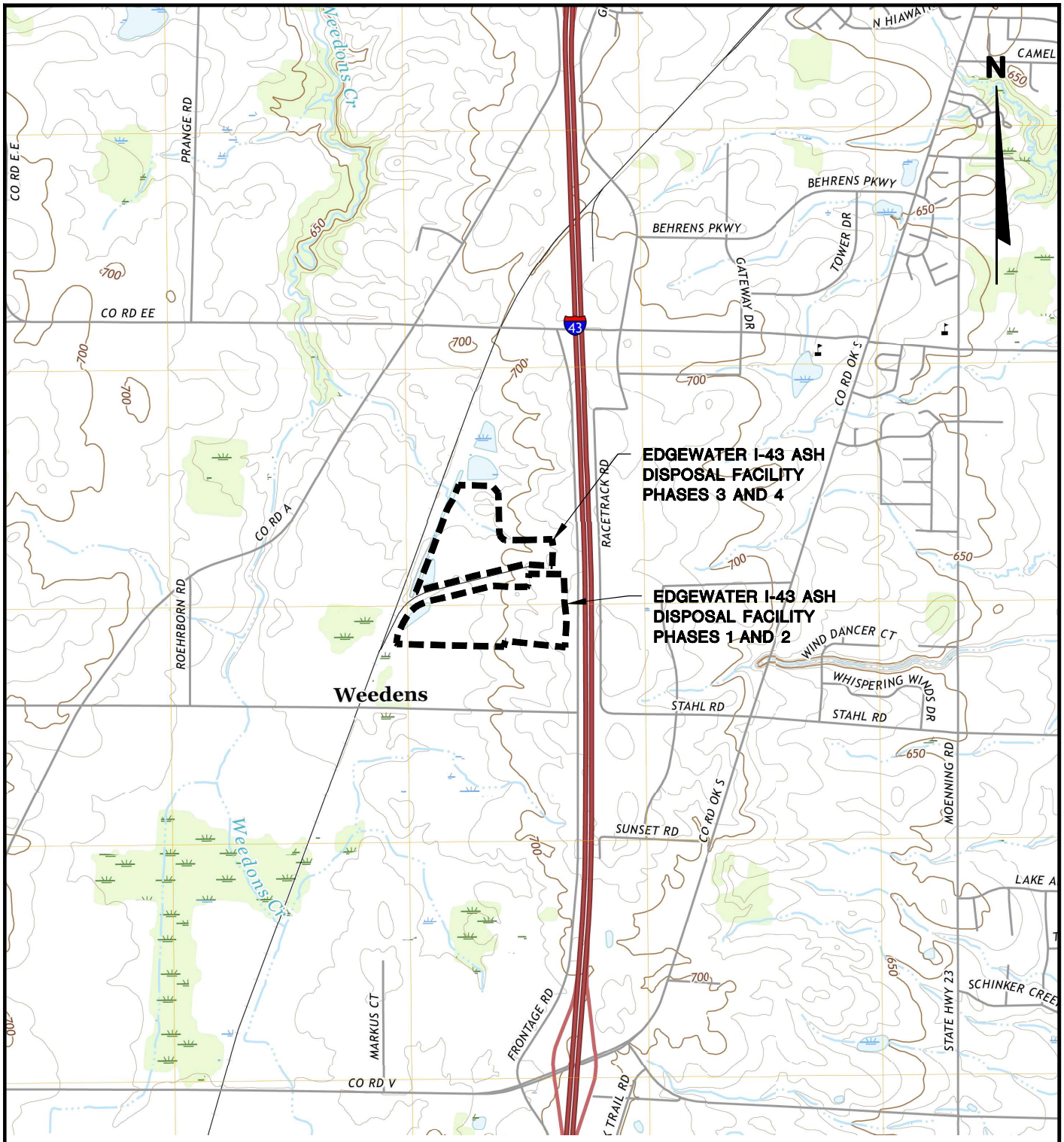
Amendments to the written closure plan will be done when a new module is constructed, when there is a change in the operation of the CCR unit that affects the plan, or when unanticipated events warrant revision to the written Closure Plan, as required by 40 CFR 257.102(b)(3) and NR 514.07(10)(c)(7).

WPL will provide notification as follows:

- Intent to initiate closure.
- Closure completion.
- Availability of the written closure plan and any amendments.

All of the above notifications will be placed in the facility's operating record and on the website per 40 CFR 257.105(i), 257.107(i), and NR 506.17(2). Notification to the DNR will be made once notifications have been placed in the operating record and on the website per 257.106(i),

Figures



SHEBOYGAN HILLS QUADRANGLE
WISCONSIN–SHEBOYGAN CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SCALE: 1" = 2,000'

WISCONSIN

CLIENT	WISCONSIN POWER AND LIGHT COMPANY EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081	SITE	CLOSURE PLAN EDGEWATER I–43 ASH DISPOSAL FACILITY TOWN OF WILSON, WISCONSIN

SITE LOCATION MAP

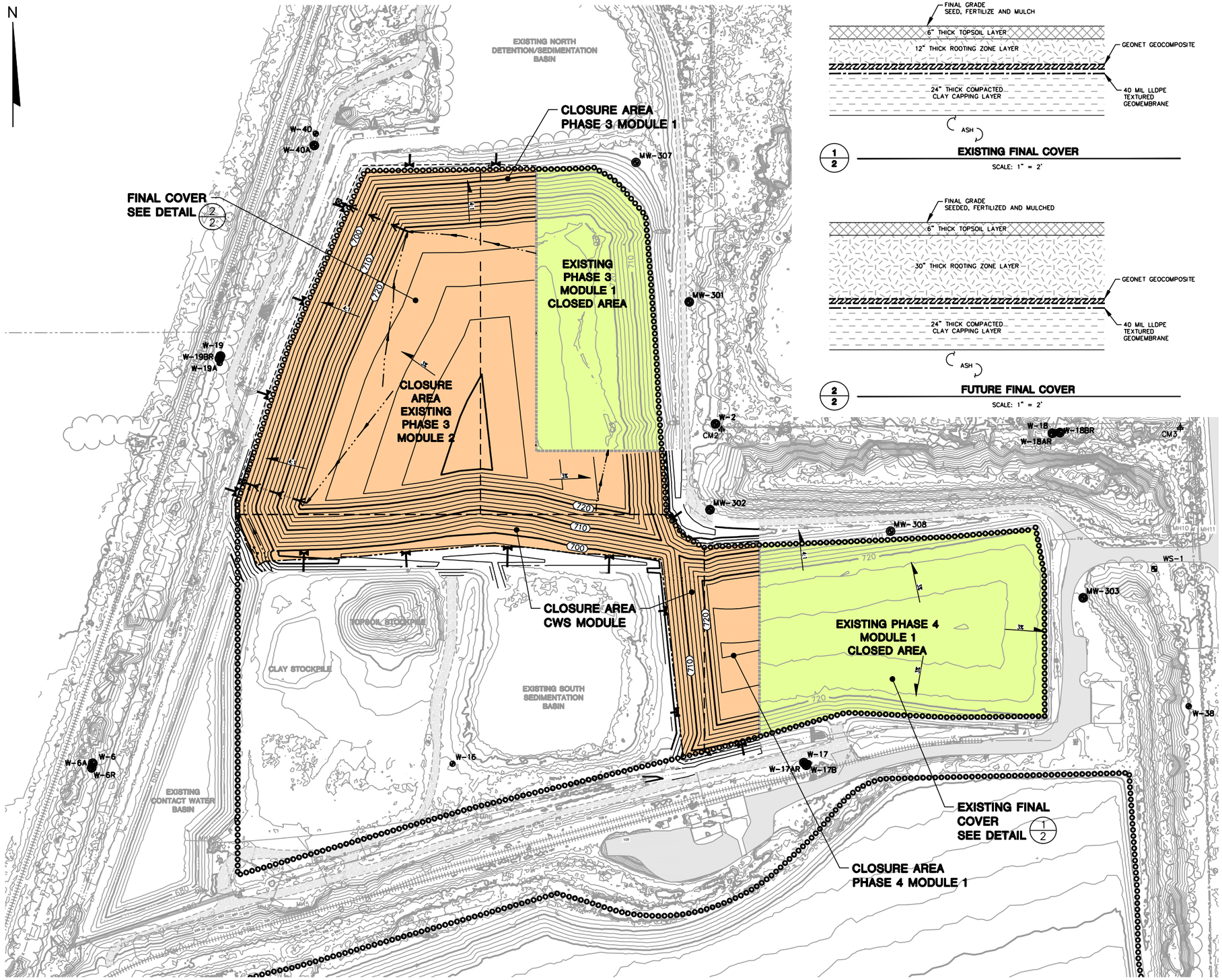
PROJECT NO.	25222259.00	DRAWN BY:	RVG
DRAWN:	01/23/2026	CHECKED BY:	PEG
REVISED:		APPROVED BY:	PEG, 2/18/26

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718–6751
PHONE: (608) 224–2830

FIGURE 1

I:\25224280.00\Drawings\Closure Plan\1_Site Location Map.dwg, 1/23/2026 12:19:16 PM



LEGEND

- APPROXIMATE PROPERTY LINE
- LIMITS OF WASTE
- MODULE LIMITS
- PROPOSED ASH LIMITS
- EXISTING GRADE (2' CONTOUR)
- 690 EXISTING GRADE (10' CONTOUR)
- EDGE OF WATER
- SWALE
- WETLAND
- CULVERT
- MH MANHOLE
- W CONTACT WATER TRANSFER PIPE
- AB ABANDONED 3" DIA. HDPE PIPE
- FM CONTACT WATER FORCEMAIN
- E/A ELECTRIC/INSTRUMENTATION
- TREELINE/TREES
- PAVED ROAD
- ACCESS ROAD
- CONCRETE
- RAILROAD TRACKS
- FENCE
- UTILITY/LIGHT POLE
- CONTROL MONUMENT
- MONITORING WELL
- PIEZOMETER
- LEACHATE HEADWELL
- PRIVATE WATER SUPPLY WELL
- 720 PROPOSED FINAL GRADE
- 3% SLOPE AND DIRECTION
- PROPOSED ACCESS ROAD
- PROPOSED FINAL COVER DIVERSION BERM
- PROPOSED DOWNSLOPE FLUME
- PROPOSED ENERGY DISSIPATOR
- PROPOSED TOE DRAIN AND DISCHARGE PIPE
- AREAS TO BE CLOSED
- CLOSED AREAS

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 CONSTRUCTION AS-BUILT GRADES, 2016 CONSTRUCTION AS-BUILT GRADES FOR PHASE 4, MODULE 1 BY SCS ENGINEERS, DECEMBER 23, 2020 DRONE SURVEY OF PHASE 3, MODULE 2 ASH GRADES AND FUTURE PHASE 4 AREAS BY RYAN INCORPORATED CENTRAL, FEBRUARY AND APRIL 2024 PHASE 3 MODULE 2 SURVEYS BY SCS ENGINEERS, AND OCTOBER 24, 2025 DRONE SURVEY BY SCS ENGINEERS.
2. CONTOUR INTERVAL IS 2 FEET.
3. WETLAND LIMITS BASED ON WETLAND DELINEATION REPORT, WISCONSIN POWER AND LIGHT COMPANY, EDGEWATER LANDFILL SITE, TOWN OF WILSON, SHEBOYGAN COUNTY, WI, JUNE 25, 2010, NATURAL RESOURCES CONSULTING, INC. (NRC).

FINAL COVER PLACEMENT

1. DOCUMENT FINAL ASH ELEVATIONS AND SURFACE IN PREPARATION OF COMPOSITE COVER PLACEMENT.
2. INSTALL COMPACTED SELECT CLAY FILL.
3. INSTALL GEOMEMBRANE, GEOCOMPOSITE, GEOCOMPOSITE DRAINS, AND GEOCOMPOSITE TOE DRAINS.
4. INSTALL ROOTING ZONE MATERIAL.
5. INSTALL FINAL GRADE SWALES, DOWNSLOPE FLUMES, AND ENERGY DISSIPATORS.
6. INSTALL TOPSOIL.
7. SEED, FERTILIZE, AND MULCH TOPSOIL AND DISTURBED AREAS.

200 0 200

SCALE: 1" = 200'

CLOSURE PLAN

SITE

SITE CLOSURE PLAN
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

CLIENT

WISCONSIN POWER AND LIGHT COMPANY
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081

FIGURE 2

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
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DRAWN BY:	RVG
CHECKED BY:	PEG
APPROVED BY:	PEG, 2/18/26
PROJECT NO.	25222259.00
DRAWN:	01/23/2026
REVISED:	01/30/2026

Appendix A

Stability Calculations

April 5, 2024
File No. 25222259.00

TECHNICAL MEMORANDUM

ANALYSIS BY: Niko Villaneuva
Brandon Suchomel

REVIEWED BY: Deb Nelson
Phil Gearing

SUBJECT: Slope Stability Analysis
Plan of Operation Modification
Edgewater I-43 Ash Disposal Facility, License #2853

PURPOSE

The purpose of the slope stability analyses was to evaluate the most critical future slope:

- The final cover 4H:1V slope in Phase 3 at the highest final cover grade

CONCLUSION

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

APPROACH

SCS Engineers (SCS) evaluated the slope stability of the southern slope of Phase 3 final cover slope at the most critical/highest final cover grade cross-section (i.e., at the time of final cover placement) after the filling of the proposed converted contact water swale liner. The 4H:1V final cover slope analyzed at the south side has a maximum final cover fill height of approximately 50 feet above base grades, and a peak elevation of approximately 731 feet above mean sea level. A piezometric surface was assumed just below the landfill clay liner. The final cover slope was evaluated for block and optimized circular failure.

RESULTS

The calculated safety factors for each slope section and failure type are shown in the summary table.

SCS recommends a minimum safety factor of 1.5 for the final grade slopes. The results indicate that the final grade slopes have acceptable minimum safety factors.

Table 1. Factor of Safety Results Summary

Scenario Analyzed	Calculated Safety Factor	Recommended Minimum Safety Factor
Critical Future Final Grades (See Figure 1)		
Optimized Circular (Rotational Failure)	1.548	1.500
Block (Translational Failure) Left of Intercell Berm	1.877	1.500
Block (Translational Failure) Contact Water Swale	1.896	1.500

REFERENCES

1. SCS Engineers, Edgewater I-43 Ash Disposal Facility, Plan Modification Request Addendum No. 1, 2024.

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 Phase 3 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 2023.1.1, Slope/W slope stability software.

8. U.S. Army Corps of Engineers, Slope Stability Engineer Manual EM 1110-2-1902, October 2003.

9. SCS Engineers, Edgewater I-43 Ash Disposal Facility, Unstable Areas Compliance Demonstration Phase 3 Modules 1 and 2, Phase 4 Module 1, 2018.

ASSUMPTIONS

- The critical final grades are the worst-case scenario (shown on Figure 1) for the longest/highest final grade slope. This includes the full buildout of approved and proposed module construction.

- Drainage layers in each of the existing and future modules and leachate drainage materials in the contact water swale area have the same properties.
- Geosynthetics installed for each of the module composite liners have the same properties.
- Clay material for each of the existing and future module composite liners have the same properties.
- Coal combustion residual (CCR) waste material will be the same in each of the existing and future modules.
- A final grade slope of 4H:1V is representative of the design final cover grades.
- The groundwater elevation will remain below the elevation at the base of the landfill liner system.
- The disposal facility will be operated to prevent development of liquid pressures, or seepage forces, within the waste, and there will be no buildup of leachate above the top of the drainage layer.
- The disposal facility will be operated to prevent placement of weak layers of waste within the overall waste mass.
- Optimized circular and sliding block failure stability analyses are appropriate to evaluate the final cover 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 CCR friction angle is a conservative assumed value based on published values and 2015 triaxial compression test results by TRI/Environmental for CCR.

