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February 9, 2016

Mr. Stephen Bopple
Ohio Environmental Protection Agency
Northeast District Office
2110 East Aurora Road
Twinsburg, Ohio 44087

Dear Mr. Bopple:

Subject: Revised Final Closure/Post-Closure Plan
Central Waste Disposal Facility
Permit to Install No. 02-14224
CEC Project 153-121.0001

On behalf of Bond Safeguard Insurance Company, Civil & Environmental Consultants, Inc. is submitting four copies of the revised Final Closure/Post-Closure Plan for the Central Waste Disposal Facility (CWDF) in Alliance, Mahoning County, Ohio. The CWDF is owned by Central Waste, Inc. and will be closed in accordance with Permit to Install (PTI) No. 02-14224 issued March 1, 2005 and the revised Final Closure/Post-Closure Plan.

The revised Final Closure/Post-Closure Plan incorporates BSIC and the Ohio EPA comments from the February 2016.

If you have any questions, please call us at 412-429-2324.

Sincerely,

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.

Matt Foltz, EIT
Project Consultant

Duane R. Lanoue, P.E.
Principal

SOLID WASTE
APPROVED
OHIO ENVIRONMENTAL PROTECTION AGENCY
FEB 16 2016
AS EVIDENCED BY COPY OF
LETTER OF APPROVAL
HERETO ATTACHED

Enclosure

cc: Craig Butler - Director Ohio EPA, CDO (without enclosure)
Commissioners – Mahoning County Solid Waste District (without enclosure)
Dave Fetchko - District Board of Health – Mahoning County (with enclosure)
Gene Stoll – Bond Safeguard Insurance Company (with enclosure)
Joe Costa, Central Waste Disposal Facility (with enclosure)

153-121.0001-L-Rev FCPC Plan.2-9-16/P

FINAL CLOSURE/POST-CLOSURE PLAN

CENTRAL WASTE DISPOSAL FACILITY
SMITH TOWNSHIP, MAHONING COUNTY, OHIO

Prepared for:

BOND SAFEGUARD INSURANCE COMPANY ("BSIC")
900 South Frontage Road, Suite 250
Woodridge, IL 60517

Prepared by:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC. ("CEC")
333 Baldwin Road
Pittsburgh, Pa 15205

OCTOBER 2015
Revised December 2015
Revised February 2016

CEC Project 153-121.0001

FINAL CLOSURE/POST-CLOSURE PLAN
CENTRAL WASTE DISPOSAL FACILITY
SMITH TOWNSHIP, MAHONING COUNTY, OHIO

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FINAL CLOSURE/POST-CLOSURE PLAN

INTRODUCTION

This Final Closure/Post-Closure Plan (Closure Plan) has been prepared for the Central Waste Disposal Facility (CWDF). The CWDF will be closed in accordance with Permit to Install (PTI) No. 02-14224 issued March 1, 2005. The CWDF is currently owned by Central Waste, Inc. (CWI). The permitted limit of waste placement is approximately 56.7 acres. As of October 2015, waste has been placed in Phases 1 through 6B over approximately 46.0 acres.

The existing grades of the landfill beyond the 2008 final cover area have grades that are either less than the minimum 5 percent slope in the previous working area at the top of the landfill or grades steeper than 3H:1V slopes due to settlement. The Closure Plan will address the regrading of waste to develop minimum and maximum grades that allow for a balance of excavation and fill volumes and the final cover system construction of the existing waste placement area.

In 2008, a 10.6 acre final cover system construction was partially completed. Construction was halted when a portion of the vegetative cover and geocomposite on the lower southwest slope failed. When halted, the installation of the recompacted soil barrier, geomembrane and geocomposite layers had been completed. Approximately 5.8 acres of vegetative cover had been placed. In addition, approximately 4.7 acres of transitional cover was constructed in 2008 on the east and west slopes directly north of the 2008 final cover construction. This Closure Plan will address the completion and repair of the 2008 final cover system and transitional cover.

In conjunction with the construction of the cell liner system for Phase 4 through 6B, an unlined waste area, permitted under PTI No. 02-880, within the permitted limits of waste was required to be relocated to the lined areas. At the completion of waste relocation activities for the Phase 5A, 5B and 6B liner construction, the southern edge of the unlined waste was temporarily covered with intermediate cover. The undisturbed portion of the unlined waste area was closed with a "1976 Cap" in accordance with Ohio EPA Guidance Document 0123. This Closure Plan will address the closure of the southern edge of the unlined waste area.

This Closure Plan incorporates the following variance request in accordance with OAC 3745-27-03(C):

1. Proposed waste regrading of the existing waste within Phase 1 through 6B to meet the minimum slope of 5% and maximum slope of 3H:1V in accordance with OAC 3745-27-08 (C)(4)(c) and (d) except for approximately 6.3 acres where the minimum proposed grade is 3%. This is discussed in more detail in Section 11(B)(5)(e).

This Closure Plan incorporates the following alteration requests/other changes as follows:

1. Proposed completion of a 3.3 acre area of the 2008 Final Cover construction without the removal of the existing recompacted soil barrier and geosynthetics based on meeting the minimum slope stability requirements and the completion of the existing vegetative cover layer to meet the minimum 30-inch thickness requirement. This is discussed in more detail in Section 11(B)(5)(e).

2. Proposed existing recompacted soil barrier requirements within the 4.9 acre area of exposed geosynthetics of the 2008 Final Cover construction that allow for the repair and recompaction of the top lift of recompacted soil barrier if in-situ permeability test results indicate a minimum permeability of 1.0×10^{-6} cm/s can be achieved. This is discussed in more detail in Section 11(G)(1).

3. Proposed methods to verify the 1976 Cap requirement of a minimum 2 feet thick layer of soil exists at the southern edge of the existing unlined waste area north of the current landfill limits. This is discussed in more detail in Section 11(G)(1).

4. Proposed design of the Phase 2B leachate collection sump and conveyance system based on current conditions with the sump pump installed through the leachate collection and cleanout pipe and the leachate forcemain installed within the waste and connected to the existing forcemain near the Phase 2A sump riser. This is discussed in more detail in Section 11(H)(1).

5. Proposed passive gas venting system installation since the landfill does not meet the minimum requirements of the New Source Performance Standards (NSPS) for the Non-Methane Organic Compound (NMOC) emissions rate of 50 Mg/yr based on Tier II test results from the November and December 2014 sampling event. This is discussed in more detail in Section 11(B)(4).

6. Proposed revisions to the Construction Quality Assurance (CQA) Plan for the soils and geosynthetics prequalification testing requirements in accordance with industry standards and Geosynthetic Research Institute (GRI) Standard Specifications. This is discussed in more detail in Section 11(B)(7).

This Closure Plan addresses the requirements of OAC Rule 3745-27-11 (Final Closure of a Sanitary Landfill Facility) and OAC Rule 3745-27-14 (Post-Closure Care of Sanitary Landfill Facilities). These rules require the plan to address OAC Rule 3745-27-10 (Groundwater Monitoring Program for a Sanitary Landfill Facility), OAC Rule 3745-27-12 (Explosive Gas Monitoring for a Sanitary Landfill Facility), OAC Rule 3745-27-15 (Financial Assurance for Solid Waste Facility Final Closure), and OAC Rule 3745-27-16 (Financial Assurance for Sanitary Landfill Facility Post-Closure Care).

This Closure Plan is presented in the order and format of the relevant regulations (OAC 3745-27-11 and Rule 3745-27-14) providing informational narrative to fulfill each regulation. Informational or policy portions of the regulations are not addressed in this plan.

There are no variances, other than the one specified above, or exemptions requested from the requirements of OAC Rule 3745-27-11 or OAC Rule 3745-27-14 or any alternative schedule for completing final closure and post-closure activities.

11(A) APPLICABILITY

11(A)(1) Operating Record

The Closure Plan will be kept in the operating record in accordance with OAC 3745-27-09.

11(A)(2) Acceptance of Waste Ceased Prior to June 1, 1994

The CWDF was closed on June 12, 2012 after filing for bankruptcy. The CWDF has ceased accepting waste.

11(B) FINAL CLOSURE/POST-CLOSURE PLAN

CWI has prepared this Closure Plan in accordance with this rule for the sanitary landfill facility, which will, at a minimum, contain all the items specified in paragraphs (B)(1) to (B)(6) of this rule. The Closure Plan will contain all of the items specified in paragraphs (B)(1) to (B)(6) of this rule for each noncontiguous unit of a sanitary landfill facility.

11(B)(1) Facility Name and Location

The CWDF is located in Smith Township, Mahoning County, Ohio at 12003 Oyster Road, Alliance, Ohio 44601. A location map showing the site on a United States Geological Survey (USGS) quadrangle is included on the Title Sheet of the Closure Plan drawing package.

11(B)(2) Variances and Exemptions

With the exception of the variance requested on page 2 of this Final Closure/Post Closure Plan, no variance or exemptions from OAC 3745-27-11, OAC 3745-27-14, or other rule in OAC Chapter 3745-27, or any alternative schedule for completing final closure activities, is proposed in the Closure Plan.

11(B)(3) Facility Contact

The CWDF contact regarding the sanitary landfill facility during closure and post-closure will be:

Joe Costa, General Manager
Central Waste, Inc.
12003 Oyster Road
Alliance, Ohio 44601
(724) 651-5429

Gene G. Stoll, P.E.
Vice President of Engineering
Bond Safeguard Insurance Company
900 South Frontage Road, Suite 250
Woodridge, IL 60517
(630) 495-9380

The Ohio EPA Northeast District Office will be notified in the event that the contact changes.

11(B)(4) Installation of Explosive Gas Control System

Municipal solid waste landfills produce gases (primarily methane and carbon dioxide) as a result of the decomposition of organic material within the waste. The purpose of a landfill gas control system is to control those gases generated within the landfill. Tier II testing was completed in November and December 2014 to determine if the site meets the minimum NSPS requirements for NMOC emission rate. The Tier II Landfill Gas Sampling Annual Report dated March 4, 2015 indicated that the NMOC emissions rate for the site in 2014 is below the NSPS emissions threshold of 50 Mg/yr based on the site-specific NMOC concentration yielded during the sampling event. Since the NMOC emissions rate is below the 50 Mg/yr threshold and no additional waste will be accepted, the NMOC emissions rate will not increase over time. Based on the NMOC emissions rate, an explosive gas collection and control system is not required per NSPS. A passive gas venting system will be installed to remove landfill gas through a series of vents spaced across the landfill. Sixteen gas extraction wells were previously installed and will be retrofitted as passive gas vents. An additional 29 passive gas vents will be installed in conjunction with final cover construction.

Since the waste within the landfill will be contained by a cell liner and final cover system, the gas generated by decomposing waste will be prevented from moving offsite. However, a passive gas venting system is needed to reduce the gas pressure placed on various landfill components, such as the FML within the final cover system. The passive gas venting system plan and details are provided in the Closure Plan drawing package.

11(B)(5) Compliance with OAC 3745-27-06

The Closure Plan drawings present the information as outlined in OAC 3745-27-06.

11(B)(5)(a) Plan Drawings

The Final Closure Plan Drawings provide a series of drawings depicting the closure design of the CWDF. The title sheet is provided as Drawing 1. Existing site conditions are presented on Drawing 2. The vertical and horizontal limits of the existing, permitted, and proposed top of waste grades are provided on Drawings 3 through 5. A waste relocation isopach is provided on Drawing 6 to show the thickness of waste cuts and fills required to achieve the proposed top of waste grades over the landfill. Drawing 7 presents the final grades of the final cover system, passive gas venting system and surface water control structures. Drawings 8 and 9 provide details for the final cover system, the passive gas venting system and surface water control structures. The Closure Plan drawings are provided in Appendix A.

11(B)(5)(b) Grid System

A grid system with Ohio State Plane northing and easting coordinates spaced no more than 500 feet apart is provided on the Closure Plan drawings.

11(B)(5)(c) Detail Drawings – Composite Cap System

The components of the permitted final cover system, from the top to bottom, include:

- 30-inch thick Vegetative Cover Layer
- Double-Sided Geocomposite Drainage Layer
- 40-mil textured Linear Low Density Polyethylene (LLDPE) Flexible Membrane Liner (FML)
- 18-inch thick Recompacted Soil Barrier (RSB)

The unlined waste area north of the CWDF requires a 2 foot thick clay cover in accordance with the 1976 Cap requirements outlined in the Ohio EPA Guidance Document 0123 dated March 29, 1995.

Drawings 8 and 9 present the details of the final cover system, 1976 Cap, cap penetrations, anchor trenches and surface water control benches. The Closure Plan drawings are provided in Appendix A.

11(B)(5)(d) Detail Drawings – Surface Water Control Structures

The surface water drainage channels and letdown structures will be constructed in accordance with the approved permit and this Closure Plan. The drainage areas to the South Sedimentation Pond as set forth in PTI 02-14224 issued March 1, 2005 have not been revised as part of this Closure Plan. The drainage areas to the North Sedimentation Pond have been reduced since the final phase, Phase 7, was not constructed. The Closure Plan is not proposing any revisions to the existing sedimentation ponds and details of the sedimentation ponds and discharge structures are not included with the Closure Plan.

Drawings 8 and 9 present the details of the surface water drainage channels and letdown structures. The Closure Plan drawings are provided in Appendix A.

11(B)(5)(e) Static and Seismic Stability

A slope stability analysis was performed to evaluate the overall stability of the proposed final cover with respect to the final grades and the final cover system of the landfill. Both static and seismic conditions were evaluated. The stability analysis evaluated the most probable potential shallow and deep failures through the interim waste and final cover grading. Results of the analysis indicate an acceptable factor of safety against slope failure for both static and seismic conditions. Slope stability analysis results are presented in Section (C)(4) of the PTI Application

Since the CWDF did not reach the permitted final waste grades over most of the landfill, the proposed final grading plan incorporates the following design revisions:

- A maximum waste height approximately 10 feet to 80 feet below permitted final waste grades;
- The landfill slopes range from 3% to 5% on the top and 3H:1V to 4H:1V grades on the slopes; and
- The north slope, which is at interim waste grades, will be regraded to incorporate an access road, surface water bench and letdown structure.

CEC, on behalf of BSIC, is proposing a variance request in accordance with OAC 3745-27-03(C) for a minimum waste grade of 3% over approximately 6.3 acres of the 46 acres of waste placement. The 3% waste grade is necessary to minimize the total volume of waste relocation and obtain a balance between the excavation and fill volumes. The balance of excavation and fill volumes is necessary so that additional waste does not need to be hauled offsite for disposal or so that additional waste or soil does not need to be hauled to the landfill. The 3% grade provides that positive drainage can be maintained and that ponding areas will not develop during settlement of waste over time.

Based on the existing and proposed waste grades at or below the final waste grades, a static and seismic stability analysis and the final cover veneer stability was not performed as part of this Closure Plan except for a 3.3 acre area of the 2008 Final Cover construction.

A 3.3 acre area of the partially constructed 2008 final cover system was evaluated for stability. This area encompasses portions of the east and west slopes in the northern most area of the 2008 final cover system. This area was not affected by the final cover failure and the vegetative cover was almost completed in this area. CEC has evaluated the static and seismic stability of this area based on the existing grades and interface test results of the final cover components. The required factors of safety for static and seismic stability were met. The 2008 Final Cover Stability Analysis is included in Appendix B.

11(B)(5)(f) Groundwater Detection Monitoring Plan

The groundwater monitoring system is described in the approved Groundwater Detection Monitoring Program (Revision 9) dated June 18, 2015.

11(B)(5)(g) Financial Assurance

Financial assurance information, including cost estimates for final closure of the landfill and for the 30-year post-closure period, is addressed. In addition, the financial assurance mechanism as required by Rules 3745-27-15 and 3745-27-16 is addressed.

Financial Assurance Instrument: A financial assurance instrument based on previously approved closure and post-closure estimates for the landfill was executed. The closure and post closure costs were estimated at $11,636,446.

Closure Cost Estimate: The closure costs were estimated at $5,727,982.

Post-Closure Cost Estimate: The post-closure costs were estimated at $5,908,464.

11(B)(6) Final Cover Material, Availability and Suitability

Soils for the RSB and vegetative cover layer will be obtained from the onsite Borrow Area C located southwest of the landfill.

The soils within Borrow Area C have previously been approved for recompacted soil barrier during the 2008 final cover construction and meet the prequalification requirements provided in

OAC 3745-27-08 (21)(f). It has been estimated that Borrow Area C has the required volume of soils necessary for both the RSB and vegetative cover layers.

11(B)(7) Quality Assurance/Quality Control Plan

The CQA/QC Plan provides a detailed description of the final cover system construction methods and construction quality assurance/quality control procedures. Attachment A of the CQA/QC Plan provides the revised material prequalification requirements for the final cover system components to meet current industry standards and GRI Standard Specifications. The revised Attachment A of the CQA/QC Plan is provided in Appendix C.

11(B)(8) Explosive Gas Monitoring Plan

The explosive gas monitoring system is described in the approved Explosive Gas Monitoring Plan.

11(B)(9) Erosion Control

The primary means to control erosion will be achieved by establishing and maintaining a dense, vegetative cover on the final cover. The surface of the final cover will be mulched, fertilized and seeded as soon as possible after construction. The seed mix used on the final cover will be dependent on the season and will include mixes previously demonstrated to provide a dense growth. Mulch will consist of hay or an approved equivalent (i.e., hydroseed mulch) applied to minimize erosion until the vegetation is established. Areas exhibiting excessive erosion will be regraded, reseeded, mulched, and fertilized as necessary.

Erosion may occur in and around surface water control structures which include surface water control benches, collection channels, culverts, perimeter channels and the sedimentation ponds. Surface water control structures will be lined with either riprap or vegetation to prevent erosion. Erosion matting may be used in grass lined benches and channels if necessary to prevent erosion.

Temporary erosion control measures include the use of sediment barriers, such as silt fences and filter socks, which will be used as necessary to reduce the sediment load in surface water run-off entering the sedimentation basin. They will also be used in areas where run-off cannot be diverted to the sedimentation basin.

Surface water runoff will be directed to the sedimentation ponds and north impoundment. The sedimentation ponds and north impoundment will reduce the transport of sediment offsite during and after earth moving activities associated with construction of the landfill. The north impoundment does not discharge offsite.

11(B)(10) Contingency Plans

Leachate: Leachate seeps are not anticipated in the landfill after construction of the final cover system. If seeps are detected, the area will be investigated by qualified personnel to determine the cause. If a breach in the RSB is suspected, the damaged portion of the final cover will be excavated and reconstructed. Leachate outbreaks will be prevented from flowing to the surface water control structures. CEC, on behalf of BSIC, will take immediate steps to eliminate or control the conditions contributing to leachate production or buildup, and will dispose of collected leachate in accordance with applicable law.

Fire: In the event of a fire during closure or post-closure periods, soil will be used to smother the flame. If a fire is burning uncontrollably, a fire break will be excavated to isolate the affected area. The local fire department will be contacted for all fires reported at the site.

Differential Settlement: Areas of landfill exhibiting excessive amounts of differential settlement may be excavated to determine the extent of potential problems. Remediation could include excavating the final cover system in the area of the potential problem to determine if the final cover system is damaged. If the final cover system is damaged, the area will be backfilled and the final cover system rebuilt over the new fill. If no damage to the final cover system is discovered, these areas will be repaired and regraded to promote run-off of surface water and reseeded. Areas will be repaired as weather permits.

11(C) MANDATORY CLOSURE

Mandatory closure of the CWDF has been triggered.

CEC, on behalf of BSIC, will begin closure activities in accordance with this Closure Plan within 7 days of the approval date of this Plan and complete closure activities no later than 365 days after closure has begun.

Final closure activities for unit(s) of a sanitary landfill facility will include, at a minimum, the items specified in sections 11(G) and (H) of this plan.

11(D) NOTIFICATION OF DATE TO CEASE ACCEPTANCE OF SOLID WASTE

The CWDF has ceased accepting solid waste.

CEC, on behalf of BSIC, will send a copy of the Closure Plan specified above to the following:

- District Board of Health – Mahoning County
- Mahoning County Solid Waste Management District
- Ohio EPA Northeast District Office

11(E) NOTIFICATION OF ACTUAL DATE

The CWDF has ceased accepting solid waste.

11(F) FINAL CLOSURE ACTIVITIES

The CWDF will begin closure activities in accordance with this Closure Plan within 7 days of the approval date of this Plan and complete closure activities no later than 365 days after closure has begun.

11(G) COMPOSITE CAP SYSTEM CONSTRUCTION

The CWDF final cover system will be constructed in accordance with the approved PTI.

11(G)(1) Composite Cap System Design

The components of the permitted final cover system, from the top to bottom, are discussed below:

Vegetative Cover Layer: The thickness of this layer will be 30 inches and will consist of clean soil final coverable of supporting vegetation. The surface of the final cover protection layer will be fertilized, seeded and mulched as necessary to provide a dense vegetative cover.

Geocomposite Drainage Layer: This geosynthetic drainage layer will consist of a geotextile layer bonded to each side of a geonet. The geonet provides drainage of percolated water. The upper geotextile layer provides a filter to allow percolated water to enter the geonet and reduce the infiltration of soil from the overlying soil cover. The bottom layer of geotextile along the 3H:1V side slopes provides a cushion for the underlying FML and provides a frictional interface contact between the textured FML and geocomposite layer.

Flexible Membrane Liner (FML): The FML reduces infiltration of water into the landfill. The FML will be a 40-mil thick LLDPE FML material, with textured surfaces to increase friction thereby increasing the stability of the final cover. The FML material and installation methods will meet the specifications in the CQA/QC Plan.

Recompacted Soil Barrier (RSB): The thickness of this layer will be 18 inches and consist of soil with a permeability less than or equal to 1.0×10^{-6} cm/sec. The prequalification testing, material and installation methods will meet the requirements of the revised Attachment A of the CQA/QC Plan provided in Appendix C.

A 4.9 acre area of the partially constructed 2008 final cover system has exposed geosynthetics. Over a four year period since 2008, the temperature of the RSB was monitored for freezing temperatures. During the monitoring period, the top two lifts experienced temperatures below 32°F. However, the second lift experienced temperatures below 32°F for a time period significantly less than the time period the top lift experienced temperatures below 32°F. The exposed geosynthetics will be removed during the repair of the 2008 final cover system. CEC has collected six undisturbed samples of the existing RSB within the 4.9 acre area of exposed geosynthetics to determine the permeability of the existing RSB. The results of the permeability tests range from 4.6×10^{-6} cm/sec to 1.8×10^{-8} cm/sec, with only two of samples having a permeability less than the minimum required permeability of 1.0×10^{-6} cm/sec. Since these results indicate that the existing RSB generally meets the minimum required permeability of 1.0×10^{-6} cm/sec per OAC 3745-27-08 (21)(g)(iv), CEC proposes that only the top lift of the RSB requires repair and recompaction to the approved Best Fit Line of Optimums compaction criteria to meet the minimum permeability requirement. The permeability results are provided in Appendix D.

Unlined Waste Area Closure: In conjunction with the construction of the cell liner system for Phase 4 through 6B, an unlined waste area, permitted under PTI No. 02-880, within the permitted limits of waste was required to be relocated to the lined areas. At the completion of waste relocation activities for the Phase 5A, 5B and 6B liner construction, the southern edge of the unlined waste was temporarily covered with intermediate cover. The undisturbed portion of the unlined waste area was closed with a "1976 Cap" in accordance with Ohio EPA Guidance Document 0123.

CEC will verify that a minimum thickness of 2 feet of soil is present along southern edge of the unlined waste area. Test pits will be excavated on a 50 foot spacing to verify the thickness of the existing soil cover. If the test pits indicate that less than 2 feet of soil exists in an area, additional soil will be placed in accordance with the requirements of recompacted soil barrier.

11(G)(2) Composite Cap System per OAC 3745-27-09(B)(1) Effective June 1, 1994

Not applicable.

11(G)(3) Composite Cap System per OAC 3745-27-10(C)(1) or (C)(4) Effective July 29, 1976

Not applicable.

11(G)(4) Composite Cap System per OAC 3745-27-11(M) Effective June 1, 1994

Not applicable.

11(H) OTHER CLOSURE ACTIVITIES

11(H)(1) Compliance with Rule 3745-27-19

The CWDF will continue to comply with Rule 3745-27-19 until the closure certification is submitted and the post-closure care period begins.

The leachate management system incorporates leachate collection sumps that pump leachate through forcemain piping to the existing aboveground leachate storage tank. In 2012, the Phase 2B leachate collection sump riser broke at the elbow located approximately 70 feet below the surface. At that time, a pump was installed at the Phase 2B leachate collection pipe cleanout and lowered to the Phase 2B sump. A temporary forcemain pipe was installed from the Phase 2B leachate collection pipe cleanout to the leachate forcemain pipe near the Phase 2A leachate sump riser. This temporary system has been operating to maintain the required minimum 12-inch head of leachate on the liner. Since it is not feasible to repair the existing Phase 2B sump riser pipe, CEC proposes to upgrade the temporary system as a permanent system. The temporary forcemain will be revised from a single-contained forcemain pipe to a dual-contained forcemain pipe installed within the waste below the final cover system. The dual-contained forcemain pipe will provide protection during final cover construction and allow for leak detection at designated leak detection risers. Collected leachate will be disposed in accordance with applicable law.

11(H)(2) Surface Water and Erosion Control

The CWDF will have surface water control structures and erosion control measures as indicated in this Closure Plan. Surface water drainage control serves the purposes of:

- Reducing excess surface water run-off in operational areas;
- Directly removing run-off from the landfill to minimize leachate generation; and
- Providing controlled run-off from the landfill side slopes to reduce erosion.

The surface water management system is designed to minimize silting and scouring, and collect, route, and retain surface water run-on, run-off, and sediment discharge from the facility. The surface water management and erosion control systems consist of:

- Perimeter surface water channels;
- Drainage culverts;
- Sedimentation ponds;
- Permanent diversion berms;
- Temporary erosion controls; and
- Permanent seeding.

The permanent and temporary surface water control structures, excluding sedimentation ponds, were designed to convey the peak flow resulting from the 25-year/24-hour storm event by non-mechanical means. To reduce erosion, the channels are lined with grass and riprap aprons are constructed at the sedimentation basin discharge structure outlets. The sedimentation ponds and discharge structures have been constructed and are operating as designed. The drainage area for each sedimentation pond has not been increased so the design of the each sedimentation pond did not require any revisions.

The final cover system slope will be maintained to repair erosion rills and poorly vegetated areas. Erosion rills will be backfilled with soil and the area will be vegetated. Poorly vegetated areas will be repaired with additional seed, fertilizer, and mulch. If needed, erosion control matting may be installed in erosion prone areas.

The north slope of the landfill, which is at interim waste grades, will be regraded to incorporate an access road, surface water bench and letdown structure.

The surface water channel north of the landfill limits will consist of a 2 foot deep by 20 foot wide "V" channel with 20 percent slopes. The surrounding area will be regraded at a minimum slope of two percent towards the channel. The surface water channel will discharge runoff from the northern portion of the CWDF to the north impoundment. This area currently discharges to the north impoundment.

11(H)(3) Groundwater Monitoring System

The groundwater monitoring system is described in the approved Groundwater Detection Monitoring Program.

A new monitoring well, MW-31D, will be installed north of Phase 5B as part of the Groundwater Detection Monitoring Program. MW-31D will be screened within the Middle Mercer Shale UAS. Due to the construction activities in this area associated with the closure construction, MW-31D will be installed after the closure construction activities are finalized. The location of MW-31D is located on Drawing 7 of the Closure Plan drawings provided in Appendix A.

11(H)(4) Vector Control

The final cover system will ensure that waste will not be exposed and become sources of food or harborage for insects and rodents. Additionally, drainage of surface water will be maintained to reduce potential mosquito breeding areas. In the event that a problem does arise with rodents or other vectors, a professional experienced in the removal of pests will be consulted to determine appropriate action.

11(H)(5) Verification of Notices

No later than 60 days, following the completion of final closure construction activities, CEC, on behalf of BSIC, will record on the plat and deed to the sanitary landfill facility, a notation describing the acreage, location, approximate depth, volume and nature of solid waste deposited within the proposed expansion. The plat and deed will be submitted to the following agencies:

- District Board of Health – Mahoning County;
- Mahoning County Recorder of Deeds; and
- Ohio EPA Northeast District Office.

11(H)(6) Posting of Signs

Following closure of the CWDF, a sign with lettering at least 3 inches high, will be posted at the landfill entrance indicating that the landfill no longer accepts solid waste. This sign will be maintained in a legible condition at least two years after final closure activities of all phases have been completed.

11(H)(7) Unauthorized Access

Access control will be accomplished by a secure locking gate at the site entrances. The site entrance gate will be maintained as needed to remain functional during the post-closure care period. The Ohio EPA, Mahoning County Health Commissioner, and the Director, or their authorized representatives, upon proper identification, may enter the facility at any time for the purpose of determining compliance with OAC Chapter 3745 and ORC Chapter 3734 or other applicable laws.

11(I) COMPLETION OF FINAL CLOSURE ACTIVITIES

Closure activities will begin 7 days after the approval date of this Closure Plan and closure activities will be completed no later than 365 days after closure has begun.

11(J) FINAL CLOSURE CERTIFICATION

Not later than 90 days after the completion of final closure activities, CEC, on behalf of BSIC, will submit to the Ohio EPA Northeast District Office for concurrence and District Board of Health – Mahoning County, a written certification report including verification that the landfill has been closed in accordance with Rule 3745-27-11 and this Closure Plan.

11(J)(1) List of Construction Certification Reports

The Final Closure Certification will include a reference to the construction certification report for construction of the final cover system with submittal date, EPA concurrence date, and a topographic map of the entire landfill facility showing the areas certified by the report. The map will show limits of waste placement, surface water control structures, leachate collection system, and passive gas venting system.

11(J)(2) Groundwater Monitoring System

The Final Closure Certification will include a demonstration that the groundwater monitoring system meets the requirements of OAC 3745-27-10.

11(J)(3) Plat and Deed

The Final Closure Certification will include a copy of the plat and deed showing the notation required by Paragraph 11(H)(5) of this Closure Plan and bearing the mark of recordation of the office of Mahoning County.

11(J)(4) Posted Signs

The Final Closure Certification will include a demonstration that the sign required by Paragraph 11(H)(6) has been posted and that all entrances and access roads have been blocked as required by Paragraph 11(H)(7) of this Closure Plan.

11(K) ENTRANCE TO FACILITY

The Ohio EPA, Health Commissioner and the Director, or their authorized representatives, upon prior identification, may enter the facility at any time for the purpose of determining compliance with applicable law.

11(L) FINAL CLOSURE OF UNIT

Final closure of the facility will be completed in a manner that minimizes the need for further maintenance and minimizes post-closure formation and release of leachate and explosive gases to air, soil, groundwater, or surface water to the extent necessary to protect human health and the environment.

14(A) POST-CLOSURE ACTIVITIES

Post-closure activities will comply with Rule 3745-27-14. Upon completion of post-closure care, written certification will be submitted to the Ohio EPA Northeast District Office for concurrence.

14(A)(1) Continuing Operation and Maintenance of Landfill Systems

The post-closure activities include the continuing operation and maintenance of the following:

- Final cover system;
- Leachate management system;
- Surface water management system;
- Passive gas venting system;
- Groundwater monitoring; and
- Gas migration monitoring system.

These systems will be monitored as part of the regular quarterly inspection process throughout the post-closure care period.

Final Cover System: The final cover system will be inspected regularly and repaired as necessary. Corrective measures will be required if inspections reveal erosions, non-vegetated areas or damage. Repairs may include regrading, seeding non-vegetated areas, or replacement of final cover system components depending on the depth of any observed damage.

Leachate Management: The leachate management system consists of leachate collection trench inside the clay cut-off wall, cleanouts, sump and pump. Leachate generated within the landfill flows to leachate collection pipes which convey leachate to a sump. Leachate is pumped from the sump using a submersible pump. Leachate is then pumped through a force main to the aboveground leachate storage tank. The leachate is disposed in accordance with applicable law.

The pump will be inspected regularly and repaired as necessary. Cleanouts located along the perimeter of the landfill provide access to the perforated leachate collection pipe to allow for an annual inspection of the leachate collection pipe and removal of any sediment using high pressure water jet cleaning devices.

Surface Water Management: The surface water management system includes surface water control benches, downchutes, culverts, perimeter channels and sedimentation ponds. These drainage structures will be inspected in accordance with the Stormwater Pollution Prevention Plan and repaired as necessary. Corrective measures will be required if inspections reveal settlement, erosion, displacement of riprap, or silting of the system. Repairs may include regrading, physical repair of structure, replacement of riprap, or revegetation. During the post-closure period, accumulated silt will be removed from the sedimentation ponds on an as-needed basis.

Passive Gas Venting System: The passive gas venting system will be inspected quarterly. Any required maintenance will be performed as needed. Possible maintenance includes replacing or repairing damaged passive gas vents.

Gas Migration Monitoring System: Gas migration monitoring is completed quarterly for the initial 5 years of post-closure and semi-annual between 5 years post-closure and the Ohio EPA Director's authorization to cease monitoring. Monitoring is conducted at designated probes, punch bar and building alarm locations in accordance with the Explosive Gas Monitoring Plan.

Groundwater Monitoring System: Groundwater monitoring wells will be inspected at the time of groundwater sample collection for cracks in the concrete pad, frost heave, and damage or vandalism to the protective steel casing. Appropriate repairs will be performed as necessary. Protective steel casings will be repainted with a high visibility paint and well identification numbers will be marked as needed.

14(A)(2) Maintaining the Integrity and Effectiveness of the Final cover System

Areas displaying noticeable amounts of differential settlement may be excavated to determine the extent of potential problems. Remediation could include removing the final cover system in the area of the potential problem to determine if the final cover system is damaged. If necessary, the area will be reconstructed and soil will be used as backfill to raise the area to the top of waste grades. The final cover system will be rebuilt over the new fill. If no damage to the final cover system is observed, only the vegetative cover layer will be repaired, regraded and reseeded to promote run-off of surface water. Repairs will be performed as weather conditions allow.

Overgrowth of the vegetative cover will be controlled by mowing. Large wooded plants will be pulled from the site to prevent root penetrations into the drainage geocomposite. Any areas lacking vegetation will be reseeded, fertilized and mulched as needed to maintain adequate vegetative cover. Areas of the final cover that are eroded will be regraded to fill in erosion rills as weather permits. The area will then be seeded, fertilized and mulched.

14(A)(3) Leachate Outbreak Repair

Leachate outbreaks will be repaired by the following methods:

- Contain and properly manage the leachate;
- If necessary, collect, treat and dispose of the leachate; and
- Take action to minimize, control or eliminate the conditions which contribute to the production of leachate.

14(A)(4) Quarterly Inspection of the Sanitary Landfill Facility

The CWDF will be inspected on a quarterly basis. Within 15 days after inspection, a report will be submitted to the Ohio EPA Northeast District Office detailing the inspection results and the schedule of any actions to be taken to maintain compliance with Rule 3745-27-14 (A)(1) and (A)(2).

14(A)(5) Monitoring and Reporting Requirements

CWI will perform groundwater monitoring and reporting in accordance with the approved Groundwater Detection Monitoring Program and OAC 3745-27-10(D)(5) or as altered by (D)(6) during the post-closure care period.

CWI will perform explosive gas monitoring and reporting in accordance with the approved Explosive Gas Monitoring Plan. The reporting schedule for explosive gas migration monitoring will be quarterly between the time of closure and 5 years post-closure. Monitoring will be semi-annual between 5 years post-closure and the Ohio EPA Director's authorization to cease monitoring.

The CWDF will comply with OAC Chapter 3745-76 for landfill emissions and comply with any monitoring required by any orders or authorizing documents.

14(A)(6) Annual Report

An annual report will be submitted no later than the first day of April to the Ohio EPA Northeast District Office, District Board of Health – Mahoning County, and to the Operating Record. The annual report will contain the following information:

- A summary of the quantity of leachate collected for treatment and disposal on a monthly basis during the year, and the location of leachate treatment and/or disposal;
- Results of analytical testing of an annual grab sample of leachate for the parameters specified in Appendix I of OAC 3745-27-10. The grab sample will be collected from the leachate storage tank or other composite sample locations; and
- The most recent updated post-closure cost estimate adjusted for inflation and for any change in the post-closure cost estimate required by OAC 3745-27-16.

14(A)(7) Reports and Record Keeping

Records and reports generated by OAC 3745-27-14 (A)(4) and (A)(6) will be kept for the duration of the post-closure period in the operating record where the records and reports are available for inspection by the Ohio EPA or District Board of Health – Mahoning County during normal working hours.

14(B) WRITTEN CERTIFICATION

Upon completion of the post-closure period, CWDF will submit to the Ohio EPA written certification that the facility has completed post-closure activities in accordance with Rule 3745-27-14 and this Closure Plan. The report will be prepared and signed by an independent, professional engineer registered in the State of Ohio. The certification will include documentation which demonstrates that all post-closure care activities have been completed. The documentation will include the following:

- A summary of changes to leachate quality and quantity;
- Rate of leachate generation and depth of leachate at each leachate sump, with an explanation of how the figures were derived;
- A summary of any on-going groundwater assessment or corrective measures;
- A summary of explosive gas migration and generation by the landfill; and
- An assessment of the integrity and stability of the final cover system if post-closure care activities cease.

14(C) COMPLETION OF GROUNDWATER DETECTION MONITORING IN NON-CONTIGUOUS UNITS

The CWDF is one contiguous unit. Refer to the Groundwater Detection Monitoring Program.

14(D) ENTRANCE TO FACILITY

The Ohio EPA, Health Commissioner and the Director, or their authorized representatives, upon prior identification, may enter any unit(s) of the sanitary landfill facility at any time during the post-closure period for the purpose of determining compliance with applicable law.

APPENDIX A

CLOSURE PLAN DRAWINGS

APPENDIX A

CLOSURE PLAN DRAWING LIST

DRAWING NO.	DRAWING TITLE
1	Title Sheet
2	Existing Conditions
3	Permitted Top of Waste Grades
4	Waste Regrading Plan
5	Waste Regrading Isopach
6	Final Cover Plan
7	Passive Gas Vent and Surface Water Control System Plan
8	Final Cover System Details
9	Passive Gas Vent and Surface Water Control System Details

CLOSURE PLAN
CENTRAL WASTE DISPOSAL FACILITY
SMITH TOWNSHIP, MAHONING COUNTY, OHIO

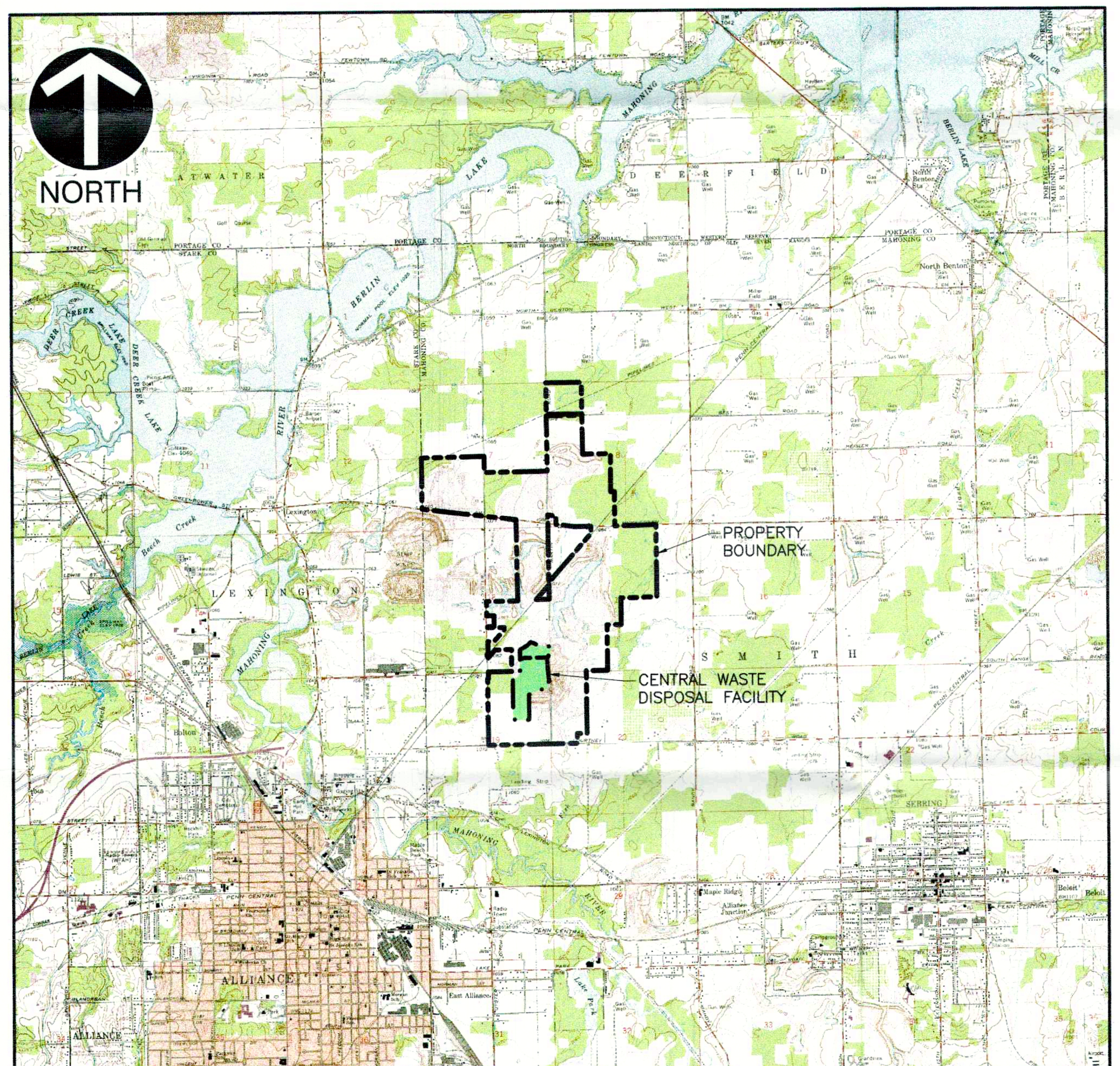
PREPARED FOR:

BOND SAFEGUARD INSURANCE COMPANY
900 S. FRONTAGE ROAD
SUITE 250
WOODRIDGE, IL 60517

PREPARED BY:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
333 BALDWIN ROAD
PITTSBURGH, PA. 15205
(412) 429-2324 (800) 365-2324

CEC PROJECT 153-121.0001



SITE VICINITY MAP

REFERENCE

USGS 7.5 MIN. TOPOGRAPHIC QUADRANGLE
ATWATER, OHIO, DATED 1960. PHOTOREVISED 1979.
DEERFIELD, OHIO, DATED 1960. PHOTOREVISED 1979.
LAKE MILTON, OHIO, DATED 1966. PHOTOREVISED 1979.
LIMAVILLE, OHIO, DATED 1960. PHOTOREVISED 1984.
ALLIANCE, OHIO, DATED 1966. PHOTOREVISED 1971 AND 1978.
DAMASCUS, OHIO, DATED 1966. PHOTOREVISED 1992.
ROBERTSVILLE, OHIO, DATED 1960. PHOTOREVISED 1985.
HOMEWORTH, OHIO, DATED 1960. PHOTOREVISED 1971.
HANOVERTON, OHIO, DATED 1959. PHOTOREVISED 1971.