Table 2. Material Properties Summary Table

Material	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)	Reference
Final Cover	125	28	0	2
CCR	86	20	0	4, 5, 6, and 9
Drainage Layer	115	30	0	2 and 9
Geosynthetics	58	19.5	0	3 and 9
Clay Liner	130	28	0	2 and 9
Subbase	135	28	0	2 and 9

Attachments: Calculations organized as follows:

- Figure 1. Slope Stability Cross Section Location
- Slope/W Outputs

BSS/NV/REO_LMH/DLN/PEG

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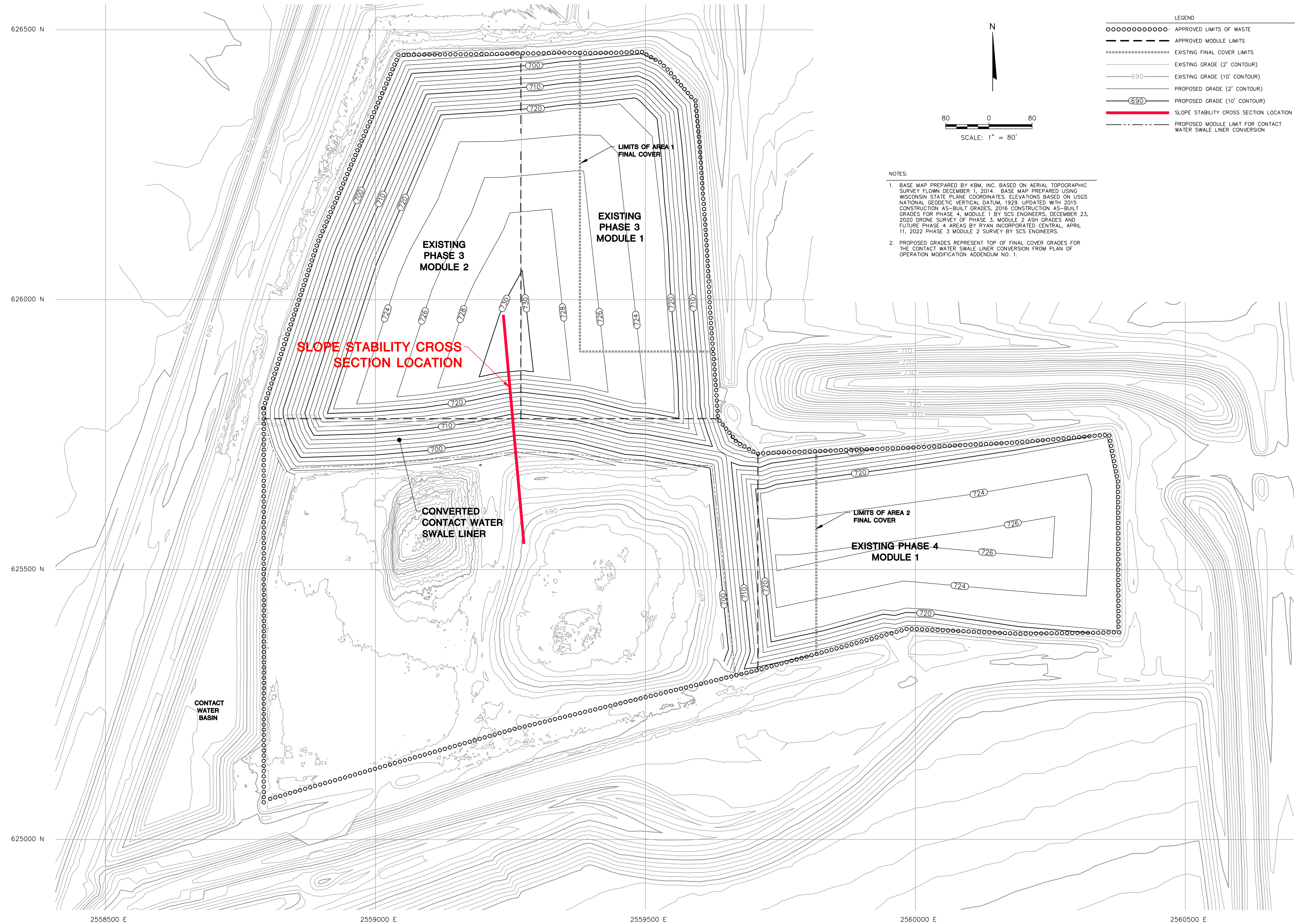


LEGEND

- APPROVED LIMITS OF WASTE
- APPROVED MODULE LIMITS
- EXISTING FINAL COVER LIMITS
- EXISTING GRADE (2' CONTOUR)
- 690 EXISTING GRADE (10' CONTOUR)
- PROPOSED GRADE (2' CONTOUR)
- 690 PROPOSED GRADE (10' CONTOUR)
- SLOPE STABILITY CROSS SECTION LOCATION
- PROPOSED MODULE LIMIT FOR CONTACT WATER SWALE LINER CONVERSION

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 CONSTRUCTION AS-BUILT GRADES, 2016 CONSTRUCTION AS-BUILT GRADES FOR PHASE 4, MODULE 1 BY SCS ENGINEERS, DECEMBER 23, 2020 DRONE SURVEY OF PHASE 3, MODULE 2 ASH GRADES AND FUTURE PHASE 4 AREAS BY RYAN INCORPORATED CENTRAL, APRIL 11, 2022 PHASE 3 MODULE 2 SURVEY BY SCS ENGINEERS.
2. PROPOSED GRADES REPRESENT TOP OF FINAL COVER GRADES FOR THE CONTACT WATER SWALE LINER CONVERSION FROM PLAN OF OPERATION MODIFICATION ADDENDUM NO. 1.

PROJECT NO.	25222259.00	DRAWN BY:	BSS
DRAWN:	03/22/2024	CHECKED BY:	PEG
REVISED:	03/22/2024	APPROVED BY:	PEG 6/13/24

CLIENT: WISCONSIN POWER AND LIGHT COMPANY
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081

ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

SITE: PLAN MODIFICATION ADDENDUM NO. 1
EDGEWATER GENERATING STATION
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

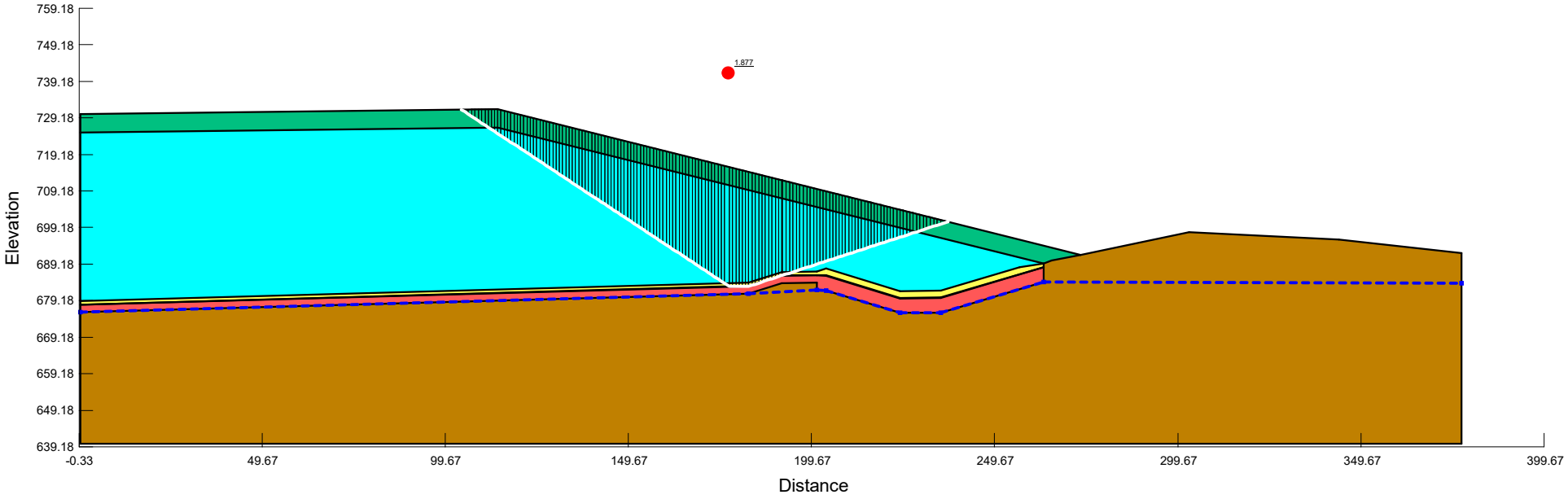
SLOPE STABILITY
CROSS SECTION LOCATION

FIGURE
1 OF 1

I-43 Plan of Operation Modification - Final Grade Stability Analysis
Block Failure-Intercell Berm
Analysis Type: Janbu
Last Solved Date: 03/27/2024, 04:20:20 PM

Factor of Safety: 1.877

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezometric Surface
	CCR	86	0	20	
	Clay Liner	130	0	28	
	Drainage Layer	115	0	30	
	Final Cover	125	0	28	
	Geosynthetics	58	0	19.5	
	Subbase	135	0	28	1



Block Failure-Intercell Berm

File Information

File Version: 11.05
Title: I-43 Plan of Operation Modification - Final Grade Stability Analysis
Created By: Villanueva, Niko
Last Edited By: Villanueva, Niko
Revision Number: 52
Date: 03/27/2024
Time: 04:16:14 PM
Tool Version: 23.1.1.829
File Name: I-43 Proposed Final Grades_Section A_240327.gsz
Directory: I:\25222259.00\Data and Calculations\Geotechnical\Slope Stability\SlopeW Analysis\
Last Solved Date: 03/27/2024
Last Solved Time: 04:20:20 PM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Block Failure-Intercell Berm

Kind: SLOPE/W
Analysis Type: Janbu
Settings
- PWP Conditions from: Piezometric Surfaces
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No
- Unit Weight of Water: 62.430189 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 10
- Restrict Block Crossing: No
- Optimize Critical Slip Surface Location: No
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Convergence
- Geometry Settings
  - Minimum Slip Surface Depth: 0.1 ft
  - Minimum Slip Surface Volume: 35.314667 ft³
  - Number of Columns: 150
- Factor of Safety Convergence Settings
  - Maximum Number of Iterations: 100
  - Tolerable difference in F of S: 0.001

Under-Relaxation Criteria
Initial Rate: 1
Minimum Rate: 0.1
Rate Reduction Factor: 0.65
Reduction Frequency (iterations): 50

Materials

CCR

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 86 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 20 °
Phi-B: 0 °

Clay Liner

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 130 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °

Drainage Layer

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 115 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Geosynthetics

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 58 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 19.5 °
Phi-B: 0 °

Subbase

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 135 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Surface: 1

Final Cover

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 125 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °

Slip Surface Limits

Left Coordinate: (0, 730.2) ft
Right Coordinate: (377.2, 692.2) ft

Slip Surface Block

Left Grid
- Upper Left: (167.74, 682.79) ft
- Lower Left: (167.74, 682.69) ft
- Lower Right: (177.24, 682.96) ft
- X Increments: 10
- Y Increments: 4
- Starting Angle: 115 °
- Ending Angle: 160 °
- Angle Increments: 10

Right Grid
- Upper Left: (177.94, 683.07) ft
- Lower Left: (177.94, 682.97) ft
- Lower Right: (182.5, 683.1) ft
- X Increments: 10
- Y Increments: 4
- Angle Increments: 10

Piezometric Surfaces

Piezometric Surface 1

Coordinates

	X	Y
Coordinate 1	0 ft	676 ft
Coordinate 2	182.5 ft	681.1 ft
Coordinate 3	201.2 ft	682.1 ft
Coordinate 4	203.7 ft	682 ft
Coordinate 5	223.8 ft	675.8 ft
Coordinate 6	234.9 ft	675.9 ft
Coordinate 7	263 ft	684.3 ft
Coordinate 8	377.2 ft	684 ft

Geometry

Name: 2D Geometry

Settings

View: 2D
Element Thickness: 1 ft

Points

	X	Y
Point 1	0 ft	640 ft

Point 2	377.2 ft	640 ft
Point 3	377.2 ft	692.2 ft
Point 4	343.6 ft	695.9 ft
Point 5	302.7 ft	697.9 ft
Point 6	265.2 ft	690.1 ft
Point 7	263.1 ft	689.3 ft
Point 8	263.1 ft	688.4 ft
Point 9	263.1 ft	688.3 ft
Point 10	263.1 ft	684.3 ft
Point 11	234.9 ft	675.9 ft
Point 12	223.8 ft	675.8 ft
Point 13	203.7 ft	682 ft
Point 14	201.2 ft	682.1 ft
Point 15	201.2 ft	684.1 ft
Point 16	191.6 ft	684 ft
Point 17	182.5 ft	681.1 ft
Point 18	0 ft	676 ft
Point 19	0 ft	678 ft
Point 20	182.5 ft	683.1 ft
Point 21	191.6 ft	686 ft
Point 22	201.2 ft	686.1 ft
Point 23	203.7 ft	686 ft
Point 24	223.8 ft	679.8 ft
Point 25	234.9 ft	679.9 ft
Point 26	0 ft	678.1 ft
Point 27	182.5 ft	683.2 ft
Point 28	191.6 ft	686.1 ft
Point 29	201.2 ft	686.2 ft
Point 30	203.7 ft	686.1 ft
Point 31	223.8 ft	679.9 ft
Point 32	234.9 ft	680 ft
Point 33	0 ft	679 ft
Point 34	182.5 ft	684.1 ft
Point 35	191.6 ft	687 ft
Point 36	201.2 ft	687.1 ft
Point 37	203.7 ft	688 ft
Point 38	0 ft	725.2 ft
Point 39	113.97399 ft	726.5815 ft
Point 40	256.51003 ft	688.33703 ft
Point 41	234.9 ft	681.9 ft
Point 42	223.8 ft	681.8 ft
Point 43	0 ft	730.2 ft
Point 44	113.97399 ft	731.5815 ft
Point 45	273.22402 ft	691.769 ft

Regions

	Material	Points	Area
Region 1	Subbase	1,2,3,4,5,45,6,7,8,9,10,11,12,13,14,15,16,17,18	16,534 ft²
Region 2	Clay Liner	18,19,20,21,22,23,24,25,9,10,11,12,13,14,15,16,17	650 ft²

Region 3	Geosynthetics	19,26,27,28,29,30,31,32,8,9,25,24,23,22,21,20	26.31 ft²
Region 4	Drainage Layer	26,33,34,35,36,37,30,29,28,27	184.58 ft²
Region 5	CCR	33,38,39,7,40,41,42,37,36,35,34	8,689.4 ft²
Region 6	Final Cover	38,39,7,6,45,44,43	1,339.4 ft²
Region 7	Drainage Layer	37,42,41,40,7,8,32,31,30	109.57 ft²

Slip Results

Slip Surfaces Analysed: 302676 of 366025 converged

Current Slip Surface

Slip Surface: 290,515
Factor of Safety: 1.877
Volume: 2,302.6823 ft³
Weight: 222,792.19 lbf
Resisting Moment: 3,771,783.9 lbf·ft
Activating Moment: 1,699,412.1 lbf·ft
Resisting Force: 80,759.502 lbf
Activating Force: 43,014.985 lbf
Slip Rank: 1 of 366,025 slip surfaces
Exit: (237.02936, 700.81766) ft
Entry: (104.07551, 731.46152) ft
Radius: 65.431871 ft
Center: (175.84965, 739.12248) ft

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Column 1	104.53916 ft	731.15464 ft	0 psf	32.895362 psf	17.490774 psf	0 psf	0 psf	Final Cover
Column 2	105.46645 ft	730.54088 ft	0 psf	98.686086 psf	52.472323 psf	0 psf	0 psf	Final Cover
Column 3	106.39374 ft	729.92712 ft	0 psf	164.47681 psf	87.453871 psf	0 psf	0 psf	Final Cover
Column 4	107.32103 ft	729.31336 ft	0 psf	230.26753 psf	122.43542 psf	0 psf	0 psf	Final Cover
Column 5	108.24832 ft	728.69960 ft	0 psf	296.05826 psf	157.41697 psf	0 psf	0 psf	Final Cover
Column 6	109.17561 ft	728.08584 ft	0 psf	361.84898 psf	192.39852 psf	0 psf	0 psf	Final Cover
Column 7	110.10290 ft	727.47208 ft	0 psf	427.63971 psf	227.38006 psf	0 psf	0 psf	Final Cover
Column 8	111.03019 ft	726.85832 ft	0 psf	493.43043 psf	262.36161 psf	0 psf	0 psf	Final Cover
Column 9	111.90719 ft	726.27784 ft	0 psf	575.1492 psf	209.33719 psf	0 psf	0 psf	CCR
Column 10	112.73391 ft	725.73065 ft	0 psf	617.61926 psf	224.79503 psf	0 psf	0 psf	CCR
Column 11	113.56063 ft	725.18346 ft	0 psf	660.08931 psf	240.25286 psf	0 psf	0 psf	CCR

Column 12	114.41638 ft	724.61704 ft	0 psf	695.21258 psf	253.03669 psf	0 psf	0 psf	CCR
Column 13	115.30117 ft	724.03141 ft	0 psf	722.98907 psf	263.1465 psf	0 psf	0 psf	CCR
Column 14	116.18596 ft	723.44579 ft	0 psf	750.76555 psf	273.25631 psf	0 psf	0 psf	CCR
Column 15	117.07075 ft	722.86016 ft	0 psf	778.54204 psf	283.36613 psf	0 psf	0 psf	CCR
Column 16	117.95554 ft	722.27453 ft	0 psf	806.31852 psf	293.47594 psf	0 psf	0 psf	CCR
Column 17	118.84033 ft	721.68890 ft	0 psf	834.09501 psf	303.58576 psf	0 psf	0 psf	CCR
Column 18	119.72512 ft	721.10327 ft	0 psf	861.8715 psf	313.69557 psf	0 psf	0 psf	CCR
Column 19	120.60991 ft	720.51764 ft	0 psf	889.64798 psf	323.80539 psf	0 psf	0 psf	CCR
Column 20	121.49470 ft	719.93201 ft	0 psf	917.42447 psf	333.9152 psf	0 psf	0 psf	CCR
Column 21	122.37949 ft	719.34638 ft	0 psf	945.20096 psf	344.02501 psf	0 psf	0 psf	CCR
Column 22	123.26428 ft	718.76075 ft	0 psf	972.97744 psf	354.13483 psf	0 psf	0 psf	CCR
Column 23	124.14906 ft	718.17512 ft	0 psf	1,000.7539 psf	364.24464 psf	0 psf	0 psf	CCR
Column 24	125.03385 ft	717.58949 ft	0 psf	1,028.5304 psf	374.35446 psf	0 psf	0 psf	CCR
Column 25	125.91864 ft	717.00387 ft	0 psf	1,056.3069 psf	384.46427 psf	0 psf	0 psf	CCR
Column 26	126.80343 ft	716.41824 ft	0 psf	1,084.0834 psf	394.57409 psf	0 psf	0 psf	CCR
Column 27	127.68822 ft	715.83261 ft	0 psf	1,111.8599 psf	404.6839 psf	0 psf	0 psf	CCR
Column 28	128.57301 ft	715.24698 ft	0 psf	1,139.6364 psf	414.79371 psf	0 psf	0 psf	CCR
Column 29	129.45780 ft	714.66135 ft	0 psf	1,167.4128 psf	424.90353 psf	0 psf	0 psf	CCR
Column 30	130.34259 ft	714.07572 ft	0 psf	1,195.1893 psf	435.01334 psf	0 psf	0 psf	CCR
Column 31	131.22738 ft	713.49009 ft	0 psf	1,222.9658 psf	445.12316 psf	0 psf	0 psf	CCR
Column 32	132.11217 ft	712.90446 ft	0 psf	1,250.7423 psf	455.23297 psf	0 psf	0 psf	CCR
Column 33	132.99696 ft	712.31883 ft	0 psf	1,278.5188 psf	465.34279 psf	0 psf	0 psf	CCR
Column 34	133.88174 ft	711.73320 ft	0 psf	1,306.2953 psf	475.4526 psf	0 psf	0 psf	CCR
Column 35	134.76653 ft	711.14757 ft	0 psf	1,334.0718 psf	485.56241 psf	0 psf	0 psf	CCR
Column 36	135.65132 ft	710.56194 ft	0 psf	1,361.8483 psf	495.67223 psf	0 psf	0 psf	CCR
Column 37	136.53611 ft	709.97632 ft	0 psf	1,389.6247 psf	505.78204 psf	0 psf	0 psf	CCR

Column 38	137.42090 ft	709.39069 ft	0 psf	1,417.4012 psf	515.89186 psf	0 psf	0 psf	CCR
Column 39	138.30569 ft	708.80506 ft	0 psf	1,445.1777 psf	526.00167 psf	0 psf	0 psf	CCR
Column 40	139.19048 ft	708.21943 ft	0 psf	1,472.9542 psf	536.11149 psf	0 psf	0 psf	CCR
Column 41	140.07527 ft	707.63380 ft	0 psf	1,500.7307 psf	546.2213 psf	0 psf	0 psf	CCR
Column 42	140.96006 ft	707.04817 ft	0 psf	1,528.5072 psf	556.33111 psf	0 psf	0 psf	CCR
Column 43	141.84485 ft	706.46254 ft	0 psf	1,556.2837 psf	566.44093 psf	0 psf	0 psf	CCR
Column 44	142.72964 ft	705.87691 ft	0 psf	1,584.0601 psf	576.55074 psf	0 psf	0 psf	CCR
Column 45	143.61442 ft	705.29128 ft	0 psf	1,611.8366 psf	586.66056 psf	0 psf	0 psf	CCR
Column 46	144.49921 ft	704.70565 ft	0 psf	1,639.6131 psf	596.77037 psf	0 psf	0 psf	CCR
Column 47	145.38400 ft	704.12002 ft	0 psf	1,667.3896 psf	606.88019 psf	0 psf	0 psf	CCR
Column 48	146.26879 ft	703.53440 ft	0 psf	1,695.1661 psf	616.99 psf	0 psf	0 psf	CCR
Column 49	147.15358 ft	702.94877 ft	0 psf	1,722.9426 psf	627.09981 psf	0 psf	0 psf	CCR
Column 50	148.03837 ft	702.36314 ft	0 psf	1,750.7191 psf	637.20963 psf	0 psf	0 psf	CCR
Column 51	148.92316 ft	701.77751 ft	0 psf	1,778.4956 psf	647.31944 psf	0 psf	0 psf	CCR
Column 52	149.80795 ft	701.19188 ft	0 psf	1,806.272 psf	657.42926 psf	0 psf	0 psf	CCR
Column 53	150.69274 ft	700.60625 ft	0 psf	1,834.0485 psf	667.53907 psf	0 psf	0 psf	CCR
Column 54	151.57753 ft	700.02062 ft	0 psf	1,861.825 psf	677.64889 psf	0 psf	0 psf	CCR
Column 55	152.46232 ft	699.43499 ft	0 psf	1,889.6015 psf	687.7587 psf	0 psf	0 psf	CCR
Column 56	153.34710 ft	698.84936 ft	0 psf	1,917.378 psf	697.86851 psf	0 psf	0 psf	CCR
Column 57	154.23189 ft	698.26373 ft	0 psf	1,945.1545 psf	707.97833 psf	0 psf	0 psf	CCR
Column 58	155.11668 ft	697.67810 ft	0 psf	1,972.931 psf	718.08814 psf	0 psf	0 psf	CCR
Column 59	156.00147 ft	697.09247 ft	0 psf	2,000.7074 psf	728.19796 psf	0 psf	0 psf	CCR
Column 60	156.88626 ft	696.50685 ft	0 psf	2,028.4839 psf	738.30777 psf	0 psf	0 psf	CCR
Column 61	157.77105 ft	695.92122 ft	0 psf	2,056.2604 psf	748.41759 psf	0 psf	0 psf	CCR
Column 62	158.65584 ft	695.33559 ft	0 psf	2,084.0369 psf	758.5274 psf	0 psf	0 psf	CCR
Column 63	159.54063 ft	694.74996 ft	0 psf	2,111.8134 psf	768.63722 psf	0 psf	0 psf	CCR

Column 64	160.42542 ft	694.16433 ft	0 psf	2,139.5899 psf	778.74703 psf	0 psf	0 psf	CCR
Column 65	161.31021 ft	693.57870 ft	0 psf	2,167.3664 psf	788.85684 psf	0 psf	0 psf	CCR
Column 66	162.19500 ft	692.99307 ft	0 psf	2,195.1429 psf	798.96666 psf	0 psf	0 psf	CCR
Column 67	163.07978 ft	692.40744 ft	0 psf	2,222.9193 psf	809.07647 psf	0 psf	0 psf	CCR
Column 68	163.96457 ft	691.82181 ft	0 psf	2,250.6958 psf	819.18629 psf	0 psf	0 psf	CCR
Column 69	164.84936 ft	691.23618 ft	0 psf	2,278.4723 psf	829.2961 psf	0 psf	0 psf	CCR
Column 70	165.73415 ft	690.65055 ft	0 psf	2,306.2488 psf	839.40592 psf	0 psf	0 psf	CCR
Column 71	166.61894 ft	690.06493 ft	0 psf	2,334.0253 psf	849.51573 psf	0 psf	0 psf	CCR
Column 72	167.50373 ft	689.47930 ft	0 psf	2,361.8018 psf	859.62554 psf	0 psf	0 psf	CCR
Column 73	168.38852 ft	688.89367 ft	0 psf	2,389.5783 psf	869.73536 psf	0 psf	0 psf	CCR
Column 74	169.27331 ft	688.30804 ft	0 psf	2,417.3547 psf	879.84517 psf	0 psf	0 psf	CCR
Column 75	170.15810 ft	687.72241 ft	0 psf	2,445.1312 psf	889.95499 psf	0 psf	0 psf	CCR
Column 76	171.04289 ft	687.13678 ft	0 psf	2,472.9077 psf	900.0648 psf	0 psf	0 psf	CCR
Column 77	171.92768 ft	686.55115 ft	0 psf	2,500.6842 psf	910.17462 psf	0 psf	0 psf	CCR
Column 78	172.81247 ft	685.96552 ft	0 psf	2,528.4607 psf	920.28443 psf	0 psf	0 psf	CCR
Column 79	173.69725 ft	685.37989 ft	0 psf	2,556.2372 psf	930.39424 psf	0 psf	0 psf	CCR
Column 80	174.58204 ft	684.79426 ft	0 psf	2,584.0137 psf	940.50406 psf	0 psf	0 psf	CCR
Column 81	175.46683 ft	684.20863 ft	0 psf	2,611.7902 psf	950.61387 psf	0 psf	0 psf	CCR
Column 82	176.56156 ft	683.48405 ft	0 psf	2,491.5859 psf	1,438.5178 psf	0 psf	0 psf	Drainage Layer
Column 83	177.66528 ft	683.04906 ft	0 psf	3,021.1325 psf	1,069.8391 psf	0 psf	0 psf	Geosynthetics
Column 84	178.55500 ft	683.05125 ft	0 psf	3,012.1537 psf	1,066.6596 psf	0 psf	0 psf	Geosynthetics
Column 85	179.43167 ft	683.06208 ft	0 psf	2,991.944 psf	1,059.5029 psf	0 psf	0 psf	Geosynthetics
Column 86	180.30833 ft	683.07292 ft	0 psf	2,971.7342 psf	1,052.3463 psf	0 psf	0 psf	Geosynthetics
Column 87	181.18500 ft	683.08375 ft	0 psf	2,951.5245 psf	1,045.1896 psf	0 psf	0 psf	Geosynthetics
Column 88	182.06167 ft	683.09458 ft	0 psf	2,931.3148 psf	1,038.033 psf	0 psf	0 psf	Geosynthetics
Column 89	182.95500 ft	683.24784 ft	0 psf	3,080.818 psf	1,090.9749 psf	0 psf	0 psf	Geosynthetics

Column 90	183.86500 ft	683.54352 ft	0 psf	3,033.0563 psf	1,074.0616 psf	0 psf	0 psf	Geosynthetics
Column 91	184.77500 ft	683.83919 ft	0 psf	2,985.2945 psf	1,057.1482 psf	0 psf	0 psf	Geosynthetics
Column 92	185.68500 ft	684.13487 ft	0 psf	2,937.5328 psf	1,040.2349 psf	0 psf	0 psf	Geosynthetics
Column 93	186.59500 ft	684.43055 ft	0 psf	2,889.771 psf	1,023.3216 psf	0 psf	0 psf	Geosynthetics
Column 94	187.50500 ft	684.72622 ft	0 psf	2,842.0092 psf	1,006.4083 psf	0 psf	0 psf	Geosynthetics
Column 95	188.41500 ft	685.02190 ft	0 psf	2,794.2475 psf	989.49493 psf	0 psf	0 psf	Geosynthetics
Column 96	189.32500 ft	685.31758 ft	0 psf	2,746.4857 psf	972.58161 psf	0 psf	0 psf	Geosynthetics
Column 97	190.23500 ft	685.61325 ft	0 psf	2,698.724 psf	955.66828 psf	0 psf	0 psf	Geosynthetics
Column 98	191.14500 ft	685.90893 ft	0 psf	2,650.9622 psf	938.75496 psf	0 psf	0 psf	Geosynthetics
Column 99	191.66873 ft	686.07910 ft	0 psf	2,624.1061 psf	929.24469 psf	0 psf	0 psf	Geosynthetics
Column 100	192.21440 ft	686.25640 ft	0 psf	2,702.62 psf	1,560.3584 psf	0 psf	0 psf	Drainage Layer
Column 101	193.16829 ft	686.56634 ft	0 psf	2,640.5546 psf	1,524.5249 psf	0 psf	0 psf	Drainage Layer
Column 102	194.12217 ft	686.87627 ft	0 psf	2,578.4892 psf	1,488.6914 psf	0 psf	0 psf	Drainage Layer
Column 103	195.07061 ft	687.18444 ft	0 psf	2,422.1644 psf	881.59576 psf	0 psf	0 psf	CCR
Column 104	196.01359 ft	687.49083 ft	0 psf	2,372.4057 psf	863.48505 psf	0 psf	0 psf	CCR
Column 105	196.95657 ft	687.79723 ft	0 psf	2,322.6469 psf	845.37434 psf	0 psf	0 psf	CCR
Column 106	197.89956 ft	688.10362 ft	0 psf	2,272.8881 psf	827.26362 psf	0 psf	0 psf	CCR
Column 107	198.84254 ft	688.41001 ft	0 psf	2,223.1294 psf	809.15291 psf	0 psf	0 psf	CCR
Column 108	199.78552 ft	688.71641 ft	0 psf	2,173.3706 psf	791.0422 psf	0 psf	0 psf	CCR
Column 109	200.72851 ft	689.02280 ft	0 psf	2,123.6118 psf	772.93149 psf	0 psf	0 psf	CCR
Column 110	201.61667 ft	689.31138 ft	0 psf	2,076.746 psf	755.87373 psf	0 psf	0 psf	CCR
Column 111	202.45000 ft	689.58215 ft	0 psf	2,032.7732 psf	739.86894 psf	0 psf	0 psf	CCR
Column 112	203.28333 ft	689.85291 ft	0 psf	1,988.8004 psf	723.86414 psf	0 psf	0 psf	CCR
Column 113	204.13696 ft	690.13027 ft	0 psf	1,943.7569 psf	707.46966 psf	0 psf	0 psf	CCR
Column 114	205.01087 ft	690.41422 ft	0 psf	1,897.6428 psf	690.6855 psf	0 psf	0 psf	CCR
Column 115	205.88478 ft	690.69818 ft	0 psf	1,851.5287 psf	673.90134 psf	0 psf	0 psf	CCR