SCALE IN FEET
0 4000 8000

LIST OF DRAWINGS

DRAWING NO.	DRAWING TITLE	REV NO.
1	TITLE SHEET	0
2	EXISTING SITE CONDITIONS	0
3	PERMITTED TOP OF WASTE GRADES	0
4	WASTE REGRADING PLAN	0
5	WASTE REGRADING ISOPACH	0
6	FINAL COVER PLAN	0
7	PASSIVE GAS VENT AND SURFACE WATER CONTROL SYSTEM PLAN	0
8	FINAL COVER SYSTEM DETAILS	0
9	PASSIVE GAS VENT AND SURFACE WATER CONTROL SYSTEM DETAILS	0

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OCTOBER 2015

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OHIO ENVIRONMENTAL PROTECTION AGENCY
FEB 16 2016
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STATE OF OHIO
DUANE R. LANOUE
E-61772
REGISTERED PROFESSIONAL ENGINEER
2-9-16

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BOND SAFEGUARD INSURANCE COMPANY
CLOSURE PLAN
CENTRAL WASTE DISPOSAL FACILITY
ALLIANCE, OHIO

DRAWN BY: MJI	CHECKED BY: TES	APPROVED BY: DRL *
DATE: 10/8/15	DWG SCALE: AS SHOWN	PROJECT NO: 153-121-0001
TITLE SHEET		DRAWING NO.: 1

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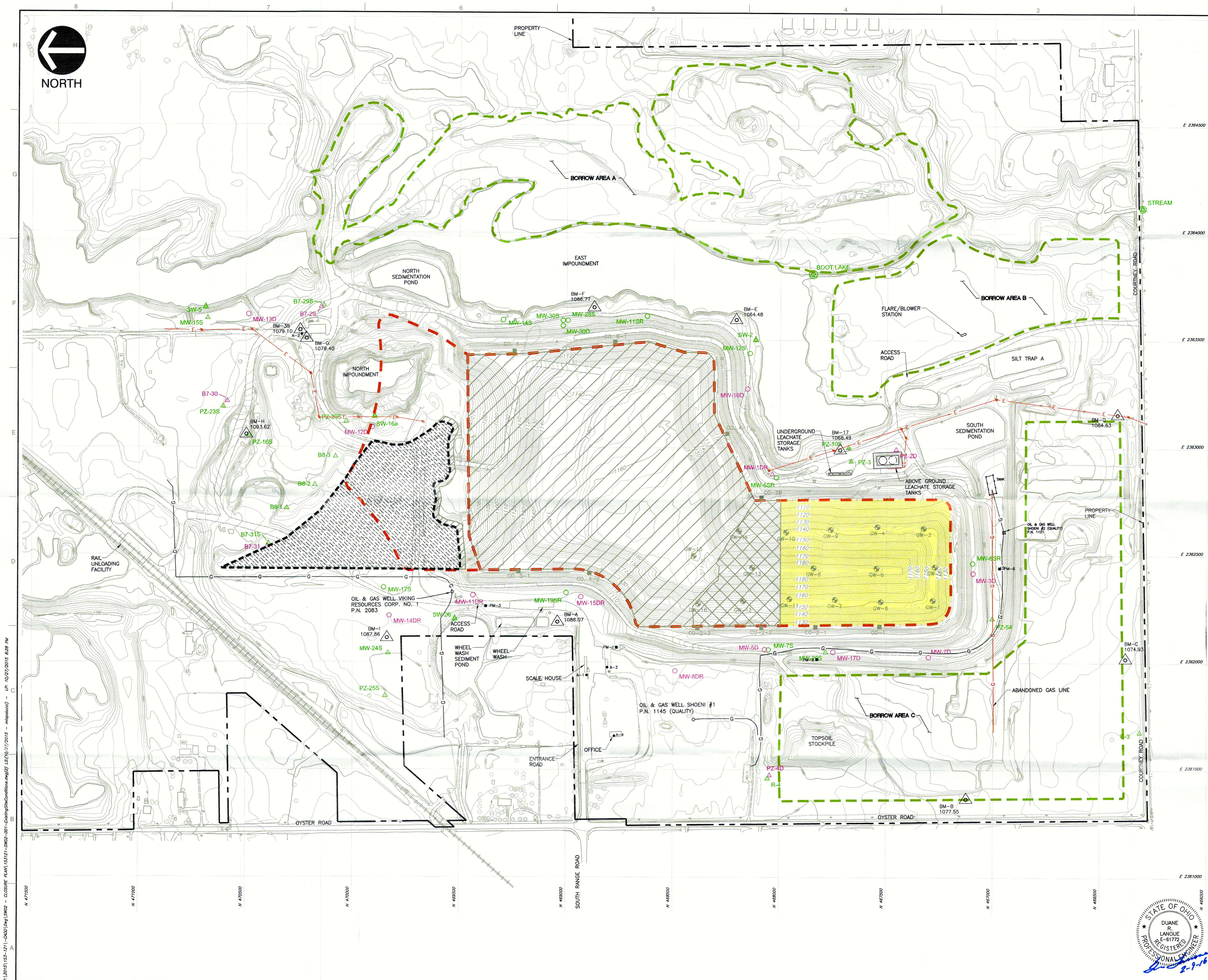

REVISION RECORD

NO	DATE	DESCRIPTION

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NO	DATE	DESCRIPTION

LEGEND

- EXISTING CONTOUR
- PERMITTED LIMIT OF WASTE
- EXISTING LIMIT OF WASTE
- BORROW AREA LIMIT
- LIMIT OF EXISTING PTI 02-880 AREA
- EXISTING UNDERGROUND ELECTRIC
- EXISTING OVERHEAD ELECTRIC
- EXISTING GAS LINE
- ABANDONED GAS LINE
- EXISTING FORCEMAIN
- BM-34 1095.53 — FACILITY BENCHMARK LOCATION
- BOOT LAKE — SURFACE WATER SAMPLING LOCATION
- SW-2A — SURFACE WATER GAUGE
- PZ-1S — GLACIAL/MINE SPOIL PIEZOMETER
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- MW-11DR — BEDROCK MONITORING WELL
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- PM-2 — PERMANENT GAS MONITORING PROBE
- GW-6 — EXISTING GAS EXTRACTION WELL
- CO-1 — EXISTING LEACHATE RISER CLEANOUT
- PTI 02-880 AREA WITH 1976 CAP
- 2008 CAP WITH PARTIAL FINAL COVER
- AREA WITH INTERMEDIATE COVER
- AREA WITH TRANSITIONAL COVER (SEE NOTE 1)

NOTES

1. THIS AREA REQUIRES STRIPPING OF IN-PLACE TRANSITIONAL COVER FOR USE IN THE WASTE REGRADING OR IN THE CONSTRUCTION OF THE FINAL COVER SYSTEM.

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OHIO ENVIRONMENTAL PROTECTION AGENCY
FEB 16 2016
AS EVIDENCED BY COPY OF LETTER OF APPROVAL HERETO ATTACHED

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OHIO EPA NEDO

REFERENCE

1. TOPOGRAPHIC MAPPING WAS PREPARED BY KEDDAL AERIAL MAPPING FROM AERIAL PHOTOGRAPHY DATED AUGUST 6, 2009.
2. GROUND SURVEY DATED 10/9/15 PERFORMED BY AKINS.

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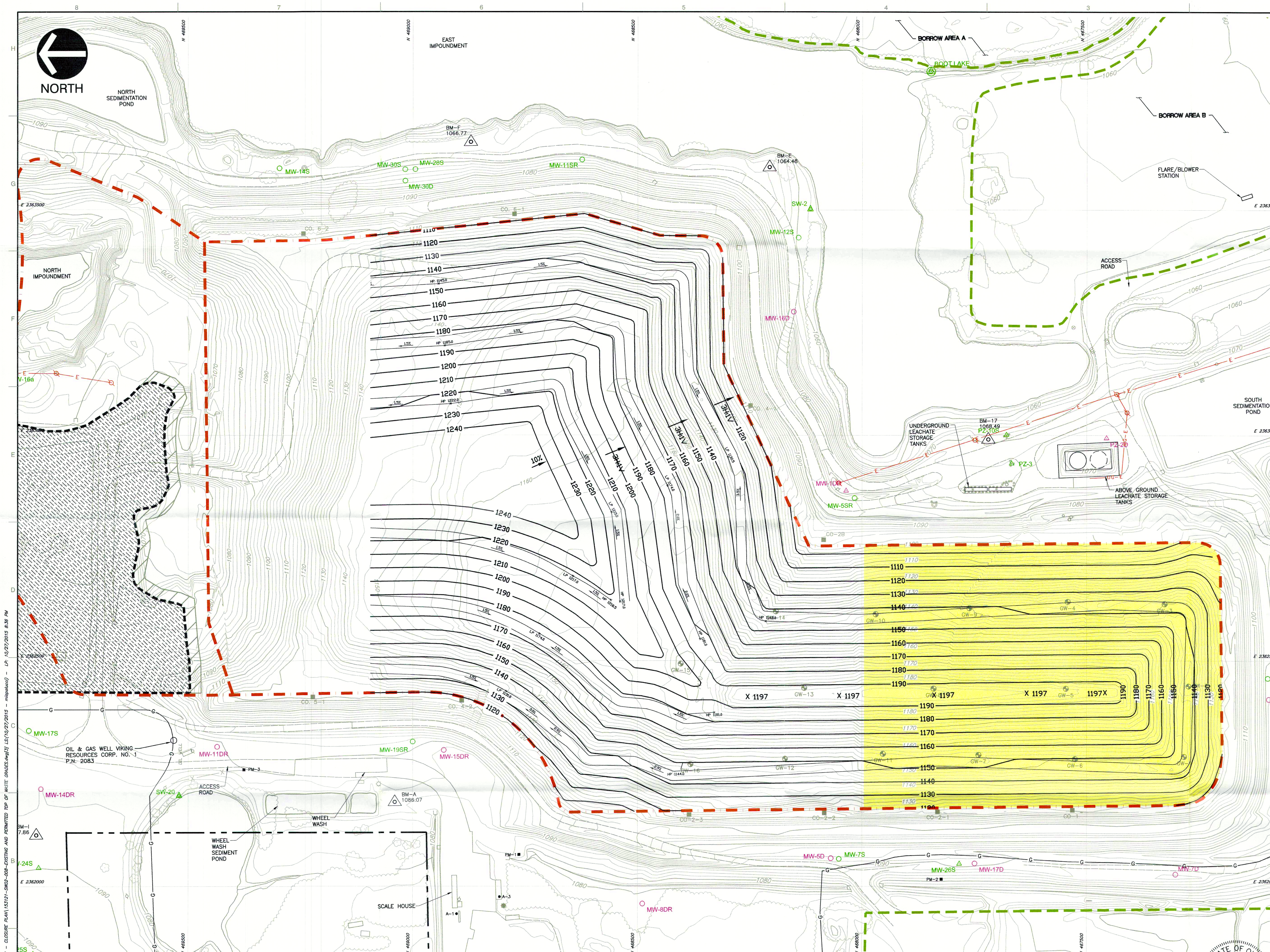
BOND SAFEGUARD INSURANCE COMPANY
CLOSURE PLAN
CENTRAL WASTE DISPOSAL FACILITY
ALLIANCE, OHIO

STATE OF OHIO — DUANE R. LANOUE — E-61772 — REGISTERED PROFESSIONAL ENGINEER — 2-9-16

DRAWN BY: MJI	CHECKED BY: TES	APPROVED BY: DRL*
DATE: 10/8/15	DWG SCALE: AS SHOWN	PROJECT NO: 153-121.0001

EXISTING SITE CONDITIONS

DRAWING NO.: 2



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SUBMITTAL RECORD

NO	DATE	DESCRIPTION

LEGEND

- EXISTING CONTOUR
- PERMITTED TOP OF WASTE CONTOUR
- PERMITTED LIMIT OF WASTE
- EXISTING LIMIT OF WASTE
- BORROW AREA LIMIT
- UG-E — EXISTING UNDERGROUND ELECTRIC
- E — EXISTING OVERHEAD ELECTRIC
- G — EXISTING GAS LINE
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- CO-1 — EXISTING LEACHATE RISER CLEANOUT
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- 2008 CAP WITH PARTIAL FINAL COVER
- AREA WITH INTERMEDIATE COVER

NOTES

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SOLID WASTE
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OHIO ENVIRONMENTAL PROTECTION AGENCY
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REFERENCE

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ALLIANCE, OHIO

STATE OF OHIO — DUANE R. LANOUE E-61772 — REGISTERED PROFESSIONAL ENGINEER — 2-9-16

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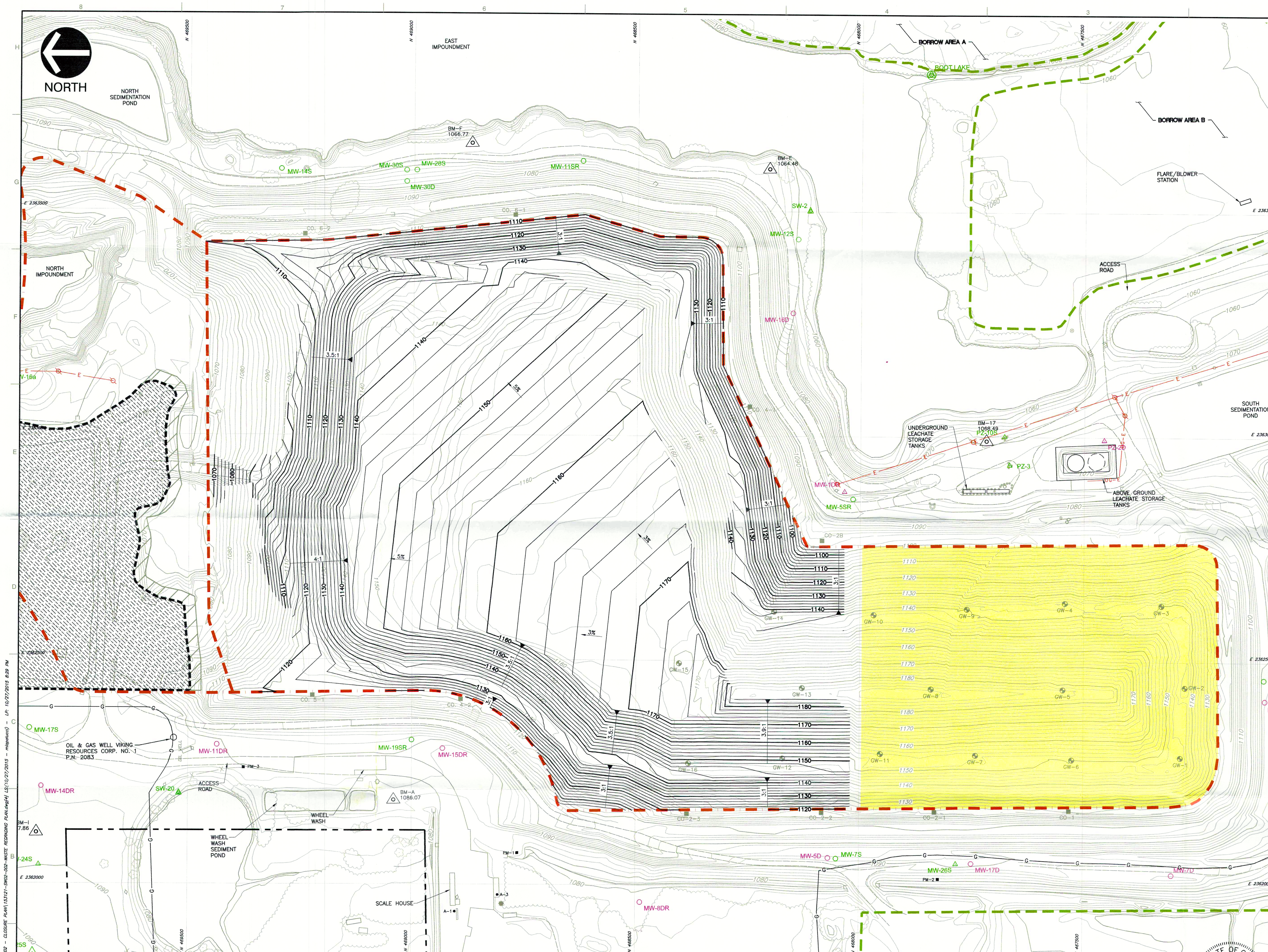
DATE:	10/8/15	DWG SCALE:	AS SHOWN	PROJECT NO:	153-121-0001

PERMITTED TOP OF WASTE GRADES

DRAWING NO.: 3

P:\2015\153-121\-CADD\Dwg\SWG3 – CLOSURE PLAN\153121-SWG3-008-EXISTING AND PERMITTED TOP OF WASTE GRADES.dwg{3} LS:(10/27/2015 – mlopdaca) – LP: 10/27/2015 8:38 PM



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LEGEND

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- PROPOSED TOP OF WASTE CONTOUR
- PERMITTED LIMIT OF WASTE
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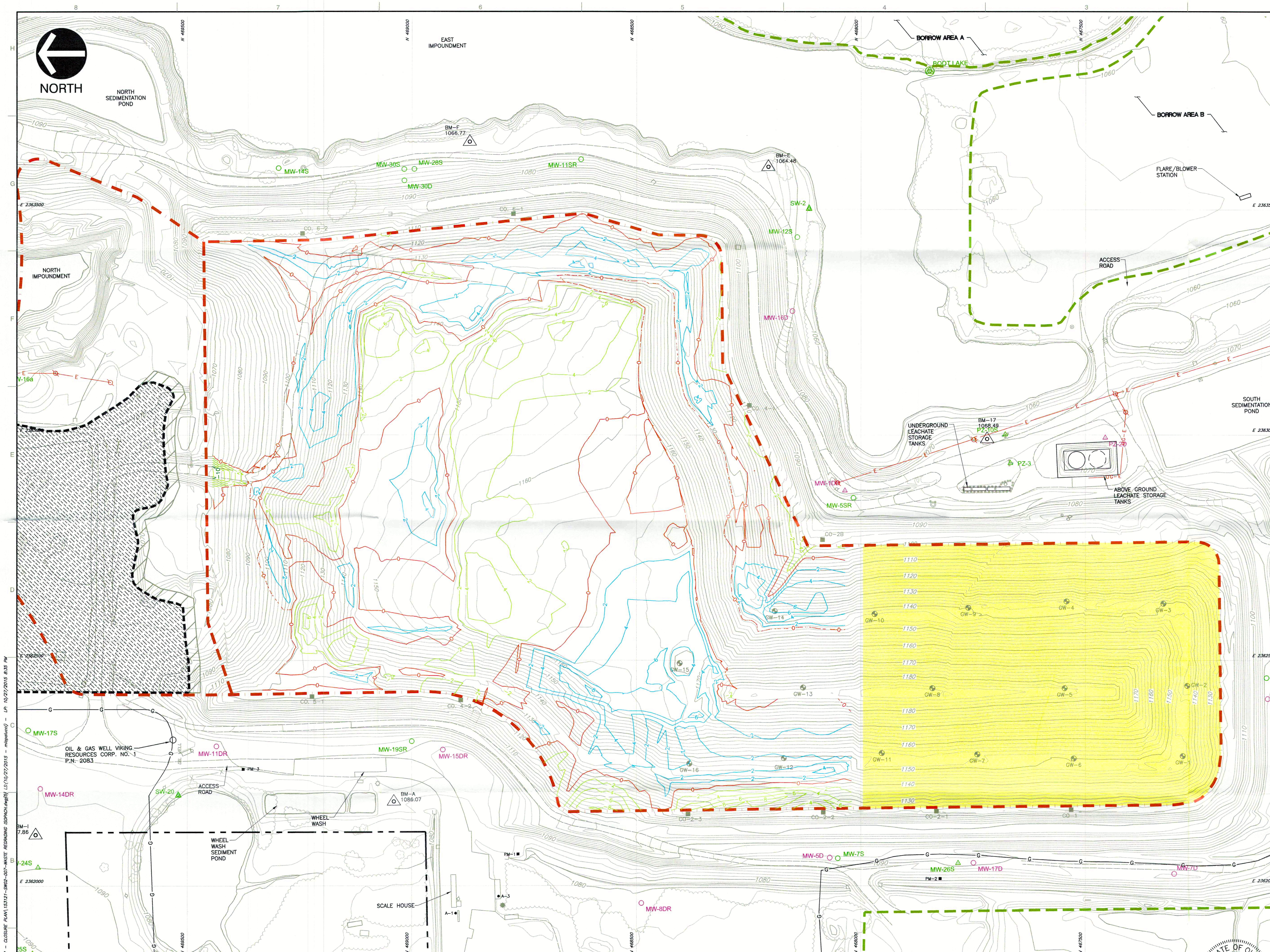
DATE: 10/8/15	DWG SCALE: AS SHOWN	PROJECT NO: 153-121-0001

WASTE REGRADING PLAN

DRAWING NO.: 4



REVISION RECORD

NO	DATE	DESCRIPTION

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NO	DATE	DESCRIPTION

LEGEND

- EXISTING CONTOUR
- CUT ISOPACH CONTOUR
- FILL ISOPACH CONTOUR
- ZERO ISOPACH CONTOUR
- PERMITTED LIMIT OF WASTE
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- AREA WITH INTERMEDIATE COVER

WASTE REGRADING VOLUME	
CUT	45,534 CY
FILL	47,253 CY

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NOTES

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SOLID WASTE APPROVED OHIO ENVIRONMENTAL PROTECTION AGENCY FEB 16 2016 AS EVIDENCED BY COPY OF LETTER OF APPROVAL ATTACHED

REFERENCE

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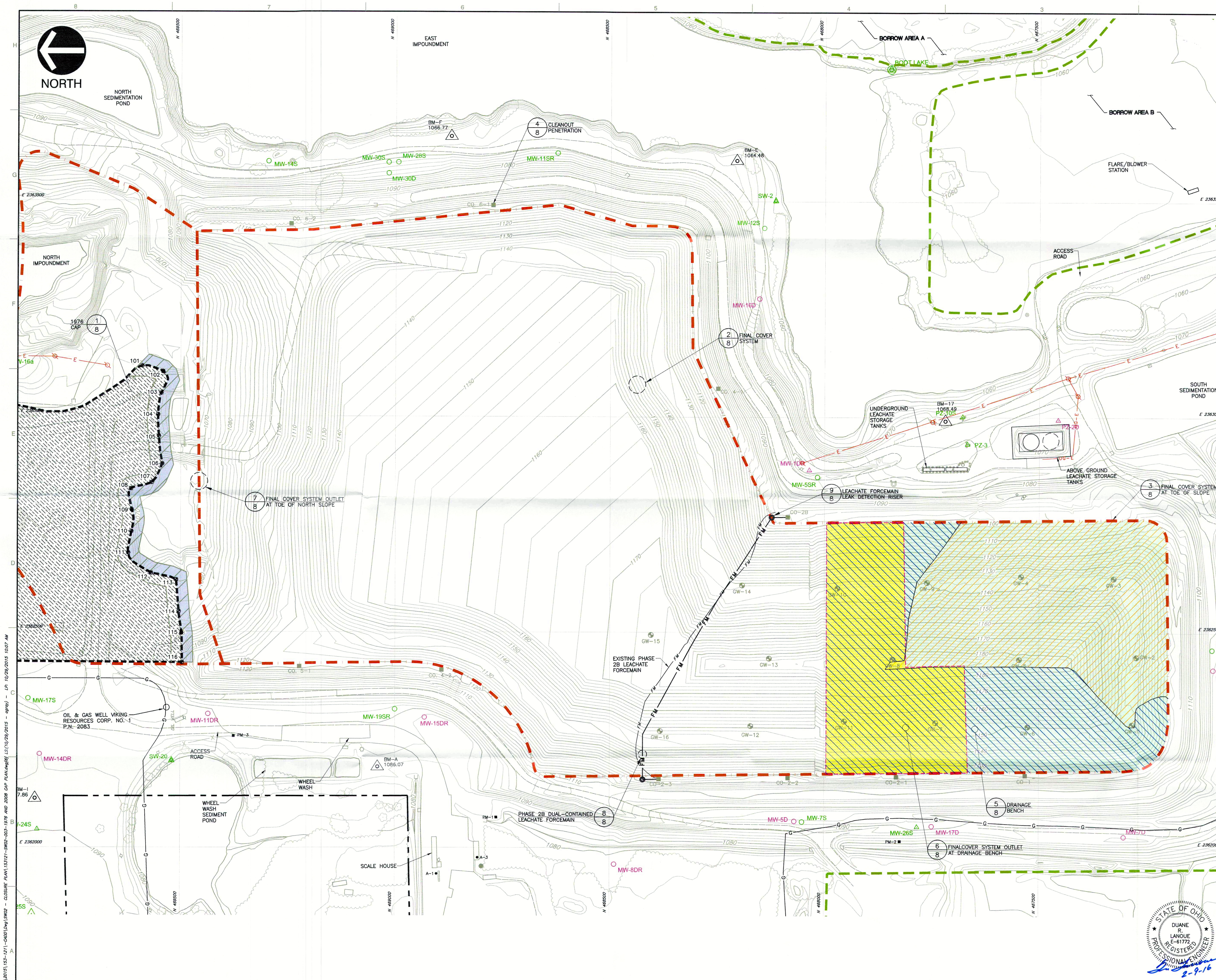
STATE OF OHIO DUANE R. LANOUE E-61772 REGISTERED PROFESSIONAL ENGINEER 2-9-16

DRAWN BY: MJI	CHECKED BY: TES	APPROVED BY: DRL *
DATE: 10/8/15	DWG SCALE: AS SHOWN	PROJECT NO: 153-121-0001

WASTE REGRADING ISOPACH

DRAWING NO.: 5



REVISION RECORD

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SUBMITTAL RECORD

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- PROPOSED FORCEMAIN
- PROPOSED FORCEMAIN LEAK DETECTION RISER
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- CO-1 — EXISTING LEACHATE RISER CLEANOUT
- PTI 02-880 AREA WITH 1976 CAP
- 1976 CAP VERIFICATION AREA (SEE NOTE 1)
- 2008 CAP TO BE REPAIRED (SEE NOTE 2)
- 2008 CAP TO REMAIN (SEE NOTE 3)
- 2008 CAP WITH CAP PROTECTION LAYER
- 2008 CAP WITH EXPOSED SYNTHETICS
- 104 — TESTPIT CONTROL POINT

NOTES

1. TEST PITS WILL BE EXCAVATED TO VERIFY THAT 2-FT OF SOIL MATERIAL EXIST AND ANY ADDITIONAL SOILS NEEDED TO MEET THE 2-FT THICKNESS SHALL MEET THE MATERIAL SPECIFICATIONS CRITERIA OUTLINED IN GUIDANCE DOCUMENT 0123 "STANDARDS FOR CURRENT CONSTRUCTION OF 1976 CAP SYSTEM" DATED MARCH 27, 1995.
2. THIS AREA REQUIRES REMOVING THE EXISTING CAP PROTECTION LAYER, THE INSTALLED GEOSYNTHETICS (40-MIL LLDPE GEOMEMBRANE AND DOUBLE SIDED GEOCOMPOSITE) AND RECOMPACTING THE TOP LIFT OF THE RECOMPACTED SOIL BARRIER.
3. THIS AREA REQUIRES THE COMPLETION OF THE CAP PROTECTION LAYER.

SOLID WASTE APPROVED OHIO ENVIRONMENTAL PROTECTION AGENCY FEB 16 2016

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REFERENCE

1. TOPOGRAPHIC MAPPING WAS PREPARED BY KEDDAL AERIAL MAPPING FROM AERIAL PHOTOGRAPHY DATED AUGUST 6, 2009.
2. GROUND SURVEY DATED 10/9/15 PERFORMED BY AKINS.

SCALE IN FEET
0 100 200

*HAND SIGNATURE ON FILE

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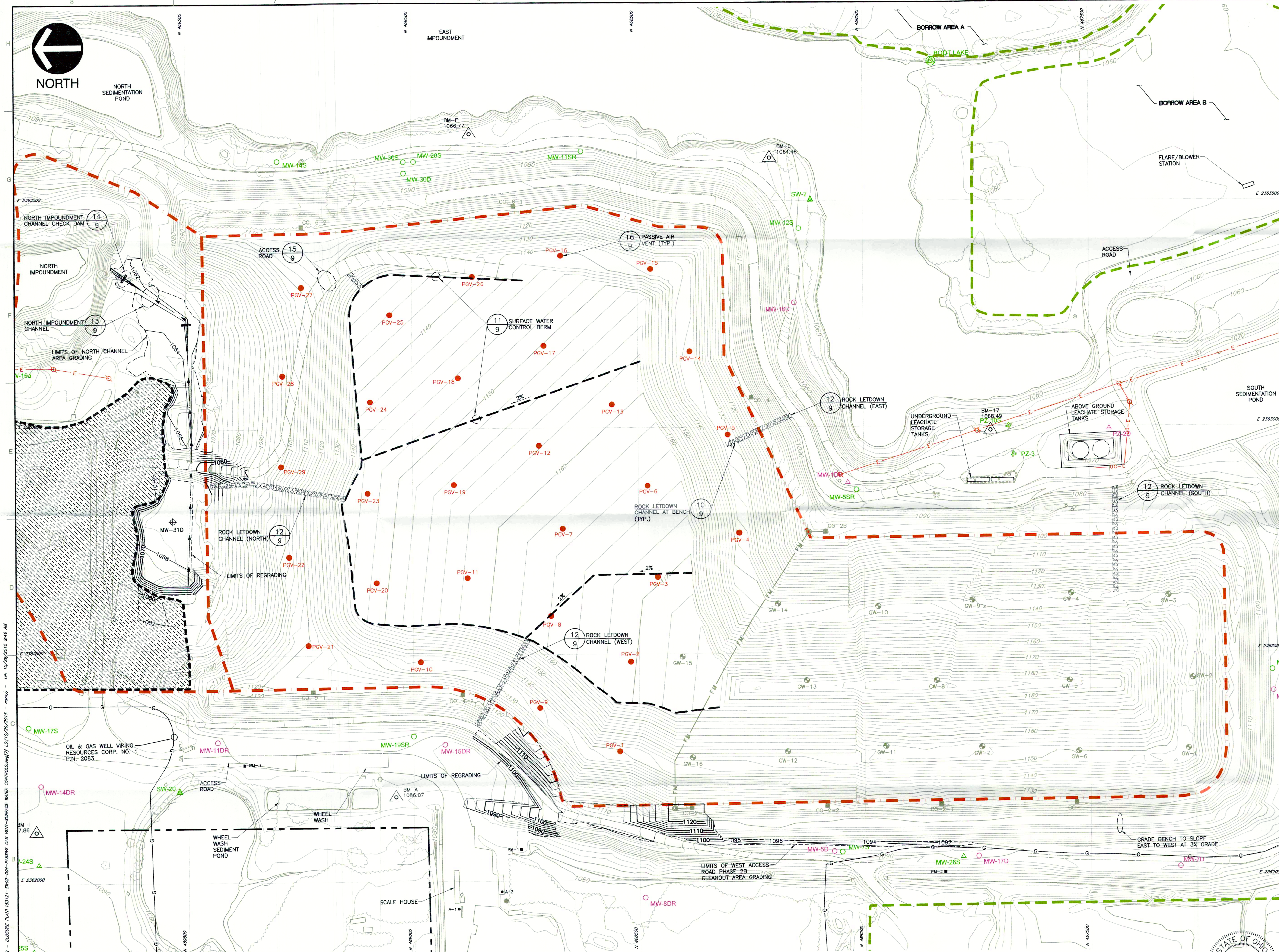
BOND SAFEGUARD INSURANCE COMPANY CLOSURE PLAN CENTRAL WASTE DISPOSAL FACILITY ALLIANCE, OHIO

STATE OF OHIO — DUANE R. LANOUE E-61772 — REGISTERED PROFESSIONAL ENGINEER — 2-9-16

DRAWN BY: MJI	CHECKED BY: TES	APPROVED BY: DRL *
DATE: 10/8/15	DWG SCALE: AS SHOWN	PROJECT NO: 153-121-0001

FINAL COVER SYSTEM PLAN

DRAWING NO.: 6



REVISION RECORD

NO	DATE	DESCRIPTION

SUBMITTAL RECORD

NO	DATE	DESCRIPTION

LEGEND

- EXISTING CONTOUR
- PERMITTED LIMIT OF WASTE
- EXISTING LIMIT OF WASTE
- BORROW AREA LIMIT
- LIMIT OF EXISTING PTI 02–880 AREA
- EXISTING UNDERGROUND ELECTRIC
- EXISTING OVERHEAD ELECTRIC
- EXISTING GAS LINE
- ABANDONED GAS LINE
- EXISTING FORCEMAIN
- PROPOSED FORCEMAIN
- PROPOSED FORCEMAIN LEAK DETECTION RISER
- BM-34 1095.53 — FACILITY BENCHMARK LOCATION
- BOOT LAKE — SURFACE WATER SAMPLING LOCATION
- SW-2A — SURFACE WATER GAUGE
- PZ-1S — GLACIAL/MINE SPOIL PIEZOMETER
- MW-20S — GLACIAL/MINE SPOIL MONITORING WELL
- PZ-4D — BEDROCK PIEZOMETER
- MW-11DR — BEDROCK MONITORING WELL
- A-3 — BUILDING GAS MONITOR
- PM-2 — PERMANENT GAS MONITORING PROBE
- GW-6 — EXISTING GAS EXTRACTION WELL
- CO-1 — EXISTING LEACHATE RISER CLEANOUT
- PTI 02–880 AREA WITH 1976 CAP
- PGV-1 — PROPOSED PASSIVE GAS VENT
- PROPOSED LETDOWN CHANNEL
- PROPOSED SURFACE WATER CONTROL BERM
- PROPOSED DRAINAGE CHANNEL
- MW-31D — PROPOSED GROUNDWATER MONITORING WELL

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2-9-16

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PASSIVE GAS VENT AND SURFACE WATER CONTROL SYSTEM PLAN

DRAWING NO.: 7

P:\2015\153-121\-CADD\Dwg\SW02 - CLOSURE PLAN\153121-SW02-004-PASSIVE GAS VENT-SURFACE WATER CONTROLS.dwg{7} LS:(10/29/2015 - gnorsy) - LP: 10/29/2015 9:46 AM

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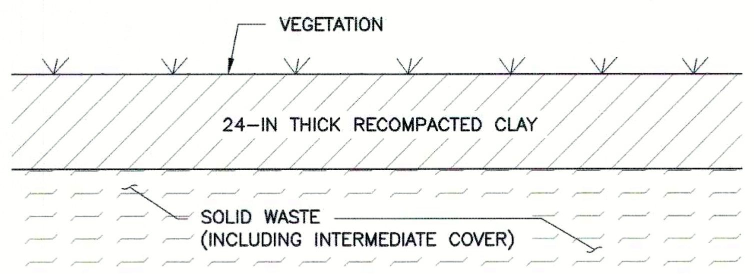
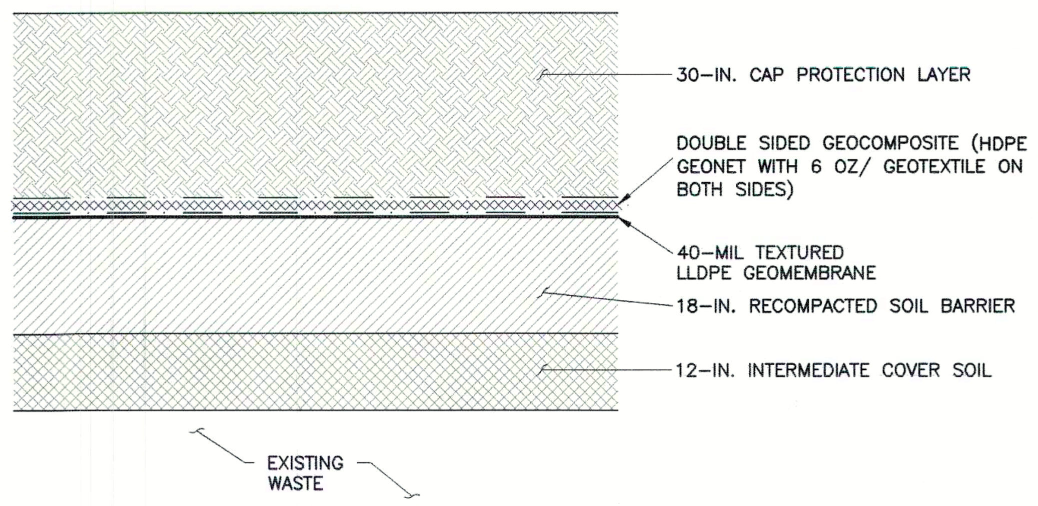
NO	DATE	DESCRIPTION

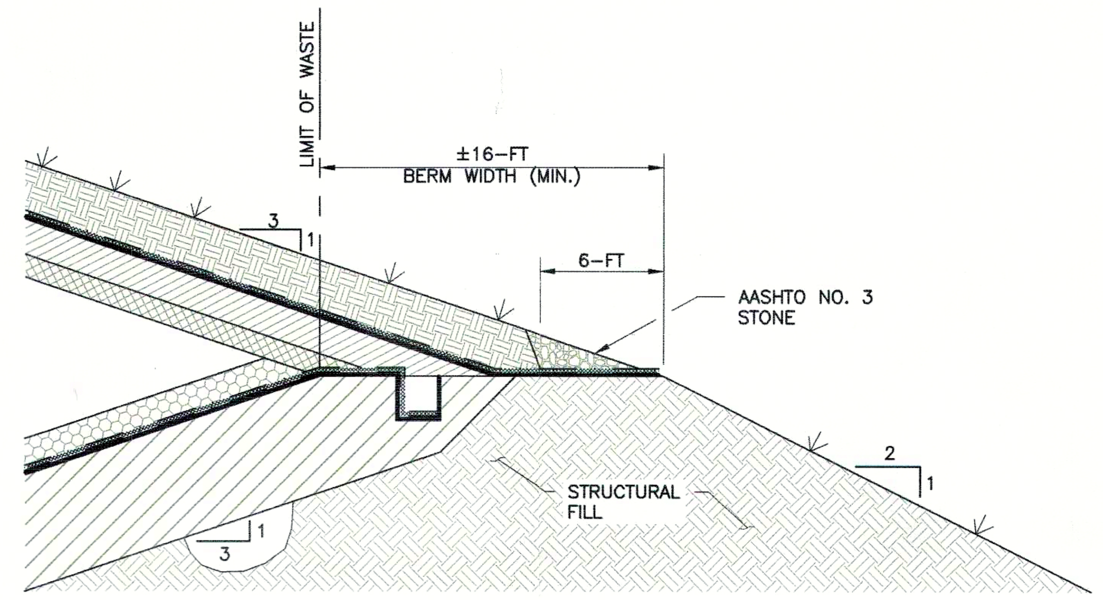
SUBMITTAL RECORD		
NO	DATE	DESCRIPTION



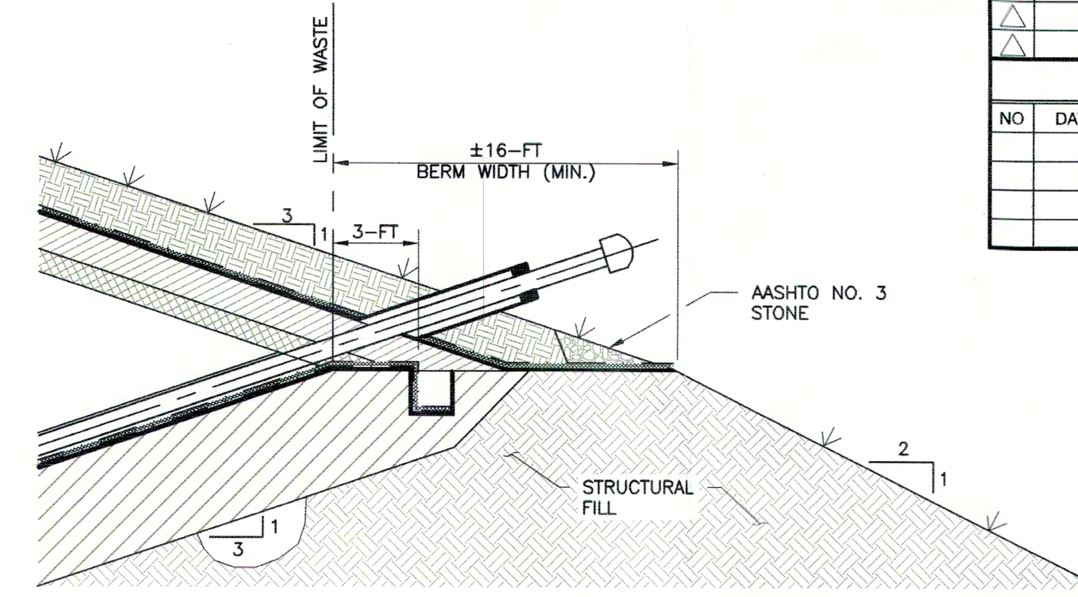
1 **1976 CAP**
N.T.S.



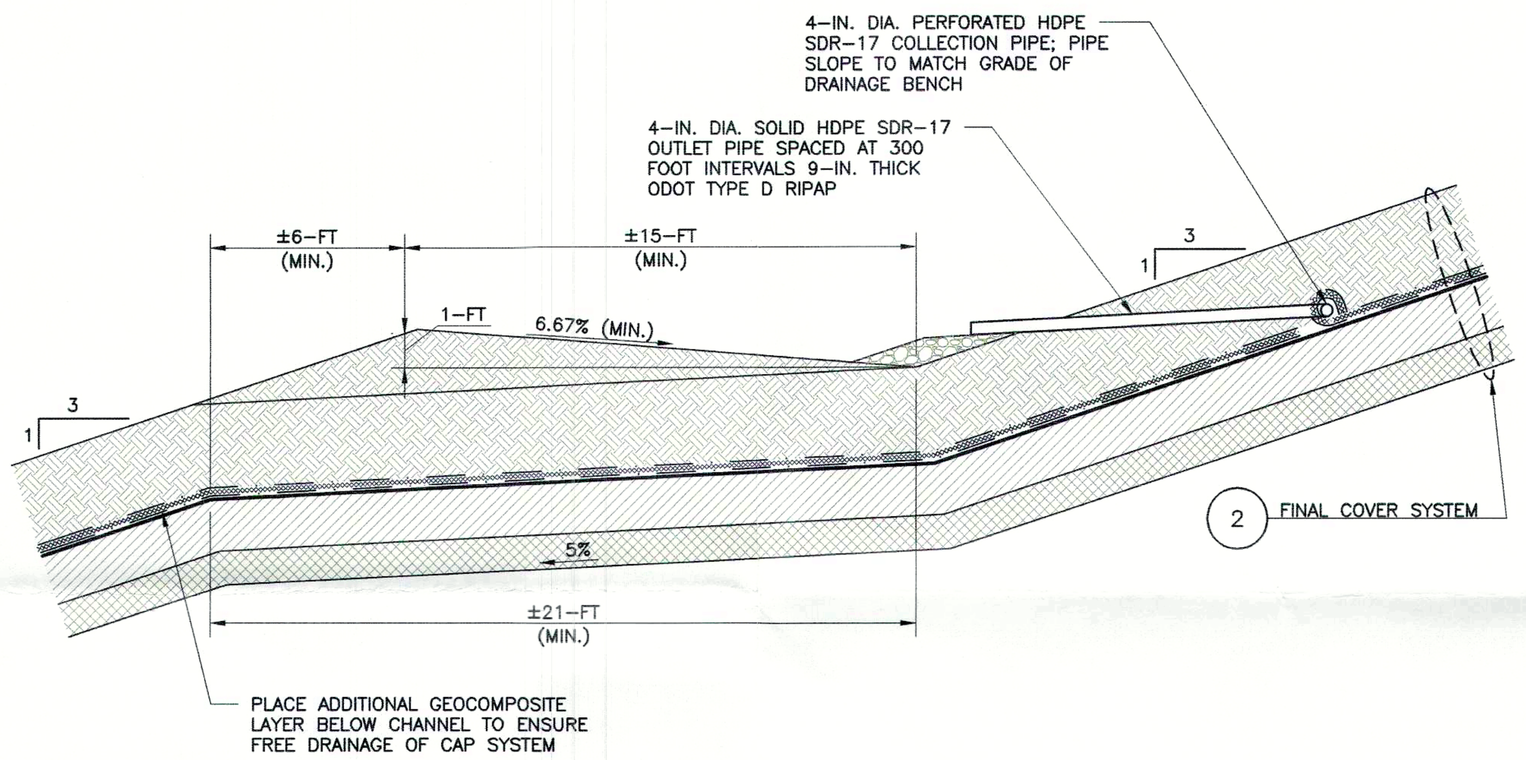
2 **FINAL COVER SYSTEM**
N.T.S.



3 **FINAL COVER SYSTEM AT TOE OF SLOPE**
N.T.S.

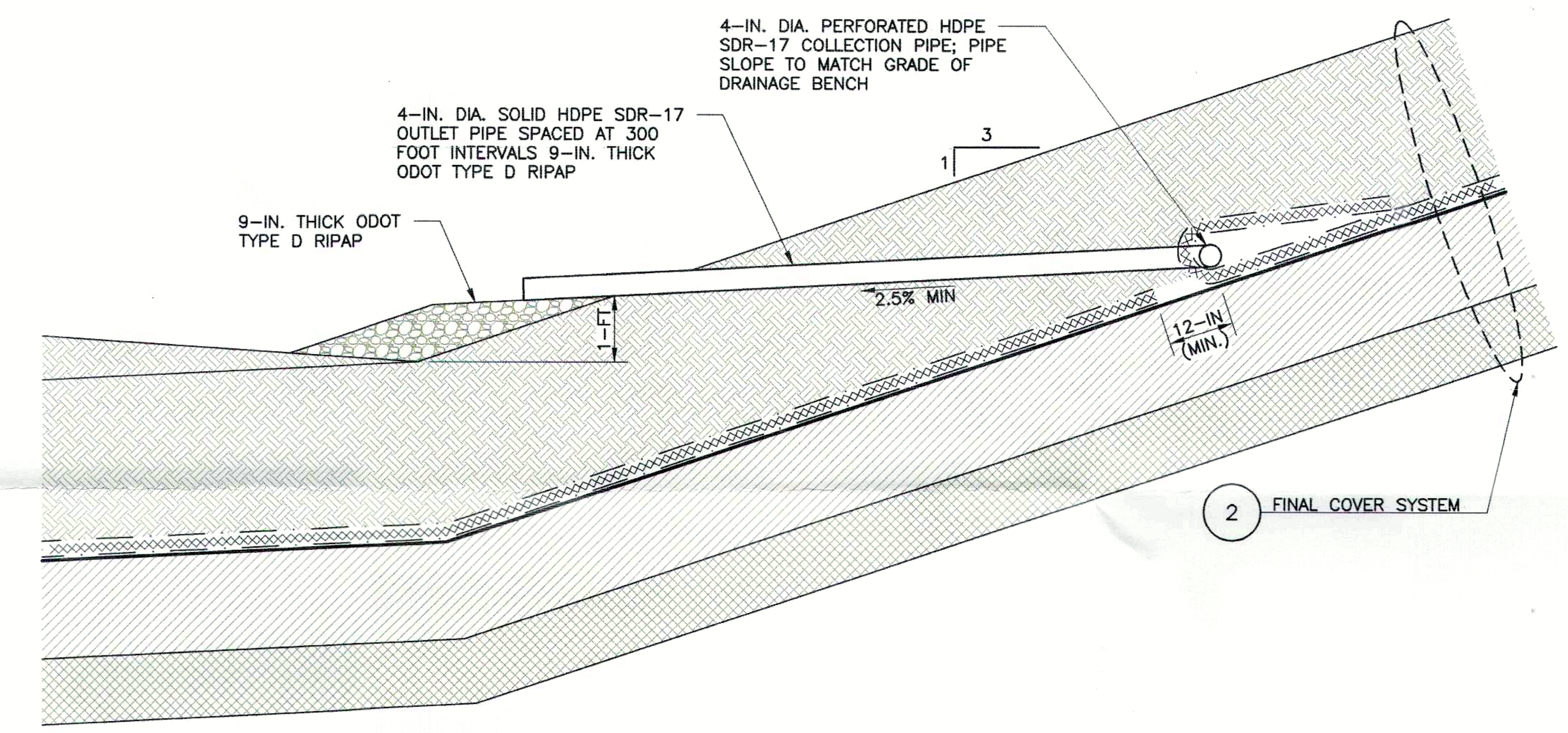


4 **CLEANOUT PENETRATION**
N.T.S.

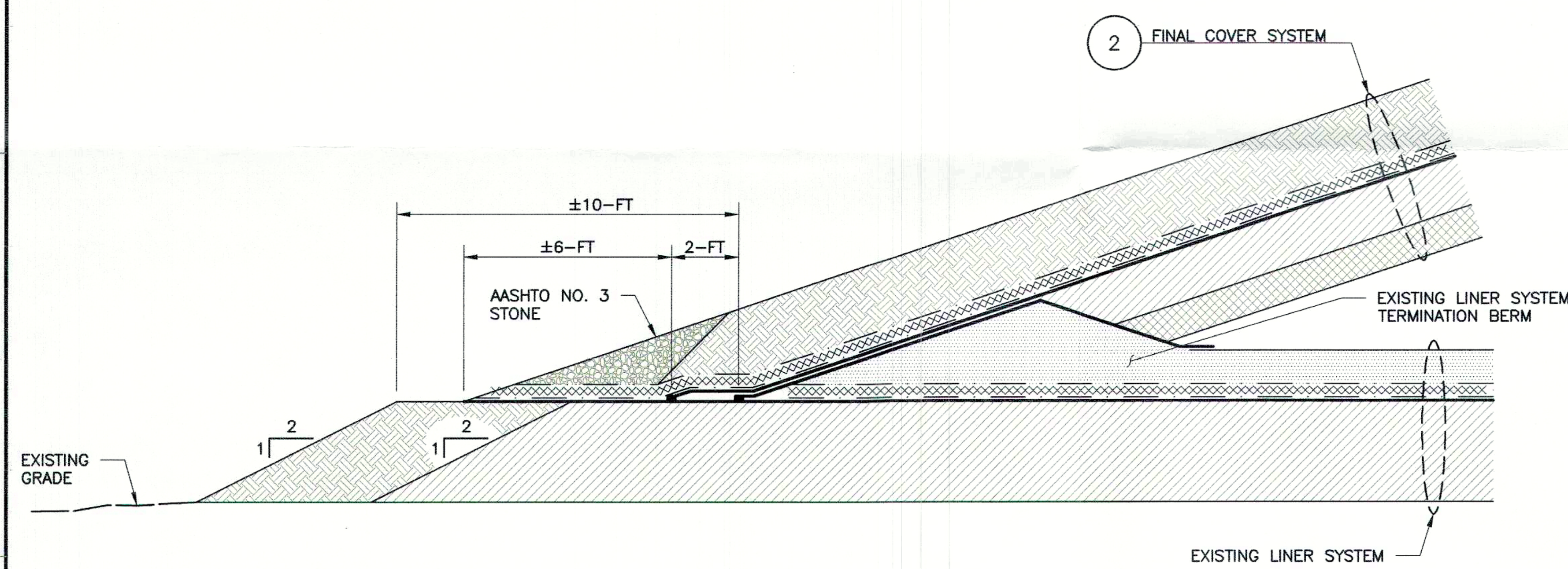


NOTE:
1. EROSION CONTROL BLANKET SHALL BE PLACED ON BENCHES WITH SLOPES GREATER THAN 3 PERCENT IN DRAINAGE DIRECTION.

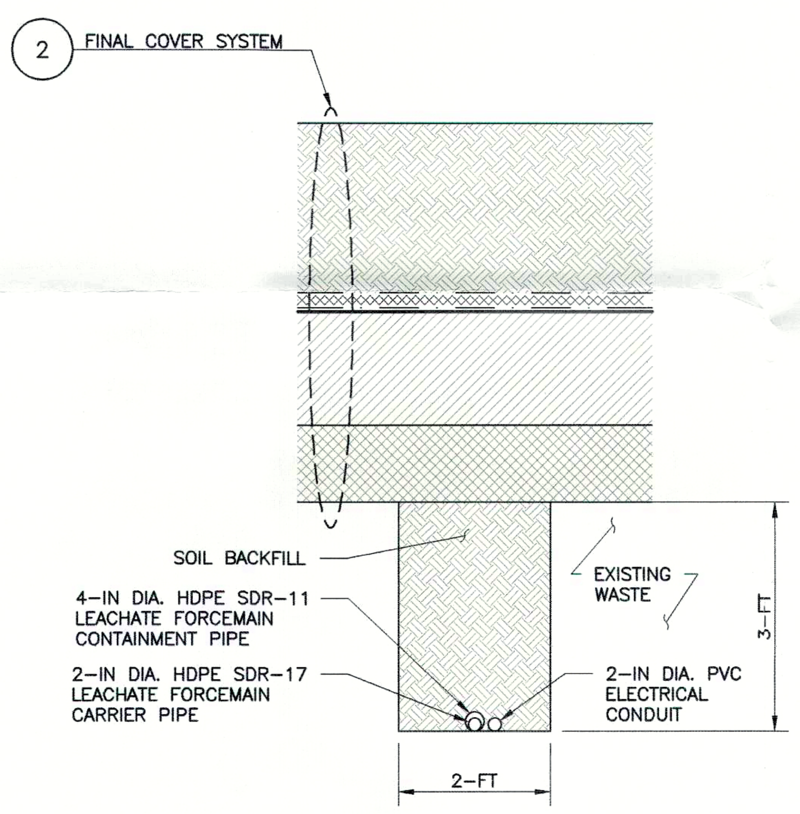
5 **DRAINAGE BENCH**
N.T.S.



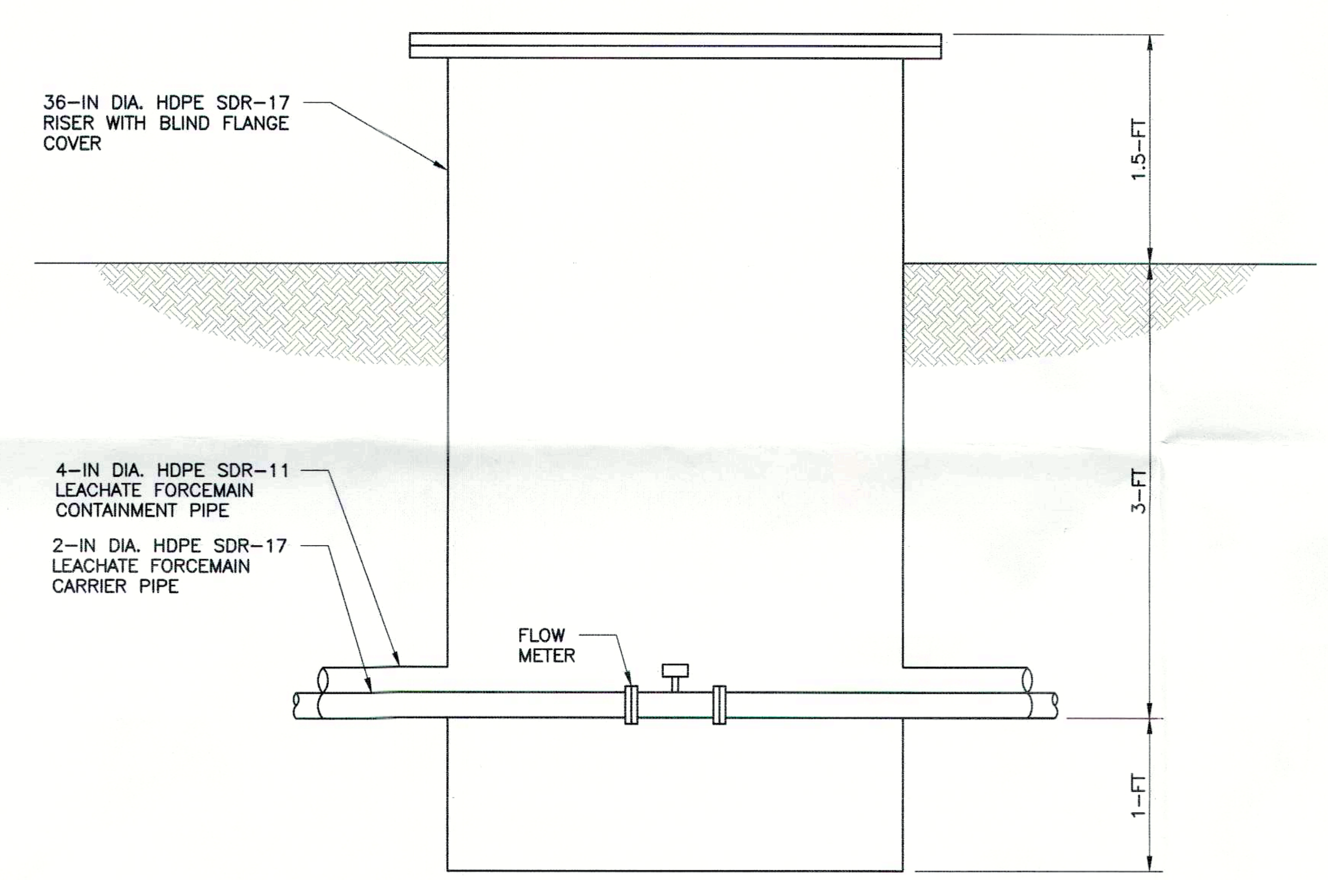
6 **FINAL COVER SYSTEM OUTLET AT DRAINAGE BENCH**
N.T.S.



7 **FINAL COVER SYSTEM OUTLET AT TOE OF NORTH SLOPE**
N.T.S.



8 **PHASE 2B DUAL-CONTAINED LEACHATE FORCEMAIN**
N.T.S.



NOTE:
1. FLOW METER INSTALLED AT RISER NEAR PHASE 2A SUMP RISER ONLY.

9 **LEACHATE FORCEMAIN LEAK DETECTION RISER**
N.T.S.

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STATE OF OHIO
DUANE R. LANOUE
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DATE: 10/8/15	DWG SCALE: AS SHOWN	PROJECT NO: 153-121.0001

FINAL COVER SYSTEM DETAILS — DRAWING NO.: 8

REVISION RECORD		
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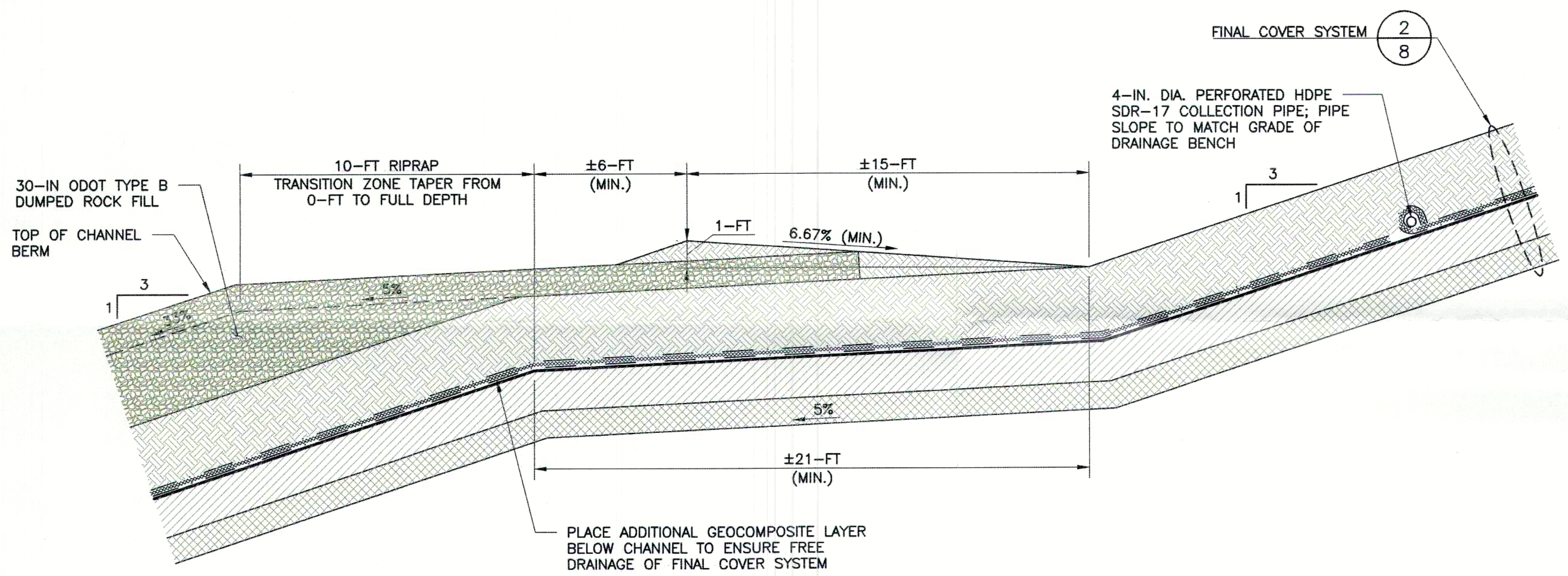
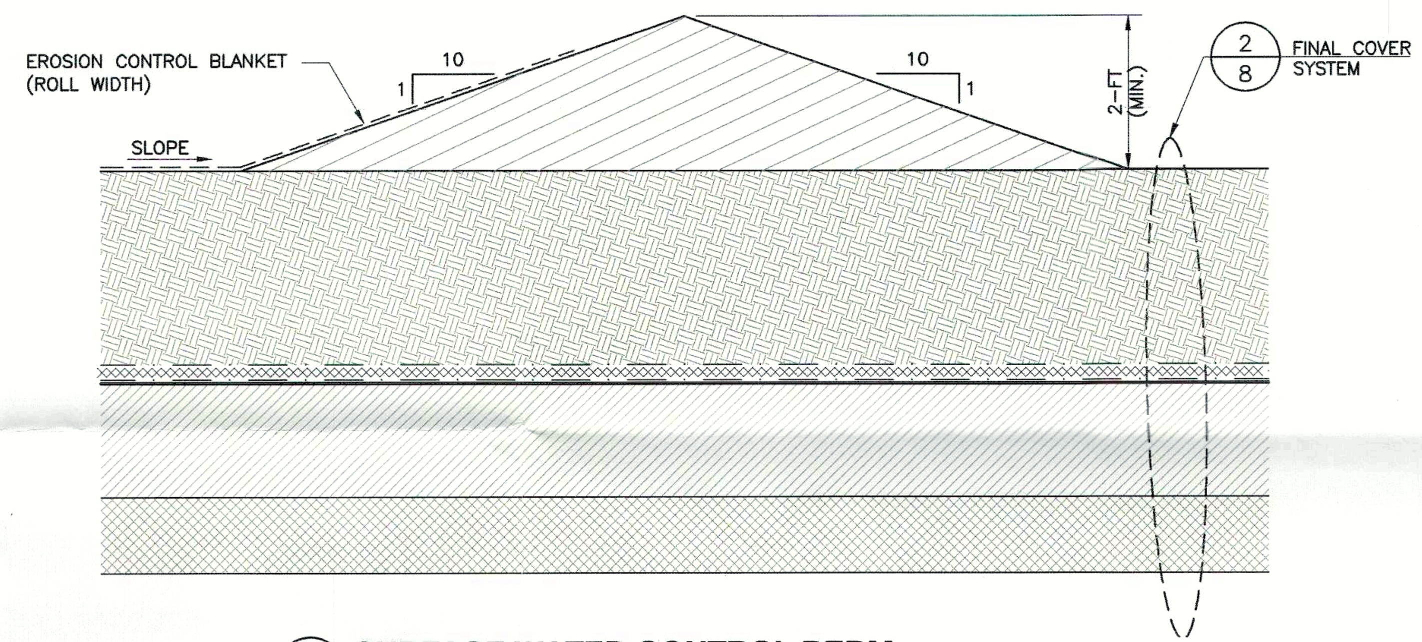
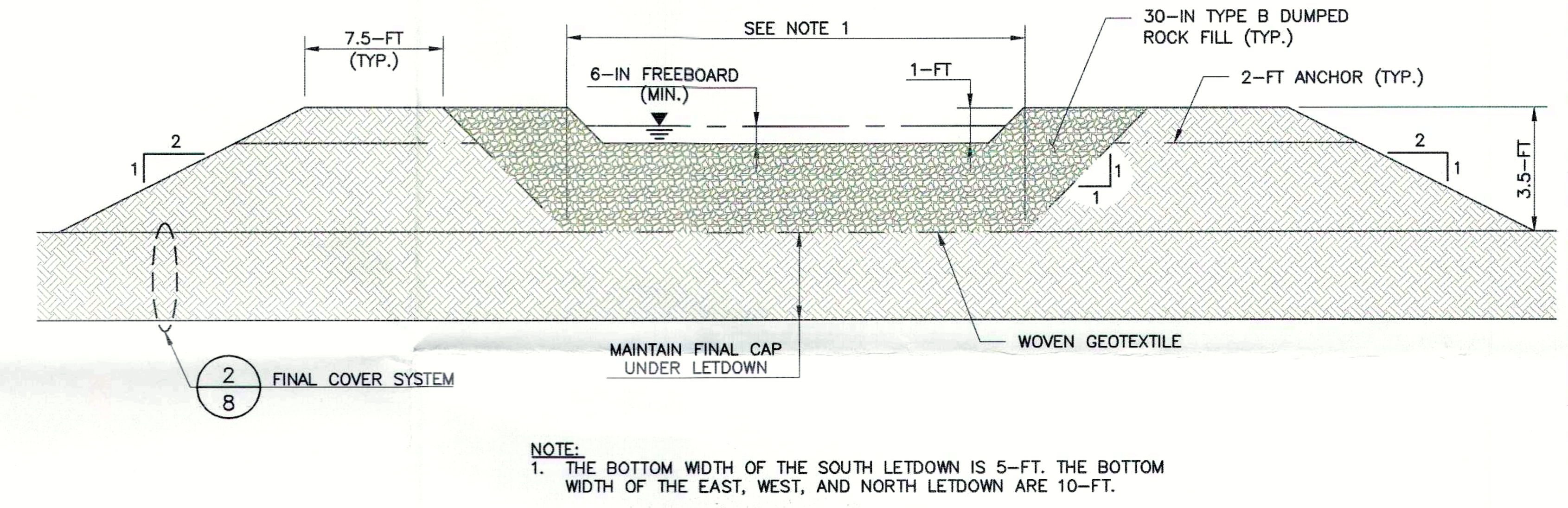
SUBMITTAL RECORD		
NO	DATE	DESCRIPTION



PROFILE A-A'

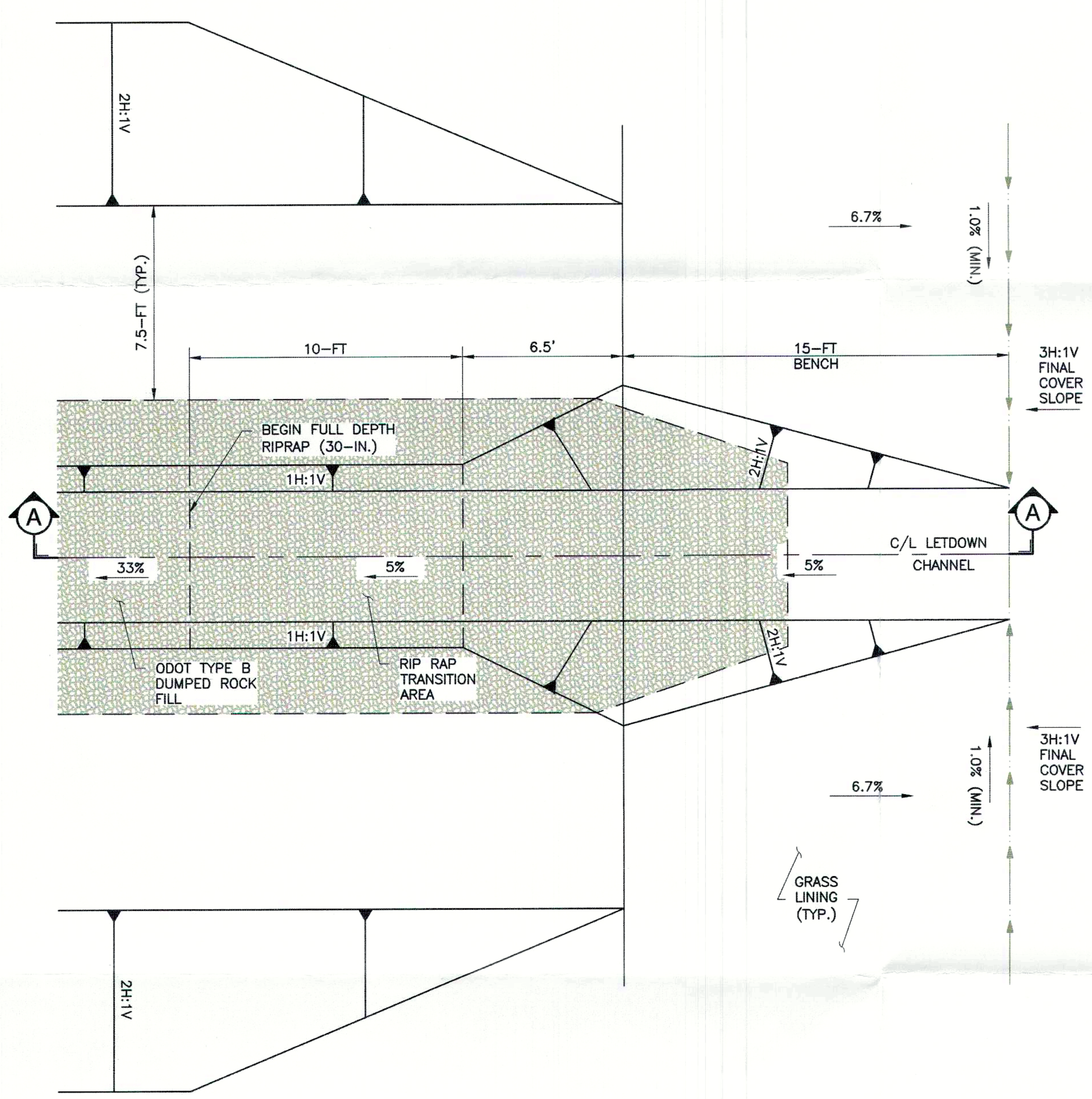


10 SURFACE WATER CONTROL BERM
N.T.S.



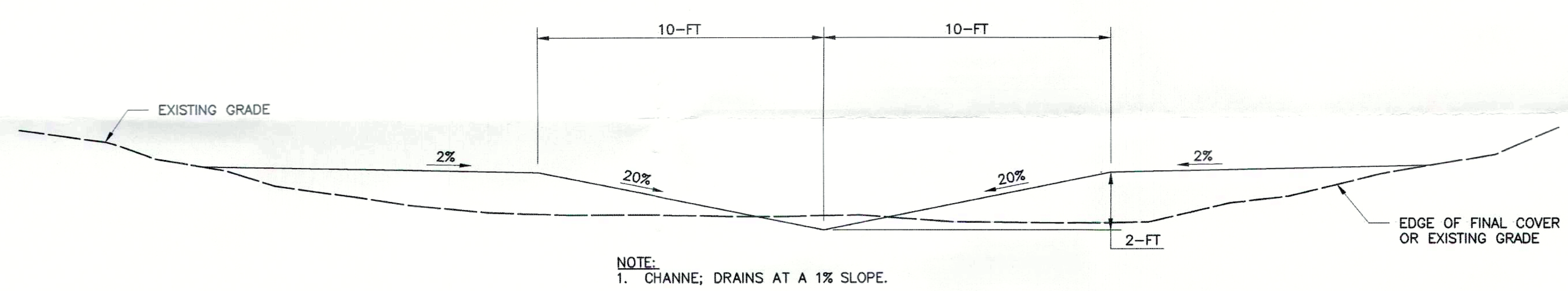
NOTE:
1. THE BOTTOM WIDTH OF THE SOUTH LETDOWN IS 5-FT. THE BOTTOM WIDTH OF THE EAST, WEST, AND NORTH LETDOWN ARE 10-FT.

11 ROCK LETDOWN CHANNEL (NORTH, SOUTH, EAST, WEST)
N.T.S.



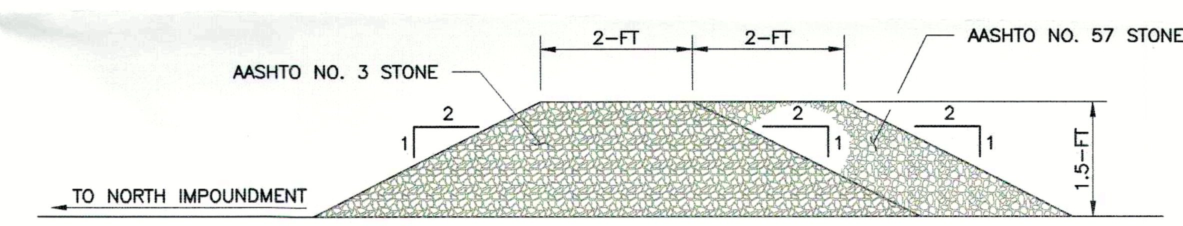
PLAN

12 ROCK LETDOWN CHANNEL AT BENCH
N.T.S.



NOTE:
1. CHANNE; DRAINS AT A 1% SLOPE.

13 NORTH IMPOUNDMENT CHANNEL
N.T.S.



14 NORTH IMPOUNDMENT CHANNEL CHECK DAM
N.T.S.

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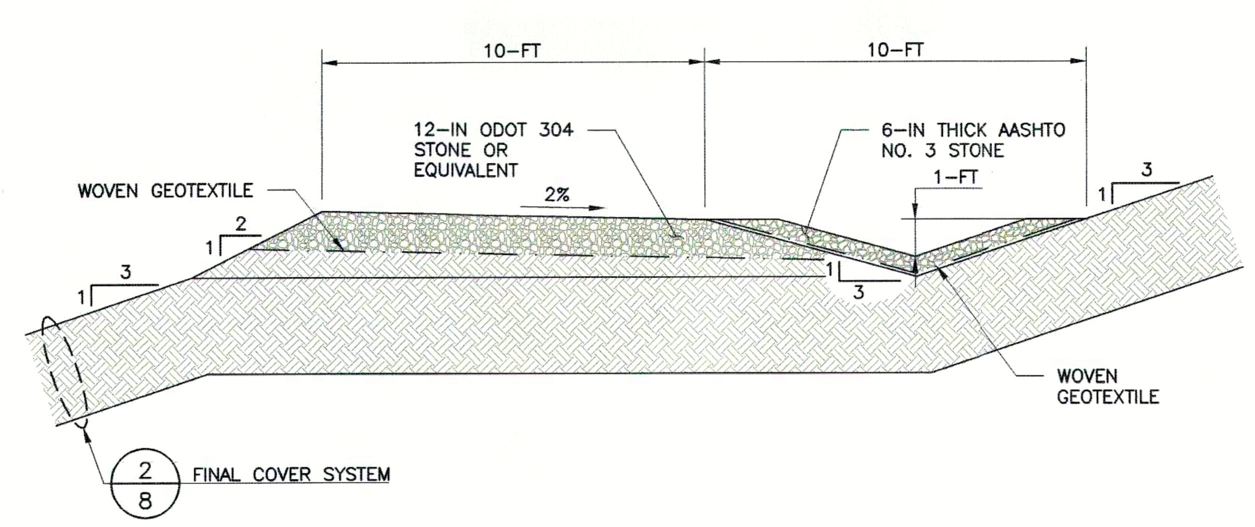
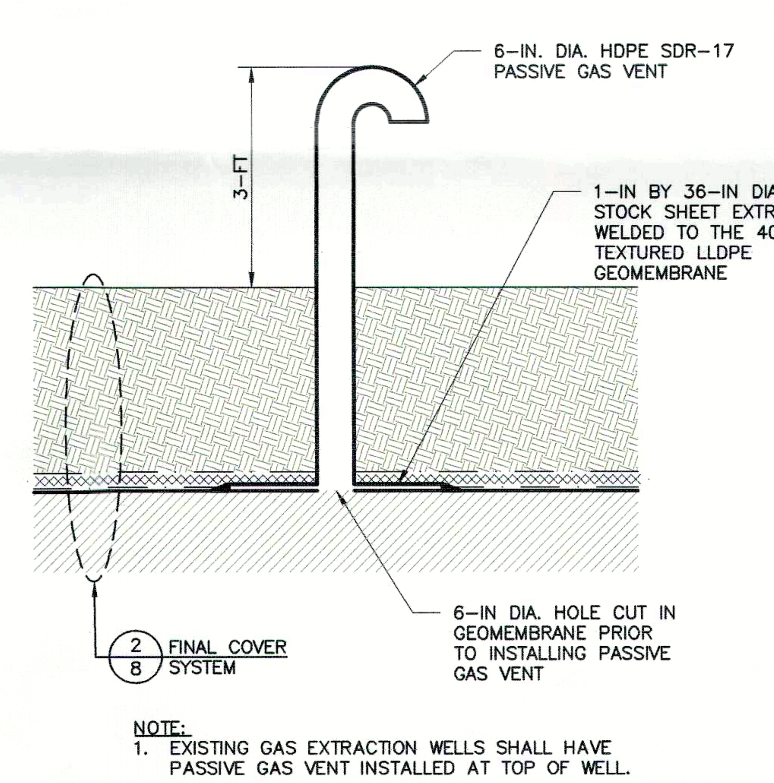


15 ACCESS ROAD
N.T.S.



NOTE:
1. EXISTING GAS EXTRACTION WELLS SHALL HAVE PASSIVE GAS VENT INSTALLED AT TOP OF WELL.

16 PASSIVE GAS VENT
N.T.S.

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DUANE R. LANOUE
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DATE: 10/8/15	DWG SCALE: AS SHOWN	PROJECT NO: 153-121.0001

PASSIVE GAS VENT AND SURFACE WATER CONTROL SYSTEM DETAILS

DRAWING NO.: 9

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APPENDIX B

2008 FINAL COVER STABILITY ANALYSIS

SOLID WASTE
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OBJECTIVE

Determine the factor of safety for the 2008 final cover system based on existing interface shear strength and geocomposite transmissivity test results. These calculations also consider the existing maximum 3.4H:1V slopes with benches spaced at approximately 30 foot vertical interval, which equates to slope length of 100 feet between drainage bench centerlines.

Spreadsheet and slope stability software methods were utilized to complete the analyses. The table below presents the scenarios evaluated and the required factors of safety:

Translational or Rotational	Static or Seismic	Drained or Undrained	OAC Rule 3745-27-08	Minimum Factor of Safety	Method of Calculation
Translational	Static	Drained	(C)(7)(c)(ii)	1.50	Software & Spreadsheet*
Translational	Seismic	Drained	(C)(7)(d)(ii)	1.0	Software & Spreadsheet*
Translational	Static	Undrained	(C)(7)(f)(ii)	1.1	Software & Spreadsheet*
Rotational	Static	Drained	(C)(7)(c)(ii)	1.5 results	Software
Rotational	Seismic	Drained	(C)(7)(d)(ii)	1.0	Software
Rotational	Static	Undrained	(C)(7)(f)(ii)	1.1	Software

* Software calculations were performed to analyze the 3.4H:1V slopes including the benches; spreadsheet calculations were performed to analyze the 3.4H:1V slopes between the benches.

METHODOLOGY

Multiple reference methods were utilized within this analysis and are described below.

"Cover Soil Slope Stability Involving Geosynthetic Interfaces", (GRI REPORT #18), by Te-Yang Soong and Robert M. Koerner, December 9, 1996, Geosynthetic Research Institute (GRI), Drexel University.

This reference was utilized to compute the factors of safety for the static and seismic drained translational analyses for the sloped areas between the benches. It considers the presence of equipment on top of the cover layer and provides a FS based on the most critical interface shear strength of final cover system components. The spreadsheet calculates a FS by dividing the cover material along the 3.4H:1V slope into active and passive blocks. Then interwedge force equations are set equal to each other and are arranged in the form of a quadratic equation that can be solved to calculate a FS.

The seismic coefficient used within the stability analysis was obtained from Figures 9-8 and 8-11 of the "Geotechnical and Stability Analyses for Ohio Waste Containment Facilities" September 14, 2004, which are included below.

"Design of Drainage Systems Over Geosynthetically Lined Slopes" (GRI Report # 19) by Te-Yang Soong and Robert M. Koerner, June 17, 1997, Geosynthetic Research Institute (GRI), Drexel University.

The analytical method presented in this reference is used to determine the head within the final cover system based on the existing transmissivity of the final cover geocomposite. The method analyzes the ability of the drainage geocomposite to adequately transmit the infiltrating rain flow impact of a specified rainfall event upon the drainage capability of the proposed final cover material and the subsequent slope stability FS. GRI Report #19 discusses in detail the design of drainage systems incorporating the effects of seepage forces upon slope stability. Exceeding the drainage capacity of the final cover geocomposite could potentially cause the final cover material to become saturated and possibly unstable. A spreadsheet was utilized to calculate the static undrained translational analysis of the 3.4H:1V slopes between the benches of the final cover system.

This calculation method is used to determine the head within the final cover system based on the existing transmissivity of the final cover geocomposite and the design strom event. For the design storm event, a factor of safety of 2 was applied to the 100 year, 1 hour storm event intensity (conservative). The reduction factors to the geocomposite transmissivity were applied as suggested within GRI Standard – GC8, and *Designing with Geosynthetics.*

The storm event intensity of 2.59 inches was obtained from the NOAA Atlas 14 – Point Precipitation Frequency Estimate website for Alliance, Ohio.

GRI Standard – GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite

This paper presents the methodology for application of reduction factors in the specification of required transmissivity of a geocomposite.

Slide 6.0, by Interactive Roc Science

This computer software program was utilized in the preparation of the translational and rotational analyses of the static and seismic drained cases for the 3.4H:1V slopes including the benches of the final cover system. The program uses limit equilibrium techniques to determine a FS for each given input cross-section and corresponding data file. SLIDE will calculate FS for both rotational and translational failure surfaces within each cross-section in terms of both static and seismic conditions based upon slope geometry, water surfaces, the shear strength parameters of materials, and the most critical contact interface within the proposed final cover system. The software utilizes a CAD based graphical interface and was utilized to calculate the factor of safety based on Spencer's Method.

PROPOSED FINAL COVER SYSTEM

The proposed final cover system is outlined below, from top to bottom:

- 30-inch thick Vegetative/Frost Protection Layer;
- Double Sided Drainage Geocomposite;
- 40-mil textured FML;
- 18-inch thick Recompacted Soil Barrier (RSB); and
- 12-inch thick Intermediate Cover Layer.

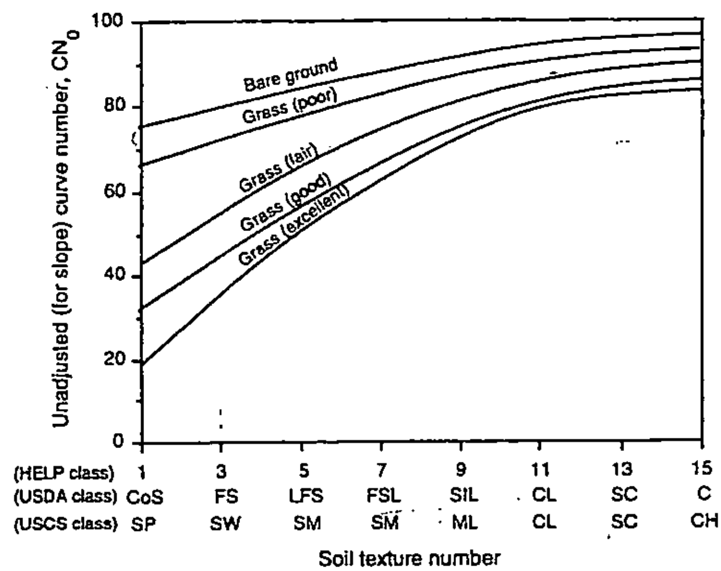
COVER MATERIAL PARAMETERS

The final cover system was analyzed for translational and rotational failure surfaces under static drained and undrained conditions and seismic drained conditions using SLIDE 6.0. This analysis was performed using the existing soil and geosynthetics shear strengths for the final cover system to determine if the factors of safety exceed 1.5 for static drained conditions, 1.1 for static undrained conditions and 1.0 for seismic drained conditions in accordance with OAC 3745-27-08(C)(7)(c), (d) & (f). The 2008 final cover system consists of maximum 3.4H:1V final slopes with benches constructed with a vertical spacing of 30 feet. Based on the results of laboratory testing, the final cover system was assigned the following material properties for the slope stability analysis:

Exisitng direct shear strength test results for the clay material used for both the recompacted soil barrier and vegetative cover soil is provided in attachment A. Existing QC and QA transmissivity test results for the geocomposite is provided in Attachment B. The existing interface test results for the final cover system are provided in Attachment C. The interface test results are from the initial tests using representative samples of the soils and geosynthetics materials and from archive samples collected from the existing geocomposite and geomembrane materials.

Cap Protection Soils
Unit weight of the cap protection layer material: γ_t = 130 pcf
Cohesion: c = 893 psf
Internal Friction Angle: ϕ= 25 degrees
Permeability: k = 1.0 x 10^{-4} cm/sec
Thickness = 2.5 feet.

The analysis assumes that clay soils will be used for the cover system soil with a fair grass cover. Based on testing of soils at the site, it is assumed that soil with a USCS classification of CL will be used. Based on Figure A-3 of GRI Report #19, below, this results in the SCS curve number of 79, which is used in the analysis.


100
80
60
40
20
0
Unadjusted (for slope) curve number, CN0
Bare ground
Grass (poor)
Grass (fair)
Grass (good)
Grass (excellent)
(HELP class) 1 3 5 7 9 11 13 15
(USDA class) CoS FS LFS FSL SIL CL SC C
(USCS class) SP SW SM SM ML CL SC CH
Soil texture number

Geosynthetic Material Shear Strength Parameters
Unit weight of the geosynthetic material: γ_t = 100 pcf
Cohesion: c = 0 psf
Internal Friction Angle: ϕ= 17.5 degrees
Thickness = 0.5 feet.

Recompacted Soil Barrier (RSB) Shear Strength Parameters
Unit weight of the barrier soil material: γ_t = 130 pcf
Cohesion: c = 893 psf
Internal Friction Angle: ϕ= 25 degrees
Thickness = 1.5 feet.

Intermediate Cover Soil Shear Strength Parameters
Unit weight of the intermediate soil material: γ_t = 130 pcf
Cohesion: c = 0 psf
Internal Friction Angle: ϕ= 27 degrees
Thickness = 1.0 feet.

Municipal Solid Waste Shear Strength Parameters
Unit weight of the solid waste material: γ_t = 90 pcf
Cohesion: c = 400 psf
Internal Friction Angle: ϕ= 33.0 degrees.

The shear strength properties of MSW are conservative when compared to the maximum recommendation in Chapter 8 of the *Geotechnical and Stability Analyses for Ohio Waste Containment Facilities* manual published by the Ohio EPA Geotechnical Resource Group, dated September, 14, 2004 (GeoRG Manual).

SEISMIC COEFFICIENT

The shear wave acceleration is modeled within the stability analysis by inputting a coefficient, (Cs) that is some fraction of gravity. The peak acceleration for the site is estimated to be 0.08 g which is taken from the "Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years (site: NEHRP B-C boundary)" published by the U.S.G.S in June of 1996 shown below. When plotting this value onto Singh and Sun's 1995 figure below for the relationship between maximum horizontal seismic acceleration at the base and crest of 100 feet of refuse, the maximum horizontal seismic acceleration at the crest of the landfill can be expected to be 0.12g. Since this analysis is for the final cover system, the acceleration at the crest of the landfill will be considered.

Figure 9-6 The peak acceleration (%g) with 2% probability of exceedance in 50 years. U.S. Geological Survey (June 1996) National Seismic Hazard Mapping Project, "Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years (for NEHRP B-C boundary)"

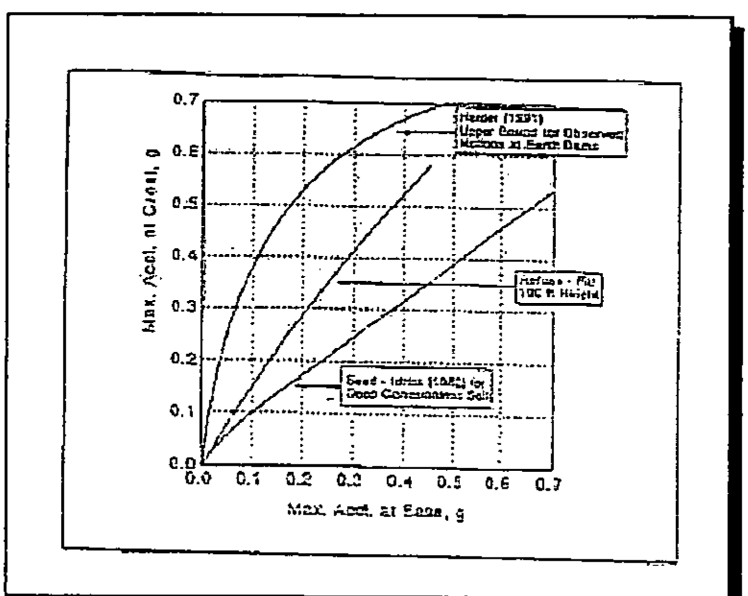


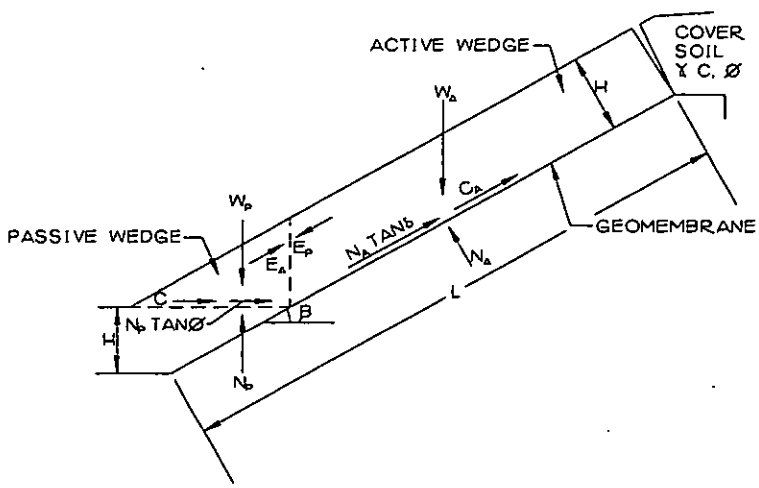
Figure 8-11 Approximate relationship between maximum accelerations at the base and crest for various ground conditions. Singh and Sun, 1995, Figure 3.

SPREADSHEET CALCULATIONS

The spreadsheet based calculations are described in more detail below.

Static and Seismic Drained Translational Analysis

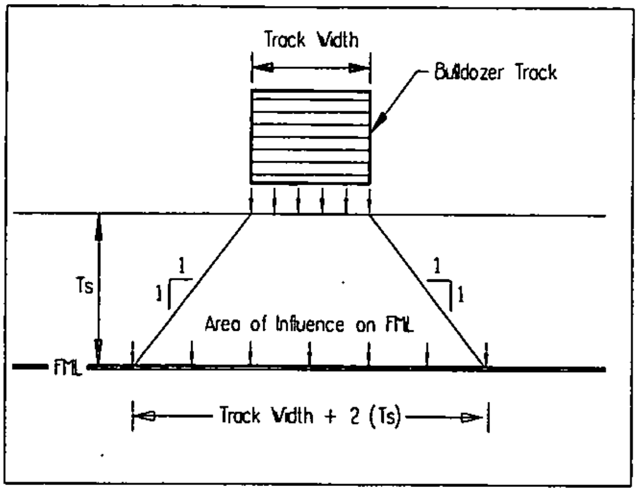
The figure below illustrates the free body diagram upon which the calculations are based.



The GRI Report #18 and #19 veneer slope stability calculations are prepared proposing the following assumptions:

- The presence of equipment along the 3.4H:1V cover sideslope is analyzed within GRI Report #18.
- The shear strength component of adhesion developed between geosynthetic material layers is ignored.
- Tensile strength of the geosynthetic materials contributing to the veneer slope stability FS is ignored.
- The cover material provides a buttress at the toe of the slope, i.e. the passive soil wedge.
- Weights of the geosynthetic components are negligible compared to the weight of cover material and therefore are not considered in the calculations.
- The effect of seepage forces upon the veneer stability of the final cover material layer, generated by a storm event, is evaluated in GRI Report # 19
- Cohesion within the final cover soil is based on laboratory test results.
- All calculations will utilize a 1-foot unit width of sideslope.

A Low Ground Pressure (LGP) bulldozer will be used to place cover material up the sideslope. The presence of equipment was only modeled in the static analysis. The pressure exerted upon the top of the geosynthetic layers by a bulldozer is modeled as illustrated below.



Stress Distribution of the LGP Bull Dozer upon the Geosynthetic Layers

The following typical LGP Bulldozer equipment specifications are used within the GRI Report #18.

- 2 tracks
- Track length = 9.4 feet
- Track width = 3.0 feet
- Operating weight = 38,300 lbs
- One Track Contact area = 28.2 ft^2
- One Track Contact pressure = 19,150 lbs / 28.2 ft^2 = 679.1 psf

Subsequently, the forces are resolved below to produce a veneer slope stability FS. The equations are shown on pages 13 and 14 of GRI Report #18 and for ease of calculations are incorporated into a spreadsheet to produce a FS corresponding to a given set of input parameters. A copy of the spreadsheet calculations displaying the results is included in Attachment A.

Static Undrained Translational Analysis

The effect of seepage forces upon the veneer stability of the final cover material layer, generated by a storm event, is evaluated using the methodologies outlined in GRI Report # 19. This calculation method is used to determine the head within the final cover system based on the existing transmissivity of the final cover geocomposite and the design strom event. For the design storm event, a factor of safety of 2 was applied to the 100 year, 1 hour storm event intensity (conservative).

An important input parameter within the GRI Report #19 spreadsheet calculation that impacts slope stability is the "runoff coefficient", RC. The RC estimates the amount of precipitation that drains off the final cover sideslope as surface water runoff, thereby not infiltrating, saturating and reducing the shear strength of the final cover material.

Calculating the RC (as a function of time) consists of determining a Soil Conservation Service (SCS) curve number using the proposed length and orientation of the final cover slope and the magnitude of a given storm event. Subsequent equations are then used to determine "potential retention" and "accumulated precipitation" values, which are then input into an equation to calculate a RC. Appendix A presents the analysis used to calculate the RC.

GRI Report #19 includes a spreadsheet calculation that considers the affects of rainfall and drainage layer capacity parameters upon a given slope stability condition. The GRI Report #19 spreadsheet is a modified version of the slope stability spreadsheet calculation presented within GRI Report #18. The following rainfall and drainage layer data was input within the GRI Report #19 spreadsheet calculation:

- The peak 100-year, 1-hour storm event corresponds to a rainfall amount of 2.59 inches/hour. Applying a factor of safety of 2.0 to the rainfall intensity results in a rainfall amount of 5.18 inches/hour;
- A final cover material permeability of $k_{c.s.} = 1.0 \times 10^{-4}$cm/sec;
- A final cover material thickness of $h_{c.s.}$ = 30-inches
- A geocomposite thickness of h_d = 250 mils = 6.35 mm; and
- A long term geocomposite transmissivity of $\theta_{lt} = 1.16 \times 10^{-4}$ m^2/sec.