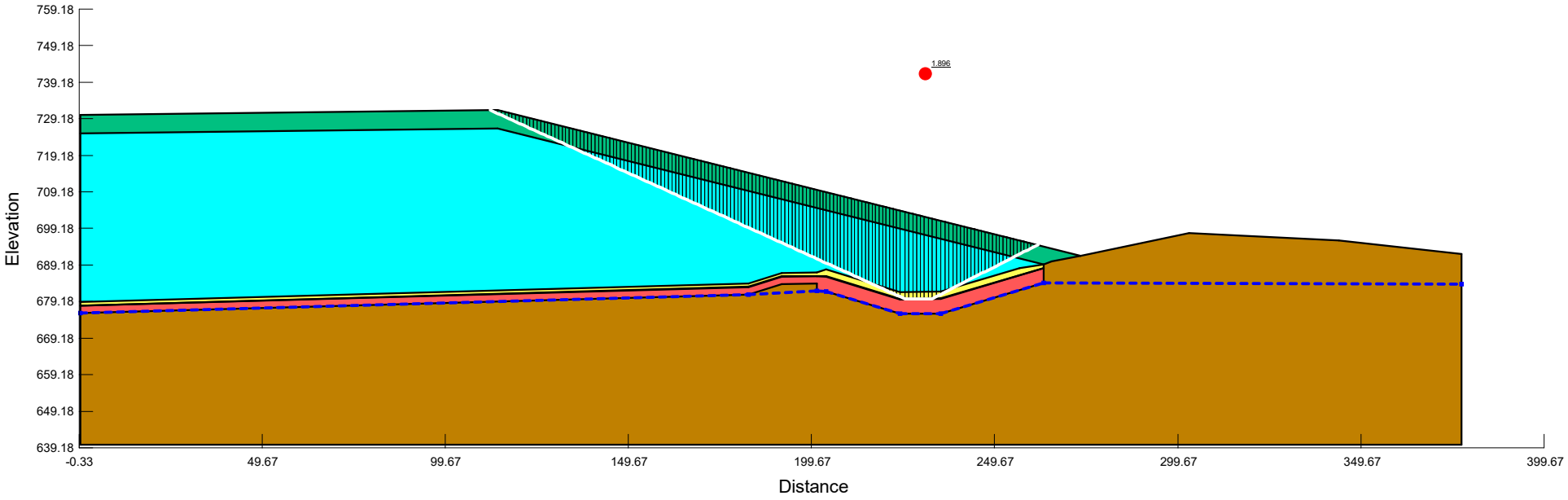
Column 116	206.75870 ft	690.98213 ft	0 psf	1,805.4146 psf	657.11718 psf	0 psf	0 psf	CCR
Column 117	207.63261 ft	691.26608 ft	0 psf	1,759.3005 psf	640.33302 psf	0 psf	0 psf	CCR
Column 118	208.50652 ft	691.55003 ft	0 psf	1,713.1864 psf	623.54886 psf	0 psf	0 psf	CCR
Column 119	209.38043 ft	691.83398 ft	0 psf	1,667.0723 psf	606.7647 psf	0 psf	0 psf	CCR
Column 120	210.25435 ft	692.11793 ft	0 psf	1,620.9582 psf	589.98054 psf	0 psf	0 psf	CCR
Column 121	211.12826 ft	692.40189 ft	0 psf	1,574.8441 psf	573.19638 psf	0 psf	0 psf	CCR
Column 122	212.00217 ft	692.68584 ft	0 psf	1,528.73 psf	556.41222 psf	0 psf	0 psf	CCR
Column 123	212.87609 ft	692.96979 ft	0 psf	1,482.6159 psf	539.62806 psf	0 psf	0 psf	CCR
Column 124	213.75000 ft	693.25374 ft	0 psf	1,436.5018 psf	522.8439 psf	0 psf	0 psf	CCR
Column 125	214.62391 ft	693.53769 ft	0 psf	1,390.3877 psf	506.05973 psf	0 psf	0 psf	CCR
Column 126	215.49783 ft	693.82164 ft	0 psf	1,344.2736 psf	489.27557 psf	0 psf	0 psf	CCR
Column 127	216.37174 ft	694.10560 ft	0 psf	1,298.1595 psf	472.49141 psf	0 psf	0 psf	CCR
Column 128	217.24565 ft	694.38955 ft	0 psf	1,252.0454 psf	455.70725 psf	0 psf	0 psf	CCR
Column 129	218.11957 ft	694.67350 ft	0 psf	1,205.9313 psf	438.92309 psf	0 psf	0 psf	CCR
Column 130	218.99348 ft	694.95745 ft	0 psf	1,159.8172 psf	422.13893 psf	0 psf	0 psf	CCR
Column 131	219.86739 ft	695.24140 ft	0 psf	1,113.7031 psf	405.35477 psf	0 psf	0 psf	CCR
Column 132	220.74130 ft	695.52535 ft	0 psf	1,067.589 psf	388.57061 psf	0 psf	0 psf	CCR
Column 133	221.61522 ft	695.80930 ft	0 psf	1,021.4749 psf	371.78645 psf	0 psf	0 psf	CCR
Column 134	222.48913 ft	696.09326 ft	0 psf	975.36077 psf	355.00229 psf	0 psf	0 psf	CCR
Column 135	223.36304 ft	696.37721 ft	0 psf	929.24667 psf	338.21813 psf	0 psf	0 psf	CCR
Column 136	224.25325 ft	696.66645 ft	0 psf	882.27287 psf	321.12106 psf	0 psf	0 psf	CCR
Column 137	225.15975 ft	696.96099 ft	0 psf	834.43938 psf	303.7111 psf	0 psf	0 psf	CCR
Column 138	226.06624 ft	697.25553 ft	0 psf	786.60589 psf	286.30113 psf	0 psf	0 psf	CCR
Column 139	226.97274 ft	697.55007 ft	0 psf	738.7724 psf	268.89116 psf	0 psf	0 psf	CCR
Column 140	227.87924 ft	697.84461 ft	0 psf	690.93891 psf	251.4812 psf	0 psf	0 psf	CCR
Column 141	228.80159 ft	698.14430 ft	0 psf	651.22169 psf	346.26071 psf	0 psf	0 psf	Final Cover

Column 142	229.73981 ft	698.44915 ft	0 psf	576.96256 psf	306.77643 psf	0 psf	0 psf	Final Cover
Column 143	230.67803 ft	698.75399 ft	0 psf	502.70343 psf	267.29215 psf	0 psf	0 psf	Final Cover
Column 144	231.61624 ft	699.05883 ft	0 psf	428.44429 psf	227.80787 psf	0 psf	0 psf	Final Cover
Column 145	232.55446 ft	699.36368 ft	0 psf	354.18516 psf	188.32359 psf	0 psf	0 psf	Final Cover
Column 146	233.49268 ft	699.66852 ft	0 psf	279.92603 psf	148.83931 psf	0 psf	0 psf	Final Cover
Column 147	234.43089 ft	699.97337 ft	0 psf	205.6669 psf	109.35503 psf	0 psf	0 psf	Final Cover
Column 148	235.43234 ft	700.29876 ft	0 psf	126.403 psf	67.209668 psf	0 psf	0 psf	Final Cover
Column 149	236.49702 ft	700.64470 ft	0 psf	42.134333 psf	22.403223 psf	0 psf	0 psf	Final Cover

I-43 Plan of Operation Modification - Final Grade Stability Analysis
Block Failure-Contact Water Swale
Analysis Type: Janbu
Last Solved Date: 03/27/2024, 04:18:15 PM

Factor of Safety: 1.896

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezometric Surface
	CCR	86	0	20	
	Clay Liner	130	0	28	
	Drainage Layer	115	0	30	
	Final Cover	125	0	28	
	Geosynthetics	58	0	19.5	
	Subbase	135	0	28	1



Block Failure-Contact Water Swale

File Information

File Version: 11.05
Title: I-43 Plan of Operation Modification - Final Grade Stability Analysis
Created By: Villanueva, Niko
Last Edited By: Villanueva, Niko
Revision Number: 52
Date: 03/27/2024
Time: 04:16:14 PM
Tool Version: 23.1.1.829
File Name: I-43 Proposed Final Grades_Section A_240327.gsz
Directory: I:\25222259.00\Data and Calculations\Geotechnical\Slope Stability\SlopeW Analysis\
Last Solved Date: 03/27/2024
Last Solved Time: 04:18:15 PM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Block Failure-Contact Water Swale

Kind: SLOPE/W
Analysis Type: Janbu
Settings
- PWP Conditions from: Piezometric Surfaces
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No
- Unit Weight of Water: 62.430189 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 10
- Restrict Block Crossing: No
- Optimize Critical Slip Surface Location: No
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Convergence
- Geometry Settings
  - Minimum Slip Surface Depth: 0.1 ft
  - Minimum Slip Surface Volume: 35.314667 ft³
  - Number of Columns: 150
- Factor of Safety Convergence Settings
  - Maximum Number of Iterations: 100
  - Tolerable difference in F of S: 0.001

Under-Relaxation Criteria
Initial Rate: 1
Minimum Rate: 0.1
Rate Reduction Factor: 0.65
Reduction Frequency (iterations): 50

Materials

CCR

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 86 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 20 °
Phi-B: 0 °

Clay Liner

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 130 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °

Drainage Layer

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 115 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Geosynthetics

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 58 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 19.5 °
Phi-B: 0 °

Subbase

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 135 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Surface: 1

Final Cover

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 125 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °

Slip Surface Limits

Left Coordinate: (0, 730.2) ft
Right Coordinate: (377.2, 692.2) ft

Slip Surface Block

Left Grid
- Upper Left: (223.8, 679.9) ft
- Lower Left: (223.8, 679.8) ft
- Lower Right: (225.2, 679.81) ft
- X Increments: 10
- Y Increments: 4
- Starting Angle: 115 °
- Ending Angle: 160 °
- Angle Increments: 10

Right Grid
- Upper Left: (232.55, 679.97) ft
- Lower Left: (232.55, 679.88) ft
- Lower Right: (234.9, 679.9) ft
- X Increments: 10
- Y Increments: 4
- Angle Increments: 10

Piezometric Surfaces

Piezometric Surface 1

Coordinates

	X	Y
Coordinate 1	0 ft	676 ft
Coordinate 2	182.5 ft	681.1 ft
Coordinate 3	201.2 ft	682.1 ft
Coordinate 4	203.7 ft	682 ft
Coordinate 5	223.8 ft	675.8 ft
Coordinate 6	234.9 ft	675.9 ft
Coordinate 7	263 ft	684.3 ft
Coordinate 8	377.2 ft	684 ft

Geometry

Name: 2D Geometry

Settings

View: 2D
Element Thickness: 1 ft

Points

	X	Y
Point 1	0 ft	640 ft

Point 2	377.2 ft	640 ft
Point 3	377.2 ft	692.2 ft
Point 4	343.6 ft	695.9 ft
Point 5	302.7 ft	697.9 ft
Point 6	265.2 ft	690.1 ft
Point 7	263.1 ft	689.3 ft
Point 8	263.1 ft	688.4 ft
Point 9	263.1 ft	688.3 ft
Point 10	263.1 ft	684.3 ft
Point 11	234.9 ft	675.9 ft
Point 12	223.8 ft	675.8 ft
Point 13	203.7 ft	682 ft
Point 14	201.2 ft	682.1 ft
Point 15	201.2 ft	684.1 ft
Point 16	191.6 ft	684 ft
Point 17	182.5 ft	681.1 ft
Point 18	0 ft	676 ft
Point 19	0 ft	678 ft
Point 20	182.5 ft	683.1 ft
Point 21	191.6 ft	686 ft
Point 22	201.2 ft	686.1 ft
Point 23	203.7 ft	686 ft
Point 24	223.8 ft	679.8 ft
Point 25	234.9 ft	679.9 ft
Point 26	0 ft	678.1 ft
Point 27	182.5 ft	683.2 ft
Point 28	191.6 ft	686.1 ft
Point 29	201.2 ft	686.2 ft
Point 30	203.7 ft	686.1 ft
Point 31	223.8 ft	679.9 ft
Point 32	234.9 ft	680 ft
Point 33	0 ft	679 ft
Point 34	182.5 ft	684.1 ft
Point 35	191.6 ft	687 ft
Point 36	201.2 ft	687.1 ft
Point 37	203.7 ft	688 ft
Point 38	0 ft	725.2 ft
Point 39	113.97399 ft	726.5815 ft
Point 40	256.51003 ft	688.33703 ft
Point 41	234.9 ft	681.9 ft
Point 42	223.8 ft	681.8 ft
Point 43	0 ft	730.2 ft
Point 44	113.97399 ft	731.5815 ft
Point 45	273.22402 ft	691.769 ft

Regions

	Material	Points	Area
Region 1	Subbase	1,2,3,4,5,45,6,7,8,9,10,11,12,13,14,15,16,17,18	16,534 ft²
Region 2	Clay Liner	18,19,20,21,22,23,24,25,9,10,11,12,13,14,15,16,17	650 ft²

Region 3	Geosynthetics	19,26,27,28,29,30,31,32,8,9,25,24,23,22,21,20	26.31 ft²
Region 4	Drainage Layer	26,33,34,35,36,37,30,29,28,27	184.58 ft²
Region 5	CCR	33,38,39,7,40,41,42,37,36,35,34	8,689.4 ft²
Region 6	Final Cover	38,39,7,6,45,44,43	1,339.4 ft²
Region 7	Drainage Layer	37,42,41,40,7,8,32,31,30	109.57 ft²

Slip Results

Slip Surfaces Analysed: 278762 of 366025 converged

Current Slip Surface

Slip Surface: 365,306
Factor of Safety: 1.896
Volume: 1,869.0061 ft³
Weight: 188,114.67 lbf
Resisting Moment: 3,457,558.8 lbf·ft
Activating Moment: 1,372,842.6 lbf·ft
Resisting Force: 73,805.371 lbf
Activating Force: 38,935.764 lbf
Slip Rank: 1 of 366,025 slip surfaces
Exit: (261.47267, 694.70684) ft
Entry: (111.87312, 731.55603) ft
Radius: 69.361184 ft
Center: (193.48039, 740.76833) ft

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Column 1	112.39834 ft	731.31668 ft	0 psf	27.23483 psf	14.481016 psf	0 psf	0 psf	Final Cover
Column 2	113.44877 ft	730.83797 ft	0 psf	81.704491 psf	43.443048 psf	0 psf	0 psf	Final Cover
Column 3	114.46215 ft	730.37614 ft	0 psf	120.07035 psf	63.842537 psf	0 psf	0 psf	Final Cover
Column 4	115.43848 ft	729.93121 ft	0 psf	142.3324 psf	75.67948 psf	0 psf	0 psf	Final Cover
Column 5	116.41480 ft	729.48627 ft	0 psf	164.59445 psf	87.516424 psf	0 psf	0 psf	Final Cover
Column 6	117.39113 ft	729.04133 ft	0 psf	186.85651 psf	99.353368 psf	0 psf	0 psf	Final Cover
Column 7	118.36745 ft	728.59640 ft	0 psf	209.11856 psf	111.19031 psf	0 psf	0 psf	Final Cover
Column 8	119.34378 ft	728.15146 ft	0 psf	231.38062 psf	123.02726 psf	0 psf	0 psf	Final Cover
Column 9	120.32010 ft	727.70652 ft	0 psf	253.64267 psf	134.8642 psf	0 psf	0 psf	Final Cover
Column 10	121.29643 ft	727.26159 ft	0 psf	275.90472 psf	146.70114 psf	0 psf	0 psf	Final Cover
Column 11	122.27275 ft	726.81665 ft	0 psf	298.16678 psf	158.53809 psf	0 psf	0 psf	Final Cover

Column 12	123.24908 ft	726.37171 ft	0 psf	320.42883 psf	170.37503 psf	0 psf	0 psf	Final Cover
Column 13	124.22540 ft	725.92678 ft	0 psf	342.69088 psf	182.21197 psf	0 psf	0 psf	Final Cover
Column 14	125.20172 ft	725.48184 ft	0 psf	364.95294 psf	194.04892 psf	0 psf	0 psf	Final Cover
Column 15	126.17805 ft	725.03690 ft	0 psf	387.21499 psf	205.88586 psf	0 psf	0 psf	Final Cover
Column 16	127.15437 ft	724.59197 ft	0 psf	409.47704 psf	217.72281 psf	0 psf	0 psf	Final Cover
Column 17	128.13070 ft	724.14703 ft	0 psf	431.7391 psf	229.55975 psf	0 psf	0 psf	Final Cover
Column 18	129.10702 ft	723.70209 ft	0 psf	454.00115 psf	241.39669 psf	0 psf	0 psf	Final Cover
Column 19	130.08335 ft	723.25716 ft	0 psf	476.2632 psf	253.23364 psf	0 psf	0 psf	Final Cover
Column 20	131.05967 ft	722.81222 ft	0 psf	498.52526 psf	265.07058 psf	0 psf	0 psf	Final Cover
Column 21	132.03600 ft	722.36728 ft	0 psf	520.78731 psf	276.90752 psf	0 psf	0 psf	Final Cover
Column 22	133.01232 ft	721.92234 ft	0 psf	543.04936 psf	288.74447 psf	0 psf	0 psf	Final Cover
Column 23	134.00048 ft	721.47202 ft	0 psf	582.85938 psf	212.14346 psf	0 psf	0 psf	CCR
Column 24	135.00047 ft	721.01629 ft	0 psf	599.12849 psf	218.06494 psf	0 psf	0 psf	CCR
Column 25	136.00046 ft	720.56057 ft	0 psf	615.3976 psf	223.98641 psf	0 psf	0 psf	CCR
Column 26	137.00045 ft	720.10485 ft	0 psf	631.66672 psf	229.90788 psf	0 psf	0 psf	CCR
Column 27	138.00044 ft	719.64913 ft	0 psf	647.93583 psf	235.82936 psf	0 psf	0 psf	CCR
Column 28	139.00043 ft	719.19341 ft	0 psf	664.20494 psf	241.75083 psf	0 psf	0 psf	CCR
Column 29	140.00042 ft	718.73769 ft	0 psf	680.47406 psf	247.6723 psf	0 psf	0 psf	CCR
Column 30	141.00041 ft	718.28196 ft	0 psf	696.74317 psf	253.59377 psf	0 psf	0 psf	CCR
Column 31	142.00040 ft	717.82624 ft	0 psf	713.01228 psf	259.51525 psf	0 psf	0 psf	CCR
Column 32	143.00039 ft	717.37052 ft	0 psf	729.2814 psf	265.43672 psf	0 psf	0 psf	CCR
Column 33	144.00038 ft	716.91480 ft	0 psf	745.55051 psf	271.35819 psf	0 psf	0 psf	CCR
Column 34	145.00037 ft	716.45908 ft	0 psf	761.81962 psf	277.27967 psf	0 psf	0 psf	CCR
Column 35	146.00036 ft	716.00335 ft	0 psf	778.08874 psf	283.20114 psf	0 psf	0 psf	CCR
Column 36	147.00035 ft	715.54763 ft	0 psf	794.35785 psf	289.12261 psf	0 psf	0 psf	CCR
Column 37	148.00034 ft	715.09191 ft	0 psf	810.62696 psf	295.04409 psf	0 psf	0 psf	CCR

Column 38	149.00033 ft	714.63619 ft	0 psf	826.89608 psf	300.96556 psf	0 psf	0 psf	CCR
Column 39	150.00032 ft	714.18047 ft	0 psf	843.16519 psf	306.88703 psf	0 psf	0 psf	CCR
Column 40	151.00031 ft	713.72475 ft	0 psf	859.4343 psf	312.8085 psf	0 psf	0 psf	CCR
Column 41	152.00030 ft	713.26902 ft	0 psf	875.70342 psf	318.72998 psf	0 psf	0 psf	CCR
Column 42	153.00029 ft	712.81330 ft	0 psf	891.97253 psf	324.65145 psf	0 psf	0 psf	CCR
Column 43	154.00028 ft	712.35758 ft	0 psf	908.24164 psf	330.57292 psf	0 psf	0 psf	CCR
Column 44	155.00027 ft	711.90186 ft	0 psf	924.51076 psf	336.4944 psf	0 psf	0 psf	CCR
Column 45	156.00026 ft	711.44614 ft	0 psf	940.77987 psf	342.41587 psf	0 psf	0 psf	CCR
Column 46	157.00025 ft	710.99042 ft	0 psf	957.04898 psf	348.33734 psf	0 psf	0 psf	CCR
Column 47	158.00024 ft	710.53469 ft	0 psf	973.3181 psf	354.25882 psf	0 psf	0 psf	CCR
Column 48	159.00023 ft	710.07897 ft	0 psf	989.58721 psf	360.18029 psf	0 psf	0 psf	CCR
Column 49	160.00022 ft	709.62325 ft	0 psf	1,005.8563 psf	366.10176 psf	0 psf	0 psf	CCR
Column 50	161.00021 ft	709.16753 ft	0 psf	1,022.1254 psf	372.02323 psf	0 psf	0 psf	CCR
Column 51	162.00020 ft	708.71181 ft	0 psf	1,038.3945 psf	377.94471 psf	0 psf	0 psf	CCR
Column 52	163.00019 ft	708.25609 ft	0 psf	1,054.6637 psf	383.86618 psf	0 psf	0 psf	CCR
Column 53	164.00018 ft	707.80036 ft	0 psf	1,070.9328 psf	389.78765 psf	0 psf	0 psf	CCR
Column 54	165.00017 ft	707.34464 ft	0 psf	1,087.2019 psf	395.70913 psf	0 psf	0 psf	CCR
Column 55	166.00016 ft	706.88892 ft	0 psf	1,103.471 psf	401.6306 psf	0 psf	0 psf	CCR
Column 56	167.00015 ft	706.43320 ft	0 psf	1,119.7401 psf	407.55207 psf	0 psf	0 psf	CCR
Column 57	168.00014 ft	705.97748 ft	0 psf	1,136.0092 psf	413.47355 psf	0 psf	0 psf	CCR
Column 58	169.00013 ft	705.52175 ft	0 psf	1,152.2783 psf	419.39502 psf	0 psf	0 psf	CCR
Column 59	170.00012 ft	705.06603 ft	0 psf	1,168.5475 psf	425.31649 psf	0 psf	0 psf	CCR
Column 60	171.00011 ft	704.61031 ft	0 psf	1,184.8166 psf	431.23796 psf	0 psf	0 psf	CCR
Column 61	172.00010 ft	704.15459 ft	0 psf	1,201.0857 psf	437.15944 psf	0 psf	0 psf	CCR
Column 62	173.00009 ft	703.69887 ft	0 psf	1,217.3548 psf	443.08091 psf	0 psf	0 psf	CCR
Column 63	174.00008 ft	703.24315 ft	0 psf	1,233.6239 psf	449.00238 psf	0 psf	0 psf	CCR

Column 64	175.00007 ft	702.78742 ft	0 psf	1,249.893 psf	454.92386 psf	0 psf	0 psf	CCR
Column 65	176.00006 ft	702.33170 ft	0 psf	1,266.1621 psf	460.84533 psf	0 psf	0 psf	CCR
Column 66	177.00005 ft	701.87598 ft	0 psf	1,282.4312 psf	466.7668 psf	0 psf	0 psf	CCR
Column 67	178.00004 ft	701.42026 ft	0 psf	1,298.7004 psf	472.68828 psf	0 psf	0 psf	CCR
Column 68	179.00003 ft	700.96454 ft	0 psf	1,314.9695 psf	478.60975 psf	0 psf	0 psf	CCR
Column 69	180.00002 ft	700.50882 ft	0 psf	1,331.2386 psf	484.53122 psf	0 psf	0 psf	CCR
Column 70	181.00001 ft	700.05309 ft	0 psf	1,347.5077 psf	490.45269 psf	0 psf	0 psf	CCR
Column 71	182.00000 ft	699.59737 ft	0 psf	1,363.7768 psf	496.37417 psf	0 psf	0 psf	CCR
Column 72	182.99211 ft	699.14525 ft	0 psf	1,379.9176 psf	502.24892 psf	0 psf	0 psf	CCR
Column 73	183.97632 ft	698.69672 ft	0 psf	1,395.93 psf	508.07695 psf	0 psf	0 psf	CCR
Column 74	184.96053 ft	698.24818 ft	0 psf	1,411.9424 psf	513.90499 psf	0 psf	0 psf	CCR
Column 75	185.94474 ft	697.79965 ft	0 psf	1,427.9547 psf	519.73302 psf	0 psf	0 psf	CCR
Column 76	186.92895 ft	697.35112 ft	0 psf	1,443.9671 psf	525.56106 psf	0 psf	0 psf	CCR
Column 77	187.91316 ft	696.90259 ft	0 psf	1,459.9795 psf	531.38909 psf	0 psf	0 psf	CCR
Column 78	188.89737 ft	696.45406 ft	0 psf	1,475.9919 psf	537.21712 psf	0 psf	0 psf	CCR
Column 79	189.88158 ft	696.00553 ft	0 psf	1,492.0043 psf	543.04516 psf	0 psf	0 psf	CCR
Column 80	190.86579 ft	695.55700 ft	0 psf	1,508.0167 psf	548.87319 psf	0 psf	0 psf	CCR
Column 81	191.85000 ft	695.10847 ft	0 psf	1,524.0291 psf	554.70122 psf	0 psf	0 psf	CCR
Column 82	192.83421 ft	694.65994 ft	0 psf	1,540.0415 psf	560.52926 psf	0 psf	0 psf	CCR
Column 83	193.81842 ft	694.21141 ft	0 psf	1,556.0539 psf	566.35729 psf	0 psf	0 psf	CCR
Column 84	194.80263 ft	693.76288 ft	0 psf	1,572.0663 psf	572.18533 psf	0 psf	0 psf	CCR
Column 85	195.78684 ft	693.31435 ft	0 psf	1,588.0787 psf	578.01336 psf	0 psf	0 psf	CCR
Column 86	196.77105 ft	692.86582 ft	0 psf	1,604.091 psf	583.84139 psf	0 psf	0 psf	CCR
Column 87	197.75526 ft	692.41729 ft	0 psf	1,620.1034 psf	589.66943 psf	0 psf	0 psf	CCR
Column 88	198.73947 ft	691.96876 ft	0 psf	1,636.1158 psf	595.49746 psf	0 psf	0 psf	CCR
Column 89	199.72368 ft	691.52023 ft	0 psf	1,652.1282 psf	601.32549 psf	0 psf	0 psf	CCR

Column 90	200.70789 ft	691.07170 ft	0 psf	1,668.1406 psf	607.15353 psf	0 psf	0 psf	CCR
Column 91	201.61667 ft	690.65754 ft	0 psf	1,682.9257 psf	612.53485 psf	0 psf	0 psf	CCR
Column 92	202.45000 ft	690.27777 ft	0 psf	1,696.4834 psf	617.46946 psf	0 psf	0 psf	CCR
Column 93	203.28333 ft	689.89800 ft	0 psf	1,710.0411 psf	622.40407 psf	0 psf	0 psf	CCR
Column 94	204.18328 ft	689.48787 ft	0 psf	1,724.6825 psf	627.73311 psf	0 psf	0 psf	CCR
Column 95	205.14983 ft	689.04739 ft	0 psf	1,740.4077 psf	633.45659 psf	0 psf	0 psf	CCR
Column 96	206.11638 ft	688.60691 ft	0 psf	1,756.1328 psf	639.18006 psf	0 psf	0 psf	CCR
Column 97	207.08294 ft	688.16642 ft	0 psf	1,771.8579 psf	644.90354 psf	0 psf	0 psf	CCR
Column 98	208.04949 ft	687.72594 ft	0 psf	1,787.583 psf	650.62701 psf	0 psf	0 psf	CCR
Column 99	209.01604 ft	687.28545 ft	0 psf	1,803.3081 psf	656.35049 psf	0 psf	0 psf	CCR
Column 100	209.98260 ft	686.84497 ft	0 psf	1,819.0333 psf	662.07396 psf	0 psf	0 psf	CCR
Column 101	210.94915 ft	686.40449 ft	0 psf	1,834.7584 psf	667.79744 psf	0 psf	0 psf	CCR
Column 102	211.91570 ft	685.96400 ft	0 psf	1,850.4835 psf	673.52091 psf	0 psf	0 psf	CCR
Column 103	212.88225 ft	685.52352 ft	0 psf	1,866.2086 psf	679.24439 psf	0 psf	0 psf	CCR
Column 104	213.84881 ft	685.08304 ft	0 psf	1,881.9337 psf	684.96786 psf	0 psf	0 psf	CCR
Column 105	214.81536 ft	684.64255 ft	0 psf	1,897.6589 psf	690.69134 psf	0 psf	0 psf	CCR
Column 106	215.77094 ft	684.20707 ft	0 psf	1,828.8156 psf	1,055.8672 psf	0 psf	0 psf	Drainage Layer
Column 107	216.71553 ft	683.77660 ft	0 psf	1,847.0339 psf	1,066.3855 psf	0 psf	0 psf	Drainage Layer
Column 108	217.66013 ft	683.34612 ft	0 psf	1,865.2523 psf	1,076.9039 psf	0 psf	0 psf	Drainage Layer
Column 109	218.60472 ft	682.91564 ft	0 psf	1,883.4707 psf	1,087.4223 psf	0 psf	0 psf	Drainage Layer
Column 110	219.54932 ft	682.48516 ft	0 psf	1,901.6891 psf	1,097.9407 psf	0 psf	0 psf	Drainage Layer
Column 111	220.49391 ft	682.05469 ft	0 psf	1,919.9075 psf	1,108.4591 psf	0 psf	0 psf	Drainage Layer
Column 112	221.43851 ft	681.62421 ft	0 psf	1,938.1259 psf	1,118.9775 psf	0 psf	0 psf	Drainage Layer
Column 113	222.38311 ft	681.19373 ft	0 psf	1,956.3443 psf	1,129.4959 psf	0 psf	0 psf	Drainage Layer
Column 114	223.32770 ft	680.76326 ft	0 psf	1,974.5627 psf	1,140.0143 psf	0 psf	0 psf	Drainage Layer
Column 115	224.49719 ft	680.23029 ft	0 psf	2,002.7551 psf	1,156.2912 psf	0 psf	0 psf	Drainage Layer

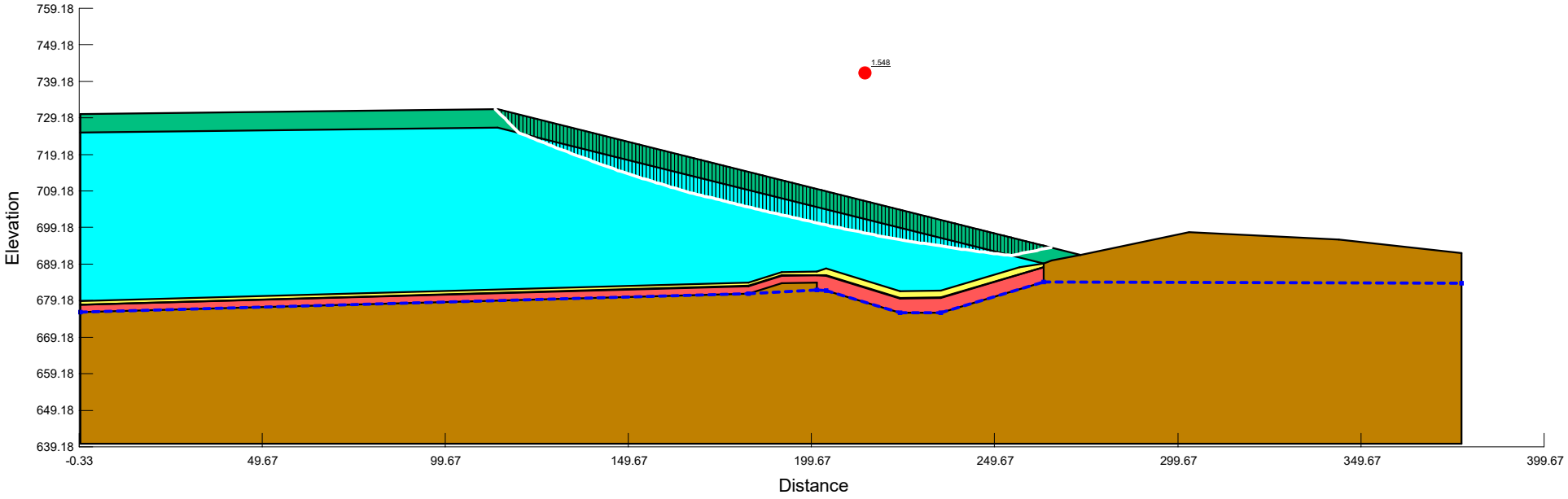
Column 116	225.72219 ft	679.91557 ft	0 psf	2,293.2003 psf	812.06482 psf	0 psf	0 psf	Geosynthetics
Column 117	226.77500 ft	679.92286 ft	0 psf	2,270.8737 psf	804.15857 psf	0 psf	0 psf	Geosynthetics
Column 118	227.82500 ft	679.93143 ft	0 psf	2,247.5011 psf	795.88188 psf	0 psf	0 psf	Geosynthetics
Column 119	228.87500 ft	679.94000 ft	0 psf	2,224.1285 psf	787.6052 psf	0 psf	0 psf	Geosynthetics
Column 120	229.92500 ft	679.94857 ft	0 psf	2,200.7558 psf	779.32851 psf	0 psf	0 psf	Geosynthetics
Column 121	230.97500 ft	679.95714 ft	0 psf	2,177.3832 psf	771.05183 psf	0 psf	0 psf	Geosynthetics
Column 122	232.03382 ft	679.97021 ft	0 psf	2,156.8106 psf	763.76669 psf	0 psf	0 psf	Geosynthetics
Column 123	233.15073 ft	680.27609 ft	0 psf	2,475.6858 psf	1,429.3379 psf	0 psf	0 psf	Drainage Layer
Column 124	234.31691 ft	680.87029 ft	0 psf	2,365.4885 psf	1,365.7154 psf	0 psf	0 psf	Drainage Layer
Column 125	235.47690 ft	681.46133 ft	0 psf	2,261.5964 psf	1,305.7333 psf	0 psf	0 psf	Drainage Layer
Column 126	236.63070 ft	682.04922 ft	0 psf	2,164.0094 psf	1,249.3914 psf	0 psf	0 psf	Drainage Layer
Column 127	237.78450 ft	682.63711 ft	0 psf	2,066.4225 psf	1,193.0496 psf	0 psf	0 psf	Drainage Layer
Column 128	238.84752 ft	683.17875 ft	0 psf	1,854.2051 psf	674.87545 psf	0 psf	0 psf	CCR
Column 129	239.81977 ft	683.67413 ft	0 psf	1,783.8141 psf	649.25524 psf	0 psf	0 psf	CCR
Column 130	240.79201 ft	684.16952 ft	0 psf	1,713.4232 psf	623.63504 psf	0 psf	0 psf	CCR
Column 131	241.76426 ft	684.66490 ft	0 psf	1,643.0322 psf	598.01483 psf	0 psf	0 psf	CCR
Column 132	242.73651 ft	685.16029 ft	0 psf	1,572.6413 psf	572.39463 psf	0 psf	0 psf	CCR
Column 133	243.70876 ft	685.65567 ft	0 psf	1,502.2504 psf	546.77442 psf	0 psf	0 psf	CCR
Column 134	244.68101 ft	686.15106 ft	0 psf	1,431.8594 psf	521.15422 psf	0 psf	0 psf	CCR
Column 135	245.65325 ft	686.64644 ft	0 psf	1,361.4685 psf	495.53401 psf	0 psf	0 psf	CCR
Column 136	246.62550 ft	687.14183 ft	0 psf	1,291.0776 psf	469.91381 psf	0 psf	0 psf	CCR
Column 137	247.59775 ft	687.63721 ft	0 psf	1,220.6866 psf	444.2936 psf	0 psf	0 psf	CCR
Column 138	248.57000 ft	688.13260 ft	0 psf	1,150.2957 psf	418.6734 psf	0 psf	0 psf	CCR
Column 139	249.54224 ft	688.62798 ft	0 psf	1,079.9048 psf	393.05319 psf	0 psf	0 psf	CCR
Column 140	250.51449 ft	689.12337 ft	0 psf	1,009.5138 psf	367.43299 psf	0 psf	0 psf	CCR
Column 141	251.48674 ft	689.61875 ft	0 psf	939.12291 psf	341.81278 psf	0 psf	0 psf	CCR