In this analysis, the permeability of the drainage layer (k_d) is a function of the transmissivity and thickness of the geocomposite determined through the following equation:

$K_d = \theta_{lt} / h_d$

Where h_d equals the thickness of the geocomposite.

Therefore the permeability of the geocomposite equals:

$K_d = (1.16 \cdot 10^{-4}\ m^2/sec) / [6.35\ mm / (1000\ mm/m)] = 0.01825\ m/sec = 1.825\ cm/sec.$

The GRI Report # 18 and 19 calculation spreadsheets are provided in Attachment A.

Geocomposite Transmissivity Calculation

To account for the reduction in transmissivity over the long term, reduction factors were applied to the installed geocomposite transmissivity based on ***GRI Standard – GC8, "Determination of the Allowable Flow Rate of a Drainage Geocomposite".*** The Reduction factors for the flow capacity of geocomposites having a geonet core used in landfill cover drainage layer applications are listed below.

$\theta_{ult} = \theta_{lt} * (RF_{IN} * RF_{CR} * RF_{CC} * RF_{BC})$

Where :

RF_{IN} = Reduction Factor for geotextile intrusion (1.0 to 1.2);
RF_{CR} = Reduction Factor for creep deformation (1.2 to 1.4);
RF_{CC} = Reduction Factor for chemical clogging (1.0 to 1.2); and
RF_{BC} = Reduction Factor for biological clogging (1.2 to 3.5).

Since the laboratory testing was performed using site-specific boundary conditions, the reduction factor for intrusion of the geotextile into the geonet was ignored (RF_{IN} =1.0).

Reduction factors for creep deformation, RF_{CR} = 1.4, biological clogging, RF_{BC} = 2.8, and chemical clogging RF_{CC} =1.1 were utilized. The resulting ultimate transmissivity (θ_{ult}) is calculated as shown below.

$$\theta_{ult} = 1.16 * 10^{-4}\ m^2/sec \times (1.0 * 1.4 * 1.1 * 2.8) = 5.00 \times 10^{-4}\ m^2/sec$$

SOFTWARE CALCULATIONS

Static and Seismic Drained Rotational Analyses and Static Undrained Rotational Analysis

As stated above, these analyses were completed using a software package called Slide 6.0. The input values utilized in the Slide analyses are the same as the values utilized in the spreadsheet calculations. For the undrained analyses, a head of 0.1 meters (0.33 feet) was assumed, which is conservative since the maximum head above the liner (h_{avh}) determined in the GRI Report # 19 calculation spreadsheet was 0.01 meters. For the translational undrained analysis, the software was permitted to search for the most critical failure surface within both the cap protection soils and the geosynthetics.

A summary of these calculations are provided in the conclusion section of this document. Output files from the software analyses are included in Attachment B.

CONCLUSIONS

The following table presents a summary of the calculated factors of safety for the various analyses performed for the final cover system. As shown, all calculated factors of safety meet the requirements of OAC 3745-27-08(C)(7). The spreadsheet outputs for these analyses are provided in Attachment D, and the software outputs for these analyses are provided in Attachment E.

EXISTING UNIT FACTOR OF SAFETY SUMMARY						
Translational or Rotational	**Static or Seismic**	**Drained or Undrained**	**OAC Rule 3745-27-08**	**Calculated Factor of Safety**	**Required Factor of Safety**	**Method of Calculation**
Translational	Static	Drained	(C)(7)(c)(ii)	2.02	1.50	Software
Translational	Static	Drained	(C)(7)(c)(ii)	2.03	1.50	Spreadsheet*
Translational	Seismic	Drained	(C)(7)(d)(ii)	1.43	1.00	Software
Translational	Seismic	Drained	(C)(7)(d)(ii)	1.54	1.00	Spreadsheet*
Translational	Static	Undrained	(C)(7)(f)(ii)	2.07	1.10	Software
Translational	Static	Undrained	(C)(7)(f)(ii)	1.13	1.10	Spreadsheet*
Rotational	Static	Drained	(C)(7)(c)(ii)	3.78	1.50	Software
Rotational	Seismic	Drained	(C)(7)(d)(ii)	2.48	1.00	Software
Rotational	Static	Undrained	(C)(7)(f)(ii)	3.78	1.10	Software

* Software calculations were performed to analyze the 3.4H:1V slopes including the benches; spreadsheet calculations were performed to analyze the 3.4H:1V slopes between the benches.

Soil Shear Strength Requirements

The laboratory results indicate that the soil material used to construct the cap protection layer exhibits an internal shear strength of 1,126 psf which results in acceptable factors of safety over the 3.4H:1V slopes. This peak shear strength value was determined as follows:

$$\tau = c + \sigma_n \tan \phi$$

Where:

c = 893 psf

σ_n = 500 psf (based on a cap protection layer thickness of 2.5' and as required by the CQA/QC Plan for testing)

ϕ = 25

τ = 1,126 psf

Any combination of c and ϕ yielding a $\tau \geq$ 1,126 psf under a normal load of 500 psf results in an acceptable FS.

Interface Shear Strength Requirements

The laboratory results indicate that the soil to geosynthetics and geosynthetics to geosynthetics interfaces for the materials used to construct final cover system exhibit an interface shear strength of **158 psf** and result in acceptable factors of safety over the 3.4H:1V slopes. This peak shear strength value was determined as follows:

$$\tau = c + \sigma_n \tan \phi$$

Where:

c	=	0 psf
σ_n	=	500psf (based on a maximum cap protection layer thickness of 2.5')
ϕ	=	17.5 ° (as described above)
τ	=	158 psf

Any combination of c and ϕ yielding a $\tau \geq 158$ psf under a normal load of 500 psf results in an acceptable FS.

Geocomposite Requirements

The results of the geocomposite transmissivity calculation indicate that a minimum geonet thickness of **250 mil** and transmissivity of **5.0×10^{-4} m^2/sec** is sufficient to result in acceptable factors of safety for stability. These values are specified in the CQA/QC Plan and were used in construction.

Attachment A

Recompacted Soil Barrier and Vegetative Cover Soil
Direct Shear Strength Test Results

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS

Client	CECI	Boring	RSL
Client Project	Central Waste	Depth	NA
Project No.	26487	Sample	RSL-6D
		Lab No.	26487003

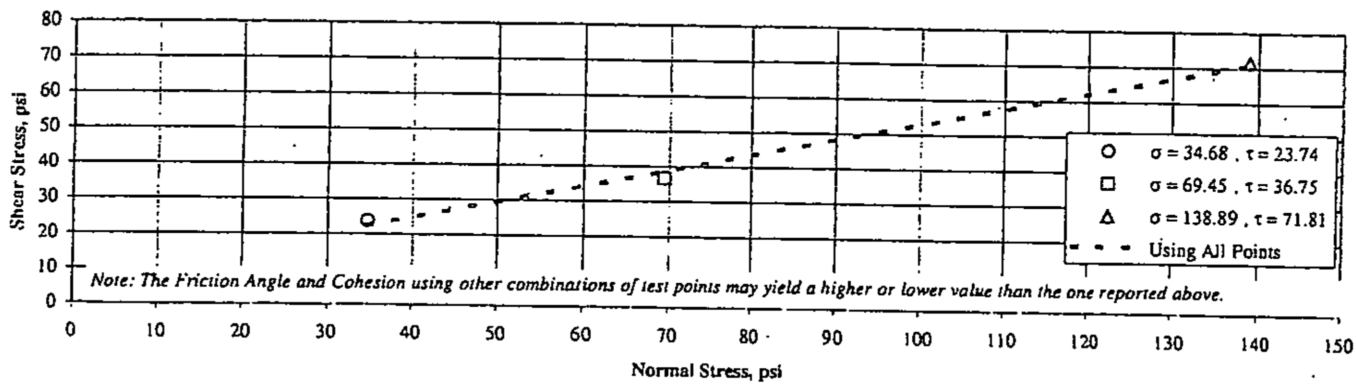
Visual Description: Light Olive Brown Lean Clay With Sand

Sample Condition: Remolded

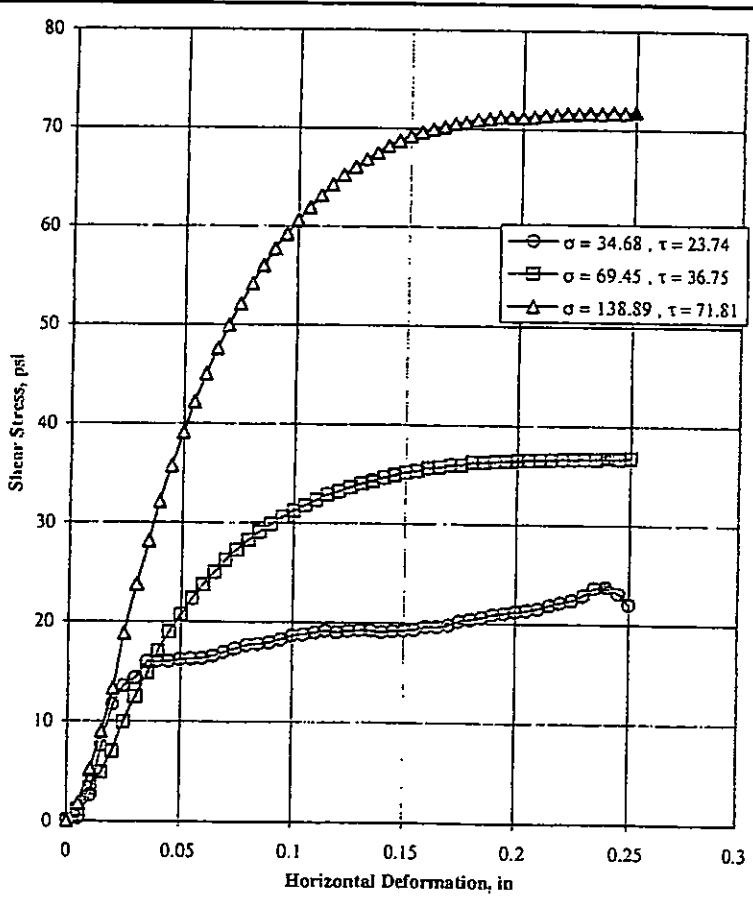
Note: Graphs are not to scale!

NORMAL STRESS vs. SHEAR STRESS

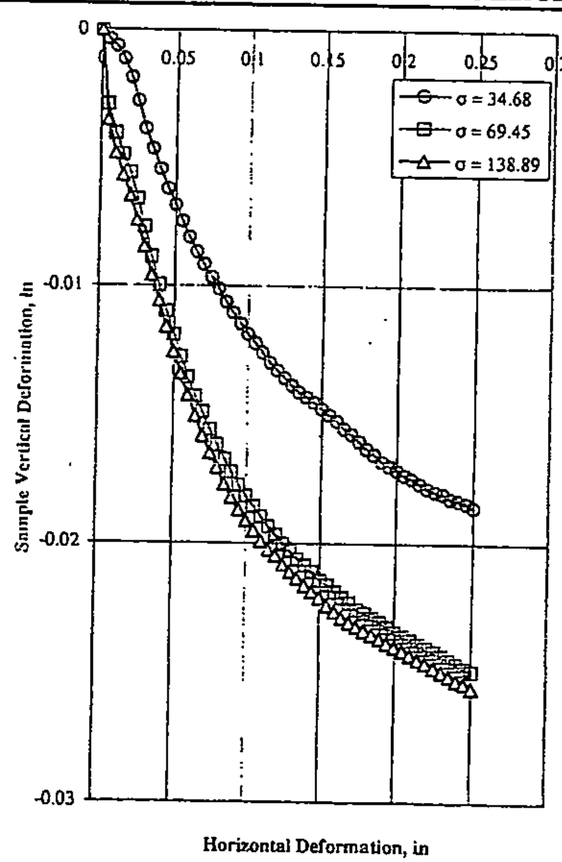
$\phi = 25.1°$ c = 6.2 psi



HORIZONTAL DEFORMATION vs. SHEAR STRESS



HORIZONTAL DEFORMATION vs. SAMPLE HEIGHT

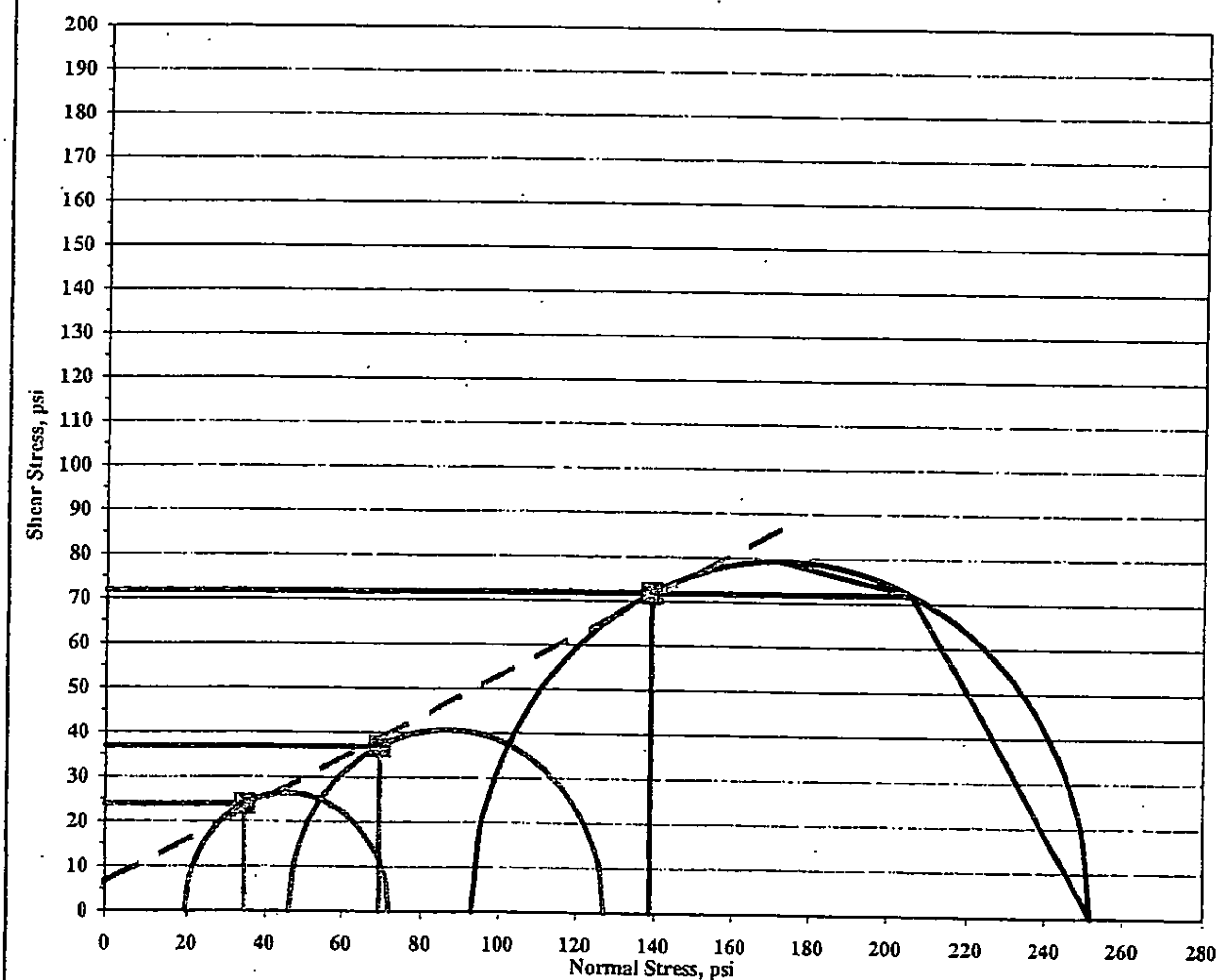


Note: The calculations performed and the parameters presented herein are for preliminary purposes only. GTS only accepts responsibility for the raw data obtained from the direct shear tests. This data may be interpreted differently by others. It is the responsibility of the user to determine the appropriateness and accuracy of the computed values.

DIRECT SHEAR TEST OF SOILS
UNDER CONSOLIDATED, DRAINED CONDITIONS
MOHRS'S CIRCLE AND FAILURE PARAMETERS

Client:	CECI	Boring:	RSL
Client Project	Central Waste	Depth:	NA
Project No.	26487	Sample:	RSL-6D
		Lab Sample ID	26487003
Material:	Light Olive Brown Lean Clay With Sand		
Condition	Remolded		

Average Friction Angle, ϕ, deg.		25.1	Using All Points
Average Cohesion, c, psi		6.2	Using All Points
Sample Condition		Remolded	
Normal Stress, psi	34.68	69.45	138.89
Shear Stress at Failure, psi	23.74	36.75	71.81
Mohr's Circle Radius, psi	26.2	40.6	79.3
Mohr's Circle Origin, psi	45.8	86.6	172.5
(Origin - Normal Stress), psi	11.1	17.2	33.6
Minor Principal Stress $\sigma 3$, psi	19.6	46.1	93.2
Major Principal Stress $\sigma 1$, psi	72.0	127.2	251.7
Principal Stress Difference, $\sigma 1-\sigma 3$, psi	52.4	81.1	158.5
Normal Stress Pole Coordinate, X, psi	56.9	103.8	206.0
Shear Stress Pole Coordinate, Y, psi	23.7	36.8	71.8
Assumed Failure Plane, deg	0 - Horizontal	0 - Horizontal	0 - Horizontal
Major Principal Failure Plane Angle, deg	57.5	57.5	57.5
Minor Principal Failure Plane Angle, deg	32.5	32.5	32.5
Maximum Shear Stress, psi	26.2	40.6	79.3
Maximum Shear Failure Plane Angle, deg	12.5	12.5	12.5
Initial Water Content, %	19.3%	19.3%	19.3%
Initial Dry Density, pcf	107.5	107.0	107.9



DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS - ASTM D 3080

Client	CECI	Boring	RSL
Client Project	Central Waste	Depth	NA
Project No.	26487	Sample	RSL-6D
		Lab No.	26487003

Visual Description: Light Olive Brown Lean Clay With Sand
Sample Condition: Remolded

SAMPLE CONDITIONS

Test No.	1			2			3		
	Initial	After Consol.	Final	Initial	After Consol.	Final	Initial	After Consol.	Final
Tare I.D.	127	-	65	127	-	22	127	-	69
Wt. Wet Soil & Tare, gm	191.8	-	246.9	191.8	-	241.66	191.8	-	245.51
Wt. Dry Soil & Tare, gm	174.33	-	221.86	174.33	-	218.66	174.33	-	223.47
Wt. Tare, gm	83.91	-	84.16	83.91	-	81.68	83.91	-	85.06
Water Content, %	19.3%	-	18.2%	19.3%	-	16.8%	19.3%	-	15.9%
Wt. of Wet Soil & Mold, gm	316.98	-	-	317.21	-	-	317.59	-	-
Wt. of Mold, gm	151.68	-	-	152.61	-	-	151.69	-	-
Wt. of Wet Soil, gm	165.3	-	-	164.6	-	-	165.9	-	-
Sample Height, in	1	0.9374	0.9188	1	0.9174	0.8925	1	0.8904	0.8648
Sample Diameter, in	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Sample Area, in^2	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
Sample Volume, cc	80.44	75.40	73.91	80.44	73.80	71.79	80.44	71.62	69.56
Wet Density, pcf	128.2	NA	138.2	127.7	NA	140.0	128.7	NA	144.6
Dry Density, pcf	107.5	NA	117.0	107.0	NA	119.9	107.9	NA	124.7

DEFORMATION RATE CALCULATIONS

	1	2	3
t_{90}, min. (Sqrt. Method)	0.38	0.24	10.50
Equivalent t_{50}, min. (Sqrt.)	0.09	0.06	2.45
t_{50}, min. (Log Method)	1.69	0.09	0.36
Selected t_{50}, min. (Max.)	1.69	0.09	2.45
Calc. Disp. Rate, in./min.	0.0028	0.0534	0.0020

TEST DATA AND SUMMARY

Test No.	1		2		3	
Normal Stress, psi	34.69		69.45		138.90	
Shear Stress at Failure, psi	23.7	Peak	36.8	Peak	71.8	10% Def.
Shear Disp. at Failure, in	0.240		0.240		0.250	
Displacement Rate, in/min	0.0010		0.0010		0.0010	

Horizontal Displacement in	Shear Force lb.	Shear Stress psi	Vertical Deformation in	Shear Force lb.	Shear Stress psi	Vertical Deformation in	Shear Force lb.	Shear Stress psi	Vertical Deformation in
0	0.0	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000
0.005	1.6	0.3	0.000	5.3	1.1	-0.003	8.6	1.7	-0.004
0.010	12.4	2.5	-0.001	15.8	3.2	-0.004	25.5	5.2	-0.005
0.015	36.8	7.5	-0.001	23.8	4.8	-0.005	44.2	9.0	-0.006
0.020	57.1	11.6	-0.002	34.0	6.9	-0.006	65.2	13.3	-0.006
0.025	66.2	13.5	-0.003	48.5	9.9	-0.007	92.2	18.8	-0.007
0.030	70.0	14.3	-0.004	61.0	12.4	-0.008	116.5	23.7	-0.008
0.035	78.2	15.9	-0.005	72.7	14.8	-0.009	138.2	28.1	-0.010
0.040	78.4	16.0	-0.005	83.4	17.0	-0.010	157.7	32.1	-0.011
0.045	78.4	16.0	-0.006	92.9	18.9	-0.011	175.5	35.7	-0.012
0.050	79.4	16.2	-0.007	101.4	20.7	-0.012	192.0	39.1	-0.013
0.055	79.6	16.2	-0.007	109.4	22.3	-0.013	206.9	42.2	-0.013
0.060	79.9	16.3	-0.008	116.1	23.7	-0.014	220.9	45.0	-0.014
0.065	81.2	16.5	-0.009	122.6	25.0	-0.014	233.6	47.6	-0.015
0.070	83.1	16.9	-0.009	128.5	26.2	-0.015	245.2	50.0	-0.016
0.075	84.7	17.3	-0.010	133.6	27.2	-0.016	255.9	52.1	-0.016
0.080	86.6	17.6	-0.010	138.4	28.2	-0.016	265.8	54.1	-0.017

0.085	87.0	17.7	-0.011	142.6	29.0	-0.017	274.8	56.0	-0.018
0.090	87.8	17.9	-0.011	146.4	29.8	-0.017	283.3	57.7	-0.018
0.095	89.4	18.2	-0.011	149.9	30.5	-0.018	290.5	59.2	-0.019
0.100	91.1	18.6	-0.012	153.1	31.2	-0.018	297.6	60.6	-0.019
0.105	91.9	18.7	-0.012	155.8	31.7	-0.019	303.9	61.9	-0.020
0.110	92.8	18.9	-0.013	158.7	32.3	-0.019	310.0	63.2	-0.020
0.115	93.8	19.1	-0.013	161.3	32.9	-0.019	315.3	64.2	-0.020
0.120	93.1	19.0	-0.013	163.0	33.2	-0.020	320.3	65.3	-0.020
0.125	93.8	19.1	-0.014	165.0	33.6	-0.020	324.4	66.1	-0.021
0.130	94.2	19.2	-0.014	166.8	34.0	-0.020	328.2	66.9	-0.021
0.135	94.1	19.2	-0.014	168.1	34.2	-0.021	331.4	67.5	-0.021
0.140	93.3	19.0	-0.014	169.8	34.6	-0.021	334.9	68.2	-0.022
0.145	93.8	19.1	-0.015	171.2	34.9	-0.021	337.5	68.8	-0.022
0.150	94.1	19.2	-0.015	172.4	35.1	-0.021	340.0	69.3	-0.022
0.155	94.5	19.3	-0.015	173.2	35.3	-0.022	341.8	69.6	-0.022
0.160	96.1	19.6	-0.015	174.7	35.6	-0.022	343.4	70.0	-0.023
0.165	96.1	19.6	-0.016	175.3	35.7	-0.022	344.6	70.2	-0.023
0.170	96.9	19.8	-0.016	176.3	35.9	-0.022	346.2	70.5	-0.023
0.175	98.8	20.1	-0.016	176.4	35.9	-0.023	346.7	70.6	-0.023
0.180	99.8	20.3	-0.016	177.7	36.2	-0.023	348.3	71.0	-0.023
0.185	100.9	20.6	-0.017	177.8	36.2	-0.023	348.7	71.0	-0.024
0.190	102.3	20.8	-0.017	178.2	36.3	-0.023	349.6	71.2	-0.024
0.195	103.0	21.0	-0.017	178.4	36.4	-0.023	349.7	71.2	-0.024
0.200	103.9	21.2	-0.017	178.9	36.4	-0.023	349.5	71.2	-0.024
0.205	104.5	21.3	-0.017	178.9	36.5	-0.024	349.9	71.3	-0.024
0.210	105.3	21.5	-0.017	179.2	36.5	-0.024	350.7	71.4	-0.024
0.215	107.0	21.8	-0.018	179.3	36.5	-0.024	351.1	71.5	-0.024
0.220	108.5	22.1	-0.018	179.5	36.6	-0.024	351.6	71.6	-0.025
0.225	109.7	22.4	-0.018	179.6	36.6	-0.024	351.7	71.7	-0.025
0.230	112.2	22.9	-0.018	179.8	36.6	-0.024	351.8	71.7	-0.025
0.235	115.9	23.6	-0.018	179.8	36.6	-0.025	351.8	71.7	-0.025
0.240	116.5	23.7	-0.018	180.4	36.8	-0.025	352.3	71.8	-0.025
0.245	113.4	23.1	-0.018	179.9	36.7	-0.025	351.9	71.7	-0.025
0.250	107.9	22.0	-0.019	180.4	36.7	-0.025	352.5	71.8	-0.026

Input Validation: Reviewed By:

Attachment B

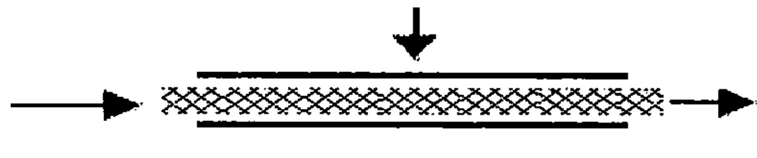
Geocomposite Transmissivity QA and QC Test Results

SKAPS Industries

ASTM D 4716

Client:	American Environmental Group, Ltd	**Job #**	2839
Project:	Central Waste, OH		
Product:	TN270-2-6		
Roll #	283910245		

Test Configuration:



Test Information:

Boundary Conditions:	Steel Plate Geocomposite Steel Plate	**Normal Load:**	10000 psf
		Gradient:	0.02 ft
		Seating Time:	15 minutes
		Flow Direction:	MD

Test Results:

Pressure (psf)	Gradient, ft	Transmissivity, m^2/sec
		15 minutes
10000	0.02	1.28×10^{-3}

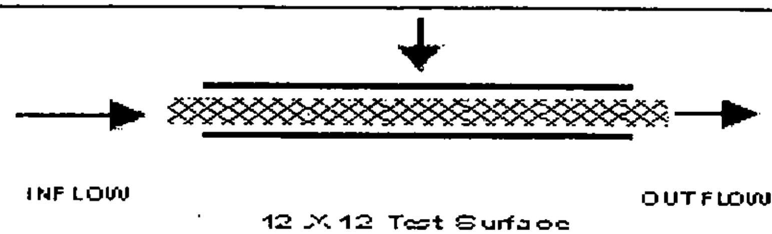
571 Industrial Parkway, Commerce, GA 30529 **Phone:** 706-336-7000 **Fax:** 706-336-7007 **Email:** skaps@skaps.com

SKAPS Industries

ASTM D 4716

Client:	American Environmental Group, Ltd	**Job #**	2839
Project:	Central Waste, OH		
Product:	TN270-2-6		
Roll #	283910245		

Test Configuration:



Test Information:

Boundary Conditions:	Steel Plate Geocomposite Steel Plate	**Normal Load:**	500 psf
		Gradient:	0.33 ft
		Seating Time:	15 minutes
		Flow Direction:	MD

Test Results:

Pressure (psf)	Gradient, ft	Transmissivity, m^2/sec
		15 minutes
500	0.33	1.39×10^{-3}

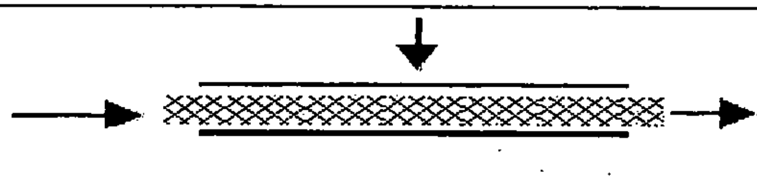
571 Industrial Parkway, Commerce, GA 30529 **Phone:** 706-336-7000 **Fax:** 706-336-7007 **Email:** skaps@skaps.com

SKAPS Industries

ASTM D 4716

Client:	American Environmental Group, Ltd	**Job #**	2839
Project:	Central Waste, OH		
Product:	TN270-2-6		

Test Configuration:



Test Information:

Boundary Conditions:	Steel Plate Geocomposite Steel Plate	**Normal Load:**	500 psf
		Gradient:	0.33 ft
		Seating Time:	15 minutes
		Flow Direction:	MD

Test Results:

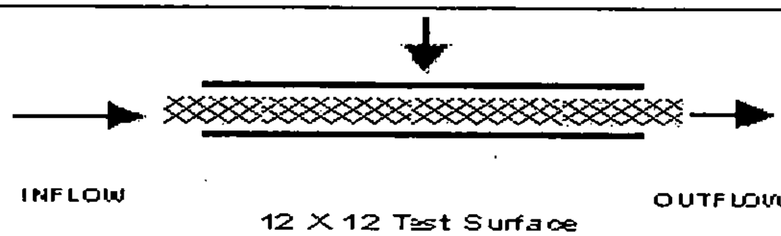
Roll Number	Gradient, ft	Transmissivity, m^2/sec 15 minutes
283910220	0.33	1.32×10^{-3}
283910245		1.39×10^{-3}

SKAPS Industries

ASTM D 4716

Client: American Environmental Group, Ltd **Project:** Central Waste, OH **Product:** TN270-2-6	**Job #** 2839

Test Configuration:



Test Information:

Boundary Conditions:	Steel Plate Geocomposite Steel Plate	**Normal Load:** 500 psf **Gradient:** 0.33 ft **Seating Time:** 15 minutes **Flow Direction:** MD

Test Results:

Roll No.	Pressure (psf)	Gradient, ft	Transmissivity, m^2/sec
			15 minutes
283910001	500	0.33	1.37×10^{-3}
283910035			1.41×10^{-3}
283910070			1.38×10^{-3}
283910105			1.36×10^{-3}
283910140			1.39×10^{-3}
283910175			1.37×10^{-3}
283910210			1.40×10^{-3}

571 Industrial Parkway, Commerce, GA 30529 **Phone:** 706-336-7000 **Fax:** 706-336-7007 **Email:** skaps@skaps.com

GEOCOMPOSITE TEST RESULTS

TRI Client: Civil & Environmental Consultants, Inc.
Project: Central Waste Landfill

Material: SKAPS TN270-2-6 Double Sided Geocomposite
Hydraulic Transmissivity (ASTM D 4716)
TRI Log #: E2312-33-02

PARAMETER — TEST REPLICATE NUMBER — MEAN — STD. DEV. — PROJ. SPEC.

Sample Identification: 283910061

Direction Tested: Machine Direction	
Normal Load (psf):	500
Hydraulic Gradient:	0.33
Test Length (in)	12
Test Width (in)	12

Plate / Sample / Plate

Seat Time (hours)	Parameter	1	2	3	4	5	6	7	8	9	10	MEAN	STD. DEV.	PROJ. SPEC.
	Specimen			1			2							
	Volume (cc)		872	872	862	833	836	830						
	Time (s)		7.25	7.31	7.25	7.25	7.21	7.25						
0.25	Flow Rate (GPM/ft width)		1.91	1.89	1.88	1.82	1.84	1.81				1.86	0.04	
	Transmissivity (m^2/s)		1.20E-03	1.19E-03	1.18E-03	1.14E-03	1.15E-03	1.14E-03				1.17E-03	2.47E-05	5.0E-04 min
	Test Temp (C)			20.0			20.0							
	Temp. Corr. Factor			1.000			1.000							

Sample Identification: 283910078

Direction Tested: Machine Direction	
Normal Load (psf):	500
Hydraulic Gradient:	0.33
Test Length (in)	12
Test Width (in)	12

Plate / Sample / Plate

Seat Time (hours)	Parameter	1	2	3	4	5	6	7	8	9	10	MEAN	STD. DEV.	PROJ. SPEC.
	Specimen			1			2							
	Volume (cc)		619	613	618	669	666	659						
	Time (s)		7.18	7.09	7.21	7.21	7.18	7.09						
0.25	Flow Rate (GPM/ft width)		1.37	1.37	1.36	1.47	1.47	1.47				1.42	0.06	
	Transmissivity (m^2/s)		8.57E-04	8.60E-04	8.52E-04	9.22E-04	9.22E-04	9.24E-04				8.90E-04	3.66E-05	5.0E-04 min
	Test Temp (C)			20.0			20.0							
	Temp. Corr. Factor			1.000			1.000							

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GEOCOMPOSITE TEST RESULTS

TRI Client: Civil & Environmental Consultants, Inc.
Project: Central Waste Landfill

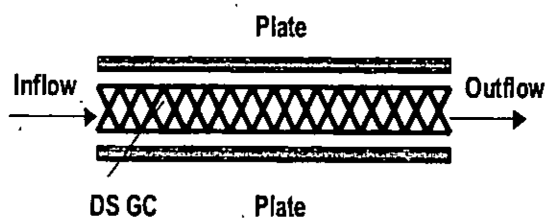
Material: SKAPS TN270-2-6 Double Sided Geocomposite
Hydraulic Transmissivity (ASTM D 4716)
TRI Log #: E2312-33-02

PARAMETER		TEST REPLICATE NUMBER 1	2	3	4	5	6	7	8	9	10	MEAN	STD. DEV.	PROJ. SPEC.
Sample Identification: 283910026														

Direction Tested: Machine Direction

Normal Load (psf):	500
Hydraulic Gradient:	0.33
Test Length (in)	12
Test Width (in)	12

Plate / Sample / Plate



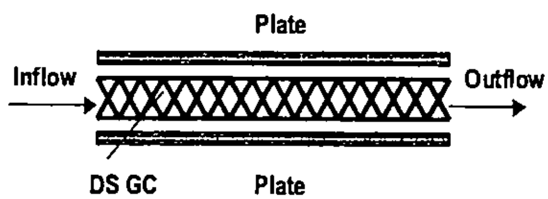
Seat Time (hours)		Specimen 1	2	3	4	5	6	7	8	9	10	MEAN	STD. DEV.	PROJ. SPEC.
	Specimen			1			2							
	Volume (cc)		874	876	869	865	874	860						
	Time (s)		7.18	7.21	7.18	7.25	7.37	7.25						
0.25	Flow Rate (GPM/ft width)		1.93	1.93	1.92	1.89	1.88	1.88				1.90	0.02	
	Transmissivity (m^2/s)		1.21E-03	1.21E-03	1.20E-03	1.19E-03	1.18E-03	1.18E-03				1.19E-03	1.44E-05	5.0E-04 min
	Test Temp (C)			20.0			20.0							
	Temp. Corr. Factor			1.000			1.000							

Sample Identification: 283910044

Direction Tested: Machine Direction

Normal Load (psf):	500
Hydraulic Gradient:	0.33
Test Length (in)	12
Test Width (in)	12

Plate / Sample / Plate



Seat Time (hours)		1	2	3	4	5	6	7	8	9	10	MEAN	STD. DEV.	PROJ. SPEC.
	Specimen			1			2							
	Volume (cc)		795	792	789	750	747	745						
	Time (s)		7.31	7.28	7.18	7.20	7.13	7.14						
0.25	Flow Rate (GPM/ft width)		1.72	1.72	1.74	1.65	1.66	1.65				1.69	0.04	
	Transmissivity (m^2/s)		1.08E-03	1.08E-03	1.09E-03	1.04E-03	1.04E-03	1.04E-03				1.06E-03	2.61E-05	5.0E-04 min
	Test Temp (C)			20.0			20.0							
	Temp. Corr. Factor			1.000			1.000							

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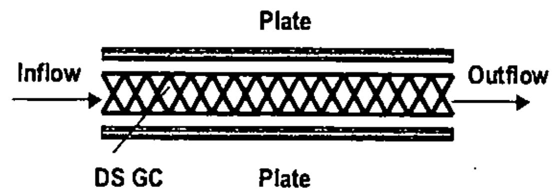
GEOCOMPOSITE TEST RESULTS

TRI Client: Civil & Environmental Consultants, Inc.
Project: Central Waste Landfill

Material: SKAPS TN270-2-6 Double Sided Geocomposite
Sample Identification: 283910004
TRI Log #: E2312-33-02

PARAMETER	TEST REPLICATE NUMBER										MEAN	STD. DEV.	PROJ. SPEC.
	1	2	3	4	5	6	7	8	9	10			
Hydraulic Transmissivity (ASTM D 4716)													
Direction Tested: Machine Direction													
Normal Load (psf): 500													
Hydraulic Gradient: 0.33													
Test Length (in): 12													
Test Width (in): 12													
Plate / Sample / Plate													
Seat Time (hours): 0.25 — Specimen			1			2							
Volume (cc)		986	1011	998	980	954	950						
Time (s)		7.15	7.31	7.25	7.37	7.18	7.15						
Flow Rate (GPM/ft width)		2.19	2.19	2.18	2.11	2.11	2.11				2.15	0.04	
Transmissivity (m^2/s)		1.37E-03	1.38E-03	1.37E-03	1.32E-03	1.32E-03	1.32E-03				1.35E-03	2.76E-05	5.0E-04 min
Test Temp (C)			20.0			20.0							
Temp. Corr. Factor			1.000			1.000							
Thickness (ASTM D 5199) — Geonet Component													
Thickness (mils)	282	286	276	284	279	282	292	290	298	276	285	7	250 min
											276	<< min	
Density (ASTM D 1505) — Geonet Component													
Density (g/cm3)	0.947	0.947	0.947								0.947	0.000	0.94 min
Carbon Black Content (ASTM D 1603, mod.) — Geonet Component													
% Carbon Black	2.31	2.32									2.32	0.01	2.0 - 3.5%



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GEOCOMPOSITE TEST RESULTS

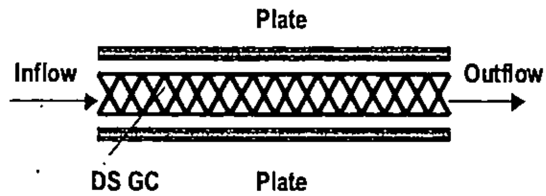
TRI Client: Civil & Environmental Consultants, Inc.
Project: Central Waste Landfill

Material: SKAPS TN270-2-6 Double Sided Geocomposite
Hydraulic Transmissivity (ASTM D 4716)
TRI Log #: E2312-33-03

Sample Identification: 283910149

Direction Tested:	Machine Direction
Normal Load (psf):	500
Hydraulic Gradient:	0.33
Test Length (in)	12
Test Width (in)	12

Plate / Sample / Plate

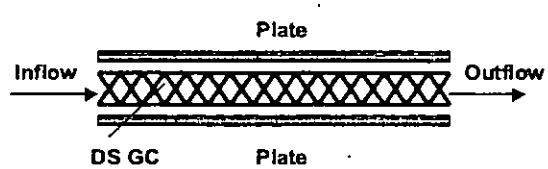


Seat Time (hours)	PARAMETER	TEST REPLICATE NUMBER 1	2	3	4	5	6	7	8	9	10	MEAN	STD. DEV.	PROJ. SPEC.
	Specimen			1			2							
	Volume (cc)		544	543	530	550	629	538						
	Time (s)		5.40	5.50	5.31	5.30	6.43	5.40						
0.25	Flow Rate (GPM/ft width)		1.60	1.57	1.58	1.65	1.55	1.58				1.59	0.03	
	Transmissivity (m^2/s)		1.00E-03	9.82E-04	9.92E-04	1.03E-03	9.73E-04	9.91E-04				9.95E-04	2.05E-05	5.0E-04 min
	Test Temp (C)			20.0			20.0							
	Temp. Corr. Factor			1.000			1.000							

Sample Identification: 283910167

Direction Tested:	Machine Direction
Normal Load (psf):	500
Hydraulic Gradient:	0.33
Test Length (in)	12
Test Width (in)	12

Plate / Sample / Plate



Seat Time (hours)	PARAMETER	TEST REPLICATE NUMBER 1	2	3	4	5	6	7	8	9	10	MEAN	STD. DEV.	PROJ. SPEC.
	Specimen			1			2							
	Volume (cc)		547	538	511	551	550	600						
	Time (s)		5.84	5.75	5.46	5.00	5.06	5.50						
0.25	Flow Rate (GPM/ft width)		1.48	1.48	1.48	1.75	1.72	1.73				1.61	0.14	
	Transmissivity (m^2/s)		9.31E-04	9.30E-04	9.30E-04	1.10E-03	1.08E-03	1.08E-03				1.01E-03	8.58E-05	5.0E-04 min
	Test Temp (C)			20.0			20.0							
	Temp. Corr. Factor			1.000			1.000							

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GEOCOMPOSITE TEST RESULTS

TRI Client: Civil & Environmental Consultants, Inc.
Project: Central Waste Landfill

Material: SKAPS TN270-2-6 Double Sided Geocomposite
Hydraulic Transmissivity (ASTM D 4716)
TRI Log #: E2312-33-03

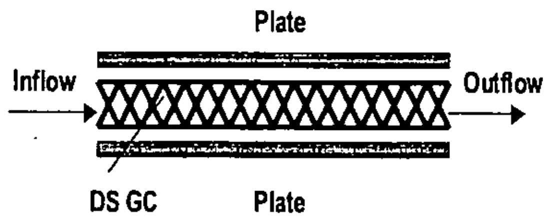
PARAMETER — **TEST REPLICATE NUMBER** — **MEAN** — **STD. DEV.** — **PROJ. SPEC.**

Sample Identification: 283910115

Direction Tested: Machine Direction

Normal Load (psf):	500
Hydraulic Gradient:	0.33
Test Length (in)	12
Test Width (in)	12

Plate / Sample / Plate



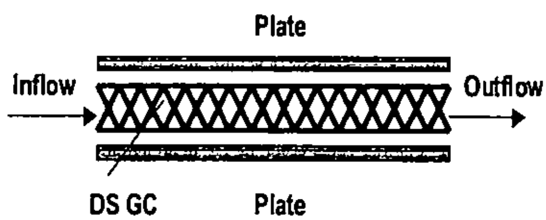
Seat Time (hours)	Parameter	1	2	3	4	5	6	7	8	9	10	MEAN	STD. DEV.	PROJ. SPEC.
		Specimen		1			2							
0.25	Volume (cc)		865	871	869	849	854	848						
	Time (s)		7.15	7.25	7.21	7.10	7.11	7.06						
	Flow Rate (GPM/ft width)		1.92	1.90	1.91	1.90	1.90	1.90				1.91	0.01	
	Transmissivity (m^2/s)		1.20E-03	1.19E-03	1.20E-03	1.19E-03	1.19E-03	1.19E-03				1.20E-03	4.68E-06	5.0E-04 min
	Test Temp (C)			20.0			20.0							
	Temp. Corr. Factor			1.000			1.000							

Sample Identification: 283910132

Direction Tested: Machine Direction

Normal Load (psf):	500
Hydraulic Gradient:	0.33
Test Length (in)	12
Test Width (in)	12

Plate / Sample / Plate



Seat Time (hours)	Parameter	1	2	3	4	5	6	7	8	9	10	MEAN	STD. DEV.	PROJ. SPEC.
		Specimen		1			2							
0.25	Volume (cc)		682	681	680	603	604	606						
	Time (s)		7.21	7.21	7.18	7.21	7.20	7.21						
	Flow Rate (GPM/ft width)		1.50	1.50	1.50	1.33	1.33	1.33				1.41	0.09	
	Transmissivity (m^2/s)		9.40E-04	9.39E-04	9.42E-04	8.31E-04	8.34E-04	8.36E-04				8.87E-04	5.84E-05	5.0E-04 min
	Test Temp (C)			20.0			20.0							
	Temp. Corr. Factor			1.000			1.000							

GEOCOMPOSITE TEST RESULTS

TRI Client: Civil & Environmental Consultants, Inc.
Project: Central Waste Landfill

Material: SKAPS TN270-2-6 Double Sided Geocomposite
Sample Identification: 283910184
TRI Log #: E2312-33-03

PARAMETER	TEST REPLICATE NUMBER 1	2	3	4	5	6	7	8	9	10	MEAN	STD. DEV.	PROJ. SPEC.
Hydraulic Transmissivity (ASTM D 4716)													

Direction Tested: Machine Direction

Normal Load (psf):	500
Hydraulic Gradient:	0.33
Test Length (in)	12
Test Width (in)	12

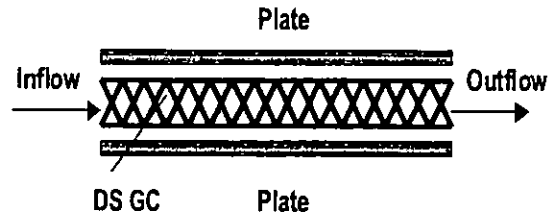


Plate / Sample / Plate

Seat Time (hours)		Specimen		1			2		MEAN	STD. DEV.	PROJ. SPEC.
0.25	Volume (cc)		697	703	697	691	681	678			
	Time (s)		7.15	7.15	7.15	7.20	7.14	7.13			
	Flow Rate (GPM/ft width)		1.55	1.56	1.55	1.52	1.51	1.51	1.53	0.02	
	Transmissivity (m^2/s)		9.69E-04	9.78E-04	9.69E-04	9.54E-04	9.48E-04	9.45E-04	9.61E-04	1.31E-05	5.0E-04 min
	Test Temp (C)			20.0			20.0				
	Temp. Corr. Factor			1.000			1.000				

PARAMETER	1	2	3	4	5	6	7	8	9	10	MEAN	STD. DEV.	PROJ. SPEC.
Thickness (ASTM D 5199) — Geonet Component													
Thickness (mils)	280	278	276	281	277	281	288	286	284	301	283	7	250 min
											276	<< min	
Density (ASTM D 1505) — Geonet Component													
Density (g/cm3)	0.947	0.947	0.947								0.947	0.000	0.94 min
Carbon Black Content (ASTM D 1603, mod.) — Geonet Component													
% Carbon Black	2.34	2.32									2.33	0.01	2.0 - 3.5%

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GEOCOMPOSITE TEST RESULTS

TRI Client: Civil & Environmental Consultants, Inc.
Project: Central Waste Landfill

Material: SKAPS TN270-2-6 Double Sided Geocomposite
Sample Identification: 283910205
TRI Log #: E2312-54-07

Hydraulic Transmissivity (ASTM D 4716)

Direction Tested: Machine Direction

Normal Load (psf):	500
Hydraulic Gradient:	0.33
Test Length (in)	12
Test Width (in)	12

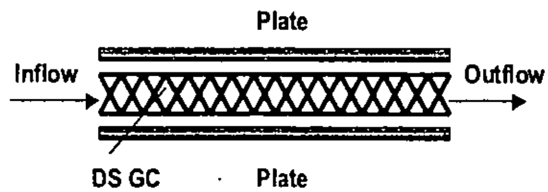

Plate / Sample / Plate

Seat Time (hours)	PARAMETER	TEST REPLICATE NUMBER 1	2	3	4	5	6	7	8	9	10	MEAN	STD. DEV.	PROJ. SPEC.
		Specimen		1			2							
	Volume (cc)		989	973	951	977	1072	978						
	Time (s)		5.18	5.09	4.96	5.12	5.62	5.15						
0.25	Flow Rate (GPM/ft width)		3.03	3.03	3.04	3.02	3.02	3.01				3.03	0.01	
	Transmissivity (m^2/s)		1.90E-03	1.90E-03	1.91E-03	1.90E-03	1.90E-03	1.89E-03				1.90E-03	5.94E-06	5.0E-04 min
	Test Temp (C)			20.0			20.0							
	Temp. Corr. Factor			1.000			1.000							

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Attachment C

Interface Shear Strength Test Results

June 27, 2008

Mr. John Schmidt, P.E.
Ohio EPA Northeast District Office
Division of Solid and Infectious Waste Management
2110 East Aurora Road
Twinsburg, Ohio 44087

Dear Mr. Schmidt:

Subject: Interface Shear Strength Testing Results
2008 Closure Construction
Permit to Install # 02-13262
Central Waste Disposal Facility
CEC Project 072-230.0005

On behalf of Central Waste, Inc. (CWI), Civil & Environmental Consultants, Inc. (CEC) is submitting the Shear Strength Testing Results for the final cover system components proposed for use in 2008 Closure construction at the Central Waste Disposal Facility in Alliance, Ohio. This information is submitted in accordance with the CQA/QC Plan and OAC 3745-27-08(G).