Column 142	252.45899 ft	690.11414 ft	0 psf	868.73197 psf	316.19258 psf	0 psf	0 psf	CCR
Column 143	253.43124 ft	690.60952 ft	0 psf	798.34104 psf	290.57238 psf	0 psf	0 psf	CCR
Column 144	254.40348 ft	691.10491 ft	0 psf	727.9501 psf	264.95217 psf	0 psf	0 psf	CCR
Column 145	255.35983 ft	691.59219 ft	0 psf	677.10021 psf	360.02057 psf	0 psf	0 psf	Final Cover
Column 146	256.30026 ft	692.07136 ft	0 psf	572.93094 psf	304.63279 psf	0 psf	0 psf	Final Cover
Column 147	257.24070 ft	692.55054 ft	0 psf	468.76168 psf	249.24501 psf	0 psf	0 psf	Final Cover
Column 148	258.18114 ft	693.02972 ft	0 psf	364.59242 psf	193.85723 psf	0 psf	0 psf	Final Cover
Column 149	259.12158 ft	693.50889 ft	0 psf	260.42316 psf	138.46945 psf	0 psf	0 psf	Final Cover
Column 150	260.06201 ft	693.98807 ft	0 psf	156.25389 psf	83.081669 psf	0 psf	0 psf	Final Cover
Column 151	261.00245 ft	694.46725 ft	0 psf	52.084631 psf	27.69389 psf	0 psf	0 psf	Final Cover

I-43 Plan of Operation Modification - Final Grade Stability Analysis
Optimized Circular Failure
Analysis Type: Bishop
Last Solved Date: 03/27/2024, 12:28:42 PM

Factor of Safety: 1.548

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezometric Surface
	CCR	86	0	20	
	Clay Liner	130	0	28	
	Drainage Layer	115	0	30	
	Final Cover	125	0	28	
	Geosynthetics	58	0	19.5	
	Subbase	135	0	28	1



Optimized Circular Failure

File Information

File Version: 11.05
Title: I-43 Plan of Operation Modification - Final Grade Stability Analysis
Created By: Villanueva, Niko
Last Edited By: Villanueva, Niko
Revision Number: 50
Date: 03/27/2024
Time: 12:27:25 PM
Tool Version: 23.1.1.829
File Name: I-43 Proposed Final Grades_Section A_240327.gsz
Directory: I:\25222259.00\Data and Calculations\Geotechnical\Slope Stability\SlopeW Analysis\
Last Solved Date: 03/27/2024
Last Solved Time: 12:28:42 PM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Optimized Circular Failure

Kind: SLOPE/W
Analysis Type: Bishop
Settings
- PWP Conditions from: Piezometric Surfaces
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No
- Unit Weight of Water: 62.430189 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 10
- Optimize Critical Slip Surface Location: Yes
- Optimizations Settings
  - Maximum Iterations: 2,000
  - Starting Points: 8
  - Ending Points: 16
  - Driving Side Maximum Convex Angle: 5 °
  - Resisting Side Maximum Convex Angle: 1 °
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Convergence
- Geometry Settings
  - Minimum Slip Surface Depth: 0.1 ft

Minimum Slip Surface Volume: 35.314667 ft³
Number of Columns: 150
Factor of Safety Convergence Settings
Maximum Number of Iterations: 100
Tolerable difference in F of S: 0.001
Under-Relaxation Criteria
Initial Rate: 1
Minimum Rate: 0.1
Rate Reduction Factor: 0.65
Reduction Frequency (iterations): 50

Materials

CCR

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 86 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 20 °
Phi-B: 0 °

Clay Liner

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 130 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °

Drainage Layer

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 115 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Geosynthetics

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 58 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 19.5 °
Phi-B: 0 °

Subbase

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 135 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Surface: 1

Final Cover

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 125 pcf

Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (83.06545, 731.20685) ft
Left-Zone Right Coordinate: (147, 723.325) ft
Left-Zone Increment: 100
Right Type: Range
Right-Zone Left Coordinate: (246.03204, 698.56699) ft
Right-Zone Right Coordinate: (293, 695.8824) ft
Right-Zone Increment: 100
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (0, 730.2) ft
Right Coordinate: (377.2, 692.2) ft

Piezometric Surfaces

Piezometric Surface 1

Coordinates

	X	Y
Coordinate 1	0 ft	676 ft
Coordinate 2	182.5 ft	681.1 ft
Coordinate 3	201.2 ft	682.1 ft
Coordinate 4	203.7 ft	682 ft
Coordinate 5	223.8 ft	675.8 ft
Coordinate 6	234.9 ft	675.9 ft
Coordinate 7	263.1 ft	684.3 ft
Coordinate 8	377.2 ft	684 ft

Geometry

Name: 2D Geometry

Settings

View: 2D
Element Thickness: 1 ft

Points

	X	Y
Point 1	0 ft	640 ft
Point 2	377.2 ft	640 ft
Point 3	377.2 ft	692.2 ft

Point 4	343.6 ft	695.9 ft
Point 5	302.7 ft	697.9 ft
Point 6	265.2 ft	690.1 ft
Point 7	263.1 ft	689.3 ft
Point 8	263.1 ft	688.4 ft
Point 9	263.1 ft	688.3 ft
Point 10	263.1 ft	684.3 ft
Point 11	234.9 ft	675.9 ft
Point 12	223.8 ft	675.8 ft
Point 13	203.7 ft	682 ft
Point 14	201.2 ft	682.1 ft
Point 15	201.2 ft	684.1 ft
Point 16	191.6 ft	684 ft
Point 17	182.5 ft	681.1 ft
Point 18	0 ft	676 ft
Point 19	0 ft	678 ft
Point 20	182.5 ft	683.1 ft
Point 21	191.6 ft	686 ft
Point 22	201.2 ft	686.1 ft
Point 23	203.7 ft	686 ft
Point 24	223.8 ft	679.8 ft
Point 25	234.9 ft	679.9 ft
Point 26	0 ft	678.1 ft
Point 27	182.5 ft	683.2 ft
Point 28	191.6 ft	686.1 ft
Point 29	201.2 ft	686.2 ft
Point 30	203.7 ft	686.1 ft
Point 31	223.8 ft	679.9 ft
Point 32	234.9 ft	680 ft
Point 33	0 ft	679 ft
Point 34	182.5 ft	684.1 ft
Point 35	191.6 ft	687 ft
Point 36	201.2 ft	687.1 ft
Point 37	203.7 ft	688 ft
Point 38	0 ft	725.2 ft
Point 39	113.97399 ft	726.5815 ft
Point 40	256.51003 ft	688.33703 ft
Point 41	234.9 ft	681.9 ft
Point 42	223.8 ft	681.8 ft
Point 43	0 ft	730.2 ft
Point 44	113.97399 ft	731.5815 ft
Point 45	273.22402 ft	691.769 ft

Regions

	Material	Points	Area
Region 1	Subbase	1,2,3,4,5,45,6,7,8,9,10,11,12,13,14,15,16,17,18	16,534 ft²
Region 2	Clay Liner	18,19,20,21,22,23,24,25,9,10,11,12,13,14,15,16,17	650 ft²
Region 3	Geosynthetics	19,26,27,28,29,30,31,32,8,9,25,24,23,22,21,20	26.31 ft²
Region 4	Drainage Layer	26,33,34,35,36,37,30,29,28,27	184.58 ft²

Region 5	CCR	33,38,39,7,40,41,42,37,36,35,34	8,689.4 ft²
Region 6	Final Cover	38,39,7,6,45,44,43	1,339.4 ft²
Region 7	Drainage Layer	37,42,41,40,7,8,32,31,30	109.57 ft²

Slip Results

Slip Surfaces Analysed: 109477 of 112212 converged

Current Slip Surface

Slip Surface: 112,212
Factor of Safety: 1.548
Volume: 1,151.4271 ft³
Weight: 126,959.35 lbf
Resisting Moment: 11,504,102 lbf·ft
Activating Moment: 7,429,425.5 lbf·ft
Resisting Force: 44,501.749 lbf
Activating Force: 29,268.743 lbf
Slip Rank: 1 of 112,212 slip surfaces
Exit: (265.15225, 693.78694) ft
Entry: (113.32553, 731.57364) ft
Radius: 68.499226 ft
Center: (248.51788, 943.53514) ft

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Column 1	113.64976 ft	731.24798 ft	0 psf	30.636178 psf	16.289545 psf	0 psf	0 psf	Final Cover
Column 2	114.45348 ft	730.44071 ft	0 psf	94.896169 psf	50.457188 psf	0 psf	0 psf	Final Cover
Column 3	115.41246 ft	729.47749 ft	0 psf	162.14379 psf	86.213384 psf	0 psf	0 psf	Final Cover
Column 4	116.37145 ft	728.51428 ft	0 psf	229.39142 psf	121.96958 psf	0 psf	0 psf	Final Cover
Column 5	117.33043 ft	727.55106 ft	0 psf	296.63904 psf	157.72578 psf	0 psf	0 psf	Final Cover
Column 6	118.28941 ft	726.58785 ft	0 psf	363.88667 psf	193.48197 psf	0 psf	0 psf	Final Cover
Column 7	119.24840 ft	725.62463 ft	0 psf	431.13429 psf	229.23817 psf	0 psf	0 psf	Final Cover
Column 8	119.75223 ft	725.11858 ft	0 psf	506.93471 psf	184.50915 psf	0 psf	0 psf	CCR
Column 9	120.28447 ft	724.89090 ft	0 psf	580.16643 psf	211.16331 psf	0 psf	0 psf	CCR
Column 10	121.30028 ft	724.48443 ft	0 psf	592.15551 psf	215.52698 psf	0 psf	0 psf	CCR
Column 11	122.31609 ft	724.07796 ft	0 psf	604.14459 psf	219.89065 psf	0 psf	0 psf	CCR
Column 12	123.33189 ft	723.67149 ft	0 psf	616.13367 psf	224.25432 psf	0 psf	0 psf	CCR

Column 13	124.34770 ft	723.26503 ft	0 psf	628.12276 psf	228.61799 psf	0 psf	0 psf	CCR
Column 14	125.36351 ft	722.85856 ft	0 psf	640.11184 psf	232.98166 psf	0 psf	0 psf	CCR
Column 15	126.37931 ft	722.45209 ft	0 psf	652.10092 psf	237.34532 psf	0 psf	0 psf	CCR
Column 16	127.39512 ft	722.04563 ft	0 psf	664.09 psf	241.70899 psf	0 psf	0 psf	CCR
Column 17	128.41092 ft	721.63916 ft	0 psf	676.07908 psf	246.07266 psf	0 psf	0 psf	CCR
Column 18	129.42673 ft	721.23269 ft	0 psf	688.06816 psf	250.43633 psf	0 psf	0 psf	CCR
Column 19	130.44254 ft	720.82622 ft	0 psf	700.05724 psf	254.8 psf	0 psf	0 psf	CCR
Column 20	131.44273 ft	720.44124 ft	0 psf	715.41991 psf	260.39155 psf	0 psf	0 psf	CCR
Column 21	132.42731 ft	720.07774 ft	0 psf	724.70691 psf	263.77174 psf	0 psf	0 psf	CCR
Column 22	133.41189 ft	719.71424 ft	0 psf	733.99391 psf	267.15193 psf	0 psf	0 psf	CCR
Column 23	134.39647 ft	719.35073 ft	0 psf	743.2809 psf	270.53212 psf	0 psf	0 psf	CCR
Column 24	135.38106 ft	718.98723 ft	0 psf	752.5679 psf	273.91231 psf	0 psf	0 psf	CCR
Column 25	136.36564 ft	718.62373 ft	0 psf	761.8549 psf	277.2925 psf	0 psf	0 psf	CCR
Column 26	137.35022 ft	718.26023 ft	0 psf	771.14189 psf	280.6727 psf	0 psf	0 psf	CCR
Column 27	138.33480 ft	717.89673 ft	0 psf	780.42889 psf	284.05289 psf	0 psf	0 psf	CCR
Column 28	139.31938 ft	717.53322 ft	0 psf	789.71589 psf	287.43308 psf	0 psf	0 psf	CCR
Column 29	140.30396 ft	717.16972 ft	0 psf	799.00288 psf	290.81327 psf	0 psf	0 psf	CCR
Column 30	141.28854 ft	716.80622 ft	0 psf	808.28988 psf	294.19346 psf	0 psf	0 psf	CCR
Column 31	142.27312 ft	716.44272 ft	0 psf	817.57687 psf	297.57365 psf	0 psf	0 psf	CCR
Column 32	143.25771 ft	716.07922 ft	0 psf	826.86387 psf	300.95384 psf	0 psf	0 psf	CCR
Column 33	144.24229 ft	715.71571 ft	0 psf	836.15087 psf	304.33403 psf	0 psf	0 psf	CCR
Column 34	145.22687 ft	715.35221 ft	0 psf	845.43786 psf	307.71422 psf	0 psf	0 psf	CCR
Column 35	146.21145 ft	714.98871 ft	0 psf	854.72486 psf	311.09441 psf	0 psf	0 psf	CCR
Column 36	147.19203 ft	714.65207 ft	0 psf	871.76299 psf	317.29578 psf	0 psf	0 psf	CCR
Column 37	148.16861 ft	714.34228 ft	0 psf	877.01669 psf	319.20797 psf	0 psf	0 psf	CCR
Column 38	149.14518 ft	714.03249 ft	0 psf	882.2704 psf	321.12016 psf	0 psf	0 psf	CCR

Column 39	150.12176 ft	713.72270 ft	0 psf	887.5241 psf	323.03236 psf	0 psf	0 psf	CCR
Column 40	151.09834 ft	713.41292 ft	0 psf	892.77781 psf	324.94455 psf	0 psf	0 psf	CCR
Column 41	152.07492 ft	713.10313 ft	0 psf	898.03152 psf	326.85674 psf	0 psf	0 psf	CCR
Column 42	153.05149 ft	712.79334 ft	0 psf	903.28522 psf	328.76893 psf	0 psf	0 psf	CCR
Column 43	154.02807 ft	712.48355 ft	0 psf	908.53893 psf	330.68113 psf	0 psf	0 psf	CCR
Column 44	154.99993 ft	712.18105 ft	0 psf	915.69988 psf	333.2875 psf	0 psf	0 psf	CCR
Column 45	155.96706 ft	711.88583 ft	0 psf	919.98796 psf	334.84823 psf	0 psf	0 psf	CCR
Column 46	156.93419 ft	711.59061 ft	0 psf	924.27604 psf	336.40897 psf	0 psf	0 psf	CCR
Column 47	157.90133 ft	711.29539 ft	0 psf	928.56412 psf	337.9697 psf	0 psf	0 psf	CCR
Column 48	158.86846 ft	711.00016 ft	0 psf	932.8522 psf	339.53043 psf	0 psf	0 psf	CCR
Column 49	159.83560 ft	710.70494 ft	0 psf	937.14028 psf	341.09117 psf	0 psf	0 psf	CCR
Column 50	160.80273 ft	710.40972 ft	0 psf	941.42836 psf	342.6519 psf	0 psf	0 psf	CCR
Column 51	161.76986 ft	710.11450 ft	0 psf	945.71644 psf	344.21263 psf	0 psf	0 psf	CCR
Column 52	162.77145 ft	709.81460 ft	0 psf	952.03993 psf	346.5142 psf	0 psf	0 psf	CCR
Column 53	163.80748 ft	709.51001 ft	0 psf	955.70627 psf	347.84863 psf	0 psf	0 psf	CCR
Column 54	164.84351 ft	709.20543 ft	0 psf	959.37261 psf	349.18307 psf	0 psf	0 psf	CCR
Column 55	165.87954 ft	708.90084 ft	0 psf	963.03895 psf	350.51751 psf	0 psf	0 psf	CCR
Column 56	166.90076 ft	708.62504 ft	0 psf	975.09128 psf	354.9042 psf	0 psf	0 psf	CCR
Column 57	167.90716 ft	708.37802 ft	0 psf	974.71902 psf	354.76871 psf	0 psf	0 psf	CCR
Column 58	168.91357 ft	708.13099 ft	0 psf	974.34675 psf	354.63322 psf	0 psf	0 psf	CCR
Column 59	169.91997 ft	707.88397 ft	0 psf	973.97449 psf	354.49772 psf	0 psf	0 psf	CCR
Column 60	170.92637 ft	707.63695 ft	0 psf	973.60222 psf	354.36223 psf	0 psf	0 psf	CCR
Column 61	171.93277 ft	707.38993 ft	0 psf	973.22996 psf	354.22674 psf	0 psf	0 psf	CCR
Column 62	172.93918 ft	707.14291 ft	0 psf	972.8577 psf	354.09124 psf	0 psf	0 psf	CCR
Column 63	173.94558 ft	706.89588 ft	0 psf	972.48543 psf	353.95575 psf	0 psf	0 psf	CCR
Column 64	174.95198 ft	706.64886 ft	0 psf	972.11317 psf	353.82026 psf	0 psf	0 psf	CCR

Column 65	175.95838 ft	706.40184 ft	0 psf	971.7409 psf	353.68476 psf	0 psf	0 psf	CCR
Column 66	176.96479 ft	706.15482 ft	0 psf	971.36864 psf	353.54927 psf	0 psf	0 psf	CCR
Column 67	177.97119 ft	705.90779 ft	0 psf	970.99638 psf	353.41378 psf	0 psf	0 psf	CCR
Column 68	178.97759 ft	705.66077 ft	0 psf	970.62411 psf	353.27829 psf	0 psf	0 psf	CCR
Column 69	179.98399 ft	705.41375 ft	0 psf	970.25185 psf	353.14279 psf	0 psf	0 psf	CCR
Column 70	180.99040 ft	705.16673 ft	0 psf	969.87958 psf	353.0073 psf	0 psf	0 psf	CCR
Column 71	181.99680 ft	704.91971 ft	0 psf	969.50732 psf	352.87181 psf	0 psf	0 psf	CCR
Column 72	182.85870 ft	704.70815 ft	0 psf	969.18851 psf	352.75577 psf	0 psf	0 psf	CCR
Column 73	183.73643 ft	704.49596 ft	0 psf	969.94771 psf	353.03209 psf	0 psf	0 psf	CCR
Column 74	184.77450 ft	704.24765 ft	0 psf	969.03451 psf	352.69972 psf	0 psf	0 psf	CCR
Column 75	185.81258 ft	703.99935 ft	0 psf	968.12132 psf	352.36734 psf	0 psf	0 psf	CCR
Column 76	186.85065 ft	703.75105 ft	0 psf	967.20813 psf	352.03497 psf	0 psf	0 psf	CCR
Column 77	187.88873 ft	703.50275 ft	0 psf	966.29493 psf	351.70259 psf	0 psf	0 psf	CCR
Column 78	188.92680 ft	703.25444 ft	0 psf	965.38174 psf	351.37022 psf	0 psf	0 psf	CCR
Column 79	189.93560 ft	703.01918 ft	0 psf	966.65285 psf	351.83286 psf	0 psf	0 psf	CCR
Column 80	190.91511 ft	702.79695 ft	0 psf	964.80335 psf	351.1597 psf	0 psf	0 psf	CCR
Column 81	191.89462 ft	702.57472 ft	0 psf	962.95386 psf	350.48654 psf	0 psf	0 psf	CCR
Column 82	192.87414 ft	702.35250 ft	0 psf	961.10436 psf	349.81338 psf	0 psf	0 psf	CCR
Column 83	193.85365 ft	702.13027 ft	0 psf	959.25487 psf	349.14022 psf	0 psf	0 psf	CCR
Column 84	194.83316 ft	701.90805 ft	0 psf	957.40537 psf	348.46706 psf	0 psf	0 psf	CCR
Column 85	195.81268 ft	701.68582 ft	0 psf	955.55587 psf	347.7939 psf	0 psf	0 psf	CCR
Column 86	196.79219 ft	701.46359 ft	0 psf	953.70638 psf	347.12073 psf	0 psf	0 psf	CCR
Column 87	197.77170 ft	701.24137 ft	0 psf	951.85688 psf	346.44757 psf	0 psf	0 psf	CCR
Column 88	198.75122 ft	701.01914 ft	0 psf	950.00739 psf	345.77441 psf	0 psf	0 psf	CCR
Column 89	199.73073 ft	700.79692 ft	0 psf	948.15789 psf	345.10125 psf	0 psf	0 psf	CCR
Column 90	200.71024 ft	700.57469 ft	0 psf	946.30839 psf	344.42809 psf	0 psf	0 psf	CCR

Column 91	201.82500 ft	700.32178 ft	0 psf	944.20353 psf	343.66198 psf	0 psf	0 psf	CCR
Column 92	203.07500 ft	700.03819 ft	0 psf	941.84331 psf	342.80293 psf	0 psf	0 psf	CCR
Column 93	204.21019 ft	699.78064 ft	0 psf	939.69988 psf	342.02278 psf	0 psf	0 psf	CCR
Column 94	205.23056 ft	699.54915 ft	0 psf	937.77323 psf	341.32154 psf	0 psf	0 psf	CCR
Column 95	206.24366 ft	699.33135 ft	0 psf	939.90027 psf	342.09572 psf	0 psf	0 psf	CCR
Column 96	207.24947 ft	699.12726 ft	0 psf	936.01276 psf	340.68079 psf	0 psf	0 psf	CCR
Column 97	208.25528 ft	698.92316 ft	0 psf	932.12525 psf	339.26585 psf	0 psf	0 psf	CCR
Column 98	209.26109 ft	698.71907 ft	0 psf	928.23774 psf	337.85091 psf	0 psf	0 psf	CCR
Column 99	210.26690 ft	698.51498 ft	0 psf	924.35024 psf	336.43597 psf	0 psf	0 psf	CCR
Column 100	211.27272 ft	698.31088 ft	0 psf	920.46273 psf	335.02103 psf	0 psf	0 psf	CCR
Column 101	212.27853 ft	698.10679 ft	0 psf	916.57522 psf	333.6061 psf	0 psf	0 psf	CCR
Column 102	213.28434 ft	697.90269 ft	0 psf	912.68771 psf	332.19116 psf	0 psf	0 psf	CCR
Column 103	214.29015 ft	697.69860 ft	0 psf	908.8002 psf	330.77622 psf	0 psf	0 psf	CCR
Column 104	215.29596 ft	697.49451 ft	0 psf	904.91269 psf	329.36128 psf	0 psf	0 psf	CCR
Column 105	216.30178 ft	697.29041 ft	0 psf	901.02518 psf	327.94634 psf	0 psf	0 psf	CCR
Column 106	217.30759 ft	697.08632 ft	0 psf	897.13767 psf	326.53141 psf	0 psf	0 psf	CCR
Column 107	218.31340 ft	696.88223 ft	0 psf	893.25016 psf	325.11647 psf	0 psf	0 psf	CCR
Column 108	219.31921 ft	696.67813 ft	0 psf	889.36265 psf	323.70153 psf	0 psf	0 psf	CCR
Column 109	220.32502 ft	696.47404 ft	0 psf	885.47514 psf	322.28659 psf	0 psf	0 psf	CCR
Column 110	221.32327 ft	696.28396 ft	0 psf	885.59843 psf	322.33147 psf	0 psf	0 psf	CCR
Column 111	222.31396 ft	696.10791 ft	0 psf	879.68619 psf	320.17959 psf	0 psf	0 psf	CCR
Column 112	223.30465 ft	695.93185 ft	0 psf	873.77396 psf	318.02771 psf	0 psf	0 psf	CCR
Column 113	224.16823 ft	695.77839 ft	0 psf	868.62031 psf	316.15194 psf	0 psf	0 psf	CCR
Column 114	225.02936 ft	695.63768 ft	0 psf	867.35385 psf	315.69099 psf	0 psf	0 psf	CCR
Column 115	226.01517 ft	695.48713 ft	0 psf	859.39196 psf	312.79309 psf	0 psf	0 psf	CCR
Column 116	227.00097 ft	695.33658 ft	0 psf	851.43006 psf	309.8952 psf	0 psf	0 psf	CCR

Column 117	227.98678 ft	695.18603 ft	0 psf	843.46817 psf	306.99731 psf	0 psf	0 psf	CCR
Column 118	228.97258 ft	695.03548 ft	0 psf	835.50627 psf	304.09941 psf	0 psf	0 psf	CCR
Column 119	229.95839 ft	694.88493 ft	0 psf	827.54437 psf	301.20152 psf	0 psf	0 psf	CCR
Column 120	230.94419 ft	694.73438 ft	0 psf	819.58248 psf	298.30363 psf	0 psf	0 psf	CCR
Column 121	231.93000 ft	694.58383 ft	0 psf	811.62058 psf	295.40573 psf	0 psf	0 psf	CCR
Column 122	233.04217 ft	694.41610 ft	0 psf	803.08363 psf	292.29854 psf	0 psf	0 psf	CCR
Column 123	234.28072 ft	694.23117 ft	0 psf	792.72201 psf	288.52722 psf	0 psf	0 psf	CCR
Column 124	235.38552 ft	694.06622 ft	0 psf	783.4794 psf	285.16318 psf	0 psf	0 psf	CCR
Column 125	236.35655 ft	693.92123 ft	0 psf	775.35581 psf	282.20644 psf	0 psf	0 psf	CCR
Column 126	237.32758 ft	693.77625 ft	0 psf	767.23222 psf	279.24969 psf	0 psf	0 psf	CCR
Column 127	238.29862 ft	693.63126 ft	0 psf	759.10862 psf	276.29294 psf	0 psf	0 psf	CCR
Column 128	239.26965 ft	693.48628 ft	0 psf	750.98503 psf	273.3362 psf	0 psf	0 psf	CCR
Column 129	240.24068 ft	693.34130 ft	0 psf	742.86144 psf	270.37945 psf	0 psf	0 psf	CCR
Column 130	241.21171 ft	693.19631 ft	0 psf	734.73785 psf	267.42271 psf	0 psf	0 psf	CCR
Column 131	242.18275 ft	693.05133 ft	0 psf	726.61425 psf	264.46596 psf	0 psf	0 psf	CCR
Column 132	243.15378 ft	692.90635 ft	0 psf	718.49066 psf	261.50921 psf	0 psf	0 psf	CCR
Column 133	244.12481 ft	692.76136 ft	0 psf	710.36707 psf	258.55247 psf	0 psf	0 psf	CCR
Column 134	245.09155 ft	692.63024 ft	0 psf	705.58199 psf	256.81084 psf	0 psf	0 psf	CCR
Column 135	246.05400 ft	692.51299 ft	0 psf	695.26873 psf	253.05712 psf	0 psf	0 psf	CCR
Column 136	247.01644 ft	692.39573 ft	0 psf	684.95548 psf	249.30341 psf	0 psf	0 psf	CCR
Column 137	247.97888 ft	692.27847 ft	0 psf	674.64222 psf	245.54969 psf	0 psf	0 psf	CCR
Column 138	248.94133 ft	692.16122 ft	0 psf	664.32897 psf	241.79597 psf	0 psf	0 psf	CCR
Column 139	249.90377 ft	692.04396 ft	0 psf	654.01571 psf	238.04225 psf	0 psf	0 psf	CCR
Column 140	250.86622 ft	691.92670 ft	0 psf	643.70246 psf	234.28853 psf	0 psf	0 psf	CCR
Column 141	251.82866 ft	691.80945 ft	0 psf	633.3892 psf	230.53482 psf	0 psf	0 psf	CCR
Column 142	252.79110 ft	691.69219 ft	0 psf	623.07595 psf	226.7811 psf	0 psf	0 psf	CCR

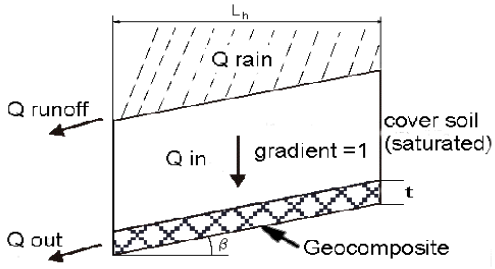
Column 143	253.75358 ft	691.57493 ft	0 psf	612.76209 psf	223.02716 psf	0 psf	0 psf	CCR
Column 144	254.72734 ft	691.61873 ft	0 psf	642.68899 psf	341.7238 psf	0 psf	0 psf	Final Cover
Column 145	255.71236 ft	691.82360 ft	0 psf	581.96321 psf	309.43533 psf	0 psf	0 psf	Final Cover
Column 146	256.69738 ft	692.02847 ft	0 psf	521.23743 psf	277.14686 psf	0 psf	0 psf	Final Cover
Column 147	257.68240 ft	692.23334 ft	0 psf	460.51165 psf	244.85839 psf	0 psf	0 psf	Final Cover
Column 148	258.66742 ft	692.43820 ft	0 psf	399.78587 psf	212.56992 psf	0 psf	0 psf	Final Cover
Column 149	259.65243 ft	692.64307 ft	0 psf	339.06009 psf	180.28145 psf	0 psf	0 psf	Final Cover
Column 150	260.63745 ft	692.84794 ft	0 psf	278.33431 psf	147.99298 psf	0 psf	0 psf	Final Cover
Column 151	261.62247 ft	693.05281 ft	0 psf	217.60853 psf	115.70451 psf	0 psf	0 psf	Final Cover
Column 152	262.60749 ft	693.25767 ft	0 psf	156.88275 psf	83.416036 psf	0 psf	0 psf	Final Cover
Column 153	263.61306 ft	693.46682 ft	0 psf	94.889892 psf	50.453851 psf	0 psf	0 psf	Final Cover
Column 154	264.63919 ft	693.68023 ft	0 psf	31.629964 psf	16.81795 psf	0 psf	0 psf	Final Cover

Purpose: To determine the maximum length of 4H:1V slope that the final cover drainage layer (geocomposite) can carry infiltrating water and remain stable, and the recommended minimum interface friction angle for final cover stability.

Approach: Use the unit gradient method to determine the maximum slope length.

References:

1. Landfilldesign.com
2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001
3. "Beyond a factor-of-safety value, i.e., the probability of failure". GRI Newsletter/Report, Vol. 15, no. 3
4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998
5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5
6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002
7. HELP Model "User's Guide", Table 4: Default Soil, Waste, and Geosynthetic Characteristics
8. Soong, T.Y. and Koerner, R.M. (1997), "The Design of Drainage Systems over Geosynthetically Lined Slopes", Geosynthetics Research Institute, Report #19.
8. SCS Engineers, Plan Modification Addendum No. 1, Edgewater I43 Ash Disposal Facility, Final Cover Grades Plan Sheet, March 2024



With Darcy's Law:

$Q = k \times i \times A$

Inflow of water in the Drainage Material

$Q_{in} = k_{veg} \times i \times A = k_{veg} \times 1 \times L_h \times 1$

Outflow of water from the geocomposite at the toe of the slope

$Q_{out} = k_{comp} \times i \times A = k_{comp} \times i \times t \times 1 = \theta_{required} \times \sin\beta = \theta \times j \times 1$

where $\theta = k_{comp} \times t$

Inflow equals Outflow (Factor of Safety = 1) (minimum allowable outflow to keep head within geocomposite)

$Q_{in} = Q_{out}$

This results in a required transmissivity of the geocomposite of:

$$\theta_{required} = \frac{k_{veg} \times L_h}{\sin\beta}$$

Which results in the ultimate transmissivity after multiplying by the Total Servicability Factor (TSF)

$$\theta_{ultimate} = \theta_{required} \times FS_d \times RF_{in} \times RF_{cr} \times RF_{cc} \times RF_{bc}$$

Assumptions: 1. Soil hydraulic gradient ¡ = 1.