The CQA/QC Plan and OAC 3745-27-08(G) requires the shear strength to be tested twice prior to the initial use of each geosynthetic material in the final cover system at the facility. Two tests were conducted on each of the interfaces listed below.

- Poly Flex 40 mil LLDPE Textured Geomembrane vs. Recompacted Soil Barrier (RSB)
- Skaps TN270-2-6 Double-sided Geocomposite vs. Poly Flex 40 mil LLDPE Textured Geomembrane
- Skaps TN270-2-6 Double-sided Geocomposite vs. Frost Protection/Vegetative Cover

Testing was conducted at the following normal loads for comparison to the required peak shear strengths listed in the QA/QC Plan and summarized in the following table.

Normal Load (psf)	Required Peak Shear Strength (psf)
500	250

Civil & Environmental Consultants, Inc.

Pittsburgh 333 Baldwin Road
Pittsburgh, Pennsylvania 15205
Phone 412/429-2324
Fax 412/429-2114
Toll Free 800/365-2324
E-mail info@cecinc.com

Chicago 877/963-6026
Cincinnati 800/759-5614
Cleveland 866/507-2324
Columbus 888/598-6808
Detroit 866/380-2324
Export 800/899-3610
Indianapolis 877/746-0749
Nashville 800/763-2326
St. Louis 866/250-3679

Corporate Web Site http://www.cecinc.com

The interfaces tested met the requirements of the facility's QA/QC Plan as shown in the following table. The laboratory testing results are included in Attachment 1.

Interface Tested	Normal Load (psf)	Required Shear Strength (psf)	Peak Shear Strength (psf)
40 mil textured vs. RSB – Test 1	500	250	329
40 mil textured vs. RSB – Test 2	500	250	348
Geocomposite vs. 40 mil textured – Test 1	500	250	277
Geocomposite vs. 40 mil textured – Test 2	500	250	297
Geocomposite vs. protective cover – Test 1	500	250	360
Geocomposite vs. protective cover – Test 2	500	250	299

Please contact Tom Johnson with CWI at (330) 823-6220 or CEC at (412) 429-2324 if you have any questions regarding this report.

Sincerely,

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.

Daniel Tolmer, P.E.
Project Manager

Duane R. Lanoue, P.E.
Senior Project Manager

Enclosure

cc: Mary Helen Smith, District Board of Health of Mahoning County (w/enclosure)
Tom Johnson, CWI (w/enclosure)
Steve Menoff, TransLoad America, Inc. (without enclosure)
Jim Stenborg, TransLoad America, Inc. (without enclosure)

LR-072-230.0005.Jn27/W

ATTACHMENT 1

LABORATORY TESTING RESULTS

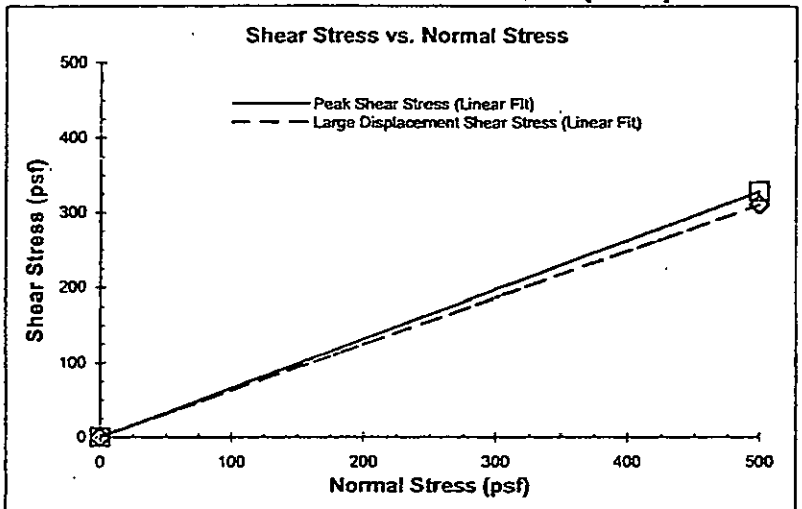
Interface Friction Test Report

Client: **CEC**
Project: **Central Waste, Closure Area 1**
Test Date: 06/16/08-06/17/08

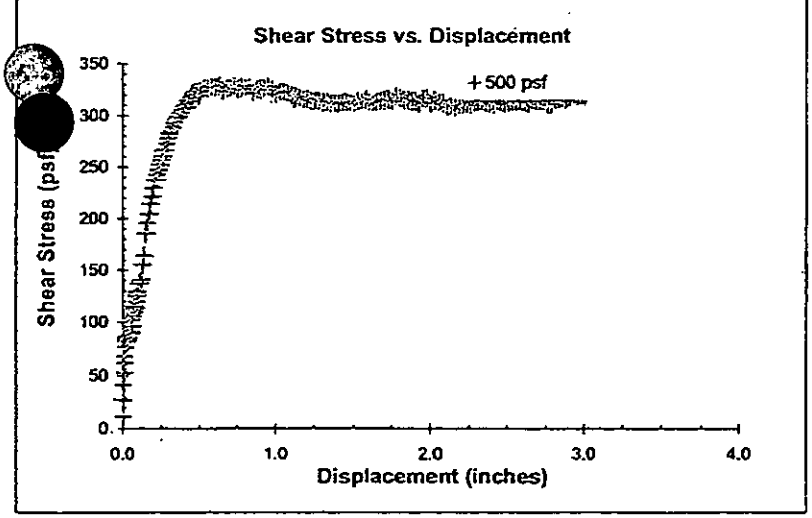
TRI Log#: E2308-23-05
Test Method: ASTM D 5321

John M. Allen, 06/17/2008
Quality Review/Date

Tested Interface: Poly Flex 40 mil LLDPE Textured Geomembrane (LT-4-07-6001-75) vs. RSB Soil (Sample 9 & 10), Test 1 of 2



Test Results	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	33.3	31.9
Y-intercept or Adhesion (psf):	0	0



Test Conditions

Upper Box &	RSB Soil (Sample 9 & 10) remolded to 109 pcf at 17% moisture content
Lower Box	Poly Flex 40 mil LLDPE textured geomembrane
Box Dimensions:	12"x12"x4"
Interface Conditioning:	Interface soaked and loading applied for a minimum of 24 hours prior to shear.
Test Condition:	Wet
Shearing Rate:	0.04 inches/minute

Test Data	
Specimen No.	1
Bearing Slide Resistance (lbs)	13
Normal Stress (psf)	500
Corrected Peak Shear Stress (psf)	329
Corrected Large Displacement Shear Stress (psf)	311
Peak Secant Angle (degrees)	33.3
Large Displacement Secant Angle (degrees)	31.9
Asperity (mils)	23.6

TRI/ENVIRONMENTAL, INC.

A Texas Research International Company

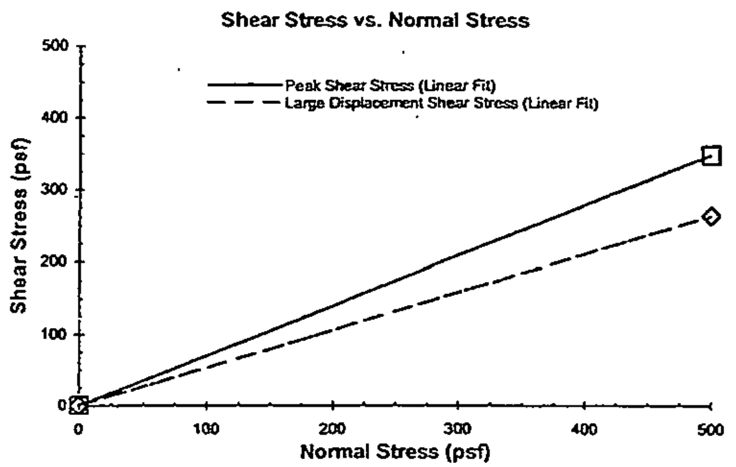
Interface Friction Test Report

Client: CEC
Project: Central Waste, Closure Area 1
Test Date: 06/16/08-06/17/08

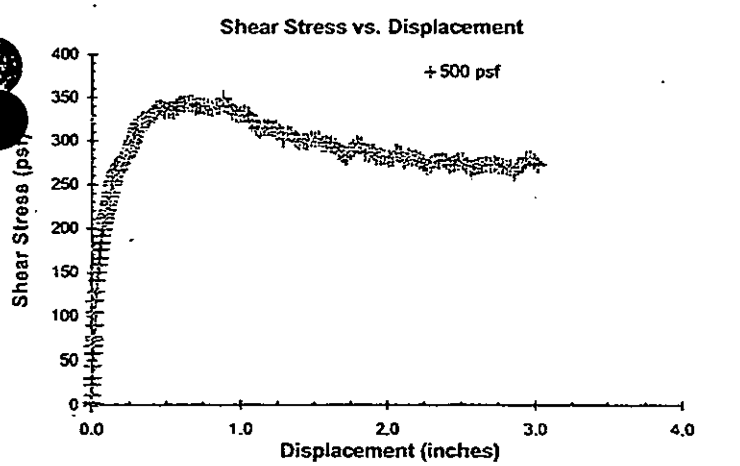
TRI Log#: E2308-23-05
Test Method: ASTM D 5321

John M. Allen, 06/17/2008
Quality Review/Date

Tested Interface: Poly Flex 40 mil LLDPE Textured Geomembrane (representative) vs. RSB Soil (Sample 9 & 10), Test 2 of 2



Test Results		
	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	34.9	27.8
Y-intercept or Adhesion (psf):	0	0



Test Conditions

Upper Box & RSB Soil (Sample 9 & 10) remolded to 109 pcf at 17% moisture content

Lower Box Poly Flex 40 mil LLDPE textured geomembrane

Box Dimensions: 12"x12"x4"

Interface Conditioning: Interface soaked and loading applied for a minimum of 24 hours prior to shear.

Test Condition: Wet

Shearing Rate: 0.04 inches/minute

Test Data	
Specimen No.	1
Bearing Slide Resistance (lbs)	13
Normal Stress (psf)	500
Corrected Peak Shear Stress (psf)	348
Corrected Large Displacement Shear Stress (psf)	264
Peak Secant Angle (degrees)	34.9
Large Displacement Secant Angle (degrees)	27.8
Asperity (mils)	23.4

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TRI/ENVIRONMENTAL, INC.
A Texas Research International Company

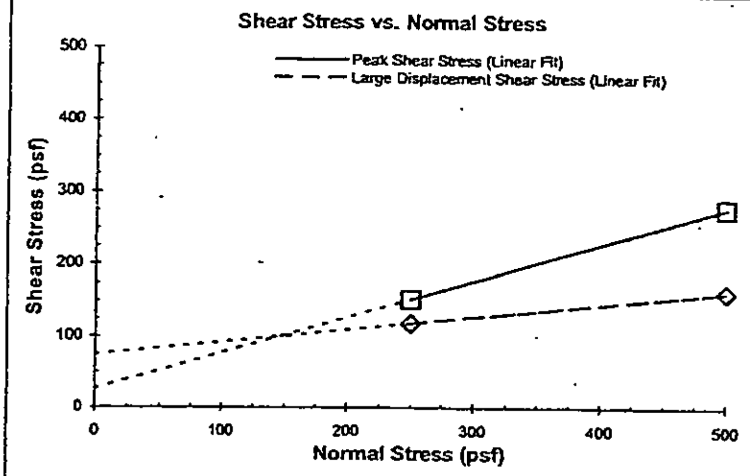
Interface Friction Test Report

Client: CEC
Project: Central Waste, Closure Area 1
Test Date: 06/09/08-06/24/08

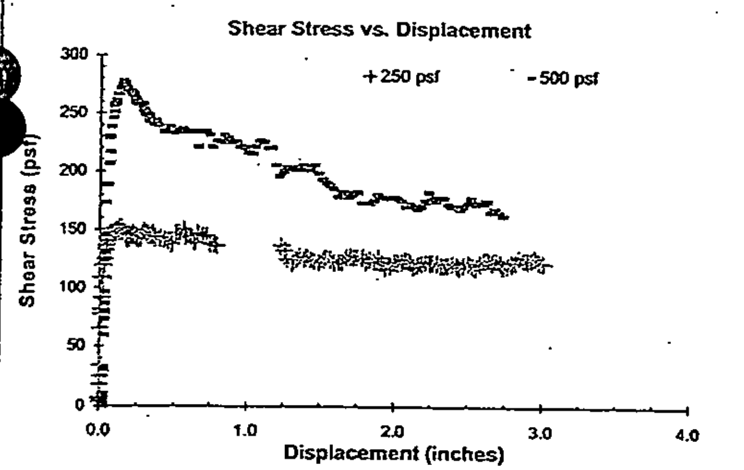
TRI Log#: E2308-23-05
Test Method: ASTM D 5321

Rich Lacey, P.E.., 06/25/2008
Quality Review/Date

Tested Interface: Skaps TN270-2-6 Double-sided Geocomposite (representative) vs. Poly Flex 40 mil LLDPE Textured Geomembrane (representative), Test 1 of 2



Test Results	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	26.7	10.0
Y-intercept or Adhesion (psf):	26	74



Test Conditions

Upper Box &	Skaps TN270-2-6 double-sided geocomposite
Lower Box	Poly Flex 40 mil LLDPE Textured Geomembrane
Box Dimensions:	12"x12"x4"
Interface Conditioning:	Interface soaked and loading applied for a minimum of 1 hour prior to shear.
Test Condition:	Wet
Shearing Rate:	0.2 inches/minute

Test Data

Specimen No.	1	2
Bearing Slide Resistance (lbs)	10	13
Normal Stress (psf)	250	500
Corrected Peak Shear Stress (psf)	152	277
Corrected Large Displacement Shear Stress (psf)	118	162
Peak Secant Angle (degrees)	31.2	29.0
Large Displacement Secant Angle (degrees)	25.3	18.0
Asperity (mils)	25.2	21.0

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TRI/ENVIRONMENTAL, INC.

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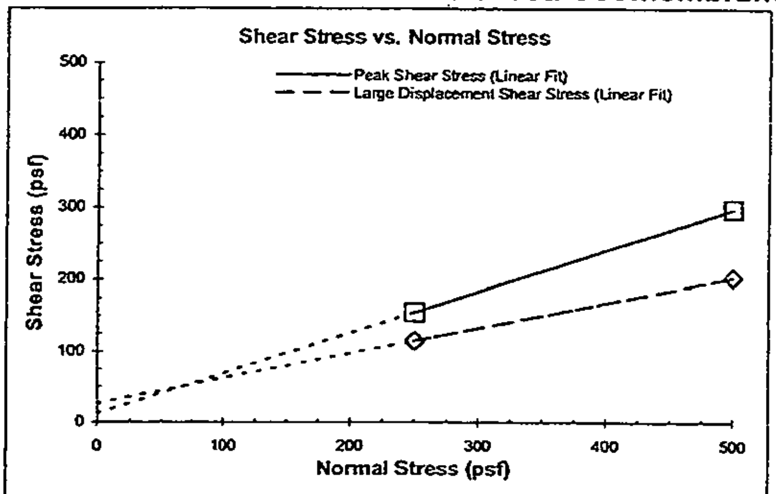
Interface Friction Test Report

Client: CEC
Project: Central Waste, Closure Area 1
Test Date: 06/17/08-06/17/08

TRI Log#: E2308-23-05
Test Method: ASTM D 5321

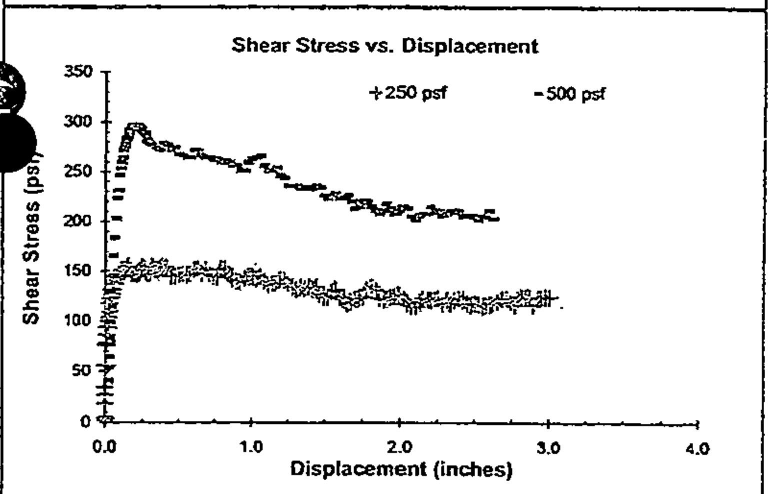
John M. Allen, E.I.T., 06/17/2008
Quality Review/Date

Tested Interface: Skaps TN270-2-6 Double-sided Geocomposite (representative) vs. Poly Flex 40 mil LLDPE Textured Geomembrane (representative), Test 2 of 2



Test Results

	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	29.7	19.4
Y-intercept or Adhesion (psf):	12	27



Test Conditions

Upper Box & Skaps TN270-2-6 double-sided geocomposite

Lower Box Poly Flex 40 mil LLDPE Textured Geomembrane

Box Dimensions: 12"x12"x4"

Interface Conditioning: Interface soaked and loading applied for a minimum of 1 hour prior to shear.

Test Condition: Wet

Shearing Rate: 0.2 inches/minute

Test Data

Specimen No.	1	2
Bearing Slide Resistance (lbs)	10	13
Normal Stress (psf)	250	500
Corrected Peak Shear Stress (psf)	155	297
Corrected Large Displacement Shear Stress (psf)	115	203
Peak Secant Angle (degrees)	31.7	30.7
Large Displacement Secant Angle (degrees)	24.7	22.1
Asperity (mils)	25.0	26.4

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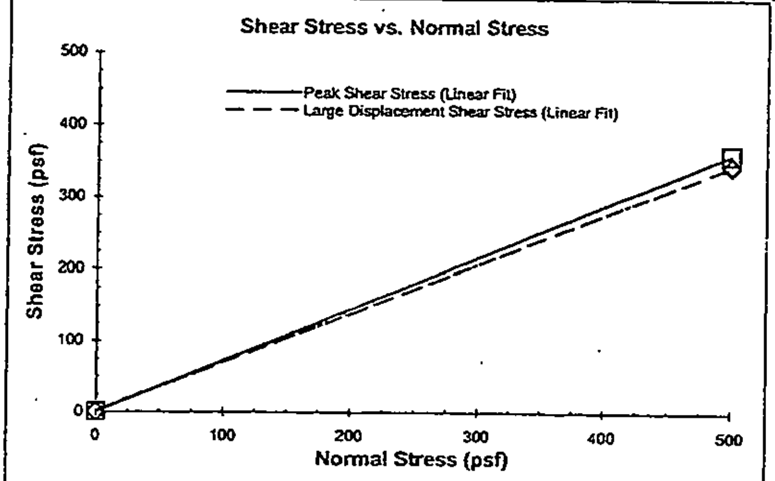
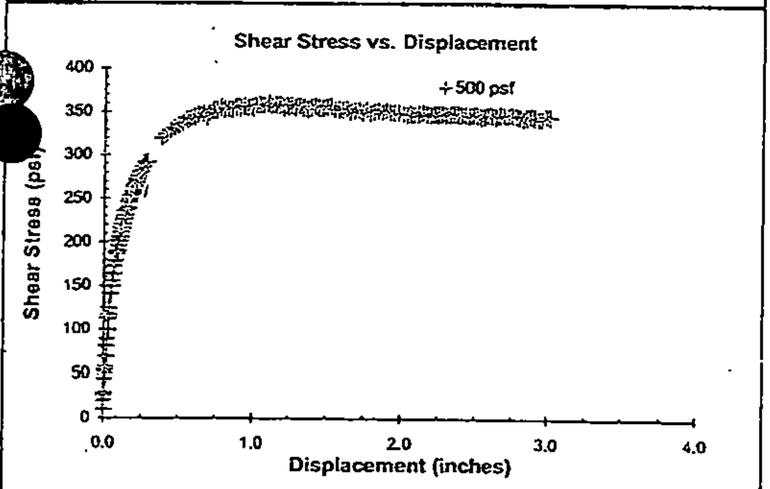
Interface Friction Test Report

Client:	CEC	TRI Log#: E2308-23-05	John M. Allen, 06/17/2008
Project:	Central Waste, Closure Area 1	Test Method: ASTM D 5321	Quality Review/Date
Test Date:	06/16/08-06/17/08		

Tested Interface: Skaps TN270-2-6 Double-sided Geocomposite (representative) vs. Frost Protection/Vegetative Cover Soil (Sample 11 & 12), Test 1 of 2



Test Results		
	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	35.8	34.6
Y-intercept or Adhesion (psf):	0	0



Test Conditions

Upper Box &	Frost Protection/Vegetative Cover soil remolded to 102.5 pcf at 15% moisture content
Lower Box	Skaps TN270-2-6 double-sided geocomposite

Box Dimensions: 12"x12"x4"

Interface Conditioning:	Interface soaked and loading applied for a minimum of 24 hours prior to shear.

Test Condition: Wet

Shearing Rate: 0.04 inches/minute

Test Data	
Specimen No.	1
Bearing Slide Resistance (lbs)	13
Normal Stress (psf)	500
Corrected Peak Shear Stress (psf)	360
Corrected Large Displacement Shear Stress (psf)	345
Peak Secant Angle (degrees)	35.8
Large Displacement Secant Angle (degrees)	34.6

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TRI/ENVIRONMENTAL, INC.
A Texas Research International Company

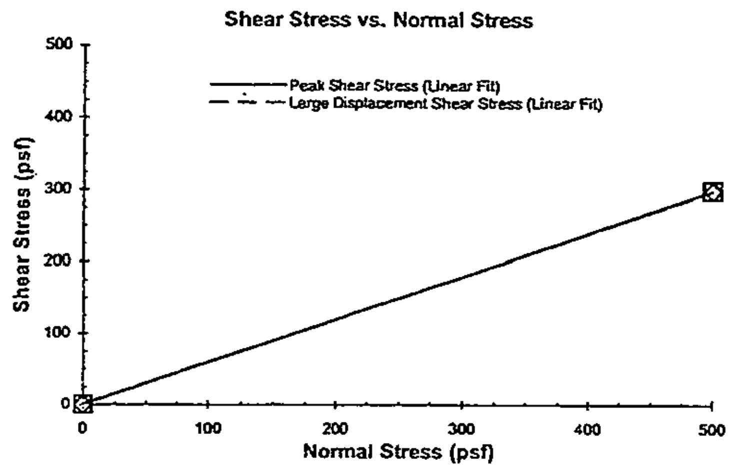
Interface Friction Test Report

Client: CEC
Project: Central Waste, Closure Area 1
Test Date: 06/16/08-06/17/08

TRI Log#: E2308-23-05
Test Method: ASTM D 5321

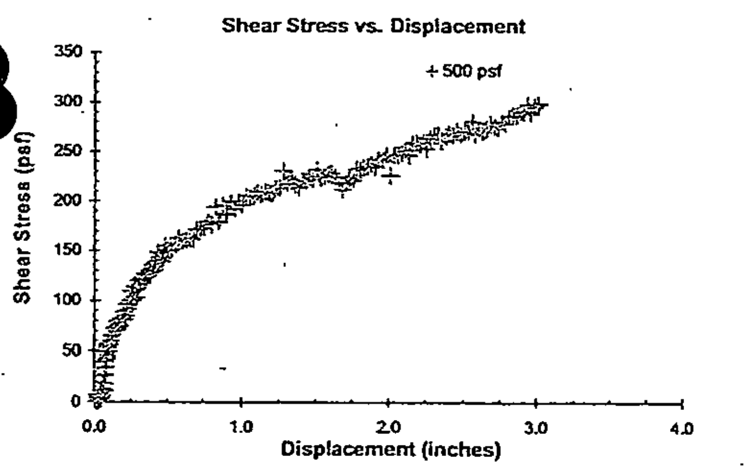
John M. Allen, 06/17/2008
Quality Review/Date

Tested Interface: Skaps TN270-2-6 Double-sided Geocomposite (representative) vs. Frost Protection/Vegetative Cover Soil (Sample 11 & 12), Test 2 of 2



Test Results

	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	30.8	30.8
Y-intercept or Adhesion (psf):	0	0



Test Conditions

Upper Box & Frost Protection/Vegetative Cover soil remolded to 102.5 pcf at 15% moisture content

Lower Box Skaps TN270-2-6 double-sided geocomposite

Box Dimensions: 12"x12"x4"

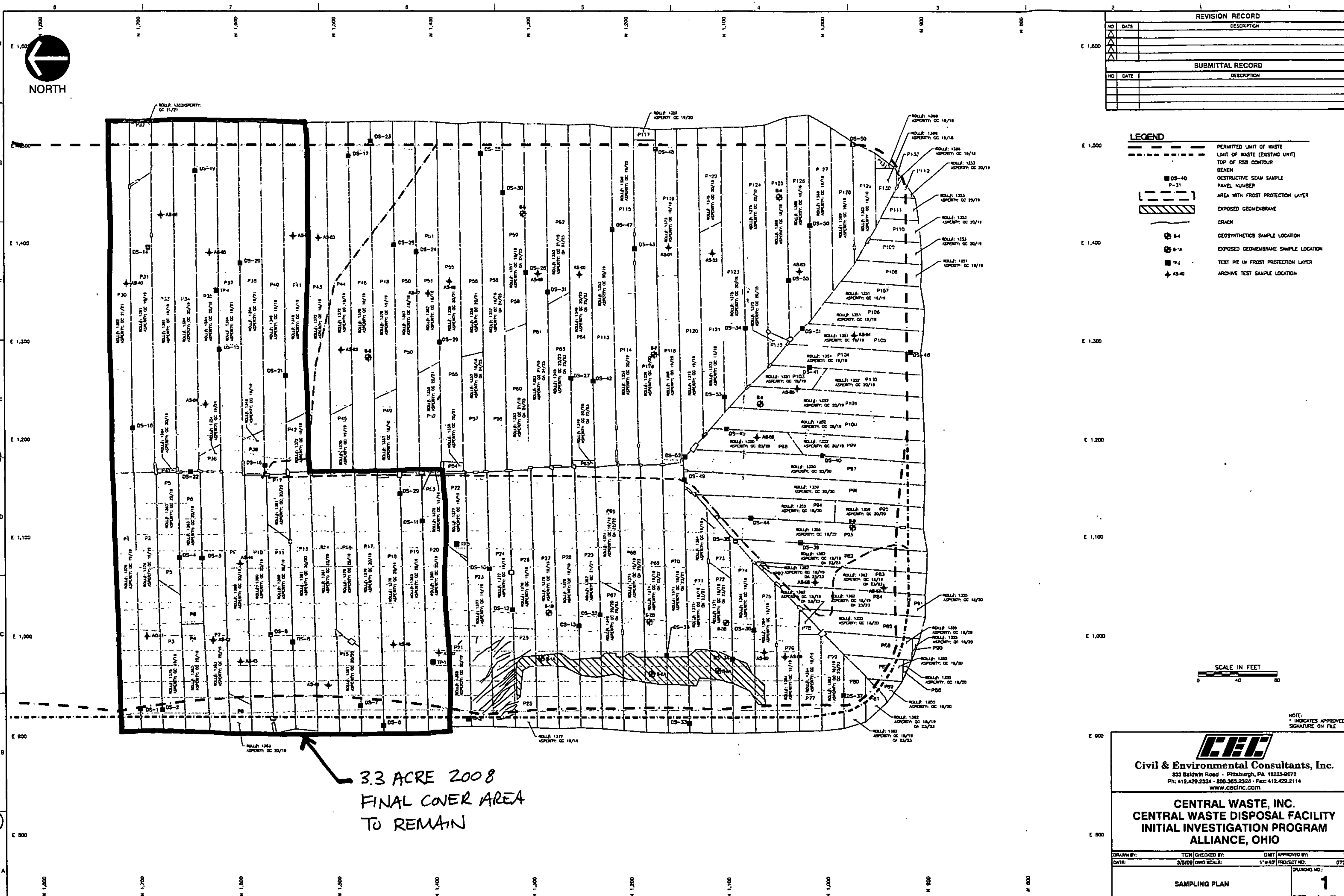
Interface Conditioning: Interface soaked and loading applied for a minimum of 24 hours prior to shear.

Test Condition: Wet

Shearing Rate: 0.04 inches/minute

Test Data

Specimen No.	1
Bearing Slide Resistance (lbs)	13
Normal Stress (psf)	500
Corrected Peak Shear Stress (psf)	299
Corrected Large Displacement Shear Stress (psf)	298
Peak Secant Angle (degrees)	30.8
Large Displacement Secant Angle (degrees)	30.8



NORTH
3.3 ACRE 2008
FINAL COVER AREA
TO REMAIN
REVISION RECORD
NO DATE DESCRIPTION
SUBMITTAL RECORD
NO DATE DESCRIPTION
LEGEND
PERMITTED LIMIT OF WASTE
LIMIT OF WASTE (EXISTING UNIT)
TOP OF RSB CONTOUR
BENCH
DS-40 DESTRUCTIVE SEAM SAMPLE
P-31 PANEL NUMBER
AREA WITH FROST PROTECTION LAYER
EXPOSED GEOMEMBRANE
CRACK
GEOSYNTHETICS SAMPLE LOCATION
EXPOSED GEOMEMBRANE SAMPLE LOCATION
TEST PIT IN FROST PROTECTION LAYER
AS-40 ARCHIVE TEST SAMPLE LOCATION
SCALE IN FEET
0
40
80
NOTE:
* INDICATES APPROVED BY SIGNATURE ON FILE
Civil & Environmental Consultants, Inc.
333 Baldwin Road - Pittsburgh, PA 15205-9072
Ph: 412.429.2324 · 800.365.2324 · Fax: 412.429.2114
www.cecinc.com
CENTRAL WASTE, INC.
CENTRAL WASTE DISPOSAL FACILITY
INITIAL INVESTIGATION PROGRAM
ALLIANCE, OHIO
DRAWN BY: TCN
CHECKED BY: DMT
APPROVED BY: *DRL
DATE: 3/5/09
DWG SCALE: 1"=40'
PROJECT NO: 072-230
SAMPLING PLAN
DRAWING NO.: 1
SHEET 1 OF 1

GEOCOMPOSITE VS. LLDPE GEOMEMBRANE INTERFACE TEST RESULTS SUMMARY
2008 CLOSURE CONSTRUCTION
CENTRAL WASTE DISPOSAL FACILITY
CENTRAL WASTE , INC.

SKAPS TN270-2-6 Geocomposite vs Poly Flex 40 mil LLDPE Textured Geomembrane Interface Sample	Poly Flex 40 mil Roll No.	QC Asperity (1)	Normal Load (psf)	Required Shear Strength(2) (psf)	Geotechnics			JLT Laboratories			TRI			Average Lab Sample Asperity	Average Lab Peak Shear Strength (psf)	Average Lab Residual Shear Strength (psf)
					Asperity Height	Peak Shear Strength (psf)	Residual Shear Strength (psf)	Asperity Height	Peak Shear Strength (psf)	Residual Shear Strength (psf)	Asperity Height	Peak Shear Strength (psf)	Residual Shear Strength (psf)			
SLOPE FAILURE INVESTIGATION INTERFACE SHEAR TEST RESULTS																
AS 40	1382	21/21	500	250	19.4	181	139	18.9	167	110	21.6	276	194	20.0	208	148
AS 41	1376	19/19	500	250	18.4	195	135	18.2	200	121	21.6	235	164	19.4	210	140
AS 42	1363	20/19	500	250	18.4	211	141	18.3	191	125	22.8	302	198	19.8	235	155
AS 43	1380	20/19	500	250	21.8	209	155	18.9	201	131	22.6	266	185	21.1	225	157
AS 44	1380	20/19	500	250	18.8	165	90	19.1	195	106	23.8	279	191	20.6	213	129
AS 45	1381	20/20	500	250	22.4	224	160	18.7	201	121	25.2	256	163	22.1	227	148
AS 46	1379	20/19	500	250	17.2	143	81	18.0	189	115	22.6	290	203	19.3	207	133
AS 60	1364	19/19	500	250	20.8	129	95	18.4	199	114	23.6	271	181	20.9	200	130
AS 61	1348	19/19	500	250	23.2	218	123	18.6	187	112	21.8	224	180	21.2	210	138
AS 62*	1372	18/19	500	250	16.4	178	136	18.3	215	122	18.6	227	174	17.8	207	144
AS 63	1372	18/19	500	250	17.0	182	137	19.3	210	118	20.4	241	229	18.9	211	161
AS 64	1384	20/19	500	250	19.4	212	124	19.0	178	112	23.6	235	197	20.7	208	144
AS 65	1384	20/19	500	250	21.4	205	158	18.5	190	118	23.4	266	211	21.1	220	162
AS 66	1361	19/19	500	250	20.8	228	158	18.3	182	91	24.8	259	220	21.3	223	156
AS 67	1385	20/19	500	250	20.2	175	119	18.0	170	101	21.6	266	194	19.9	204	138
Minimum					16.4	129	81	18.0	167	91	18.6	224	163	18	200	129
Maximum					23.2	228	160	19.3	215	131	25.2	302	229	22	235	162
Average					19.7	190	130	18.6	192	114	22.5	260	192	20	214	146

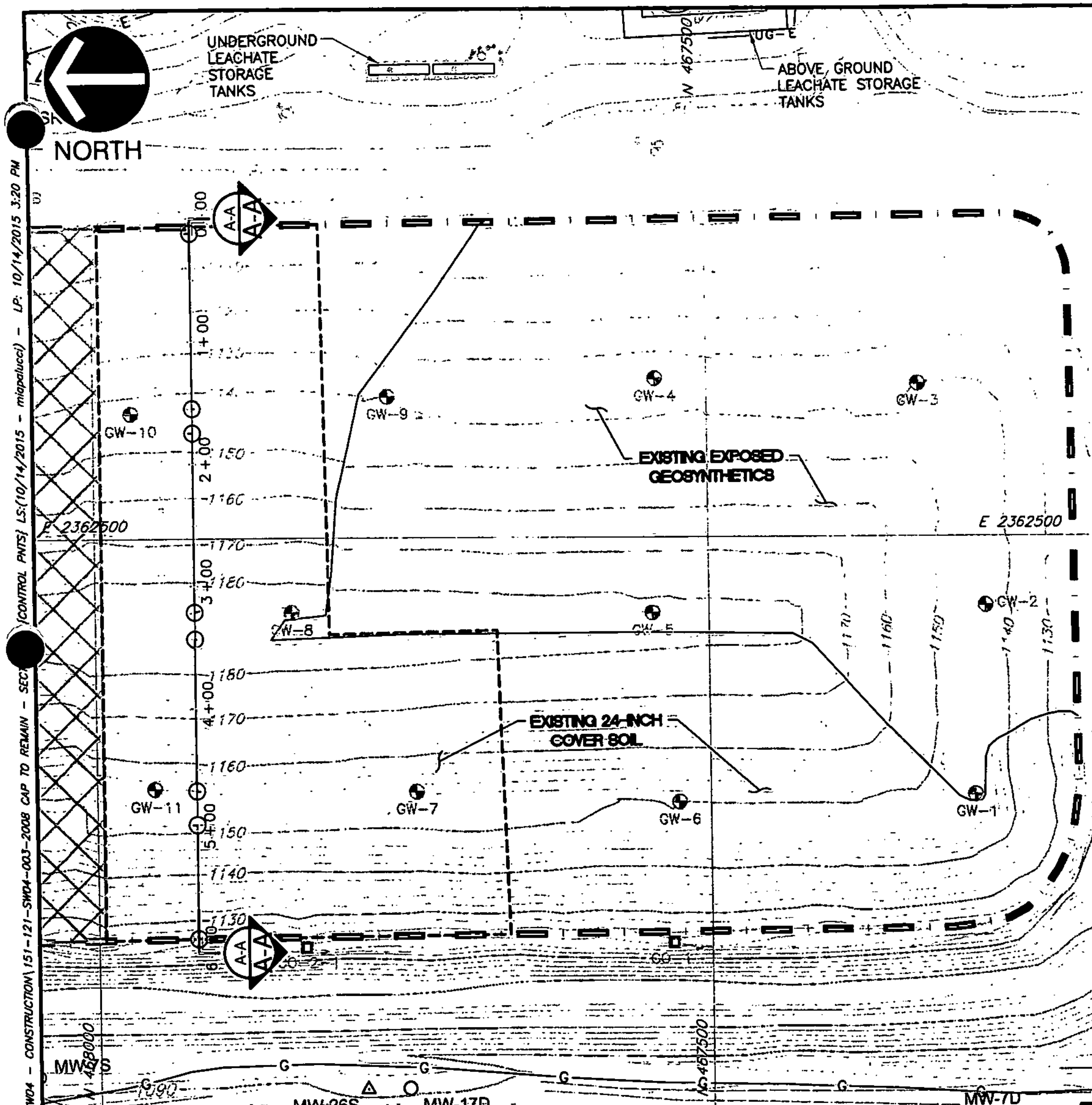
Notes:

1. QC Asperity values represents each side of the geomembrane.
2. A peak interface shear strength of 250 psf is required to achieve a slope stability factor of safety of 1.5, and a peak interface shear strength of 167 is required to achieve a slope stability factor of safety of 1.0, based on a maximum slope of 3H:1V.

* Indicates Geomembrane sampled was tested with a different Geocomposite sample.

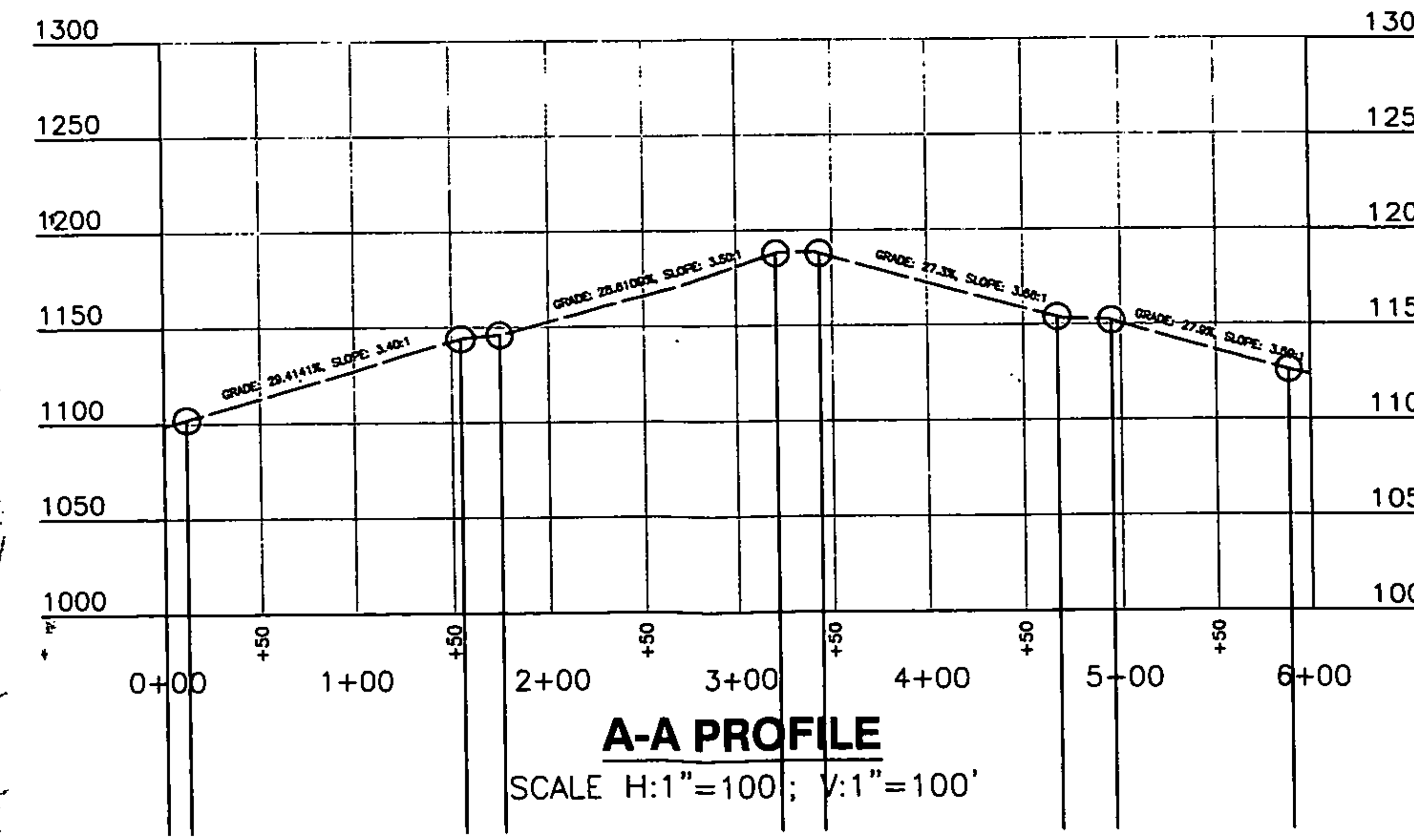
Attachment D

Spreadsheet Based Translational Failure Surface Calculations



LEGEND

	EXISTING CONTOUR
	LIMIT OF WASTE
E	EXISTING OVERHEAD ELECTRIC
G	EXISTING GAS LINE
SW-2A	SURFACE WATER GAUGE
MW-20S	GLACIAL/MINE SPOIL MONITORING WELL
MW-11DR	BEDROCK MONITORING WELL
CO-1	EXISTING LEACHATE RISER CLEANOUT
	AREA WITH TRANSITIONAL COVER
	2008 CAP WITH PARTIAL FINAL COVER



A-A PROFILE

SCALE H:1"=100'; V:1"=100'

SCALE IN FEET

0 100 200

*HAND SIGNATURE ON FILE

REFERENCE

1. TOPOGRAPHIC MAPPING WAS PREPARED BY KEDDAL AERIAL MAPPING FROM AERIAL PHOTOGRAPHY DATED AUGUST 6, 2009.
2. GROUND SURVEY DATED 10/9/15 PERFORMED BY AKINS.

CEC

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SURETY MANAGEMENT COMPANY
CLOSURE CONSTRUCTION
CENTRAL WASTE DISPOSAL FACILITY
ALLIANCE, OHIO

2008 CAP SECTION

DRAWN BY:	MJI	CHECKED BY:	DRAFT	APPROVED BY:	DRAFT	FIGURE NO.:	1
DATE:	10/14/15	DWG SCALE:	AS SHOWN	PROJECT NO:	153-121.0004		

CENTRAL WASTE DISPOSAL FACILITY
FINAL COVER SYSTEM
SHALLOW SLOPE STABILITY ANALYSIS
INPUT TABLE

Denotes an input value
Denotes an automatically calculated cell

INPUT VALUES

Parameter	Value	Unit		Converted	Unit	Converted	Unit
thickness of cover soil at the top of the slope = hc =	2.50	ft	=	0.762	meters =	762	mm
thickness of cover soil at the bottom of the slope = D =	2.50	ft					
Drainage layer thickness = t =	250	mil	=	0.635	cm =	6.35	mm
slope beneath the geomembrane (xH:1V) =	3.40	H:1V					
slope angle beneath the geomembrane = β =	16.39	degrees					
finished slope angle = ω =	16.39	degrees		(for uniform cover soil thickness $\omega = \beta$)			
length of slope measured along the geomembrane = L =	100.0	ft	=	30.48	meters		
length of slope between drainage outlets = L =	100.0	ft	=	30.48	meters		
Moist Unit Weight of Cover soil = γ_t =	130.00	pcf	=	20.42	kN/m^3		
Saturated unit weight = γ_{sat} =	140.00	pcf	=	21.99	kN/m^3		
friction angle of the cover soil = ϕ =	25	degrees					
cohesion of the cover soil = c =	893	lb/ft^2					
minimum interface friction angle = δ =	17.5	degrees					
minimum interface adhesion = ca =	0.0	lb/ft^2					
Unadjusted Curve Number	79						
STORM EVENT ______ YEAR	100	Year					
STORM EVENT ______ HOUR	1	Hour					
STORM EVENT RAINFALL	2.59	Inches	=	65.79	mm/hour		
FACTOR OF SAFETY FOR DRAINAGE	2.0						
DESIGN STORM EVENT RAINFALL	5.18	Inches	=	131.57	mm/hour		
Permeability of cover material = q_h =	1.00E-04	cm/sec					
Permeability of drainage layer = k_d =	1.825	cm/sec					
Long Term Design Transmissivity = θ =	1.16E-04	m^2/sec					
Reduction Factor for geotextile intrusion = RF_{in} =	1						
Reduction Factor for creep deformation = RF_{CR} =	1.4						
Reduction Factor for chemical clogging = RF_{CC} =	1.1						
Reduction Factor for biological clogging = RF_{BC} =	2.8						
equipment ground pressure (= wt. of equipment/(2wb)) = q =	679.1	lb/ft^2					
length of each equipment track = w =	9.40	ft					
width of each equipment track = b =	3.00	ft					
influence factor* at geomembrane interface = I =	0.97	See Table -->					
acceleration/deceleration of the bulldozer = a =	0.00	g					
seismic coefficient = Cs =	0.12	g					

*Influence Factor Default Values

Cover Soil Thickness	Equipment Track Width: Very Wide	Wide	Standard
*300 mm	1.00	0.97	0.94
300-1000 mm	0.97	0.92	0.70
*1000 mm	0.96	0.75	0.30

OUTPUT SUMMARY

Ultimate Geocomposite Transmissivity Specification = 5.00E-04 m^2/sec

Slope Stability Factor of Safety Summary

Method	FS	Required FS
Static - Translational - Drained	2.03	1.50
Seismic - Translational - Drained	1.54	1.00
Static - Translational - Saturated	1.13	1.10

Final Cover Runoff Coefficient Calculation

The adjusted SCS Curve Number is calculated as:

$CN = 100 - (100\text{-}CN_0) * (L^2 / S)^{CN_0^{-0.81}}$

Where:

CN_0	SCS curve number (unadjusted for slope), from Figure A-3 of GRI Report #19 Appendix
L	Standardized Dimensionless Length = L divided by 152 meters
S	Standardized Dimensionless Inclination = s / 0.04 (where s is defined as the vertical rise over the horizontal distance expressed as a ratio)

Input Variables

CN_0 =	79					
Slope Length =	100	feet or	30.47851	meters		
S =	3.40	on 1	0.294	percent,	which yields	7.353
Storm Event						
100	year	1	hour	storm		
5.180	inches/hour or	131.572	millimeters/hour			

Calculated Variables

$CN_0^{-0.81}$ =	0.02904
L^2 / S =	0.0055
100 - CN_0 =	21

The adjusted SCS Curve Number is equal to:

CN = 81.9

The Potential Retention, (PR) in millimeters is calculated by:

PR = (25400 / CN) - 254 0.0001

PR = 56 millimeters

The Runoff Coefficient, RC(t), as a function of time is determined by:

$$RC(t) = \frac{[P(t) - 0.2 * PR]^2}{P(t) * [P(t) + 0.8 * PR]}$$

Where:

P(t) = Accumulated Precipitation, mm

P(t) = I * t

Where: P(t) = I*t

I = Rainfall Intensity, mm per hour

t = time, hours

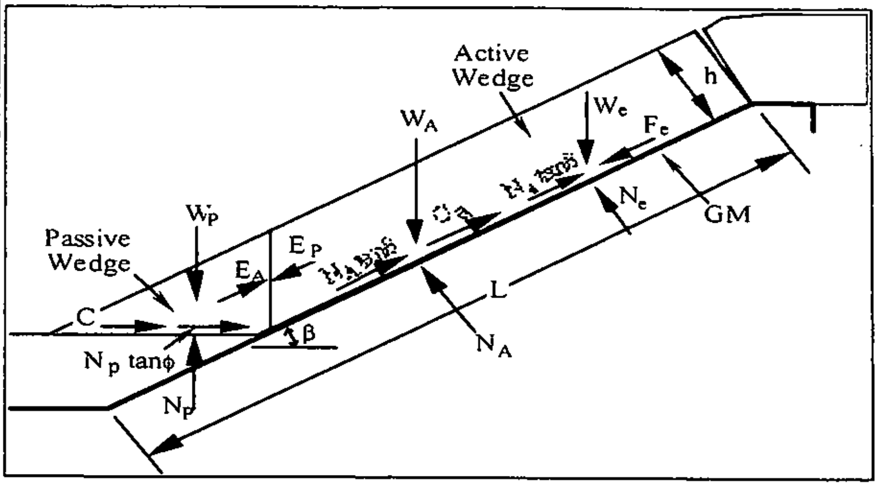
P(t) = 131.572 millimeters

RC(t) = 0.624

COVER PLACEMENT WITH THE INCORPORATION OF EQUIPMENT LOADS

Placement of the Cover Material Layer

across the sideslopes with the incorporation of Equipment Loads



Calculation of FS

Active Wedge:

Wa= 29501.0 lb

Na= 28302.2 lb

Passive Wedge:

Wp= 1500.7 lb

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

a= 9662.1

b= -20295

c= 1420.6

FS= 2.028

thickness of protective cover soil = h =	2.50	ft			
pro. cov. mat. slope angle beneath the geomembrane = β =	16.39	°	= 0.29	(rad.)	
finished protective cover material slope angle = ω =	16.39	°	= 0.29	(rad.)	
length of slope measured along the geomembrane = L =	100.0	1E-04			
unit weight of the protective cover soil = γ =	130.0	lb/ft^3			
friction angle of the protective cover soil = ϕ =	25.0	°	= 0.44	(rad.)	
cohesion of the protective cover soil = c =	893.0	lb/ft^2			C= 7912.0067 lb
critical interface friction angle = δ =	17.50	°	= 0.31	(rad.)	
adhesion = ca =	0.0	lb/ft^2			Ca= 0 lb

thickness of the protective cover soil = h =	2.50	ft	b/h= 1.2
equipment ground pressure (= wt. of equipment/(2wb)) = q =	679.1	lb/ft^2	We=qwI= 6192.0
length of each equipment track = w =	9.4	ft	Ne=Wecosβ= 5940.4
width of each equipment track = b =	3.0	ft	Fe=We(a/g)= 0.0
influence factor* at geomembrane interface = I =	0.97		
acceleration/deceleration of the bulldozer = a =	0.00	g	

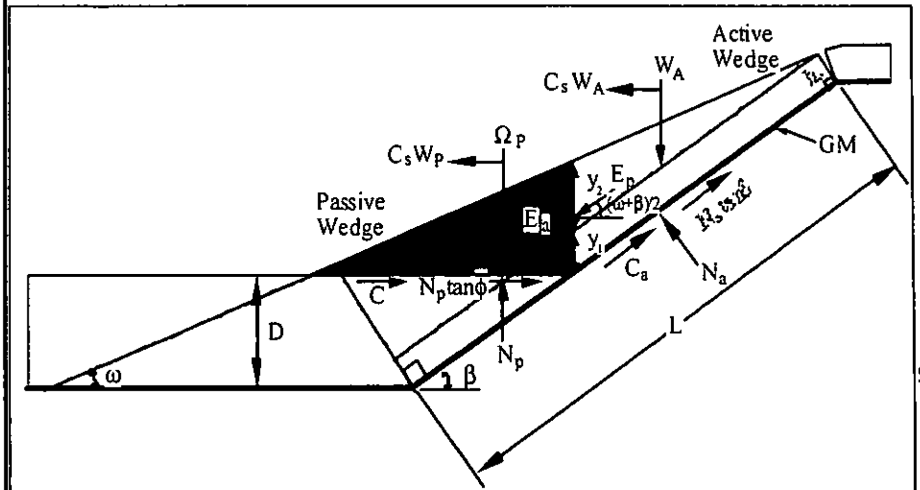
*Influence Factor Default Values

Cover Soil Thickness	Equipment Track Width		
	Very Wide	Wide	Standard
²300 mm	1.00	0.97	0.94
300-1000 mm	0.97	0.92	0.70
³1000 mm	0.95	0.75	0.30

Note: Denotes an automatically calculated cell

Denotes input values

UNIFORMED AND/OR TAPERED COVER SOIL WITH CONSIDERATION OF SEISMIC FORCES



Calculation of FS

Active Wedge:

Wa=	29501.0	lb
Na=	28302.2	lb
Ca=	0.0	lb

Passive Wedge:

Wp=	1500.7	lb
C=	7912.0	lb

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

a=	11230.5
b=	-17992
c=	1126.4

FS= 1.537

(Note: for uniform cover soil thickness the input value of ω = β)

thickness of cover soil at top (crest) of the slope = hc =	2.50	ft			
thickness of cover soil along the bottom of the site = D =	2.50	ft			
soil slope angle beneath the geomembrane = β =	16.39	°	= 0.29	(rad.)	
finished cover soil slope angle = ω =	16.39	°	= 0.29	(rad.)	
length of slope measured along the geomembrane = L =	100.0	1E-04			

y2=	0.00	(ft)
y1=	2.61	(ft)
(ω+β)/2=	0.286	(rad.)
(=	16.4	°)

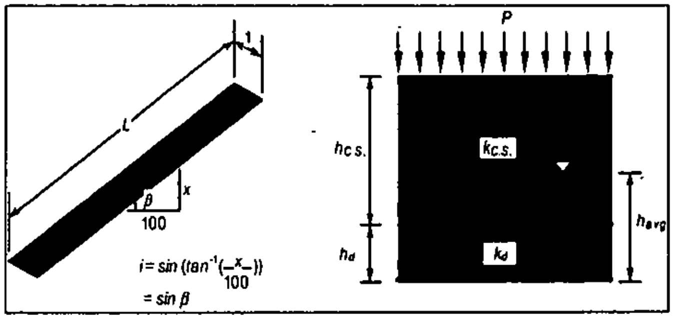
unit weight of the cover soil = γ =	130.0	lb/ft^3		
friction angle of the cover soil = φ =	25.0	°	= 0.44	(rad.)
cohesion of the cover soil = c =	893.0	lb/ft^2		
critical interface friction angle = δ =	17.5	°	= 0.31	(rad.)
adhesion between cover soil and geocomposite = ca =	0.0	lb/ft^2		
seismic coefficient = Cs =	0.120	g		

Note: Denotes an automatically calculated cell

Denotes input values

numbers in Italics are calculated values

Calculation of DLC and PSR



L =	30.48	m
β =	16.39	°
h_{CS} =	762.00	mm
h_d or t_{GS} =	6.35	mm
k_{CS} =	1.00E-04	cm/s
k_d or k_{GS} =	1.825	cm/s
P =	131.57	mm/hr
RC =	0.624	

0.0001

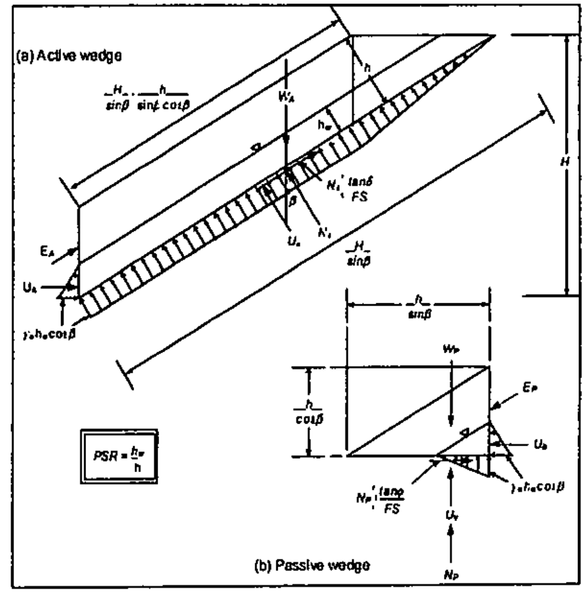
* Note: If there is only only one soil above the geomembrane treat it as the drainage layer.

i =	*0.2822*	
$L(\cos\beta)$ =	*29.24*	m
x =	*8.60*	m
$h_{C.S.}$ =	*0.8*	m
h_d or t_{GS} =	*0.00635*	m
$h_{C.S.} + h_d$ =	*0.77*	m
$k_{C.S.}$ =	*1.0E-06*	m/s
k_d or k_{GS} =	*1.8E-02*	m/s
$P\ (RC)$ =	*82.2*	mm/hr
Actual runoff =	*127.97*	mm/hr
PERC =	*3.60*	mm/hr
$FLUX_{actual}$ =	*0.105*	m³/hr
$FLUX_{allow}$ =	*0.118*	m³/hr
q =	*2.9E-05*	m³/sec
h_{avg} =	*0.01*	m

DLC	1.118
PSR	0.00739

DLC = 1.1183

PSR = 0.007



thickness of cover soil = h =	*0.77*	m		
length of slope measured along the geomembrane = L =	*30*	m		
soil slope angle beneath the geomembrane = β =	*16.4*	°	= *0.29*	(rad.)
vertical height of the slope measured from the toe = H =	*8.6*	m		
parallel submergence ratio = PSR =	*0.01*			
depth of the water surface measured from the geomembrane = h_w =	*0.01*	m		
dry unit weight of the cover soil = γ_{dry} =	20.4	kN/m³		
saturated unit weight of the cover soil = γ_{sat} =	22.0	kN/m³		
unit weight of water = γ_w =	9.81	kN/m³		
friction angle of the cover soil = ϕ =	25.0	°	= *0.44*	(rad.)
Minimum interface friction angle = δ =	17.5	°	= *0.31*	(rad.)

Calculation of FS

Active Wedge:

W_A = *456.25801* kN

U_n = *1.6283585* kN

U_h = *0.0001582* kN

N_A = *436.08982* kN

Passive Wedge:

W_P = *22.268243* kN

U_v = *0.0005378* kN

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

where a = *123.5*

b = *-155.9*

c = *18.1*

FS= 1.13

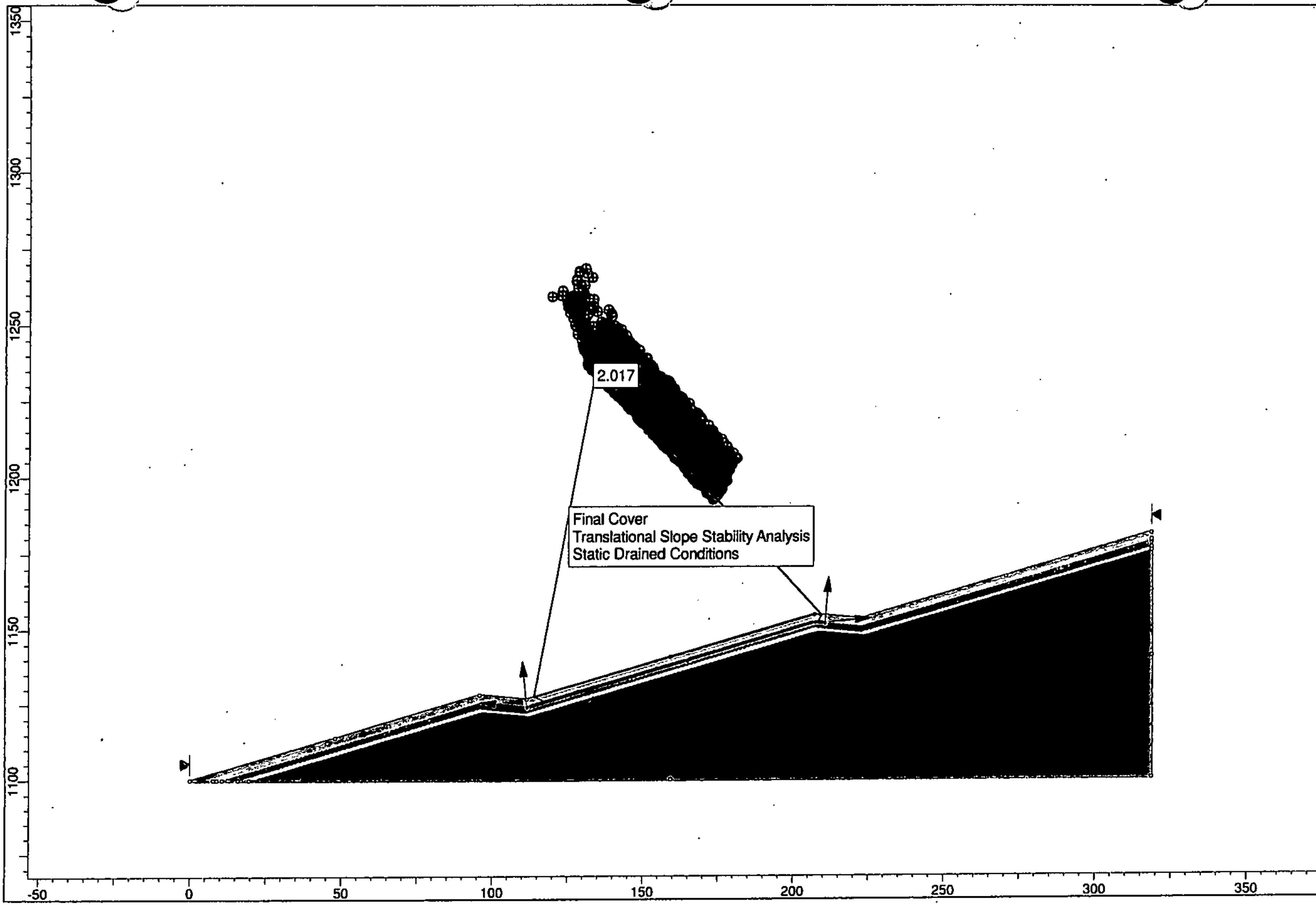
Note: numbers in boxes are input values

numbers in italics are calculated values

Constructed by Te-Yang Soong

Attachment E

Software Based Translational and Rotational Failure Surface Calculations



Trans.Static.Drained.sli

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: Trans.Static.Drained.sli
Slide Modeler Version: 6.029
Project Title: SLIDE - An Interactive Slope Stability Program

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 5000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 95
Left Projection Angle (End Angle): 175
Right Projection Angle (Start Angle): 5
Right Projection Angle (End Angle): 85
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Cap/Protective Cover	Geosynthetics	RSB	Intermediate Cover	Waste
Color					
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	100	130	130	90
Cohesion [psf]	893	0	893	0	400
Friction Angle [deg]	25	17.5	25	27	33
Water Surface	None	None	None	None	None
Ru Value	0	0	0	0	0

Global Minimums

Method: spencer

FS: 2.017200
Axis Location: 134.534, 1236.711
Left Slip Surface Endpoint: 113.970, 1127.487
Right Slip Surface Endpoint: 209.575, 1154.725
Resisting Moment=1.79714e+006 lb-ft
Driving Moment=890907 lb-ft
Resisting Horizontal Force=15399.8 lb
Driving Horizontal Force=7634.26 lb
Total Slice Area=280.046 ft2

Global Minimum Coordinates

Method: spencer

X	Y
113.97	1127.49
118.224	1125.74
180.395	1143.97
208.21	1152.22

209.575	1154.73

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 2390
Number of Invalid Surfaces: 2610

Error Codes:

Error Code -108 reported for 1074 surfaces
Error Code -111 reported for 764 surfaces
Error Code -112 reported for 772 surfaces

Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 2.0172

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	3.6957	625.989	Cap/Protective Cover	893	25	580.877	1171.74	597.77	0	597.77
2	0.557804	199.934	Geosynthetics	0	17.5	69.5647	140.326	445.055	0	445.055
3	4.14475	1567.82	Geosynthetics	0	17.5	54.8761	110.696	351.083	0	351.083
4	4.14475	1569.23	Geosynthetics	0	17.5	54.9251	110.795	351.398	0	351.398
5	4.14475	1570.64	Geosynthetics	0	17.5	54.9747	110.895	351.713	0	351.713
6	4.14475	1572.04	Geosynthetics	0	17.5	55.0238	110.994	352.028	0	352.028
7	4.14475	1573.45	Geosynthetics	0	17.5	55.0729	111.093	352.343	0	352.343
8	4.14475	1574.86	Geosynthetics	0	17.5	55.1224	111.193	352.657	0	352.657
9	4.14475	1576.26	Geosynthetics	0	17.5	55.1715	111.292	352.972	0	352.972
10	4.14475	1577.67	Geosynthetics	0	17.5	55.2206	111.391	353.287	0	353.287
11	4.14475	1579.08	Geosynthetics	0	17.5	55.2702	111.491	353.602	0	353.602
12	4.14475	1580.48	Geosynthetics	0	17.5	55.3193	111.59	353.919	0	353.919
13	4.14475	1581.89	Geosynthetics	0	17.5	55.3683	111.689	354.234	0	354.234
14	4.14475	1583.3	Geosynthetics	0	17.5	55.4179	111.789	354.549	0	354.549
15	4.14475	1584.7	Geosynthetics	0	17.5	55.467	111.888	354.864	0	354.864
16	4.14475	1586.11	Geosynthetics	0	17.5	55.5161	111.987	355.179	0	355.179
17	4.14475	1587.52	Geosynthetics	0	17.5	55.5656	112.087	355.493	0	355.493
18	4.63583	1773.99	Geosynthetics	0	17.5	55.4541	111.862	354.779	0	354.779
19	4.63583	1769.18	Geosynthetics	0	17.5	55.3034	111.558	353.817	0	353.817
20	4.63583	1764.37	Geosynthetics	0	17.5	55.1532	111.255	352.856	0	352.856
21	4.63583	1759.55	Geosynthetics	0	17.5	55.0025	110.951	351.892	0	351.892
22	4.63583	1754.74	Geosynthetics	0	17.5	54.8523	110.648	350.93	0	350.93
23	4.63583	1732.29	Geosynthetics	0	17.5	54.1503	109.232	346.44	0	346.44
24	0.066527	22.1497	Geosynthetics	0	17.5	30.8234	62.177	197.2	0	197.2
25	1.29857	211.998	Cap/Protective Cover	893	25	372.771	751.954	-302.474	0	-302.474

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 2.0172

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	113.97	1127.49	0	0	0
2	117.666	1125.97	3050.2	703.229	12.9828
3	118.224	1125.74	3190.95	735.68	12.9828
4	122.368	1126.95	2991.13	689.61	12.9828
5	126.513	1128.17	2791.12	643.499	12.9828
6	130.658	1129.39	2590.94	597.346	12.9828
7	134.803	1130.6	2390.58	551.152	12.9828
8	138.947	1131.82	2190.04	504.917	12.9828
9	143.092	1133.03	1989.32	458.64	12.9828
10	147.237	1134.25	1788.42	412.322	12.9827
11	151.382	1135.46	1587.34	365.963	12.9828
12	155.526	1136.68	1386.08	319.562	12.9827
13	159.671	1137.9	1184.64	273.12	12.9827
14	163.816	1139.11	983.021	226.637	12.9828
15	167.961	1140.33	781.224	180.113	12.9828
16	172.105	1141.54	579.248	133.547	12.9828
17	176.25	1142.76	377.092	86.9393	12.9828
18	180.395	1143.97	174.757	40.2906	12.9828
19	185.031	1145.35	-56.1261	-12.94	12.9828
20	189.667	1146.72	-286.383	-66.0261	12.9828
21	194.302	1148.09	-516.014	-118.968	12.9828
22	198.938	1149.47	-745.018	-171.765	12.9828
23	203.574	1150.84	-973.397	-224.418	12.9828
24	208.21	1152.22	-1198.85	-276.398	12.9828
25	208.276	1152.34	-1220.91	-281.484	12.9828
26	209.575	1154.73	0	0	0

List Of Coordinates

Block Search Window

X	Y
164.974	1139.88
164.974	1139.36
207.61	1151.9
207.561	1152.41

Block Search Window

X	Y
111.625	1124.19
111.673	1123.68
164.974	1139.36
164.974	1139.88

Block Search Window

X	Y
207.561	1152.41
207.61	1151.9
210.857	1151.59
210.857	1152.09

External Boundary

X	Y
7.6905	1100
8.86002	1100
10.632	1100
15.948	1100
19.492	1100
159.352	1100
318.704	1100
318.704	1140.83
318.704	1175.94
318.704	1176.98
318.704	1178.54
318.704	1179.06
318.704	1179.41
318.704	1181.67
270.735	1167.56

222.767	1153.45
207.32	1154.94
159.352	1140.83
111.384	1126.73
95.9366	1128.22
47.9683	1114.11
0	1100

Material Boundary

X	Y
8.86002	1100
96.1779	1125.68
111.625	1124.19
207.561	1152.41
223.008	1150.92
318.704	1179.06

Material Boundary

X	Y
10.632	1100
96.2262	1125.17
111.673	1123.68
207.61	1151.9
223.057	1150.41
318.704	1178.54

Material Boundary

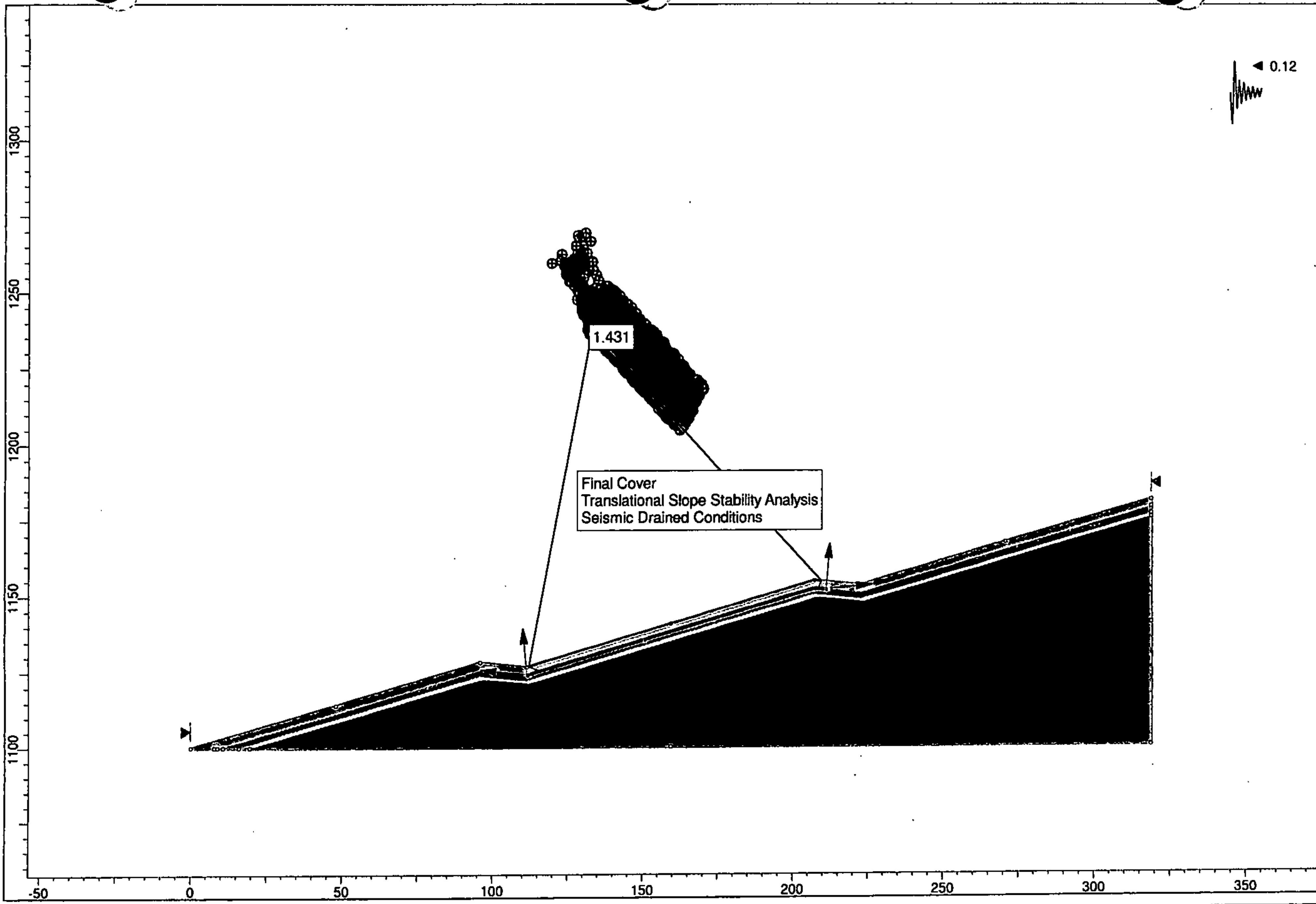
X	Y
15.948	1100
96.371	1123.65
111.818	1122.16
207.754	1150.38
223.201	1148.89
318.704	1176.98

Material Boundary

X	Y
19.492	1100
96.4675	1122.64
111.914	1121.15
207.851	1149.37
223.298	1147.88

318.704 1175.94

Trans.Static.Drained.sli



Trans.Seismic.Drained.sli

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: Trans.Seismic.Drained.sli
Slide Modeler Version: 6.029
Project Title: SLIDE - An Interactive Slope Stability Program

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 5000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 95
Left Projection Angle (End Angle): 175
Right Projection Angle (Start Angle): 5
Right Projection Angle (End Angle): 85
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

Seismic Load Coefficient (Horizontal): 0.12

Material Properties

Property	Cap/Protective Cover	Geosynthetics	RSB	Intermediate Cover	Waste
Color	■	■	■	□	■
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	100	130	130	90
Cohesion [psf]	893	0	893	0	400
Friction Angle [deg]	25	17.5	25	27	33
Water Surface	None	None	None	None	None
Ru Value	0	0	0	0	0

Global Minimums

Method: spencer

FS: 1.430780
Axis Location: 133.211, 1238.295
Left Slip Surface Endpoint: 112.227, 1126.974
Right Slip Surface Endpoint: 209.677, 1154.715
Resisting Moment=1.87284e+006 lb-ft
Driving Moment=1.30896e+006 lb-ft
Resisting Horizontal Force=15724.1 lb
Driving Horizontal Force=10989.9 lb
Total Slice Area=286.275 ft2

Global Minimum Coordinates

Method: spencer

X	Y

112.227	1126.97
116.48	1125.23
171.356	1141.31
208.312	1152.21
209.677	1154.72

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 3735
Number of Invalid Surfaces: 1265

Error Codes:

Error Code -108 reported for 262 surfaces
Error Code -111 reported for 88 surfaces
Error Code -112 reported for 915 surfaces

Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.43078

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	3.6957	625.989	Cap/Protective Cover	893	25	933.039	1334.97	947.817	0	947.817
2	0.557804	199.934	Geosynthetics	0	17.5	106.046	151.728	481.218	0	481.218
3	4.22119	1596.85	Geosynthetics	0	17.5	73.8919	105.723	335.311	0	335.311
4	4.22119	1598.5	Geosynthetics	0	17.5	73.9687	105.833	335.658	0	335.658
5	4.22119	1600.15	Geosynthetics	0	17.5	74.0449	105.942	336.006	0	336.006
6	4.22119	1601.81	Geosynthetics	0	17.5	74.1218	106.052	336.352	0	336.352
7	4.22119	1603.46	Geosynthetics	0	17.5	74.198	106.161	336.7	0	336.7
8	4.22119	1605.11	Geosynthetics	0	17.5	74.2749	106.271	337.047	0	337.047
9	4.22119	1606.77	Geosynthetics	0	17.5	74.3511	106.38	337.395	0	337.395
10	4.22119	1608.42	Geosynthetics	0	17.5	74.4272	106.489	337.741	0	337.741
11	4.22119	1610.07	Geosynthetics	0	17.5	74.5041	106.599	338.089	0	338.089
12	4.22119	1611.73	Geosynthetics	0	17.5	74.5803	106.708	338.436	0	338.436
13	4.22119	1613.38	Geosynthetics	0	17.5	74.6572	106.818	338.782	0	338.782
14	4.22119	1615.03	Geosynthetics	0	17.5	74.7334	106.927	339.13	0	339.13
15	4.22119	1616.69	Geosynthetics	0	17.5	74.8102	107.037	339.478	0	339.478
16	4.61952	1769.5	Geosynthetics	0	17.5	74.7655	106.973	339.275	0	339.275
17	4.61952	1768.21	Geosynthetics	0	17.5	74.711	106.895	339.028	0	339.028
18	4.61952	1766.92	Geosynthetics	0	17.5	74.6565	106.817	338.779	0	338.779
19	4.61952	1765.62	Geosynthetics	0	17.5	74.602	106.739	338.532	0	338.532
20	4.61952	1764.33	Geosynthetics	0	17.5	74.5468	106.66	338.283	0	338.283
21	4.61952	1763.04	Geosynthetics	0	17.5	74.4922	106.582	338.036	0	338.036
22	4.61952	1761.74	Geosynthetics	0	17.5	74.4377	106.504	337.788	0	337.788
23	4.61952	1738.77	Geosynthetics	0	17.5	73.4669	105.115	333.382	0	333.382
24	0.066527	22.1497	Geosynthetics	0	17.5	36.6095	52.3801	166.129	0	166.129
25	1.29857	211.998	Cap/Protective Cover	893	25	499.233	714.293	-383.238	0	-383.238

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.43078

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	112.227	1126.97	0	0	0
2	115.923	1125.46	4809.39	1467.39	16.9674
3	116.48	1125.23	4954.82	1511.77	16.9675
4	120.702	1126.46	4659.82	1421.76	16.9675
5	124.923	1127.7	4364.51	1331.66	16.9675
6	129.144	1128.94	4068.9	1241.46	16.9674
7	133.365	1130.18	3772.99	1151.18	16.9675
8	137.586	1131.41	3476.76	1060.8	16.9676
9	141.807	1132.65	3180.24	970.323	16.9675
10	146.029	1133.89	2883.4	879.756	16.9675
11	150.25	1135.13	2586.27	789.097	16.9675
12	154.471	1136.36	2288.82	698.344	16.9675
13	158.692	1137.6	1991.08	607.498	16.9675
14	162.913	1138.84	1693.02	516.558	16.9675
15	167.135	1140.08	1394.66	425.526	16.9675
16	171.356	1141.31	1096	334.4	16.9674
17	175.975	1142.68	766.783	233.953	16.9675
18	180.595	1144.04	437.809	133.58	16.9675
19	185.214	1145.4	109.075	33.2799	16.9675
20	189.834	1146.76	-219.418	-66.9467	16.9675
21	194.453	1148.12	-547.671	-167.1	16.9675
22	199.073	1149.48	-875.683	-267.18	16.9675

23	203.692	1150.85	-1203.45	-367.186	16.9675
24	208.312	1152.21	-1526.95	-465.889	16.9675
25	208.378	1152.33	-1547.49	-472.154	16.9674
26	209.677	1154.72	0	0	0

List Of Coordinates

Block Search Window

X	Y
111.625	1124.19
111.673	1123.68
150.812	1135.2
150.812	1135.72

Block Search Window

X	Y
150.812	1135.72
150.812	1135.2
207.61	1151.9
207.561	1152.41

Block Search Window

X	Y
207.561	1152.41
207.61	1151.9
211.384	1151.54
211.384	1152.04

External Boundary

X	Y
7.6905	1100
8.86002	1100
10.632	1100
15.948	1100
19.492	1100
159.352	1100
318.704	1100
318.704	1140.83
318.704	1175.94
318.704	1176.98
318.704	1178.54

318.704	1179.06
318.704	1179.41
318.704	1181.67
270.735	1167.56
222.767	1153.45
207.32	1154.94
159.352	1140.83
111.384	1126.73
95.9366	1128.22
47.9683	1114.11
0	1100

Material Boundary

X	Y
8.86002	1100
96.1779	1125.68
111.625	1124.19
207.561	1152.41
223.008	1150.92
318.704	1179.06

Material Boundary

X	Y
10.632	1100
96.2262	1125.17
111.673	1123.68
207.61	1151.9
223.057	1150.41
318.704	1178.54

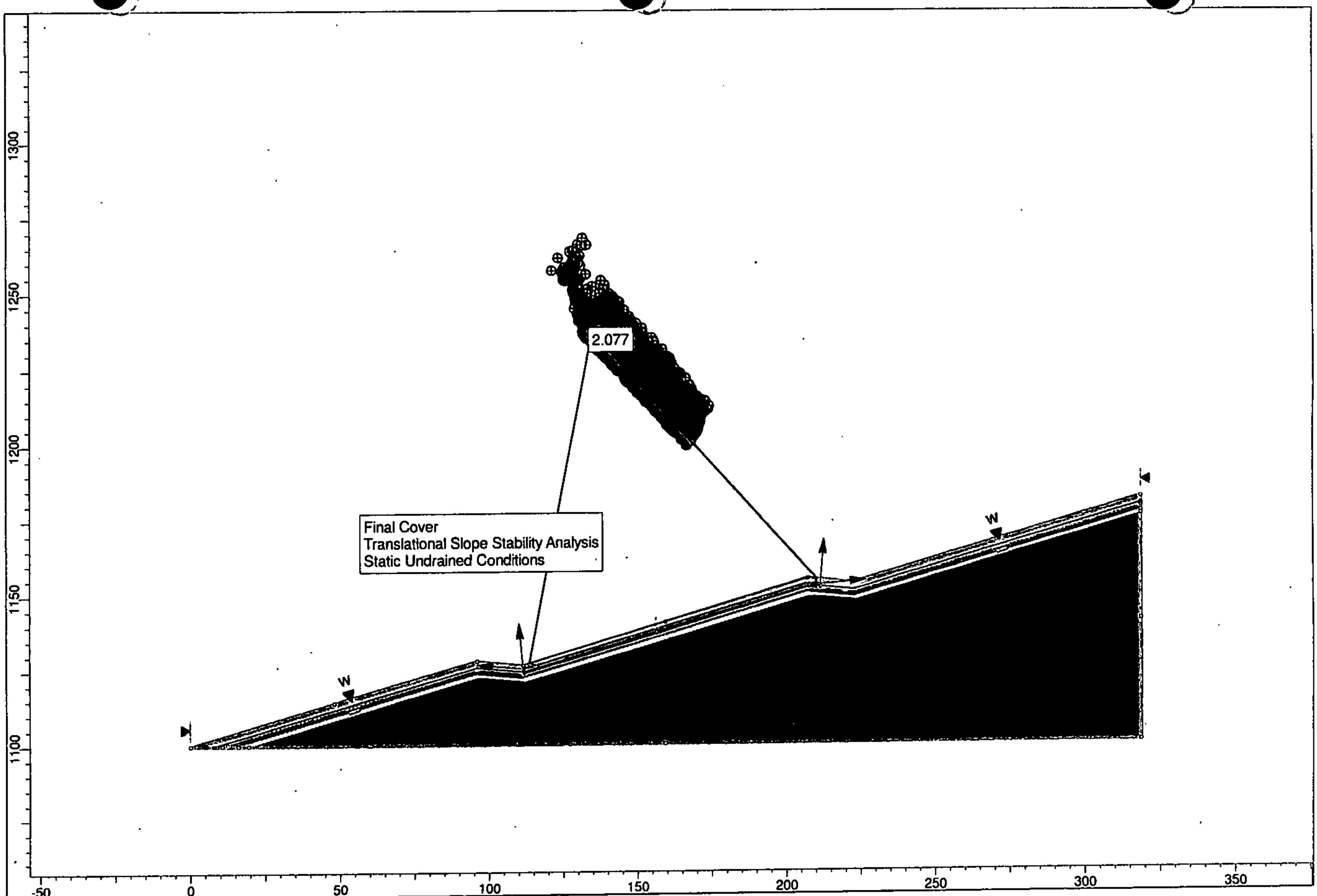
Material Boundary

X	Y
15.948	1100
96.371	1123.65
111.818	1122.16
207.754	1150.38
223.201	1148.89
318.704	1176.98

Material Boundary

X	Y
19.492	1100

96.4675	1122.64
111.914	1121.15
207.851	1149.37
223.298	1147.88
318.704	1175.94



Trans.Static.UnDrained.sli

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: Trans.Static.UnDrained.sli
Slide Modeler Version: 6.029
Project Title: SLIDE - An Interactive Slope Stability Program

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 5000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 95
Left Projection Angle (End Angle): 175
Right Projection Angle (Start Angle): 5
Right Projection Angle (End Angle): 85
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Cap/Protective Cover	Geosynthetics	RSB	Intermediate Cover	Waste
Color					
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	100	130	130	90
Cohesion [psf]	893	0	893	0	400
Friction Angle [deg]	25	17.5	25	27	33
Water Surface	Water Table	None	None	None	None
Hu Value	1				
Ru Value		0	0	0	0

Global Minimums

Method: spencer

FS: 2.076870
Axis Location: 134.780, 1237.885
Left Slip Surface Endpoint: 113.601, 1127.378
Right Slip Surface Endpoint: 210.478, 1154.638
Resisting Moment=1.93768e+006 lb-ft
Driving Moment=932981 lb-ft
Resisting Horizontal Force=16866.6 lb
Driving Horizontal Force=8121.17 lb
Total Slice Area=273.781 ft2

Global Minimum Coordinates

Method: spencer

X	Y
113.601	1127.38
118.149	1125.76
196.524	1148.81

209.083	1152.86
210.478	1154.64

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 3139
Number of Invalid Surfaces: 1861

Error Codes:

Error Code -108 reported for 438 surfaces
Error Code -111 reported for 616 surfaces
Error Code -112 reported for 807 surfaces

Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 2.07687

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.01518	680.103	Cap/Protective Cover	893	25	541.412	1124.44	496.329	0	496.329
2	0.532545	189.611	Geosynthetics	0	17.5	63.5268	131.937	418.453	0	418.453
3	4.35416	1625.56	Geosynthetics	0	17.5	52.8979	109.862	348.436	0	348.436
4	4.35416	1625.63	Geosynthetics	0	17.5	52.8998	109.866	348.452	0	348.452
5	4.35416	1625.69	Geosynthetics	0	17.5	52.9022	109.871	348.465	0	348.465
6	4.35416	1625.76	Geosynthetics	0	17.5	52.9041	109.875	348.48	0	348.48
7	4.35416	1625.83	Geosynthetics	0	17.5	52.9061	109.879	348.493	0	348.493
8	4.35416	1625.89	Geosynthetics	0	17.5	52.9085	109.884	348.507	0	348.507
9	4.35416	1625.96	Geosynthetics	0	17.5	52.9104	109.888	348.522	0	348.522
10	4.35416	1626.02	Geosynthetics	0	17.5	52.9128	109.893	348.535	0	348.535
11	4.35416	1626.09	Geosynthetics	0	17.5	52.9147	109.897	348.551	0	348.551
12	4.35416	1626.16	Geosynthetics	0	17.5	52.9171	109.902	348.564	0	348.564
13	4.35416	1626.22	Geosynthetics	0	17.5	52.9191	109.906	348.577	0	348.577
14	4.35416	1626.29	Geosynthetics	0	17.5	52.9215	109.911	348.593	0	348.593
15	4.35416	1626.35	Geosynthetics	0	17.5	52.9234	109.915	348.606	0	348.606
16	4.35416	1626.42	Geosynthetics	0	17.5	52.9258	109.92	348.621	0	348.621
17	4.35416	1626.49	Geosynthetics	0	17.5	52.9277	109.924	348.634	0	348.634
18	4.35416	1626.55	Geosynthetics	0	17.5	52.9301	109.929	348.65	0	348.65
19	4.35416	1626.62	Geosynthetics	0	17.5	52.9321	109.933	348.663	0	348.663
20	4.35416	1626.68	Geosynthetics	0	17.5	52.934	109.937	348.676	0	348.676
21	3.71206	1367.66	Geosynthetics	0	17.5	51.7461	107.47	340.853	0	340.853
22	3.71206	1329.33	Geosynthetics	0	17.5	50.2959	104.458	331.298	0	331.298
23	3.71206	1288.12	Geosynthetics	0	17.5	48.7363	101.219	321.028	0	321.028
24	1.42263	409.455	Cap/Protective Cover	893	25	476.904	990.468	211.137	2.11496	209.022
25	1.39573	173.854	Cap/Protective Cover	893	25	378.321	785.723	-230.055	0	-230.055

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 2.07687

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	113.601	1127.38	0	0	0
2	117.617	1125.95	2880.77	542.171	10.6586
3	118.149	1125.76	2993.68	563.421	10.6586
4	122.503	1127.04	2777.8	522.792	10.6586
5	126.857	1128.33	2561.91	482.161	10.6586
6	131.212	1129.61	2346.02	441.529	10.6586
7	135.566	1130.89	2130.11	400.894	10.6586
8	139.92	1132.17	1914.2	360.259	10.6586
9	144.274	1133.45	1698.27	319.621	10.6586
10	148.628	1134.73	1482.34	278.982	10.6586
11	152.982	1136.01	1266.4	238.341	10.6586
12	157.337	1137.29	1050.45	197.699	10.6586
13	161.691	1138.57	834.496	157.055	10.6586
14	166.045	1139.85	618.529	116.409	10.6586
15	170.399	1141.13	402.554	75.7621	10.6586
16	174.753	1142.41	186.57	35.1131	10.6586
17	179.107	1143.69	-29.4229	-5.5375	10.6586
18	183.461	1144.97	-245.425	-46.1898	10.6586
19	187.816	1146.25	-461.435	-86.8437	10.6586
20	192.17	1147.53	-677.454	-127.499	10.6586
21	196.524	1148.81	-893.482	-168.156	10.6586
22	200.236	1150.01	-1108.76	-208.673	10.6586
23	203.948	1151.2	-1318.01	-248.054	10.6586
24	207.66	1152.4	-1520.77	-286.214	10.6586
25	209.083	1152.86	-939.121	-176.746	10.6586

26	210.478	1154.64	0	0	0

List Of Coordinates

Water Table

X	Y
7.6905	1100
96.146	1126.02
111.593	1124.53
207.53	1152.74
222.977	1151.25
318.704	1179.41

Block Search Window

X	Y
156.378	1138.52
156.378	1136.83
207.61	1151.9
207.449	1153.24

Block Search Window

X	Y
111.673	1125.37
111.673	1123.68
156.378	1136.83
156.378	1138.52

Block Search Window

X	Y
207.449	1153.24
207.61	1151.9
211.311	1151.54
211.798	1152.85

External Boundary

X	Y
7.6905	1100
8.86002	1100
10.632	1100
15.948	1100
19.492	1100
159.352	1100
318.704	1100
318.704	1140.83
318.704	1175.94
318.704	1176.98
318.704	1178.54
318.704	1179.06
318.704	1179.41
318.704	1181.67
270.735	1167.56
222.767	1153.45
207.32	1154.94
159.352	1140.83
111.384	1126.73
95.9366	1128.22
47.9683	1114.11
0	1100