2. Typical topsoil in the site area is assumed to be silty clay based on the Preliminary Site Feasibility Report prepared by Mead and Hunt, Inc. in December 1977. Estimated permeability of 1.90E-05 cm/sec is from the HELP Model User's Guide.
3. Geocomposite hydraulic gradient = sinβ where β=14˚ (4:1 horizontal/vertical final cover slope).
4. Factor of safety and transmissivity reduction factors are from recommended values in GRI report #19 (Leachate collection system example) and HELP model "Users Guide"
5. Maximum 4:1 horizontal final cover slope length from crest to toe drain is 167 feet as shown in the Plan Modification Addendum final cover drawings.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg}	=	Permeability of the vegetative supporting soil	=	1.90E-05	cm/sec
S	=	The liner's slope, **S** = tan **β**	=	25%	β = 14 ˚
FS_{slope}	=	Minimum factor of safety against sliding, for soil/geocomposite or geocomposite/geomembrane interfaces	=	1.5	
$\delta_{req'd}$	=	Minimum interface friction angle = $\tan^{-1}(FS_{slope}*\tan(b))$	=	20.6	degrees
FS_d	=	Overall factor of safety for drainage	=	2.0	
RF_{in}	=	Intrusion Reduction Factor	=	1.1	
RF_{cr}	=	Creep Reduction Factor	=	1.2	
RF_{cc}	=	Chemical Clogging Reduction Factor	=	1.1	
RF_{bc}	=	Biological Clogging Reduction Factor	=	1.4	

Determine the ultimate transmissivity based on a given slope length

L_h (feet)	L_h (meter)	Θ_{ult} (m^2/sec)	
167	51	1.57E-04	~ Total slope length (4H:1V slope only)

Conclusions: For the proposed design with a toe-of-slope drainage outlet and the assumed vegetative layer hydraulic conductivity, a minimum transmissivity of 1.57E-04 m^2/sec is required for the final cover sideslopes For ease of construction, the same drainage geocomposite required for the 3% final cover plateau could also be used on the final cover sideslopes.

A minimum interface friction angle of 20.6 degrees is required to achieve a minimum recommended final cover slope stability safety factor of 1.5.

Purpose: To determine the maximum length of 3% slope that the final cover plateau drainage geocomposite can carry infiltrating water and maintain the flow within the geocomposite.

Approach: Use the unit gradient method to determine the maximum slope length.

References: Landfill Design.com

"GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001.

"Beyond a factor-of-safety value, i.e., the probability of failure". GRI Newsletter/Report, Vol. 15, no.3.

"Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.

"Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J.P. Giroud, J.G. Zornberg and A. Zhao, *Geosynthetics International* , Vol. 7, Nos 4-5.

"Lateral Drainage Design update - part 2". G.N. Richardson, J.P. Giroud and A. Zhao, *Geotechnical Fabrics Report* , March, 2002

Giroud, Zornberg, and Zhao, 2000, "Hydraulic Design of Liquid Collection Layers", Geosynthetics International

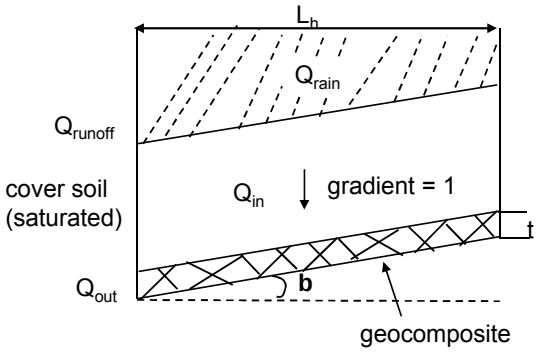
HELP Model "User's Guide" Table 4 - Default Soil, Waste, and Geosynthetic Characteristics

Soong, T.Y. and Koerner, R.M. (1997), "The Design of Drainage Systems over Geosynthetically Lined Slopes", Geosynthetics Research Institute, Report #19.

With Darcy's Law:
$Q = k * i * A$

Inflow of water in the geocomposite
$Qin = k_{veg} * i * A = k_{veg} * 1 * L_h * 1$

Outflow of water from the geocomposite at the toe of the slope
$Q_{out} = k_{comp} * i * A = k_{comp} * i * t * 1 = \theta_{required} * \sin\beta$



Inflow equals outflow (Factor of Safety = 1)
$Q_{in} = Q_{out} = \theta * i * 1$ where $\theta = k_{comp} * t$ (minimum allowable outflow to keep head within geocomposite)

This results in a required transmissivity of the geocomposite of:

$$\theta_{required} = \frac{k_{veg} * Lh}{\sin\beta}$$

Which results in the ultimate transmissivity after multiplying by the Total Servicability Factor (TSF)
$\theta_{ultimate} = \theta_{required} * FS_d * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$

Calculation:

L_h= Drainage pipe spacing or length of slope measured horizontally	=	See Below
k_{veg} = Permeability of the vegetative supporting soil	=	1.9E-05 cm/sec
S = The liner's slope, S = tan**b**	=	3% **b** (degrees) = 1.7 °

FSd = Overall factor of safety for drainage	=	2
RF_{in} = Intrustion Reduction Factor	=	1.1
RF_{cr} = Creep Reduction Factor	=	1.2
RF_{cc} = Chemical Clogging Reduction Factor	=	1.1
RF_{bc} = Biological Clogging Reduction Factor	=	1.4

Determine the maximum slope length for transmissivities of example products currently available

L_h (feet)	L_h (meter)	Θ_{ult} (m^2/sec)	
319	97	2.5E-03	GSE FabriNet TRx Geocomposite (Double-Sided), 300 mil
115	35	9.0E-04	GSE FabriNet Geocomposite (Double-Sided), 300 mil
64	19	5.0E-04	GSE FabriNet Geocomposite (Double-Sided), 250 mil
13	4	1.0E-04	GSE FabriNet Geocomposite (Double-Sided), 200 mil

Determine the ultimate transmissivity based on a given slope length

L_h (feet)	L_h (meter)	Θ_{ult} (m^2/sec)	
335	102	2.6E-03	~ Total slope length (3% slope only)

Assumptions:

1. Soil hydraulic gradient i = 1.
2. Typical topsoil in the site area is classified as silty clay based on the Preliminary Site Feasibility Report. Prepared by Meand and Hunt, inc. in December 1977. Estimated permeability of 1.9E-05 cm/sec is from the HELP Model User's Guide.
3. Geocomposite hydraulic gradient = sinβ where β=2° (3% final cover slope).
4. Factor of safety and transmissivity reduction factors are from recommended values in GRI report #19 (Leachate collection system example) and HELP model "Users Guide".
5. Maximum horizontal final cover slope length at 3% is 335 feet as shown on the expansion final grades plan sheet.
6. Geocomposite transmissivities for GSE products were tested at a gradient of 0.1 and normal load of 10,000 psf.

Conclusions: For the proposed design with a toe-of-slope drainage outlet and the assumed vegetative layer hydraulic conductivity, a minimum transmissivity of 2.63E-03 m^2/sec is required. Since this transmissivity is not achieved by the GSE FabriNet TRx Geocomposite (Double-Sided), 300 mil, a pipe system has been designed to provide the necessary drainage for the final cover plateau. The drainage pipe system layout will maintain the flow within the geocomposite when the flow length to the drainage outlet is a maximum of 319 feet and the geocomposite minimum transmissivity is 2.5E-03 m^2/sec.

SCS ENGINEERS

Sheet No.	1 of 2				
Calc. No.					
Rev. No.					
Job No. 25214060	Job: Edgewater	By:	BJM	Date	1/8/2015
Client: Wisconsin Power & Light Company	Subject: Liner Side Slope Drainage Layer Stability	Chk'd:	ZB	Date	1/13/2015

EVALUATION:

Evaluate the landfill liner side slope drainage layer for static veneer slope stability.

The side slope on the south expansion base runs at a 3:1 slope for a maximum 45 feet (conservative, longest slope)

The following calculations evaluate the static veneer slope stability of the 3:1 slope.

REFERENCES:

1.) Koerner, Robert M. & Te-Yang Soong, Analysis and Design of Veneer Cover Soils, Geosynthetic Research Institute.

2.) U.S. Department of Transportation - Federal Highway Administration Recycled Materials, Coal Bottom Ash User's Guide

EQUATIONS:

$FS = (-b+(b^2-4*a*c)^{1/2})/(2*a)$

$a = (W_A-N_A*\cos\beta)*\cos\beta$

$b = -((W_A-N_A*\cos\beta)*\sin\beta*\tan\varphi+(N_A*\tan\delta+C_a)*\sin\beta*\cos\beta+(C+W_P*\tan\varphi)*\sin\beta)$

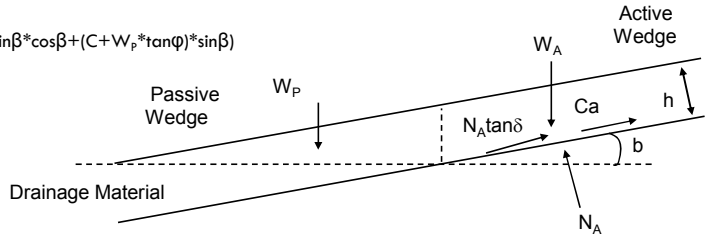
$c = (N_A*\tan\delta+C_a)*(\sin\beta)^2*\tan\varphi$

$N_A = W_A*\cos\beta$

$W_A = \mathbf{g}*h^2*(L/h-1/\sin\beta-\tan\beta/2)$

$W_P = (\mathbf{g}*h^2)/\sin 2\beta)$

$C_a = c_a(L-h/\sin\beta)$



DEFINITIONS OF VARIABLES:

FS = Factor of Safety

a, b, & c = intermediate variables (= calculated variable)

N_A = Effective force normal to the failure plane of the active wedge (= calculated variable)

W_A = Total weight of active wedge (= calculated variable)

W_P = Total weight of passive wedge (= calculated variable)

β = Soil slope angle beneath the geomembrane (= 18.42 degrees or 0.322 radians
based on liner slope of 3 to 1)

φ = Friction angle of the drainage layer material (= 35 degrees, 0.611 radians based on Ref #2)

δ = Interface friction angle for liner system geosynthetics (to be determined)

c_a = Adhesion for liner system geosynthetics at active wedge (to be determined) , Variable+

$\mathbf{g}$ = Unit weight of the drainage layer material (= 110 pcf based on conservative wet density of drainage material).

C = Cohesive force along the failure plane of the passive wedge (assumed 0 for drainage layer material)

C_a = Adhesive force of the active wedge for the liner system geosynthetics

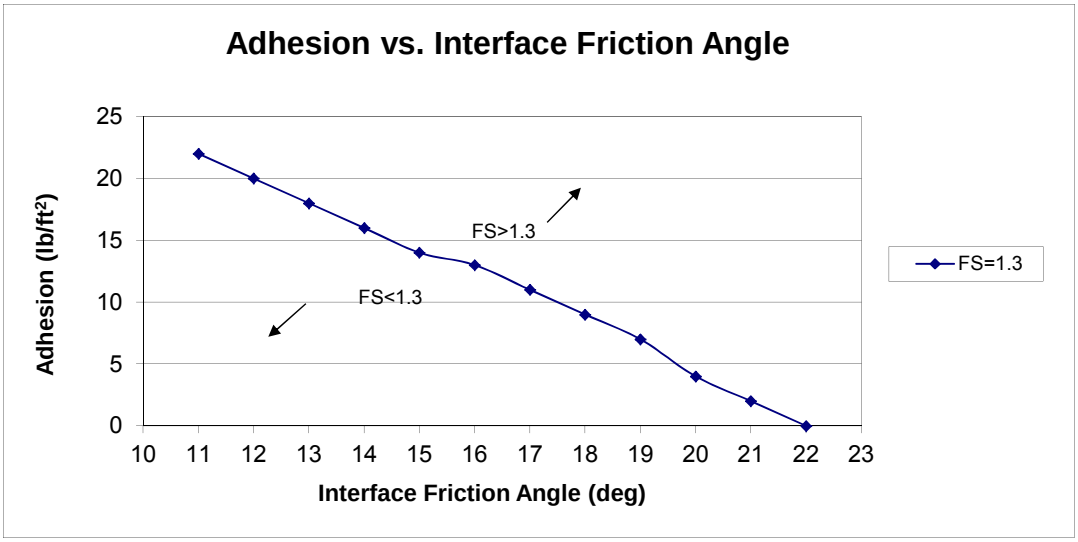
h = Thickness of the drainage layer material(= 1.0 foot based on base design)

L = Length of slope measured along the geomembrane (= 45 feet based on base design)

CALCULATIONS:

To determine the minimum adhesion necessary for a range of interface friction angles to reach a FS of 1.3 or greater.

d		c_a	W_A	W_P	N_A	C_a	a	b	c	FS
(deg)	(rad)	(lb/ft^2)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	
11	0.192	22	4,584	183	4,349	920	434	-671	123	**1.3**
12	0.209	20	4,584	183	4,349	837	434	-670	123	**1.3**
13	0.227	18	4,584	183	4,349	753	434	-669	123	**1.3**
14	0.244	16	4,584	183	4,349	669	434	-668	123	**1.3**
15	0.262	14	4,584	183	4,349	586	434	-667	122	**1.3**
16	0.279	13	4,584	183	4,349	544	434	-679	125	**1.3**
17	0.297	11	4,584	183	4,349	460	434	-678	125	**1.3**
18	0.314	9	4,584	183	4,349	377	434	-678	125	**1.3**
19	0.332	7	4,584	183	4,349	293	434	-679	125	**1.3**
20	0.349	4	4,584	183	4,349	167	434	-667	122	**1.3**
21	0.367	2	4,584	183	4,349	84	434	-667	123	**1.3**
22	0.384	0	4,584	183	4,349	0	434	-669	123	**1.3**



CONCLUSION:

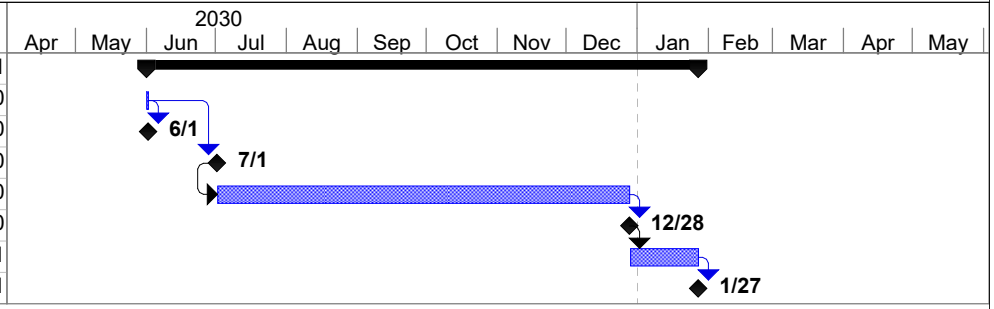
The landfill liner side slope drainage layer was evaluated for static veneer slope stability along its longest slope. Drainage layer material is assumed to be bottom ash, if an alternative material is used this calculation will need to be re-evaluated. Calculations were performed to determine the minimum adhesion necessary for a range of interface friction angles to reach a FS of 1.3 or greater. Each interface friction angle and the coinciding adhesion was graphed in order to easily determine if a material interface is acceptable along the side slope.

Appendix B

Schedule

Estimated Closure Plan Schedule
Edgewater I-43 Ash Disposal Facility

ID	Task Name	Duration	Start	Finish
1	**Closure of Phase 4 Module 1**	**241 days**	**Sat 6/1/30**	**Mon 1/27/31**
2	CCR filling ceases	1 day	Sat 6/1/30	Sat 6/1/30
3	Other regulatory permits - none	0 days	Sat 6/1/30	Sat 6/1/30
4	Notification of Intent to Close	0 days	Mon 7/1/30	Mon 7/1/30
5	Construction Activities	180 days	Tue 7/2/30	Sat 12/28/30
6	Notification of Closure Completion	0 days	Sat 12/28/30	Sat 12/28/30
7	Documentation	30 days	Sun 12/29/30	Mon 1/27/31
8	State Submittal:Documentation Report	0 days	Mon 1/27/31	Mon 1/27/31



Project: Closure Plan
Date: Thu 2/12/26

Task	Inactive Milestone	Finish-only	
Split	Inactive Summary	External Tasks	
Milestone	Manual Task	External Milestone	
Summary	Duration-only	Progress	
Project Summary	Manual Summary Rollup	Deadline	
External Tasks	Manual Summary		
External Milestone	Start-only		