Material Boundary

X	Y
8.86002	1100
96.1779	1125.68
111.625	1124.19
207.561	1152.41
223.008	1150.92
318.704	1179.06

Material Boundary

X	Y
10.632	1100
96.2262	1125.17
111.673	1123.68
207.61	1151.9
223.057	1150.41
318.704	1178.54

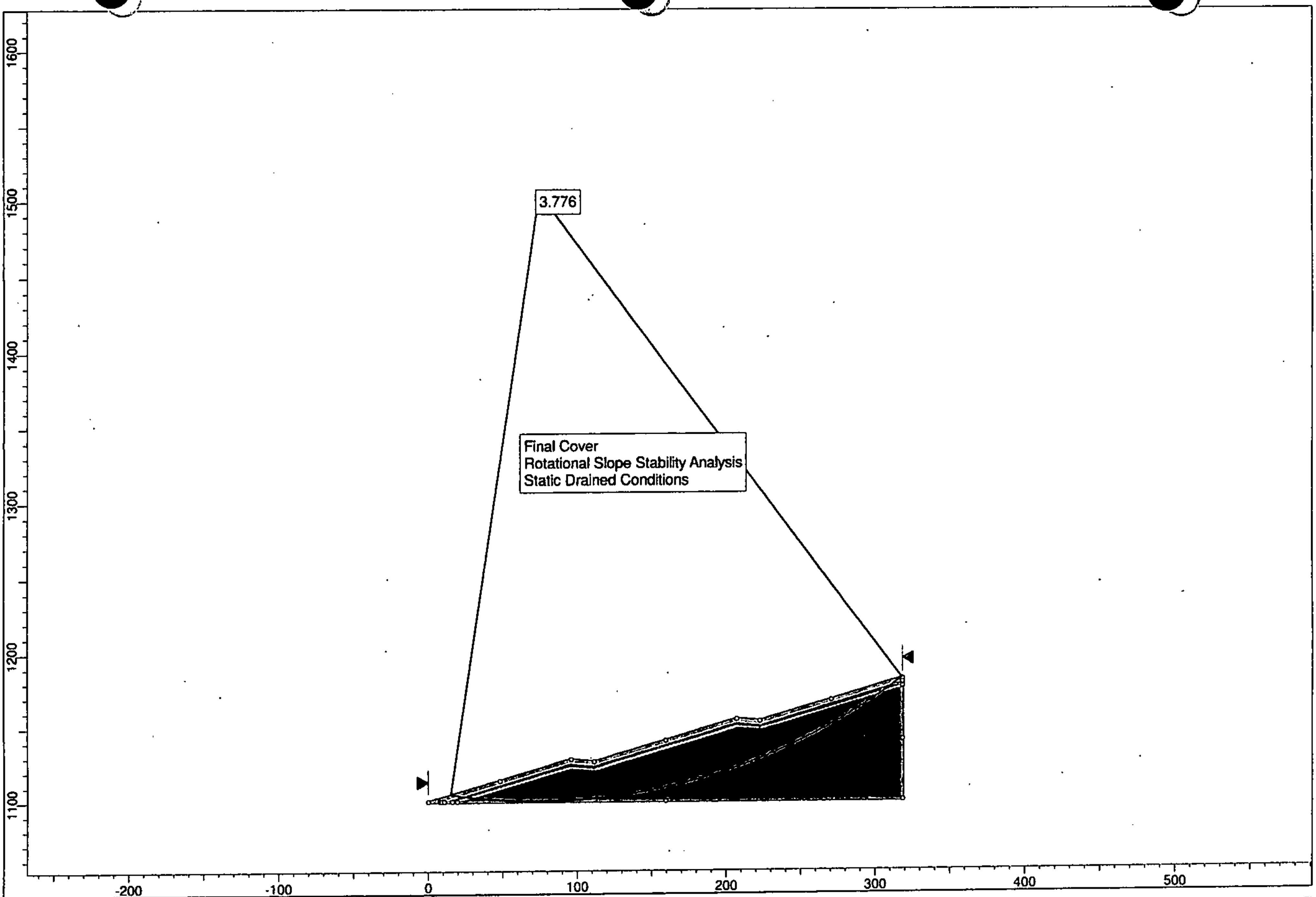
Material Boundary

X	Y
15.948	1100
96.371	1123.65
111.818	1122.16
207.754	1150.38

223.201	1148.89
318.704	1176.98

Material Boundary

X	Y
19.492	1100
96.4675	1122.64
111.914	1121.15
207.851	1149.37
223.298	1147.88
318.704	1175.94



Rot.Static.Drained.sli

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: Rot.Static.Drained.sli
Slide Modeler Version: 6.029
Project Title: SLIDE - An Interactive Slope Stability Program

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 10
Circles per division: 10
Number of iterations: 10
Divisions to use in next iteration: 50%
Composite Surfaces: Disabled
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Cap/Protective Cover	Geosynthetics	RSB	Intermediate Cover	Waste
Color	■	■	■	□	■
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	100	130	130	90
Cohesion [psf]	893	0	893	0	400
Friction Angle [deg]	25	17.5	25	27	33
Water Surface	None	None	None	None	None
Ru Value	0	0	0	0	0

Global Minimums

Method: spencer

FS: 3.775990
Center: 74.610, 1505.475
Radius: 405.449
Left Slip Surface Endpoint: 15.046, 1104.425
Right Slip Surface Endpoint: 318.557, 1181.625
Resisting Moment=2.23273e+008 lb-ft
Driving Moment=5.91296e+007 lb-ft
Resisting Horizontal Force=525833 lb
Driving Horizontal Force=139257 lb
Total Slice Area=6512.77 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 1991
Number of Invalid Surfaces: 0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 3.77599

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	5.99028	1014.65	Cap/Protective Cover	893	25	270.518	1021.48	275.514	0	275.514
2	1.22379	446.47	Geosynthetics	0	17.5	32.3507	122.156	387.43	0	387.43
3	3.72611	1835.16	RSB	893	25	312.762	1180.99	617.593	0	617.593
4	2.53168	1675.71	Intermediate Cover	0	27	96.1811	363.179	712.778	0	712.778
5	16.2726	16498.5	Waste	400	33	300.552	1134.88	1131.62	0	1131.62
6	16.2726	25266.8	Waste	400	33	394.967	1491.39	1680.59	0	1680.59
7	16.2726	33073.4	Waste	400	33	475.674	1796.14	2149.87	0	2149.87
8	16.2726	39922.4	Waste	400	33	543.367	2051.75	2543.48	0	2543.48
9	16.2726	42289.2	Waste	400	33	560.947	2118.13	2645.68	0	2645.68
10	16.2726	41928.6	Waste	400	33	549.196	2073.76	2577.37	0	2577.37
11	16.2726	45854.9	Waste	400	33	582.11	2198.04	2768.75	0	2768.75
12	16.2726	48817.7	Waste	400	33	604.019	2280.77	2896.13	0	2896.13
13	16.2726	50770.1	Waste	400	33	614.898	2321.85	2959.4	0	2959.4
14	16.2726	51685.3	Waste	400	33	614.943	2322.02	2959.66	0	2959.66
15	16.2726	51528.6	Waste	400	33	604.279	2281.75	2897.64	0	2897.64
16	16.2726	45394.1	Waste	400	33	536.567	2026.07	2503.92	0	2503.92
17	16.2726	38993.9	Waste	400	33	468.28	1768.22	2106.87	0	2106.87
18	16.2726	35338.6	Waste	400	33	427.271	1613.37	1868.43	0	1868.43
19	16.2726	30383.9	Waste	400	33	375.602	1418.27	1568	0	1568
20	16.2726	24038.3	Waste	400	33	313.157	1182.48	1204.91	0	1204.91
21	16.2726	16189.3	Waste	400	33	239.77	905.368	778.197	0	778.197
22	2.58731	1712.53	Intermediate Cover	0	27	73.4316	277.277	544.187	0	544.187
23	3.74791	1845.9	RSB	893	25	274.627	1036.99	308.785	0	308.785
24	1.2161	443.664	Geosynthetics	0	17.5	25.4174	95.9759	304.396	0	304.396
25	5.8536	991.5	Cap/Protective Cover	893	25	241.159	910.613	37.772	0	37.772

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 3.77599

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	15.0461	1104.43	0	0	0
2	21.0364	1103.58	1852.46	408.211	12.4272
3	22.2602	1103.42	1954.51	430.698	12.4272
4	25.9863	1102.95	3408.29	751.055	12.4272
5	28.518	1102.65	3863.93	851.461	12.4272
6	44.7905	1101.12	10484.8	2310.44	12.4271
7	61.0631	1100.25	18374.5	4049.04	12.4272
8	77.3357	1100.04	26579.2	5857.03	12.4272
9	93.6083	1100.47	34308.7	7560.31	12.4272
10	109.881	1101.56	40545.2	8934.59	12.4272
11	126.153	1103.32	44961.9	9907.86	12.4272
12	142.426	1105.74	47724.8	10516.7	12.4272
13	158.699	1108.84	48560.9	10700.9	12.4271
14	174.971	1112.64	47312	10425.7	12.4271
15	191.244	1117.16	43936.5	9681.89	12.4271
16	207.516	1122.43	38512.1	8486.58	12.4272
17	223.789	1128.47	32118.2	7077.61	12.4272
18	240.061	1135.32	25298.6	5574.82	12.4271
19	256.334	1143.03	17840.5	3931.36	12.4272
20	272.606	1151.66	10423.6	2296.95	12.4271
21	288.879	1161.27	3937.39	867.648	12.4272
22	305.152	1171.95	-473.514	-104.344	12.4271
23	307.739	1173.75	-1264.94	-278.743	12.4271
24	311.487	1176.42	-1059.2	-233.406	12.4271
25	312.703	1177.3	-1295.82	-285.548	12.4271
26	318.557	1181.63	0	0	0

List Of Coordinates

External Boundary

X	Y
7.6905	1100
8.86002	1100
10.632	1100
15.948	1100
19.492	1100
159.352	1100
318.704	1100
318.704	1140.83
318.704	1175.94
318.704	1176.98
318.704	1178.54
318.704	1179.06
318.704	1179.41
318.704	1181.67
270.735	1167.56
222.767	1153.45
207.32	1154.94
159.352	1140.83
111.384	1126.73
95.9366	1128.22

47.9683	1114.11
0	1100

Material Boundary

X	Y
8.86002	1100
96.1779	1125.68
111.625	1124.19
207.561	1152.41
223.008	1150.92
318.704	1179.06

Material Boundary

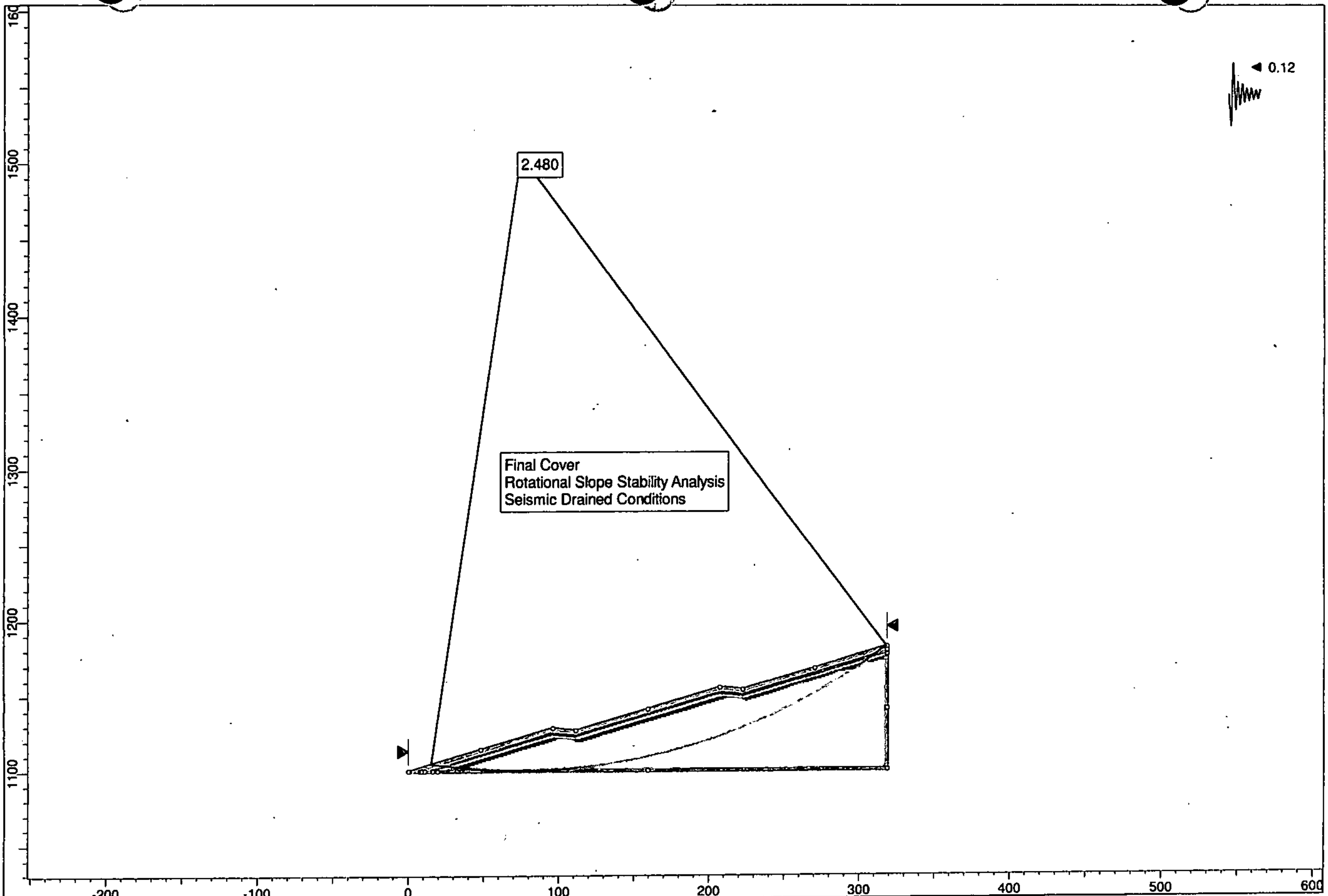
X	Y
10.632	1100
96.2262	1125.17
111.673	1123.68
207.61	1151.9
223.057	1150.41
318.704	1178.54

Material Boundary

X	Y
15.948	1100
96.371	1123.65
111.818	1122.16
207.754	1150.38
223.201	1148.89
318.704	1176.98

Material Boundary

X	Y
19.492	1100
96.4675	1122.64
111.914	1121.15
207.851	1149.37
223.298	1147.88
318.704	1175.94



Rot.Seismic.Drained.sli

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: Rot.Seismic.Drained.sli
Slide Modeler Version: 6.029
Project Title: SLIDE - An Interactive Slope Stability Program

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 10
Circles per division: 10
Number of iterations: 10
Divisions to use in next iteration: 50%
Composite Surfaces: Disabled
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

Seismic Load Coefficient (Horizontal): 0.12

Material Properties

Property	Cap/Protective Cover	Geosynthetics	RSB	Intermediate Cover	Waste
Color					
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	100	130	130	90
Cohesion [psf]	893	0	893	0	400
Friction Angle [deg]	25	17.5	25	27	33
Water Surface	None	None	None	None	None
Ru Value	0	0	0	0	0

Global Minimums

Method: spencer

FS: 2.479780
Center: 74.610, 1505.475
Radius: 405.449
Left Slip Surface Endpoint: 15.046, 1104.425
Right Slip Surface Endpoint: 318.557, 1181.625
Resisting Moment=2.18901e+008 lb-ft
Driving Moment=8.82746e+007 lb-ft
Resisting Horizontal Force=516106 lb
Driving Horizontal Force=208126 lb
Total Slice Area=6512.77 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 2097

Number of Invalid Surfaces: 0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 2.47978

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	5.99028	1014.65	Cap/Protective Cover	893	25	432.667	1072.92	385.835	0	385.835
2	1.22379	446.47	Geosynthetics	0	17.5	49.656	123.136	390.536	0	390.536
3	3.72611	1835.16	RSB	893	25	497.737	1234.28	731.875	0	731.875
4	2.53168	1675.71	Intermediate Cover	0	27	150.39	372.934	731.922	0	731.922
5	16.2726	16498.5	Waste	400	33	479.803	1189.81	1216.2	0	1216.2
6	16.2726	25266.8	Waste	400	33	623.088	1545.12	1763.33	0	1763.33
7	16.2726	33073.4	Waste	400	33	742.429	1841.06	2219.03	0	2219.03
8	16.2726	39922.4	Waste	400	33	839.671	2082.2	2590.36	0	2590.36
9	16.2726	42289.2	Waste	400	33	859.205	2130.64	2664.95	0	2664.95
10	16.2726	41928.6	Waste	400	33	834.425	2069.19	2570.33	0	2570.33
11	16.2726	45854.9	Waste	400	33	876.731	2174.1	2731.88	0	2731.88
12	16.2726	48817.7	Waste	400	33	902.116	2237.05	2828.81	0	2828.81
13	16.2726	50770.1	Waste	400	33	910.964	2258.99	2862.58	0	2862.58
14	16.2726	51685.3	Waste	400	33	903.947	2241.59	2835.8	0	2835.8
15	16.2726	51528.6	Waste	400	33	881.619	2186.22	2750.53	0	2750.53
16	16.2726	45394.1	Waste	400	33	778.198	1929.76	2355.62	0	2355.62
17	16.2726	38993.9	Waste	400	33	675.633	1675.42	1963.98	0	1963.98
18	16.2726	35338.6	Waste	400	33	613.002	1520.11	1724.81	0	1724.81
19	16.2726	30383.9	Waste	400	33	536.499	1330.4	1432.69	0	1432.69
20	16.2726	24038.3	Waste	400	33	446.337	1106.82	1088.41	0	1088.41
21	16.2726	16189.3	Waste	400	33	342.671	849.749	692.554	0	692.554
22	2.58731	1712.53	Intermediate Cover	0	27	100.106	248.242	487.204	0	487.204
23	3.74791	1845.9	RSB	893	25	408.156	1012.14	255.493	0	255.493
24	1.2161	443.664	Geosynthetics	0	17.5	34.7108	86.0752	272.996	0	272.996
25	5.8536	991.5	Cap/Protective Cover	893	25	363.47	901.325	17.8525	0	17.8525

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 2.47978

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	15.0461	1104.43	0	0	0
2	21.0364	1103.58	2798.73	940.088	18.5671
3	22.2602	1103.42	2868.96	963.679	18.5671
4	25.9863	1102.95	4847.77	1628.36	18.5671
5	28.518	1102.65	5245.8	1762.06	18.5672
6	44.7905	1101.12	12944	4347.85	18.567
7	61.0631	1100.25	21600	7255.41	18.5671
8	77.3357	1100.04	30208.5	10147	18.5671
9	93.6083	1100.47	37967.5	12753.2	18.5671
10	109.881	1101.56	43981.2	14773.2	18.5671
11	126.153	1103.32	48039.2	16136.3	18.5671
12	142.426	1105.74	50203	16863.1	18.5671
13	158.699	1108.84	50261.4	16882.7	18.5671
14	174.971	1112.64	48126.6	16165.7	18.5672
15	191.244	1117.16	43832.2	14723.2	18.5672
16	207.516	1122.43	37532.1	12607	18.5672
17	223.789	1128.47	30536.4	10257.1	18.5671
18	240.061	1135.32	23406.3	7862.13	18.5671
19	256.334	1143.03	15851.5	5324.48	18.5671
20	272.606	1151.66	8586.29	2884.12	18.5671
21	288.879	1161.27	2512.67	844.003	18.5671
22	305.152	1171.95	-1243.9	-417.824	18.5671
23	307.739	1173.75	-2068.68	-694.866	18.5671
24	311.487	1176.42	-1439.77	-483.617	18.5671
25	312.703	1177.3	-1690.67	-567.895	18.5672
26	318.557	1181.63	0	0	0

List Of Coordinates

External Boundary

X	Y
7.6905	1100
8.86002	1100
10.632	1100
15.948	1100
19.492	1100
159.352	1100
318.704	1100
318.704	1140.83
318.704	1175.94
318.704	1176.98
318.704	1178.54
318.704	1179.06
318.704	1179.41
318.704	1181.67
270.735	1167.56

222.767	1153.45
207.32	1154.94
159.352	1140.83
111.384	1126.73
95.9366	1128.22
47.9683	1114.11
0	1100

Material Boundary

X	Y
8.86002	1100
96.1779	1125.68
111.625	1124.19
207.561	1152.41
223.008	1150.92
318.704	1179.06

Material Boundary

X	Y
10.632	1100
96.2262	1125.17
111.673	1123.68
207.61	1151.9
223.057	1150.41
318.704	1178.54

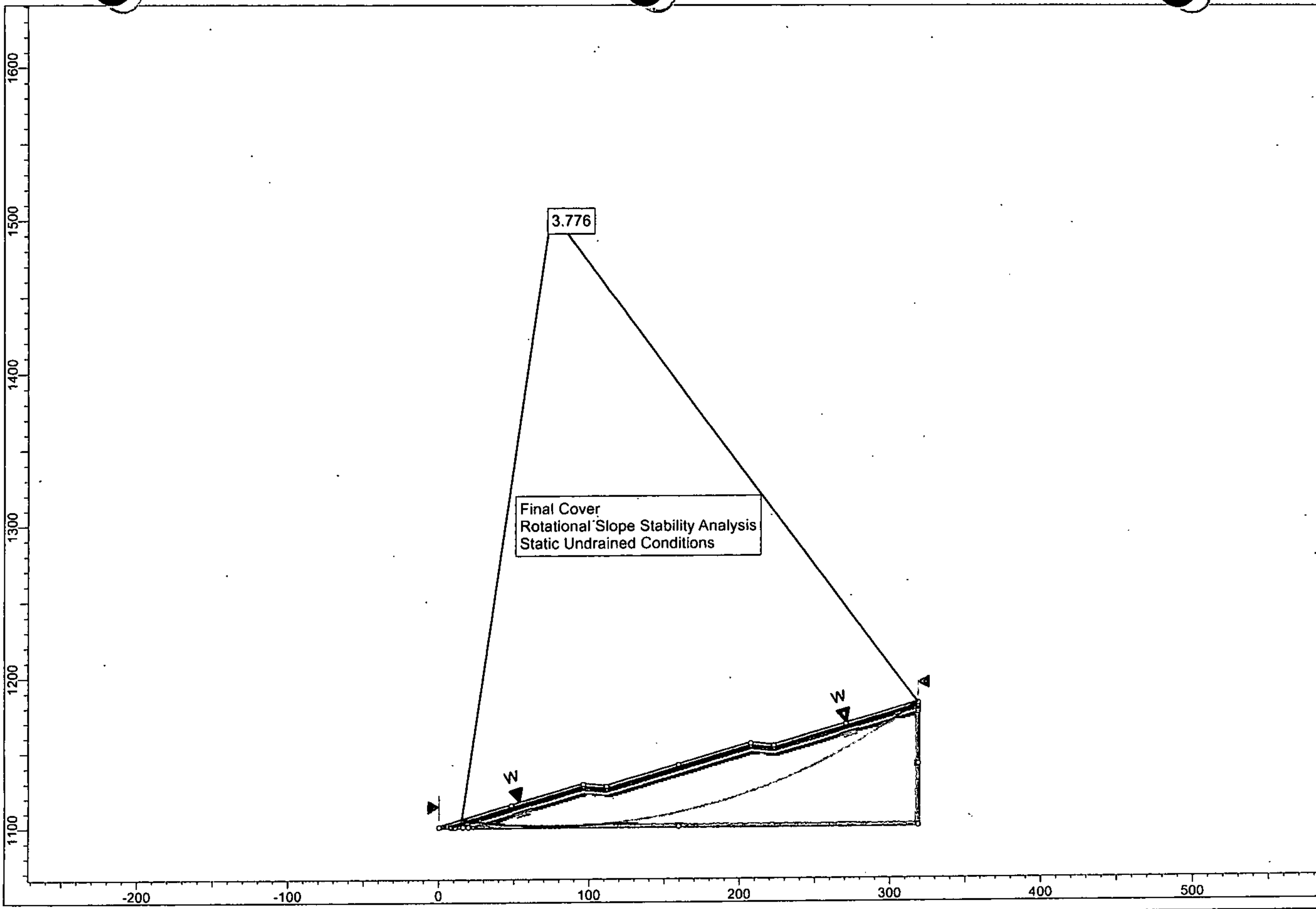
Material Boundary

X	Y
15.948	1100
96.371	1123.65
111.818	1122.16
207.754	1150.38
223.201	1148.89
318.704	1176.98

Material Boundary

X	Y
19.492	1100
96.4675	1122.64
111.914	1121.15
207.851	1149.37
223.298	1147.88

318.704	1175.94



Rot.Static.Undrained.slim

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: Rot.Static.UnDrained.sli
Slide Modeler Version: 6.029
Project Title: SLIDE - An Interactive Slope Stability Program

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 10
Circles per division: 10
Number of iterations: 10
Divisions to use in next iteration: 50%
Composite Surfaces: Disabled
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Cap/Protective Cover	Geosynthetics	RSB	Intermediate Cover	Waste
Color					
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	100	130	130	90
Cohesion [psf]	893	0	893	0	400
Friction Angle [deg]	25	17.5	25	27	33
Water Surface	Water Table	None	None	None	None
Hu Value	1				
Ru Value		0	0	0	0

Global Minimums

Method: spencer

FS: 3.775990
Center: 74.610, 1505.475
Radius: 405.449
Left Slip Surface Endpoint: 15.046, 1104.425
Right Slip Surface Endpoint: 318.557, 1181.625
Resisting Moment=2.23273e+008 lb-ft
Driving Moment=5.91296e+007 lb-ft
Resisting Horizontal Force=525833 lb
Driving Horizontal Force=139257 lb
Total Slice Area=6512.77 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 1965
Number of Invalid Surfaces: 0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 3.77599

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	5.99028	1014.65	Cap/Protective Cover	893	25	270.518	1021.48	275.514	0	275.514
2	1.22379	446.47	Geosynthetics	0	17.5	32.3507	122.156	387.43	0	387.43
3	3.72611	1835.16	RSB	893	25	312.762	1180.99	617.593	0	617.593
4	2.53168	1675.71	Intermediate Cover	0	27	96.1811	363.179	712.778	0	712.778
5	16.2726	16498.5	Waste	400	33	300.552	1134.88	1131.62	0	1131.62
6	16.2726	25266.8	Waste	400	33	394.967	1491.39	1680.59	0	1680.59
7	16.2726	33073.4	Waste	400	33	475.674	1796.14	2149.87	0	2149.87
8	16.2726	39922.4	Waste	400	33	543.367	2051.75	2543.48	0	2543.48
9	16.2726	42289.2	Waste	400	33	560.947	2118.13	2645.68	0	2645.68
10	16.2726	41928.6	Waste	400	33	549.196	2073.76	2577.37	0	2577.37
11	16.2726	45854.9	Waste	400	33	582.11	2198.04	2768.75	0	2768.75
12	16.2726	48817.7	Waste	400	33	604.019	2280.77	2896.13	0	2896.13
13	16.2726	50770.1	Waste	400	33	614.898	2321.85	2959.4	0	2959.4
14	16.2726	51685.3	Waste	400	33	614.943	2322.02	2959.66	0	2959.66
15	16.2726	51528.6	Waste	400	33	604.279	2281.75	2897.64	0	2897.64
16	16.2726	45394.1	Waste	400	33	536.567	2026.07	2503.92	0	2503.92
17	16.2726	38993.9	Waste	400	33	468.28	1768.22	2106.87	0	2106.87
18	16.2726	35338.6	Waste	400	33	427.271	1613.37	1868.43	0	1868.43
19	16.2726	30383.9	Waste	400	33	375.602	1418.27	1568	0	1568
20	16.2726	24038.3	Waste	400	33	313.157	1182.48	1204.91	0	1204.91
21	16.2726	16189.3	Waste	400	33	239.77	905.368	778.197	0	778.197
22	2.58731	1712.53	Intermediate Cover	0	27	73.4316	277.277	544.187	0	544.187
23	3.74791	1845.9	RSB	893	25	274.627	1036.99	308.785	0	308.785
24	1.2161	443.664	Geosynthetics	0	17.5	25.4174	95.9759	304.396	0	304.396
25	5.8536	991.5	Cap/Protective Cover	893	25	241.159	910.613	37.772	0	37.772

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 3.77599

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	15.0461	1104.43	0	0	0
2	21.0364	1103.58	1852.46	408.211	12.4272
3	22.2602	1103.42	1954.51	430.698	12.4272
4	25.9863	1102.95	3408.29	751.055	12.4272
5	28.518	1102.65	3863.93	851.461	12.4272
6	44.7905	1101.12	10484.8	2310.44	12.4271
7	61.0631	1100.25	18374.5	4049.04	12.4272
8	77.3357	1100.04	26579.2	5857.03	12.4272
9	93.6083	1100.47	34308.7	7560.31	12.4272
10	109.881	1101.56	40545.2	8934.59	12.4272
11	126.153	1103.32	44961.9	9907.86	12.4272
12	142.426	1105.74	47724.8	10516.7	12.4272
13	158.699	1108.84	48560.9	10700.9	12.4271
14	174.971	1112.64	47312	10425.7	12.4271
15	191.244	1117.16	43936.5	9681.89	12.4271
16	207.516	1122.43	38512.1	8486.58	12.4272
17	223.789	1128.47	32118.2	7077.61	12.4272
18	240.061	1135.32	25298.6	5574.82	12.4271
19	256.334	1143.03	17840.5	3931.36	12.4272
20	272.606	1151.66	10423.6	2296.95	12.4271
21	288.879	1161.27	3937.39	867.648	12.4272
22	305.152	1171.95	-473.514	-104.344	12.4271
23	307.739	1173.75	-1264.94	-278.743	12.4271
24	311.487	1176.42	-1059.2	-233.406	12.4271
25	312.703	1177.3	-1295.82	-285.548	12.4271
26	318.557	1181.63	0	0	0

List Of Coordinates

Water Table

X	Y
7.6905	1100
96.146	1126.02
111.593	1124.53
207.53	1152.74
222.977	1151.25
318.704	1179.41

External Boundary

X	Y
7.6905	1100
8.86002	1100
10.632	1100
15.948	1100
19.492	1100
159.352	1100
318.704	1100
318.704	1140.83
318.704	1175.94

318.704	1176.98
318.704	1178.54
318.704	1179.06
318.704	1179.41
318.704	1181.67
270.735	1167.56
222.767	1153.45
207.32	1154.94
159.352	1140.83
111.384	1126.73
95.9366	1128.22
47.9683	1114.11
0	1100

Material Boundary

X	Y
8.86002	1100
96.1779	1125.68
111.625	1124.19
207.561	1152.41
223.008	1150.92
318.704	1179.06

Material Boundary

X	Y
10.632	1100
96.2262	1125.17
111.673	1123.68
207.61	1151.9
223.057	1150.41
318.704	1178.54

Material Boundary

X	Y
15.948	1100
96.371	1123.65
111.818	1122.16
207.754	1150.38
223.201	1148.89
318.704	1176.98

Material Boundary

X	Y
19.492	1100
96.4675	1122.64
111.914	1121.15
207.851	1149.37
223.298	1147.88
318.704	1175.94

APPENDIX C

ATTACHMENT A
CONSTRUCTION QUALITY ASSURANCE/
QUALITY CONTROL PLAN

ATTACHMENT A - TABLE 1
MINIMUM TEST FREQUENCIES FOR SOIL COMPONENTS

Component	Required Test	Minimum Frequency	Acceptance Criteria	Sample Size
SOIL STRUCTURAL FILL	Density/Moisture Relationship (ASTM D698 or D1557)	1 per 10,000 cu.yd.	N/A	50 lb
	Nuclear Density Gauge In-Place Density and Moisture Content (ASTM D6938)	Placed Material: 5 tests per acre/lift	≥ 95% of Standard Proctor maximum dry density or ≥ 90% of Modified Proctor maximum dry density +/- 4% optimum moisture content	N/A
	Maximum Particle Size	Visual inspection of each lift during or following placement	12 inches or less	N/A
	Lift Depth	Placed Material	Visual ≤ 12 inches uncompacted thickness	N/A
	Consolidated Undrained Triaxial Compression Test (ASTM D4767) -with Pore Pressure Readings or Direct Shear Test (ASTM D3080)	Once initially unless material or conditions change	See Attachment B for required shear strength.	N/A
ROCK STRUCTURAL FILL	Particle Size	Placed Material	Visual 100% ≤ 24-inches	N/A
	Lift Depth	Placed Material	Visual ≤ 24 inches uncompacted thickness	N/A
	Compaction	Placed Material	Visual Observation of non-movement	N/A

ATTACHMENT A - TABLE 1
MINIMUM TEST FREQUENCIES FOR SOIL COMPONENTS

Component	Required Test	Minimum Frequency	Acceptance Criteria	Sample Size
RECOMPACTED SOIL BARRIER[1]	Sieve and Hydrometer (ASTM D422)	1 per 1,500 cu.yd.	100% $\leq$ 2-inch, 90% $\leq$ 3/ 4-inch, and 50% $\leq$ No. 200 sieve.	5-10 lb
	Unified Soil Classification (ASTM D2487)	1 per 1,500 cu.yd.	Prior to placement.	5-10 lb
	Density/Moisture Relationship[2] (ASTM D698 or D1557)	1 per 1,500 cu.yd.	Prior to placement.	50 lb
	Specific Gravity [3] (ASTM D854)	1 per 1,500 cu.yd.	N/A	5-10 lb
	Permeability: Flexible Wall Permeameter (ASTM 5084)	1 per 10,000 cu.yd.	Permeability $\leq 1 \times 10^{-6}$ cm/sec	50 lb
	Nuclear Density Gauge In-Place Density and Moisture Content (ASTM D6938)	Placed Material: 5 tests per acre/lift	$\geq$ 95% of Standard Proctor maximum dry density or $\geq$ 90% of Modified Proctor maximum dry density with a moisture content at or above optimum, or as modified by test pad; or Compaction to a moisture content and dry density that meets or exceeds the best fit line of optimums.	N/A
	Moisture Content (ASTM D2216)	At discretion of CQA firm.	N/A; To confirm nuclear density gauge moisture correction.	Varies
	Lift Depth	Placed Material	$\leq$ 8 inches uncompacted depth	N/A
	Total Thickness	Placed Material	Minimum 18 inches. Required thickness verified by survey	N/A
	Consolidated Undrained Triaxial Compression Test (ASTM D4767) -with Pore Pressure Readings or Direct Shear Test (ASTM D3080)	One sample per material type	See Attachment B for required shear strength.	N/A

ATTACHMENT A - TABLE 1
MINIMUM TEST FREQUENCIES FOR SOIL COMPONENTS

Component	Required Test	Minimum Frequency	Acceptance Criteria	Sample Size
VEGETATIVE COVER LAYER	Visual Observation	Placed Material	Reasonably free of debris, plant matter, and foreign objects. No particles greater than 12 inches in diameter, Max lift thickness is 30 inches.	N/A
	Total Thickness	Placed Material	≥ 30 inches verified through survey or direct measurement	N/A

Notes:

1. Results of pre-construction testing of the borrow soils performed on representative samples shall be submitted to the Ohio EPA no later than seven days prior to the intended use of the material during construction.
2. If the use of the Best Fit Line of Optimums is proposed, both standard and modified Proctor tests will be performed on alternating samples.
3. This testing is only required if the use of the Best Fit Line of Optimums is proposed.

ATTACHMENT A - TABLE 2

40 mil LLDPE TEXTURED GEOMEMBRANE QA/QC TESTING

REQUIRED PHYSICAL PROPERTIES				
PROPERTY	**TEST METHOD**	**REQUIRED VALUES** (1)	**MANUFACTURER QC TEST FREQUENCY**	**QUALITY ASSURANCE TEST FREQUENCY**
THICKNESS (mil)	ASTM D5994	34 minimum 36 lowest individual for 8 of 10 values 38 minimum average	Each Roll	Every 100,000 sf
ASPERITY HEIGHT (mil) (min. avg.)	ASTM D7466	20 minimum	See Note 2	Every 100,000 sf
SHEET DENSITY (g/cm^3) (max.)	ASTM D1505 Or ASTM D792	0.939	See Note 2	Every 100,000 sf
TENSILE PROPERTIES (min.) (each direction) • Break Strength (lb/in) • Break Elongation (%)	ASTM D6693 Type IV	 60 250	See Note 2	Every 100,000 sf
CARBON BLACK CONTENT (allowable range in %)	ASTM D1603	2.0 – 3.0 %	See Note 2	Every 100,000 sf
CARBON BLACK DISPERSION (acceptable levels)	ASTM D5596	9 in Categories 1 or 2, and 1 in Category 3	See Note 2	Every 100,000 sf
PUNCTURE RESISTANCE (avg. min.) (lb)	ASTM D4833	44	See Note 2	Every 100,000 sf
TEAR RESISTANCE (avg. min.) (lb)	ASTM D1004	22	See Note 2	Every 100,000 sf

Notes: (1) With the exception of Asperity Height, the required values are from GRI Test Method GM 17, Standard Specification for "Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes".
(2) Testing shall be completed at the manufacturer's standard testing frequency.

TABLE 2 (CONT.)

REQUIRED PHYSICAL PROPERTIES				
PROPERTY	TEST METHOD	REQUIRED VALUES (1)	MANUFACTURER QC TEST FREQUENCY	QUALITY ASSURANCE TEST FREQUENCY
OXIDATIVE INDUCTION TIME • Standard (avg. min.) or • High Pressure (avg. in.)	ASTM D3895 ASTM D5885	100 min 400 min	See Note 2	See Note 3
OVEN AGING AT 85°C • Standard OIT (min avg % retained after 90 days) or • High Pressure OIT (min avg % retained after 90 days)	ASTM D5721 ASTM D3895 ASTM D5885	35% 60%	Certify Each Formulation	See Note 3
UV RESISTANCE • High Pressure OIT (min avg % retained after 1600 hours)	ASTM D5885	35%	Certify Each Formulation	See Note 3
STRESS CRACK RESISTANCE	ASTM D5397	200 hours	Per GRI GM 10	See Note 3
INTERFACE SHEAR STRENGTH	ASTM D5321	See Attachment B	See Note 3	See Attachment B
GEOMEMBRANE RESIN				
DENSITY (max.) (g/ml)	ASTM D1505/D792	0.926	Each Resin Batch	See Note 3
MELT FLOW INDEX (g/10 min) (max.)	ASTM D1238	1.0	Each Resin Batch	See Note 3

Notes: (1) Required values are from GRI Test Method GM 17, Standard Specification for "Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes".
(2) Testing shall be completed at the manufacturer's standard testing frequency.
(3) Not Required

TABLE 2 (CONT.)

INSTALLATION TESTING SUMMARY				
PROPERTY	**TEST METHOD**	**SAMPLE SIZE**	**FIELD TEST FREQUENCY**	**ACCEPTANCE CRITERIA[(2)]**
TRIAL SEAM TESTING [(1)]:				
PEEL TEST (lb/in) Fusion Welds	ASTM D6392	As Needed	Minimum 1 test per welder/machine combination; and prior to each seaming period	The average of the 3 tests shall be greater than 60 lb/in with one result being less than 60 lb/in but greater than 48 lb/in. Three (3) out of three (3) tests shall not have a break code of AD. AD-BRK is only an acceptable break code if seam incursion is less than 25%. Refer to schematic on Page 4 for break codes.
PEEL TEST (lb/in) Extrusion Welds	ASTM D6392		Minimum 1 test per welder/machine combination; and prior to each seaming period	The average of the 3 tests shall be greater than 52 lb/in with one result being less than 52 lb/in but greater than 42 lb/in. Three (3) out of three (3) tests shall not have one of the following break codes: AD1, AD2, AD-BRK or AD-WLD. Refer to schematic on Page 4 for break codes.
DESTRUCTIVE SEAM TESTING [(1)]:				
PEEL TEST (lb/in) Fusion Welds	ASTM D6392	As Needed	Minimum 1 per 500 lf of seaming per device	The average of the 5 tests shall be greater than 60 lb/in with one result being less than 60 lb/in but greater than 48 lb/in. Five (5) out of five (5) tests shall not have a break code of AD. AD-BRK is only an acceptable break code if seam incursion is less than 25%. Refer to schematic on Page 4 for break codes.
PEEL TEST (lb/in) Extrusion Welds	ASTM D6392		Minimum 1 per 500 lf of seaming per device	The average of the 5 tests shall be greater than 52 lb/in with one result being less than 52 lb/in but greater than 42 lb/in. Five (5) out of five (5) tests shall not have one of the following break codes: AD1, AD2, AD-BRK or AD-WLD. Refer to schematic on Page 4 for break codes.
NON-DESTRUCTIVE SEAM TESTING:				
AIR-PRESSURE	GRI GM6		Every Fusion Welded Seam	No more than 3 psi drop with initial pressure of 30 to 35 psi for 5 minutes.
VACUUM	ASTM D5641		Every Extrusion Weld	Examine weld for 10 seconds with minimum vacuum of 3 psi.

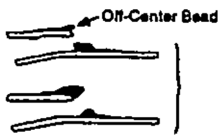
Notes:
(1) For double fusion welded seams, both tracks shall be tested for compliance with the minimum property values listed.
(2) Accepted specifications for breaks and unacceptable break codes obtained from the standard specifications in GRI-GM19.

TABLE 2 (CONT.)

ASTM D 6392 LOCATION OF SEAM STRENGTH TESTING BREAK CODES FOR SEAMS TESTED IN SHEAR AND PEEL

EXTRUSION WELDED SEAMS

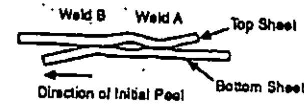
Schematic of Untested Specimen

Types of Break	Location of Break Code	Break Description
	AD1	Failure in adhesion. Specimens may also delaminate under the bead and break through the thin extruded material in the outer area.
	AD2	Failure in adhesion.
	AD-WLD(1)	Break through the fillet.
	SE1	Break at seam edge in the bottom sheet (applicable to shear only).
	SE2	Break at seam edge in the top sheet (applicable to shear only).
	SE3	Break at seam edge in the bottom sheet (applicable to peel only).
	BRK1	Break in the bottom sheeting. A "B" in parebtheses following the code means the specimen broke in the buffed area.
	BRK2	Break in the top sheeting. A "B" in parebtheses following the code means the specimen broke in the buffed area.
	AD-BRK	Break in the bottom sheeting after some adhesion failure between the fillet and the bottom sheet.
	HT	Break at the edge of the hot tack for specimens which could not be delaminated in the hot tack.
	SIP	Separation in the plane of the sheet.

(1) Acceptance of AD-WLD breaks may depend on whether test values meet a minimum specification value.

FUSION WELDED SEAMS

Schematic of Untested Specimen



Types of Break	Location of Break Code	Break Description
	AD	Adhesion Failure
	BRK	Break in sheeting. Break can be in either top or bottom sheet
	SE1	Break in outer edge of seam. Break can be in either top or bottom sheet.
	SE2	Break at inner edge of seam through both sheets.
	AD-BRK	Break in first seam after some adhesion failure. Break can be in either top or bottom sheet.
	SIP	Separation in the plane of the sheet. Break can be in either top or bottom sheet.

ATTACHMENT A - TABLE 3

DOUBLE SIDED GEOCOMPOSITE DRAINAGE LAYER QA/QC TESTING

PROPERTY	TEST METHOD	FINAL COVER SYSTEM REQUIRED VALUES	MANUFACTURER QC TEST FREQUENCY	QA TEST FREQUENCY
GEONET COMPONENT				
THICKNESS (mil) (min.)	ASTM D5199	250	See Note 1	1 per 250,000 sf
DENSITY (g/cm^3) (min.)	ASTM D792 or ASTM D1505	0.94 (g/cm^3)	See Note 1	1 per 250,000 sf
CARBON BLACK CONTENT (%) (min.)	ASTM D1603	2.0 - 3.5 %	See Note 1	1 per 250,000 sf
GEOTEXTILE COMPONENT				
MASS PER UNIT AREA (oz/sy) (min.)	ASTM D5261	5.0	See Note 1	1 per 250,000 sf
APPARENT OPENING SIZE (Sieve)	ASTM D4751	70 - 140	See Note 1	1 per 250,000 sf
PERMITTIVITY (sec^{-1}) (min.)	ASTM D4491	1.30	See Note 1	1 per 250,000 sf
GRAB STRENGTH(2) (lbs) (min.)	ASTM D4632	160	See Note 1	1 per 250,000 sf
TRAPEZOIDAL TEAR(2) (lbs) (min.)	ASTM D4533	65	See Note 1	1 per 250,000 sf
CBR PUNCTURE RESISTENCE (lbs) (min.)	ASTM D6241	435	See Note 1	1 per 250,000 sf
UV RESISTANCE (%) (min.) **At 500 hours of exposure**	ASTM D4355	70	Certify	N/A
GEOCOMPOSITE COMPONENT				
TRANSMISSIVITY (m^2/sec) (min.)	ASTM D4716	Final Cover: 5.0×10^{-4}	See Note 1	1 per 50,000 sf (See Note 3)
INTERFACE SHEAR STRENGTH (min)	ASTM D5321	See Attachment B	N/A	See Attachment B

Notes:

(1) Testing shall be completed at the manufacturer's standard testing frequency.
(2) Minimum values measured in machine and cross machine direction.
(3) Transmissivity tested with 500 psf at a gradient of 0.33.
(4) The geonet and geotextile components of the double sided geocomposite shall be tested separately for the above parameters.

APPENDIX D

2008 FINAL COVER RSB PERMEABILITY RESULTS

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER

ASTM D5084-00 Method F; Mercury U-Tube Permometer - Inflow Volume = Outflow Volume

Cl[redacted]	Civil & Environmental Consultants, Inc.	Boring	RSB-1
C[redacted]roject	153-121.0002 Closure Construction Central Waste	Depth	09/17/15
[redacted]No.	36291	Sample	Shelby Tube
Vis[redacted] Description	Brown Clay	Lab Sample No.	36291001
Sample Condition	Undisturbed		

SAMPLE CONDITIONS

Sample Status	Initial	Final
Tare Number	w102	w107
Wt. Tare & WS, gm	257.42	715.89
Wt. Tare & DS, gm	226.97	601.01
Wt. Tare, gm	8.49	8.46
Moisture Content, %	13.9%	19.4%
Wt. Tube & WS., gm	894.2	NA
Wt. Of Tube, gm	219.66	NA
Wt. Of WS., gm	674.6	706.8
Length 1, in	3.136	3.158
Length 2, in	3.142	3.19
Length 3, in	3.175	3.168
Top Diameter, in	2.834	2.775
Middle Diameter, in	2.834	2.859
Bottom Diameter, in	2.844	2.868
Average Length, L, cm	8.00	8.06
Average Area, A, cm^2	40.79	40.70
Sample Volume, cc	326.5	327.9
Unit Wet Wt., gm/cc	2.07	2.16
Unit Wet Wt., pcf	128.9	134.5
Unit Dry Wt., pcf	113.2	112.7
Unit Dry Wt., gm/cc	1.81	1.81
Sp[redacted]Gravity, Assumed	2.7	2.7
Vo[redacted]atio, e	0.489	0.495
P[redacted], n	0.328	0.331
Pore Volume, cc	107.21	108.61
Saturation, %	77.0%	

TEST CONSTANTS & EQUATIONS

Pipette Area, a_o - cm^2	0.031416
Annulus Area, a_a, cm^2	0.76712
Manometer Constant, $M_1 = a_a a_o/(a_a+a_o)$, cm^2	0.03018
Manometer Constant, $M_2 = 1 + a_p/a_a$	1.0410
Sample Constant, $S = L/A$, cm^{-1}	0.198
Specific Gravity, $\delta = \delta_{hg} - \delta_w$, gm/cc	12.562
Test Constant, $C = M_1 S/\delta$	4.76E-04
Mercury Level at Equilibrium, R_{eq}, cm	3.1
Mercury Level of Pipette at t=0, R_{p0}, cm	8
Initial Head Difference, $z_1 = (R_{p0} - R_{eq})M_2$, cm	5.10
Trial Constant, $T = M_2 / z_1$, cm	0.2041
Temperature Correction for 20°C, R_t	0.958

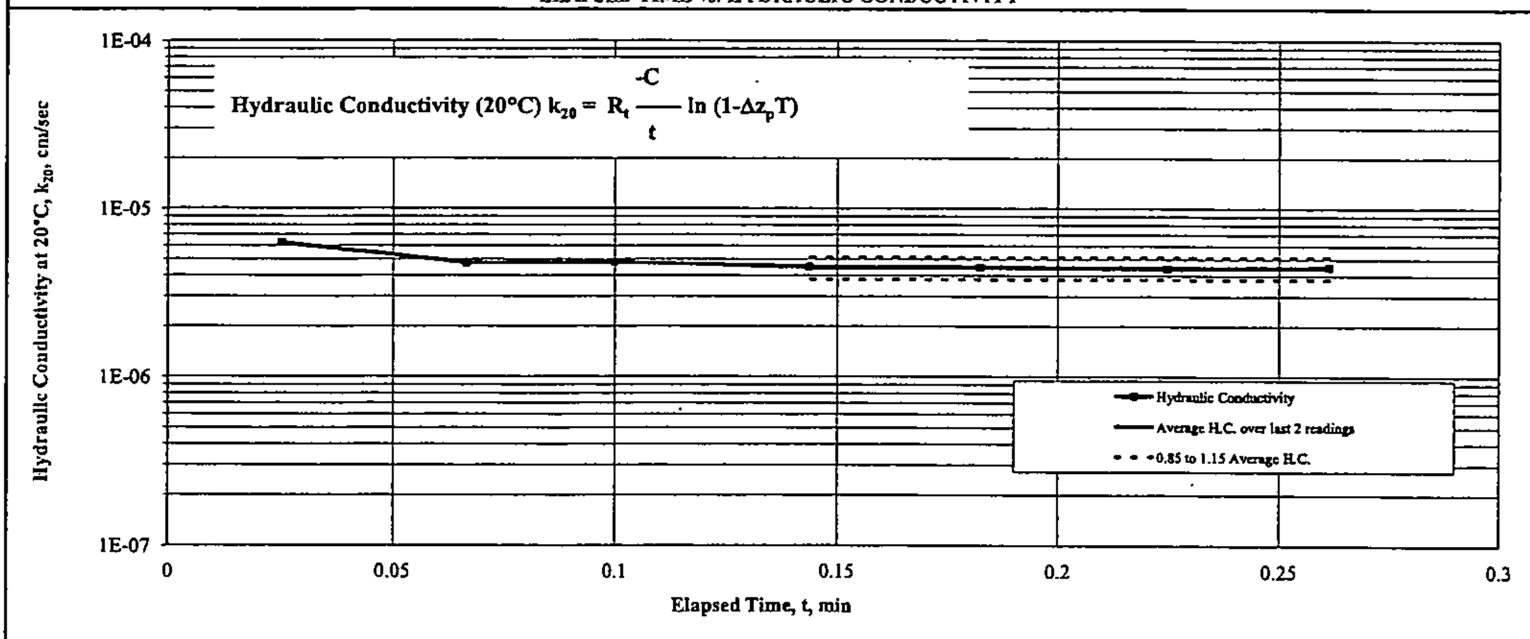
SAMPLE SUMMARY

Avg. Hydraulic Conductivity, k_{20}, cm/sec	4.5E-06
Initial Water Content, %	13.9%
Initial Dry Density, pcf	113.2
% Compaction	NA
Sample Status	Undisturbed
B Parameter	95
Permeant	Deaired Water
Cell Pressure, psi	100
Back Pressure, psi	95
Avg.(Mid-Height) Confining Stress, psi	5
Maximum Gradient	8.0
Average Test Temperature, °C	21.8

TEST DATA

t_t Elapsed Time min	R_{pt} Mercury Height cm	Δz_p $R_{p0}-R_{pt}$ cm	i Gradient cm / cm	H_t Head cm	ΔH_t Percent of Initial Head from t=0 %	σ'_{max} Effective Stress Max psi	σ'_{min} Effective Stress Min psi	k_{20} Hydraulic Conductivity cm/sec
0.00	8	0	8.0	64.1	100.0%	5.46	4.54	NA
0.03	7.9	0.1	7.8	62.8	98.0%	5.45	4.55	6.26E-06
0.07	7.8	0.2	7.6	61.5	95.9%	5.44	4.56	4.76E-06
0.10	7.7	0.3	7.5	60.2	93.9%	5.43	4.57	4.80E-06
0.14	7.6	0.4	7.3	58.8	91.8%	5.42	4.58	4.51E-06
0.18	7.5	0.5	7.1	57.5	89.8%	5.41	4.59	4.48E-06
0.22	7.4	0.6	7.0	56.2	87.8%	5.40	4.60	4.41E-06
0.26	7.3	0.7	6.8	54.9	85.7%	5.39	4.61	4.48E-06

ELAPSED TIME vs. HYDRAULIC CONDUCTIVITY



In[redacted]lidation: ALO   Reviewed By: SVG   Date Tested: 9/22/2015

N[redacted] average Hydraulic Conductivity is calculated using the average of the last 4 determinations where all requisite flow and Hydraulic Conductivity conditions are achieved!

Prerequisits: Inflow / Outflow Ratio = 1 by definition of test procedure. Final Hydraulic Conductivity = +-25% of average Hydraulic Conductivity when k > 1E-8 cm/sec and +-50% when k < 1E-8 cm/sec.

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER

ASTM D5084-00 Method F; Mercury U-Tube Permometer - Inflow Volume = Outflow Volume

Cli[illegible]	Civil & Environmental Consultants, Inc.	Boring	RSB-2
C[illegible]roject	153-121.0002 Closure Construction Central Waste	Depth	09/17/15
[illegible]No.	36291	Sample	Shelby Tube
Vis[illegible] Description	Brown Clay	Lab Sample No.	36291002
Sample Condition	Undisturbed		

SAMPLE CONDITIONS		
Sample Status	Initial	Final
Tare Number	w107	w64
Wt. Tare & WS, gm	166.98	433.29
Wt. Tare & DS, gm	149	367.07
Wt. Tare, gm	8.46	8.37
Moisture Content, %	12.8%	8.4%
Wt. Tube & WS., gm	408.9	NA
Wt. Of Tube, gm	0	NA
Wt. Of WS., gm	408.9	392.9
Length 1, in	2.001	1.996
Length 2, in	2.069	2.075
Length 3, in	2.032	1.935
Top Diameter, in	2.839	2.879
Middle Diameter, in	2.811	2.854
Bottom Diameter, in	2.834	2.893
Average Length, L, cm	5.17	5.09
Average Area, A, cm^2	40.52	41.89
Sample Volume, cc	209.4	213.0
Unit Wet Wt., gm/cc	1.95	1.84
Unit Wet Wt., pcf	121.9	115.1
Unit Dry Wt., pcf	108.1	106.2
Unit Dry Wt., gm/cc	1.73	1.70
Sp[illegible] Gravity, Assumed	2.7	2.7
V[illegible]atio, e	0.559	0.586
P[illegible], n	0.359	0.370
Pore Volume, cc	75.08	78.75
Saturation, %	61.8%	

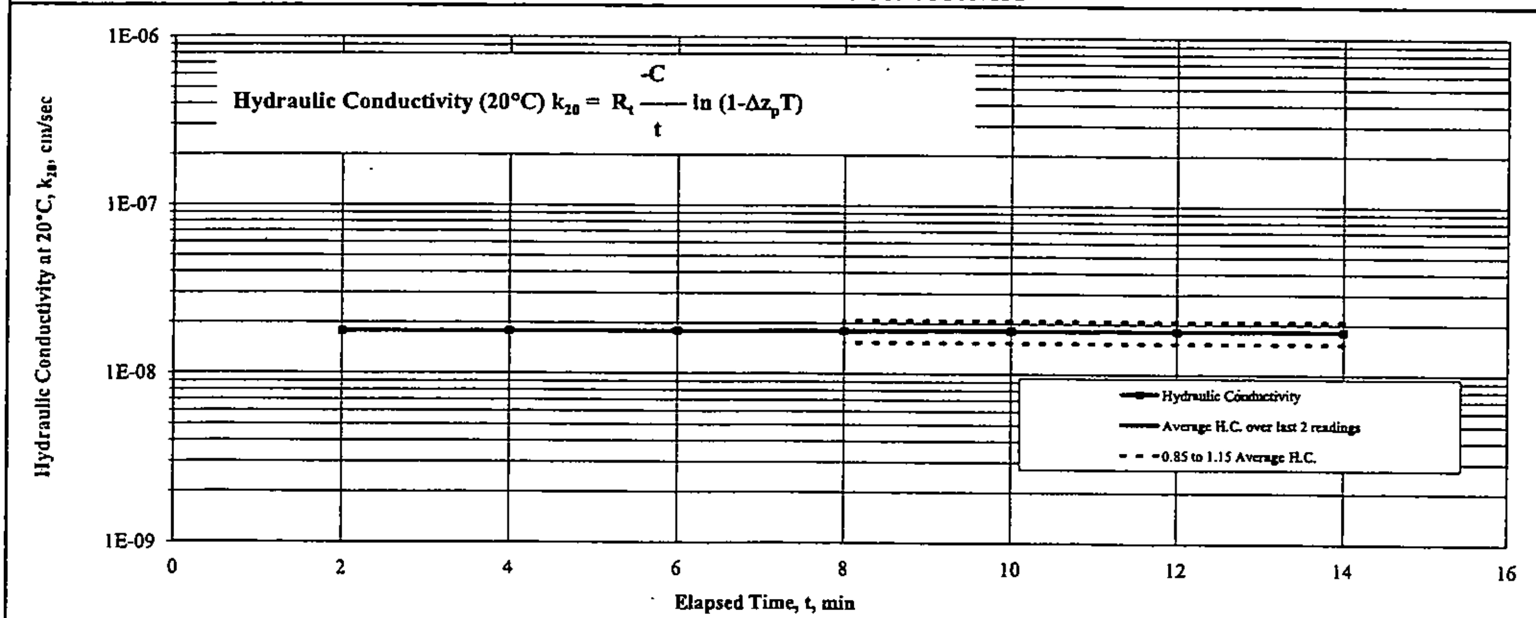
TEST CONSTANTS & EQUATIONS	
Pipette Area, a_p - cm^2	0.031416
Annulus Area, a_a, cm^2	0.76712
Manometer Constant, $M_1 = a_a a_p/(a_a+a_p)$, cm^2	0.03018
Manometer Constant, $M_2 = 1 + a_p/a_a$	1.0410
Sample Constant, $S = L/A$, cm^{-1}	0.121
Specific Gravity, $\delta = \delta_{hg} - \delta_w$, gm/cc	12.562
Test Constant, $C = M_1 S/\delta$	2.92E-04
Mercury Level at Equilibrium, R_{eq}, cm	3.1
Mercury Level of Pipette at t=0, R_{p0}, cm	9.65
Initial Head Difference, $z_1 = (R_{p0}-R_{eq})M_2$, cm	6.82
Trial Constant, $T = M_2 / z_1$, cm	0.1527
Temperature Correction for 20°C, R_t	0.955

SAMPLE SUMMARY	
Avg. Hydraulic Conductivity, k_{20}, cm/sec	1.8E-08
Initial Water Content, %	12.8%
Initial Dry Density, pcf	108.1
% Compaction	NA
Sample Status	Undisturbed
B Parameter	97
Permeant	Deaired Water
Cell Pressure, psi	100
Back Pressure, psi	95
Avg.(Mid-Height) Confining Stress, psi	5
Maximum Gradient	16.8
Average Test Temperature, °C	21.9

TEST DATA

t_t Elapsed Time min	R_{pt} Mercury Height cm	Δz_p $R_{p0}-R_{pt}$ cm	i Gradient cm / cm	H_t Head cm	ΔH_t Percent of Initial Head from t=0 %	σ'_{max} Effective Stress Max psi	σ'_{min} Effective Stress Min psi	k_{20} Hydraulic Conductivity cm/sec
0.00	9.65	0	16.8	85.7	100.0%	5.61	4.39	NA
2.00	9.6	0.05	16.7	85.0	99.2%	5.60	4.40	1.78E-08
4.00	9.55	0.1	16.6	84.3	98.5%	5.60	4.40	1.79E-08
6.00	9.5	0.15	16.5	83.7	97.7%	5.60	4.40	1.79E-08
8.00	9.45	0.2	16.3	83.0	96.9%	5.59	4.41	1.80E-08
10.00	9.4	0.25	16.2	82.4	96.2%	5.59	4.41	1.81E-08
12.00	9.35	0.3	16.1	81.7	95.4%	5.58	4.42	1.81E-08
14.00	9.3	0.35	15.9	81.1	94.7%	5.58	4.42	1.82E-08

ELAPSED TIME vs. HYDRAULIC CONDUCTIVITY



In[illegible]lidation: ALO	Reviewed By: SVG	Date Tested: 9/25/2015

N[illegible] average Hydraulic Conductivity is calculated using the average of the last 4 determinations where all requisite flow and Hydraulic Conductivity conditions are achieved!

Prerequisits: Inflow / Outflow Ratio = 1 by definition of test procedure. Final Hydraulic Conductivity = +-25% of average Hydraulic Conductivity when k > 1E-8 cm/sec and +-50% when k < 1E-8 cm/sec.

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER

ASTM D5084-00 Method F; Mercury U-Tube Permometer - Inflow Volume = Outflow Volume

Cl[redacted]	Civil & Environmental Consultants, Inc.	Boring	RSB-3
C[redacted]roject	153-121.0002 Closure Construction Central Waste	Depth	09/17/15
[redacted]No.	36291	Sample	Shelby Tube
Visual Description	Brown Clay	Lab Sample No.	36291003
Sample Condition	Undisturbed		

SAMPLE CONDITIONS		
Sample Status	Initial	Final
Tare Number	w64	105
Wt. Tare & WS, gm	272.13	934.7
Wt. Tare & DS, gm	233.38	801.95
Wt. Tare, gm	8.42	84.05
Moisture Content, %	17.2%	18.5%
Wt. Tube & WS., gm	853.2	NA
Wt. Of Tube, gm	0	NA
Wt. Of WS., gm	853.2	862.4
Length 1, in	3.9	3.859
Length 2, in	3.899	3.84
Length 3, in	3.901	3.829
Top Diameter, in	2.902	3.826
Middle Diameter, in	2.896	3.884
Bottom Diameter, in	2.91	3.861
Average Length, L, cm	9.91	9.76
Average Area, A, cm^2	42.69	75.38
Sample Volume, cc	422.9	735.7
Unit Wet Wt., gm/cc	2.02	1.17
Unit Wet Wt., pcf	125.9	73.1
Unit Dry Wt., pcf	107.4	61.7
Unit Dry Wt., gm/cc	1.72	0.99
S[redacted] Gravity, Assumed	2.7	2.7
V[redacted]atio, e	0.569	1.729
[redacted], n	0.363	0.634
Pore Volume, cc	153.34	466.17
Saturation, %	81.8%	

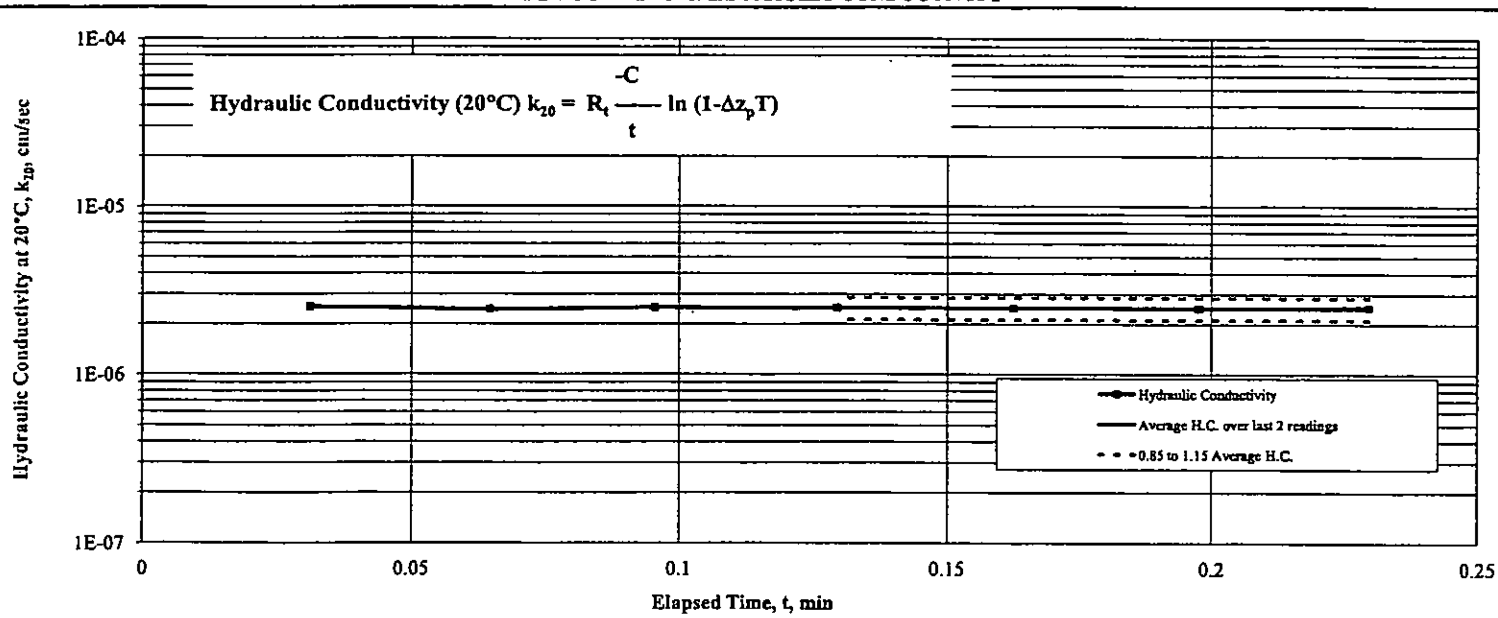
TEST CONSTANTS & EQUATIONS	
Pipette Area, a_p - cm^2	0.031416
Annulus Area, a_a, cm^2	0.76712
Manometer Constant, $M_1 = a_a a_p/(a_a+a_p)$, cm^2	0.03018
Manometer Constant, $M_2 = 1 + a_p/a_a$	1.0410
Sample Constant, $S = L/A$, cm^{-1}	0.129
Specific Gravity, $\delta = \delta_{hg} - \delta_w$, gm/cc	12.562
Test Constant, $C = M_1 S/\delta$	3.11E-04
Mercury Level at Equilibrium, R_{eq}, cm	3.1
Mercury Level of Pipette at t=0, R_{p0}, cm	9.5
Initial Head Difference, $z_1 = (R_{p0}-R_{eq})M_2$, cm	6.66
Trial Constant, $T = M_2 / z_1$, cm	0.1563
Temperature Correction for 20°C, R_t	0.958

SAMPLE SUMMARY	
Avg. Hydraulic Conductivity, k_{20}, cm/sec	2.5E-06
Initial Water Content, %	17.2%
Initial Dry Density, pcf	107.4
% Compaction	NA
Sample Status	Undisturbed
B Parameter	95
Permeant	Deaired Water
Cell Pressure, psi	110
Back Pressure, psi	105
Avg.(Mid-Height) Confining Stress, psi	5
Maximum Gradient	8.6
Average Test Temperature, °C	21.8

TEST DATA

t_t Elapsed Time	R_{pt} Mercury Height	Δz_p $R_{p0}-R_{pt}$	i Gradient	H_t Head	ΔH_t Percent of Initial Head from t=0	σ'_{max} Effective Stress Max	σ'_{min} Effective Stress Min	k_{20} Hydraulic Conductivity
min	*cm*	*cm*	*cm / cm*	*cm*	*%*	*psi*	*psi*	*cm/sec*
0.00	9.5	0	8.6	83.7	100.0%	5.60	4.40	NA
0.03	9.4	0.1	8.4	82.4	98.4%	5.59	4.41	2.52E-06
0.06	9.3	0.2	8.3	81.1	96.9%	5.58	4.42	2.44E-06
0.10	9.2	0.3	8.2	79.8	95.3%	5.57	4.43	2.50E-06
0.13	9.1	0.4	8.0	78.5	93.8%	5.56	4.44	2.48E-06
0.16	9	0.5	7.9	77.2	92.2%	5.55	4.45	2.49E-06
0.20	8.9	0.6	7.8	75.8	90.6%	5.54	4.46	2.47E-06
0.23	8.8	0.7	7.6	74.5	89.1%	5.53	4.47	2.51E-06

ELAPSED TIME vs. HYDRAULIC CONDUCTIVITY



In[redacted]alidation: ALO	Reviewed By: SVG	Date Tested: 9/28/2015

N[redacted] average Hydraulic Conductivity is calculated using the average of the last 4 determinations where all requisite flow and Hydraulic Conductivity conditions are achieved!

Prerequisits: Inflow / Outflow Ratio = 1 by definition of test procedure. Final Hydraulic Conductivity = +-25% of average Hydraulic Conductivity when k > 1E-8 cm/sec and +-50% when k < 1E-8 cm/sec.

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER

ASTM D5084-00 Method F; Mercury U-Tube Permometer - Inflow Volume = Outflow Volume

Cli[redacted]	Civil & Environmental Consultants, Inc.	Boring	RSB-4
C[redacted]roject	153-121.0002 Closure Construction Central Waste	Depth	09/17/15
[redacted]No.	36291	Sample	Shelby Tube
Visual Description	Brown Clay	Lab Sample No.	36291004
Sample Condition	Undisturbed		

SAMPLE CONDITIONS

Sample Status	Initial	Final
Tare Number	W100	z
Wt. Tare & WS, gm	267.3	738.13
Wt. Tare & DS, gm	237.53	626.24
Wt. Tare, gm	8.39	8.33
Moisture Content, %	13.0%	18.1%
Wt. Tube & WS., gm	942.7	NA
Wt. Of Tube, gm	227.64	NA
Wt. Of WS., gm	715.0	747.4
Length 1, in	3.256	3.27
Length 2, in	3.269	3.245
Length 3, in	3.274	3.299
Top Diameter, in	2.846	2.869
Middle Diameter, in	2.849	2.871
Bottom Diameter, in	2.856	2.81
Average Length, L, cm	8.30	8.31
Average Area, A, cm^2	41.17	41.16
Sample Volume, cc	341.5	342.0
Unit Wet Wt., gm/cc	2.09	2.19
Unit Wet Wt., pcf	130.6	136.4
Unit Dry Wt., pcf	115.6	115.5
Unit Dry Wt., gm/cc	1.85	1.85
Sp[redacted] Gravity, Assumed	2.7	2.7
V[redacted]tio, e	0.457	0.459
[redacted], n	0.314	0.315
Pore Volume, cc	107.17	107.61
Saturation, %	76.7%	

TEST CONSTANTS & EQUATIONS

Pipette Area, a_p - cm^2	0.031416
Annulus Area, a_a, cm^2	0.76712
Manometer Constant, $M_1 = a_a a_p/(a_a+a_p)$, cm^2	0.03018
Manometer Constant, $M_2 = 1 + a_p/a_a$	1.0410
Sample Constant, $S = L/A$, cm^{-1}	0.202
Specific Gravity, $\delta = \delta_{hg} - \delta_w$, gm/cc	12.562
Test Constant, $C = M_1 S/\delta$	4.85E-04
Mercury Level at Equilibrium, R_{eq}, cm	3.1
Mercury Level of Pipette at t=0, R_{p0}, cm	12
Initial Head Difference, $z_1 = (R_{p0}-R_{eq})M_2$, cm	9.26
Trial Constant, $T = M_2 / z_1$, cm	0.1124
Temperature Correction for 20°C, R_t	0.960

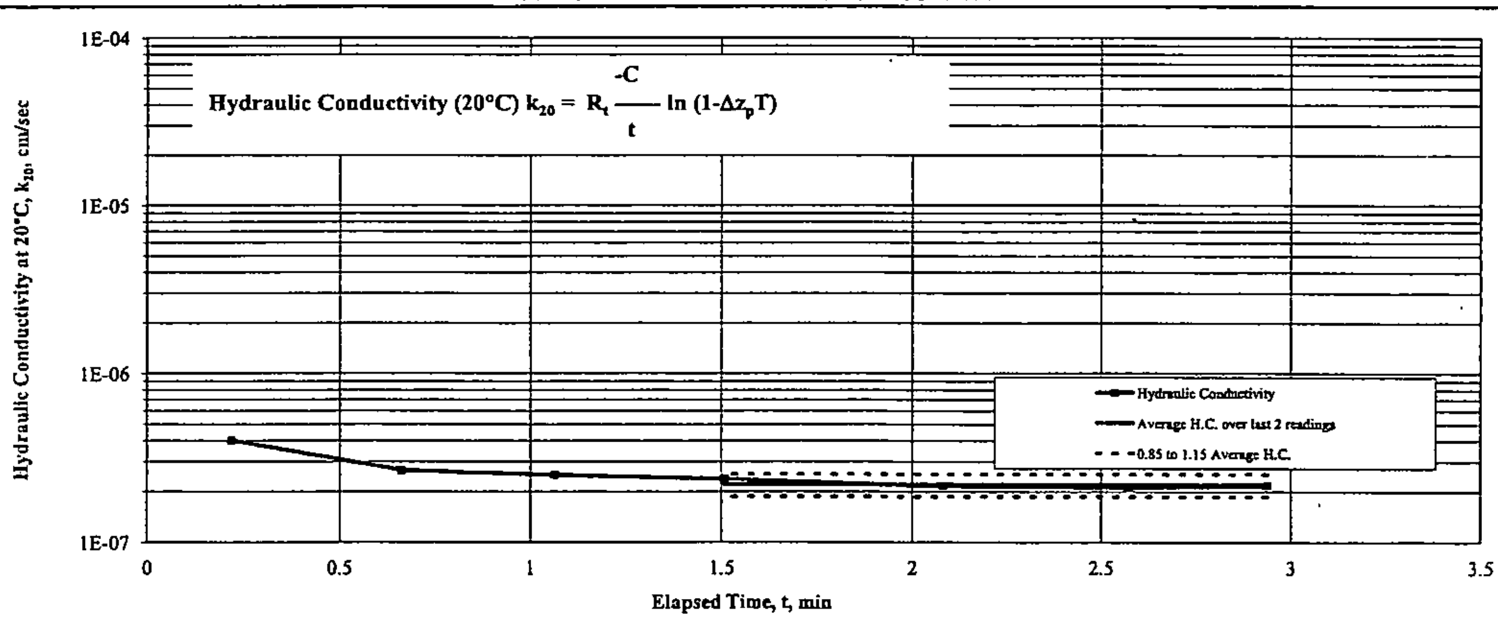
SAMPLE SUMMARY

Avg. Hydraulic Conductivity, k_{20}, cm/sec	2.2E-07
Initial Water Content, %	13.0%
Initial Dry Density, pcf	115.6
% Compaction	NA
Sample Status	Undisturbed
B Parameter	95
Permeant	Deaired Water
Cell Pressure, psi	100
Back Pressure, psi	95
Avg.(Mid-Height) Confining Stress, psi	5
Maximum Gradient	14.0
Average Test Temperature, °C	21.7

TEST DATA

t_t Elapsed Time *min*	R_{pt} Mercury Height *cm*	Δz_p $R_{p0}-R_{pt}$ *cm*	i Gradient *cm / cm*	H_t Head *cm*	ΔH_t Percent of Initial Head from t=0 *%*	σ'_{max} Effective Stress Max *psi*	σ'_{min} Effective Stress Min *psi*	k_{20} Hydraulic Conductivity *cm/sec*
0.00	12	0	14.0	116.4	100.0%	5.83	4.17	NA
0.22	11.9	0.1	13.8	115.1	98.9%	5.82	4.18	4.01E-07
0.66	11.8	0.2	13.7	113.8	97.8%	5.81	4.19	2.66E-07
1.06	11.7	0.3	13.5	112.5	96.6%	5.80	4.20	2.51E-07
1.51	11.6	0.4	13.4	111.2	95.5%	5.79	4.21	2.37E-07
2.08	11.5	0.5	13.2	109.8	94.4%	5.78	4.22	2.16E-07
2.57	11.4	0.6	13.1	108.5	93.3%	5.77	4.23	2.11E-07
2.94	11.3	0.7	12.9	107.2	92.1%	5.76	4.24	2.16E-07

ELAPSED TIME vs. HYDRAULIC CONDUCTIVITY



In[redacted]lidation: ALO   Reviewed By: SVG   Date Tested: 9/22/2015

N[redacted] average Hydraulic Conductivity is calculated using the average of the last 4 determinations where all requisite flow and Hydraulic Conductivity conditions are achieved!

Prerequisits: Inflow / Outflow Ratio = 1 by definition of test procedure. Final Hydraulic Conductivity = +-25% of average Hydraulic Conductivity when k > 1E-8 cm/sec and +-50% when k < 1E-8 cm/sec.

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER

ASTM D5084-00 Method F; Mercury U-Tube Permometer - Inflow Volume = Outflow Volume

Cli[redacted]	Civil & Environmental Consultants, Inc.	Boring	RSB-5
C[redacted]roject	153-121.0002 Closure Construction Central Waste	Depth	09/17/15
[redacted]No.	36291	Sample	Shelby Tube
Vi[redacted] Description	Brownish Gray Clay	Lab Sample No.	36291005
Sample Condition	Undisturbed		

SAMPLE CONDITIONS		
Sample Status	Initial	Final
Tare Number	w66	120
Wt. Tare & WS, gm	41.73	900.14
Wt. Tare & DS, gm	37.2	789.62
Wt. Tare, gm	8.3	83.31
Moisture Content, %	15.7%	15.6%
Wt. Tube & WS., gm	816.2	NA
Wt. Of Tube, gm	0	NA
Wt. Of WS., gm	816.2	816.0
Length 1, in	3.55	3.52
Length 2, in	3.62	3.491
Length 3, in	3.562	3.496
Top Diameter, in	2.834	2.873
Middle Diameter, in	2.835	2.845
Bottom Diameter, in	2.839	2.841
Average Length, L, cm	9.09	8.90
Average Area, A, cm^2	40.75	41.24
Sample Volume, cc	370.3	366.9
Unit Wet Wt., gm/cc	2.20	2.22
Unit Wet Wt., pcf	137.5	138.8
Unit Dry Wt., pcf	118.9	120.0
Unit Dry Wt., gm/cc	1.91	1.92
Sp[redacted] Gravity, Assumed	2.7	2.7
V[redacted]atio, e	0.417	0.404
P[redacted] n	0.294	0.288
Pore [redacted]olume, cc	108.97	105.57
Saturation, %	101.5%	

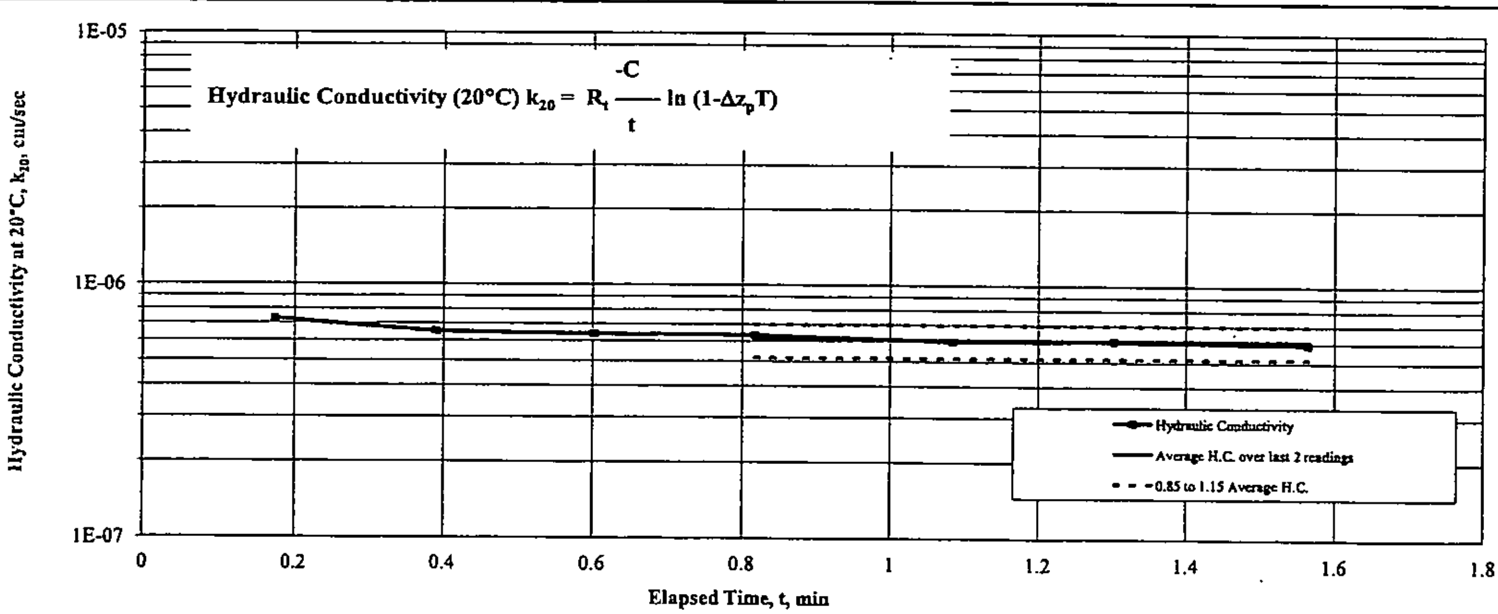
TEST CONSTANTS & EQUATIONS	
Pipette Area, a_o - cm^2	0.031416
Annulus Area, a_a, cm^2	0.76712
Manometer Constant, $M_1 = a_a a_o/(a_a+a_o)$, cm^2	0.03018
Manometer Constant, $M_2 = 1 + a_p/a_a$	1.0410
Sample Constant, $S = L/A$, cm^{-1}	0.216
Specific Gravity, $\delta = \delta_{hg} - \delta_w$, gm/cc	12.562
Test Constant, $C = M_1 S/\delta$	5.18E-04
Mercury Level at Equilibrium, R_{eq}, cm	3.1
Mercury Level of Pipette at t=0, R_{p0}, cm	9.7
Initial Head Difference, $z_1 = (R_{p0}-R_{eq})M_2$, cm	6.87
Trial Constant, $T = M_2 / z_1$, cm	0.1515
Temperature Correction for 20°C, R_t	0.958

SAMPLE SUMMARY	
Avg. Hydraulic Conductivity, k_{20}, cm/sec	6.1E-07
Initial Water Content, %	15.7%
Initial Dry Density, pcf	118.9
% Compaction	NA
Sample Status	Undisturbed
B Parameter	95
Permeant	Deaired Water
Cell Pressure, psi	110
Back Pressure, psi	100
Avg.(Mid-Height) Confining Stress, psi	10
Maximum Gradient	9.7
Average Test Temperature, °C	21.8

TEST DATA

t_t Elapsed Time min	R_{pt} Mercury Height cm	Δz_p $R_{p0}-R_{pt}$ cm	i Gradient cm / cm	H_t Head cm	ΔH_t Percent of Initial Head from t=0 %	σ'_{max} Effective Stress Max psi	σ'_{min} Effective Stress Min psi	k_{20} Hydraulic Conductivity cm/sec
0.00	9.7	0	9.7	86.3	100.0%	10.61	9.39	NA
0.17	9.6	0.1	9.6	85.0	98.5%	10.60	9.40	7.29E-07
0.39	9.5	0.2	9.4	83.7	97.0%	10.60	9.40	6.52E-07
0.60	9.4	0.3	9.3	82.4	95.5%	10.59	9.41	6.39E-07
0.82	9.3	0.4	9.1	81.1	93.9%	10.58	9.42	6.33E-07
1.08	9.2	0.5	9.0	79.8	92.4%	10.57	9.43	6.02E-07
1.30	9.1	0.6	8.8	78.5	90.9%	10.56	9.44	6.06E-07
1.56	9	0.7	8.7	77.2	89.4%	10.55	9.45	5.93E-07

ELAPSED TIME vs. HYDRAULIC CONDUCTIVITY



In[redacted]lidation: ALO Reviewed By: SVG Date Tested: 9/28/2015

N[redacted]verage Hydraulic Conductivity is calculated using the average of the last 4 determinations where all requisite flow and Hydraulic Conductivity conditions are achieved!

Prerequisits: Inflow / Outflow Ratio = 1 by definition of test procedure. Final Hydraulic Conductivity = +-25% of average Hydraulic Conductivity when k > 1E-8 cm/sec and +-50% when k < 1E-8 cm/sec.

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER

ASTM D5084-00 Method F; Mercury U-Tube Permometer - Inflow Volume = Outflow Volume

Client	Civil & Environmental Consultants, Inc.	Boring	RSB-6
Client Project	153-121.0002 Closure Construction Central Waste	Depth	09/17/15
[illegible] No.	36291	Sample	Shelby Tube
Visual Description	Brown Clay	Lab Sample No.	36291006
Sample Condition	Undisturbed		

SAMPLE CONDITIONS		
Sample Status	Initial	Final
Tare Number	w100	w66
Wt. Tare & WS, gm	71.56	777.39
Wt. Tare & DS, gm	63.12	674.72
Wt. Tare, gm	8.39	8.28
Moisture Content, %	15.4%	15.4%
Wt. Tube & WS., gm	766.4	NA
Wt. Of Tube, gm	0	NA
Wt. Of WS., gm	766.4	766.3
Length 1, in	3.473	3.381
Length 2, in	3.45	3.389
Length 3, in	3.433	3.382
Top Diameter, in	2.83	2.845
Middle Diameter, in	2.825	2.826
Bottom Diameter, in	2.821	2.838
Average Length, L, cm	8.77	8.60
Average Area, A, cm^2	40.45	40.76
Sample Volume, cc	354.7	350.4
Unit Wet Wt., gm/cc	2.16	2.19
Unit Wet Wt., pcf	134.8	136.5
Unit Dry Wt., pcf	116.8	118.2
Unit Dry Wt., gm/cc	1.87	1.90
Specific Gravity, Assumed	2.7	2.7
Void Ratio, e	0.442	0.425
Porosity, n	0.307	0.298
Pore Volume, cc	108.74	104.46
Saturation, %	94.2%	

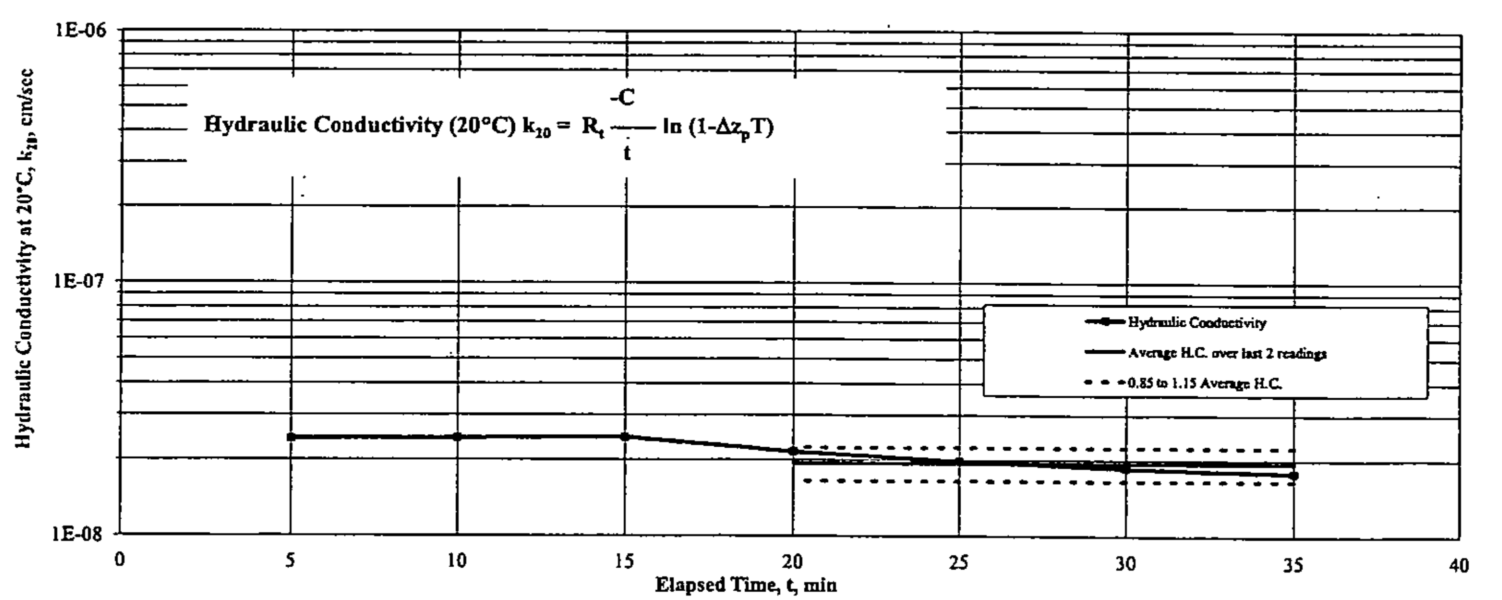
TEST CONSTANTS & EQUATIONS	
Pipette Area, a_o - cm^2	0.031416
Annulus Area, a_a, cm^2	0.76712
Manometer Constant, $M_1 = a_a a_n/(a_a+a_n)$, cm^2	0.03018
Manometer Constant, $M_2 = 1 + a_p/a_a$	1.0410
Sample Constant, S = L/A, cm^{-1}	0.211
Specific Gravity, $\delta = \delta_{hg} - \delta_w$, gm/cc	12.562
Test Constant, $C = M_1 S/\delta$	5.07E-04
Mercury Level at Equilibrium, R_{eq}, cm	3.1
Mercury Level of Pipette at t=0, R_{p0}, cm	9.9
Initial Head Difference, $z_1 = (R_{p0}-R_{eq})M_2$, cm	7.08
Trial Constant, $T = M_2 / z_1$, cm	0.1471
Temperature Correction for 20°C, R_t	0.965

SAMPLE SUMMARY	
Avg. Hydraulic Conductivity, k_{20}, cm/sec	1.9E-08
Initial Water Content, %	15.4%
Initial Dry Density, pcf	116.8
% Compaction	NA
Sample Status	Undisturbed
B Parameter	95
Permeant	Deaired Water
Cell Pressure, psi	110
Back Pressure, psi	105
Avg.(Mid-Height) Confining Stress, psi	5
Maximum Gradient	10.3
Average Test Temperature, °C	21.5

TEST DATA

t_t Elapsed Time	R_{pt} Mercury Height	Δz_p $R_{p0}-R_{pt}$	i Gradient	H_t Head	ΔH_t Percent of Initial Head from t=0	σ'_{max} Effective Stress Max	σ'_{min} Effective Stress Min	k_{20} Hydraulic Conductivity
min	*cm*	*cm*	*cm / cm*	*cm*	*%*	*psi*	*psi*	*cm/sec*
0.00	9.9	0	10.3	88.9	100.0%	5.63	4.37	NA
5.00	9.8	0.1	10.2	87.6	98.5%	5.62	4.38	2.41E-08
10.00	9.7	0.2	10.0	86.3	97.1%	5.61	4.39	2.43E-08
15.00	9.6	0.3	9.9	85.0	95.6%	5.60	4.40	2.45E-08
20.00	9.55	0.35	9.8	84.3	94.9%	5.60	4.40	2.15E-08
25.00	9.5	0.4	9.7	83.7	94.1%	5.60	4.40	1.97E-08
30.00	9.45	0.45	9.7	83.0	93.4%	5.59	4.41	1.86E-08
35.00	9.4	0.5	9.6	82.4	92.6%	5.59	4.41	1.78E-08

ELAPSED TIME vs. HYDRAULIC CONDUCTIVITY



Initial Validation: ALO | Reviewed By: SVG | Date Tested: 9/28/2015

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Prerequisits: Inflow / Outflow Ratio = 1 by definition of test procedure. Final Hydraulic Conductivity = +-25% of average Hydraulic Conductivity when k > 1E-8 cm/sec and +-50% when k < 1E-8 cm/sec.

SOLID WASTE
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OHIO ENVIRONMENTAL PROTECTION AGENCY

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